SECTION I: 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 Carbonyl 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 μ_i to 35 μ_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 μ_i to 90 μ_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.

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

N = number of turns   L = inductance (μh) A_L = inductance index (μh)/100 turns)

Please see section IV on "Toroid Mounts & E-Core Bobbins" for information on mounting toroids to PC Boards. Amidon also provides complete wound and mounted cores.

- **For standard wound toroid, please see section V.**
- **For custom inductors based on your specifications, please call or fax today. You will be assured of prompt response with quotations in less than 72 hours.**
- **Amidon provides low cost manual and automated coil windings. Please call for more information.**

IRON POWDER MATERIAL

MATERIAL #0 (μ=1):
Most commonly used for frequencies above 100 MHz. Available in toroidal form only. Note: Due to the nature of this material the inductance resulting from the use of the given AL value may not be as accurate as we would like. Inductance vs. number of turns will vary greatly depending upon the winding technique.

MATERIAL #1 (μ=20):
A Carbonyl 'C' material, very similar to material #3 except that it has higher volume resistivity and better stability. Available in toroidal form and shielded coil form.

MATERIAL #2 (μ=10):
A Carbonyl 'E' iron powder material having high volume resistivity. Offers high 'Q' for the 2 MHz to 30 MHz. frequency range. Available in toroidal form and shielded coil form.

MATERIAL #3 (μ=35):
A carbonyl 'HP' material having excellent stability and good 'Q' for the lower frequencies from 50 KHz. to 500 KHz. Available in toroidal form and shielded coil form.

MATERIAL #6 (μ=8):
A carbonyl 'SF' material. Offers very good 'Q' and temperature stability for the 20 MHz to 50 MHz frequency range. Available in both toroidal form and shielded coil form.

MATERIAL #7 (μ=9):
A carbonyl 'TH' material. Very similar to the #2 and #6 materials but offers better temperature stability than either. Available in both toroidal form and shielded coil form. Frequency ranges from 5 MHz to 35 MHz.

MATERIAL #10 (μ=6):
A powdered iron 'W' material. Offers good 'Q' and high stability for frequencies from 40 MHz to 100 MHz. Available in toroidal form and shielded coil form.

MATERIAL #12 (μ=4):
A synthetic oxide material which provides good 'Q' and moderate stability for frequencies from 50 MHz to 200 MHz. If high 'Q' is of prime importance this material is a good choice. If stability is of a prime importance, consider the #17 material. The #12 material is available in all sizes up to T-94, in toroidal form. Not available in shielded coil form.

MATERIAL #15 (μ=25):
A carbonyl 'GS6' material. Has excellent stability and good 'Q'. A good choice for commercial broadcast frequencies where good 'Q' and stability are essential. Available in toroidal form only.

MATERIAL #17 (μ=4):
This is a new carbonyl material which is very similar to the #12 material except that it has better temperature stability. However, as compared to the #12 material, there is a slight 'Q' loss of about 10 % from 50 MHz to 100 MHz. Above 100 MHz, the 'Q' will gradually deteriorate to approximately 20% lower. It is available in both toroidal form and the shielded coil form.

MATERIAL #26 (μ=75):
A Hydrogen Reduced material. Has highest permeability of all of the iron powder materials. Used for EMI filters and DC chokes. The #26 is very similar to the older #41 material but can provide an extended frequency range.

IRON POWDER TOROIDAL CORES (For Resonant Circuits)

MATERIAL 0 — Permeabilty 1 — Freq. Range 100 MHz - 300 MHz — Color - Tan

Core number	O.D. (inches)	I.D. (inches)	Hgt. (inches)	ℓ_e (cm)	A_e (cm)^2	V_e (cm)^3	A_L Value μh/100 turns
T-12-0	.125	.062	.050	.74	.010	.007	3.0
T-16-0	.160	.078	.060	.95	.016	.015	3.0
T-20-0	.200	.088	.070	1.15	.025	.029	3.5
T-25-0	.255	.120	.096	1.50	.042	.063	4.5
T-30-0	.307	.151	.128	1.83	.065	.119	6.0
T-37-0	.375	.205	.128	2.32	.070	.162	4.9
T-44-0	.440	.229	.159	2.67	.107	.286	6.5
T-50-0	.500	.303	.190	3.03	.121	.367	6.4
T-68-0	.690	.370	.190	4.24	.196	.831	7.5
T-80-0	.795	.495	.250	5.15	.242	1.246	8.5
T-94-0	.942	.560	.312	6.00	.385	2.310	10.6
T-106-0	1.060	.570	.437	6.50	.690	4.485	19.0
T-130-0	1.300	.780	.437	8.29	.730	6.052	15.0

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 — Permeabilty 20 — Freq. Range 0.5 MHz - 5 MHz — Color - Blue

Core number	O.D. (inches)	I.D. (inches)	Hgt. (inches)	ℓ_e (cm)	A_e (cm)^2	V_e (cm)^3	A_L Value μh/100 turns
T-12-1	.125	.062	.050	.74	.010	.007	48
T-16-1	.160	.078	.060	.95	.016	.015	44
T-20-1	.200	.088	.070	1.15	.025	.029	52
T-25-1	.255	.120	.096	1.50	.042	.063	70
T-30-1	.307	.151	.128	1.83	.065	.119	85
T-37-1	.375	.205	.128	2.32	.070	.162	80
T-44-1	.440	.229	.159	2.67	.107	.286	105
T-50-1	.500	.303	.190	3.03	.121	.367	100
T-68-1	.690	.370	.190	4.24	.196	.831	115
T-80-1	.795	.495	.250	5.15	.242	1.246	115
T-94-1	.942	.560	.312	6.00	.385	2.310	160
T-106-1	1.060	.570	.437	6.50	.690	4.485	325
T-130-1	1.300	.780	.437	8.29	.730	6.052	200
T-157-1	1.570	.950	.570	10.05	1.140	11.457	320
T-184-1	1.840	.950	.710	11.12	2.040	22.685	500
T-200-1	2.000	1.250	.550	12.97	1.330	17.250	250

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

IRON POWDER TOROIDAL CORES (For Resonant Circuits)

MATERIAL 2		Permeabilty 10		Freq. Range 2 MHz - 30 MHz		Color - Red	
Core number	O.D. (inches)	I.D. (inches)	Hgt. (inches)	ℓ_e (cm)	A_e (cm)^2	V_e (cm)^3	A_L Value μh/100 turns
T-12-2	.125	.062	.050	.74	.010	.007	20
T-16-2	.160	.078	.060	.95	.016	.015	22
T-20-2	.200	.088	.070	1.15	.025	.029	25
T-25-2	.255	.120	.096	1.50	.042	.063	34
T-30-2	.307	.151	.128	1.83	.065	.119	43
T-37-2	.375	.205	.128	2.32	.070	.162	40
T-44-2	.440	.229	.159	2.67	.107	.286	52
T-50-2	.500	.303	.190	3.03	.121	.367	49
T-68-2	.690	.370	.190	4.24	.196	.831	57
T-80-2	.795	.495	.250	5.15	.242	1.246	55
T-94-2	.942	.560	.312	6.00	.385	2.310	84
T-106-2	1.060	.570	.437	6.50	.690	4.485	135
T-130-2	1.300	.780	.437	8.29	.730	6.052	110
T-157-2	1.570	.950	.570	10.05	1.140	11.457	140
T-184-2	1.840	.950	.710	11.12	2.040	22.685	240
T-200-2	2.000	1.250	.550	12.97	1.330	17.250	120
T-200A-2	2.000	1.250	1.000	12.97	2.240	29.050	218
T-225 -2	2.250	1.405	.550	14.56	1.508	21.956	120
T-225A-2	2.250	1.485	1.000	14.56	2.730	39.749	215
T-300 -2	3.058	1.925	.500	19.83	1.810	35.892	114
T-300A-2	3.048	1.925	1.000	19.83	3.580	70.991	228
T-400 -2	4.000	2.250	.650	24.93	3.660	91.244	180
T-400A-2	4.000	2.250	1.300	24.93	7.432	185.280	360
T-520 -2	5.200	3.080	.800	33.16	5.460	181.000	207

MATERIAL 3		Permeabilty 35		Freq. Range 0.05 MHz - 0.5 MHz		Color - Gray	
Core number	O.D. (inches)	I.D. (inches)	Hgt. (inches)	ℓ_e (cm)	A_e (cm)^2	V_e (cm)^3	A_L Value μh/100 turns
T-12-3	.125	.062	.050	.74	.010	.007	60
T-16-3	.160	.078	.060	.95	.016	.015	61
T-20-3	.200	.088	.070	1.15	.025	.029	76
T-25-3	.255	.120	.096	1.50	.042	.063	100
T-30-3	.307	.151	.128	1.83	.065	.119	140
T-37-3	.375	.205	.128	2.32	.070	.162	120
T-44-3	.440	.229	.159	2.67	.107	.286	180
T-50-3	.500	.303	.190	3.03	.121	.367	175
T-68-3	.690	.370	.190	4.24	.196	.831	195
T-80-3	.795	.495	.250	5.15	.242	1.246	180
T-94-3	.942	.560	.312	6.00	.385	2.310	248
T-106-3	1.060	.570	.437	6.50	.690	4.485	450
T-130-3	1.300	.780	.437	8.29	.730	6.052	350
T-157-3	1.570	.950	.570	10.05	1.140	11.457	420
T-184-3	1.840	.950	.710	11.12	2.040	22.685	720
T-200-3	2.000	1.250	.550	12.97	1.330	17.250	425
T-200A-3	2.000	1.250	1.000	12.97	2.240	29.050	460
T-225 -3	2.250	1.405	.550	14.56	1.508	21.956	425

Orders placed are shipped same day from stock.

IRON POWDER TOROIDAL CORES (For Resonant Circuits)

MATERIAL 6		Permeabilty 8		Freq. Range 10 MHz - 50 MHz		Color - Yellow	
Core number	O.D. (inches)	I.D. (inches)	Hgt. (inches)	ℓ_e (cm)	A_e $(cm)^2$	V_e $(cm)^3$	A_L Value μh/100 turns
T-12-6	.125	.062	.050	.74	.010	.007	17
T-16-6	.160	.078	.060	.95	.016	.015	19
T-20-6	.200	.088	.070	1.15	.025	.029	22
T-25-6	.255	.120	.096	1.50	.042	.063	27
T-30-6	.307	.151	.128	1.83	.065	.119	36
T-37-6	.375	.205	.128	2.32	.070	.162	30
T-44-6	.440	.229	.159	2.67	.107	.286	42
T-50-6	.500	.303	.190	3.03	.121	.367	46
T-68-6	.690	.370	.190	4.24	.196	.831	47
T-80-6	.795	.495	.250	5.15	.242	1.246	45
T-94-6	.942	.560	.312	6.00	.385	2.310	70
T-106-6	1.060	.570	.437	6.50	.690	4.485	116
T-130-6	1.300	.780	.437	8.29	.730	6.052	96
T-157-6	1.570	.950	.570	10.05	1.140	11.457	115
T-184-6	1.840	.950	.710	11.12	2.040	22.685	195
T-200-6	2.000	1.250	.550	12.97	1.330	17.250	100
T-200A-6	2.000	1.250	1.000	12.97	2.240	29.050	180
T-225 -6	2.250	1.405	.550	14.56	1.508	21.956	100

MATERIAL 7		Permeabilty 9		Freq. Range 3 MHz - 35 MHz		Color - White	
Core number	O.D. (inches)	I.D. (inches)	Hgt. (inches)	ℓ_e (cm)	A_e $(cm)^2$	V_e $(cm)^3$	A_L Value μh/100 turns
T-25-7	.255	.120	.096	1.50	.042	.063	29
T-37-7	.375	.205	.128	2.32	.070	.162	32
T-50-7	.500	.303	.190	3.03	.121	.367	43
T-68-7	.690	.370	.190	4.24	.196	.831	52

MATERIAL 10		Permeabilty 6		Freq. Range 30 MHz - 100 MHz		Color - Black	
Core number	O.D. (inches)	I.D. (inches)	Hgt. (inches)	ℓ_e (cm)	A_e $(cm)^2$	V_e $(cm)^3$	A_L Value μh/100 turns
T-12-10	.125	.062	.050	.74	.010	.007	12
T-16-10	.160	.078	.060	.95	.016	.015	13
T-20-10	.200	.088	.070	1.15	.025	.029	16
T-25-10	.255	.120	.096	1.50	.042	.063	19
T-30-10	.307	.151	.128	1.83	.065	.119	25
T-37-10	.375	.205	.128	2.32	.070	.162	25
T-44-10	.440	.229	.159	2.67	.107	.286	33
T-50-10	.500	.303	.190	3.03	.121	.367	31
T-68-10	.690	.370	.190	4.24	.196	.831	32
T-80-10	.795	.495	.250	5.15	.242	1.246	32
T-94-10	.942	.560	.312	6.00	.385	2.310	58

All items listed in this CATALOG can usually be shipped immediately from stock.

IRON POWDER TOROIDAL CORES (For Resonant Circuits)

MATERIAL 12		Permeabilty 4		Freq. Range 50 MHz - 200 MHz		Color - Green & White	
Core number	O.D. (inches)	I.D. (inches)	Hgt. (inches)	ℓ_e (cm)	A_e $(cm)^2$	V_e $(cm)^3$	A_L Value µh/100 turns
T-12-12	.125	.062	.050	.74	.010	.007	7.5
T-16-12	.160	.078	.060	.95	.016	.015	8.0
T-20-12	.200	.088	.070	1.15	.025	.029	10.0
T-25-12	.255	.120	.096	1.50	.042	.063	12.0
T-30-12	.307	.151	.128	1.83	.065	.119	16.0
T-37-12	.375	.205	.128	2.32	.070	.162	15.0
T-44-12	.440	.229	.159	2.67	.107	.286	18.5
T-50-12	.500	.303	.190	3.03	.121	.367	18.0
T-68-12	.690	.370	.190	4.24	.196	.831	21.0
T-80-12	.795	.495	.250	5.15	.242	1.246	22.0
T-94-12	.942	.560	.312	6.00	.385	2.310	32.0

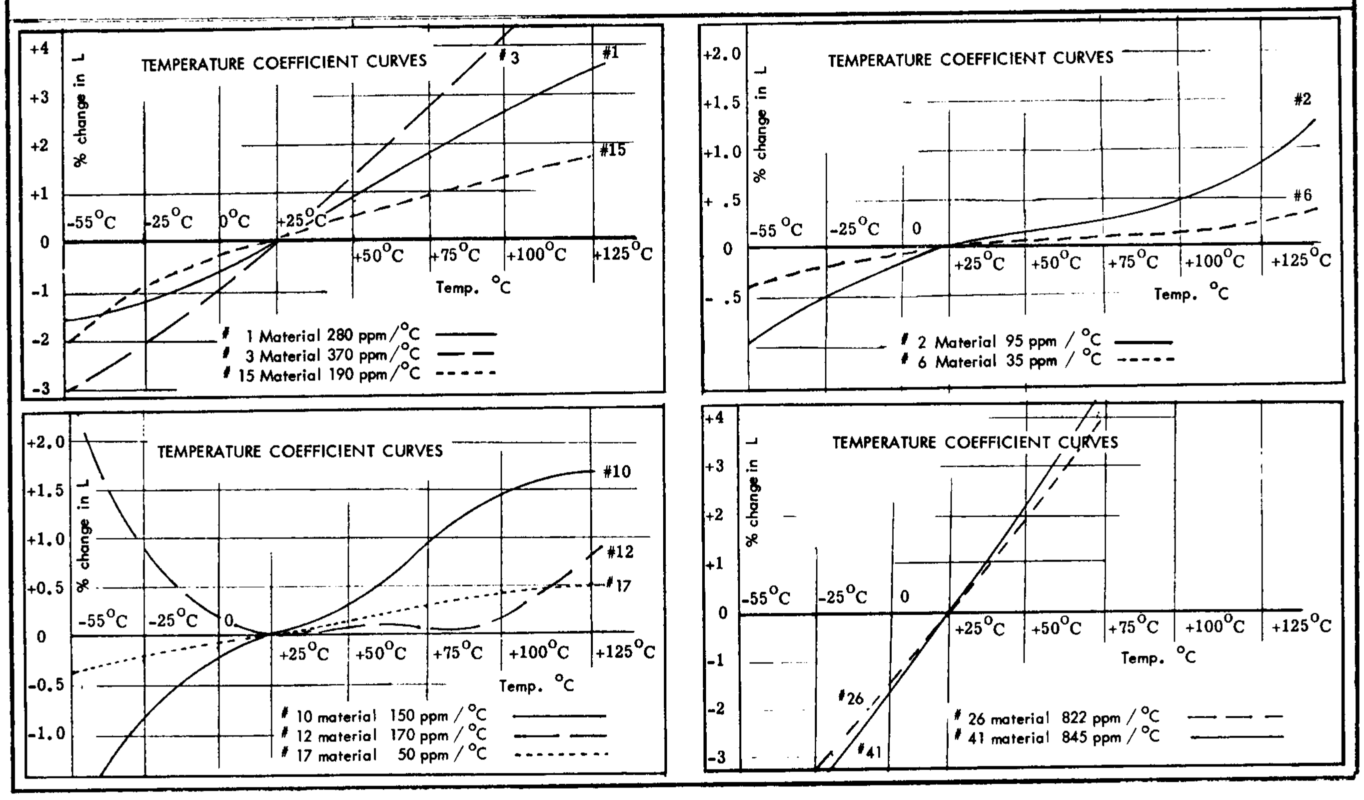
Note: The #17 material offers greater temperature stability than #12 materials, but #12 material can provide higher 'Q'.

MATERIAL 15		Permeabilty 25		Freq. Range 0.1 MHz - 2. MHz		Color - Red & White	
Core number	O.D. (inches)	I.D. (inches)	Hgt. (inches)	ℓ_e (cm)	A_e $(cm)^2$	V_e $(cm)^3$	A_L Value µh/100 turns
T-12-15	.125	.062	.050	.74	.010	.007	50
T-16-15	.160	.078	.060	.95	.016	.015	55
T-20-15	.200	.088	.070	1.15	.025	.029	65
T-25-15	.255	.120	.096	1.50	.042	.063	85
T-30-15	.307	.151	.128	1.83	.065	.119	93
T-37-15	.375	.205	.128	2.32	.070	.162	90
T-44-15	.440	.229	.159	2.67	.107	.286	160
T-50-15	.500	.303	.190	3.03	.121	.367	135
T-68-15	.690	.370	.190	4.24	.196	.831	180
T-80-15	.795	.495	.250	5.15	.242	1.246	170
T-94-15	.942	.560	.312	6.00	.385	2.310	200
T-106-15	1.060	.570	.437	6.50	.690	4.485	345
T-130-15	1.300	.780	.437	8.29	.730	6.052	250
T-157-15	1.570	.950	.570	10.05	1.140	11.457	360

MATERIAL 17		Permeabilty 4		Freq. Range 20 MHz - 200 MHz		Color - Blue & Yellow	
Core number	O.D. (inches)	I.D. (inches)	Hgt. (inches)	ℓ_e (cm)	A_e $(cm)^2$	V_e $(cm)^3$	A_L Value µh/100 turns
T-12-17	.125	.062	.050	.75	.010	.008	7.5
T-16-17	.160	.078	.060	.95	.016	.014	8.0
T-20-17	.200	.088	.070	1.15	.025	.026	10.0
T-25-17	.255	.120	.096	1.50	.042	.055	12.0
T-30-17	.307	.151	.128	1.83	.065	.110	16.0
T-37-17	.375	.205	.128	2.30	.070	.147	15.0
T-44-17	.440	.229	.159	2.67	.107	.266	18.5
T-50-17	.500	.303	.190	3.03	.121	.358	18.0
T-68-17	.690	.370	.190	4.24	.196	.759	21.0
T-80-17	.795	.495	.250	5.14	.231	1.190	32.0
T-90-17	.942	.560	.312	6.00	.385	2.310	32.0

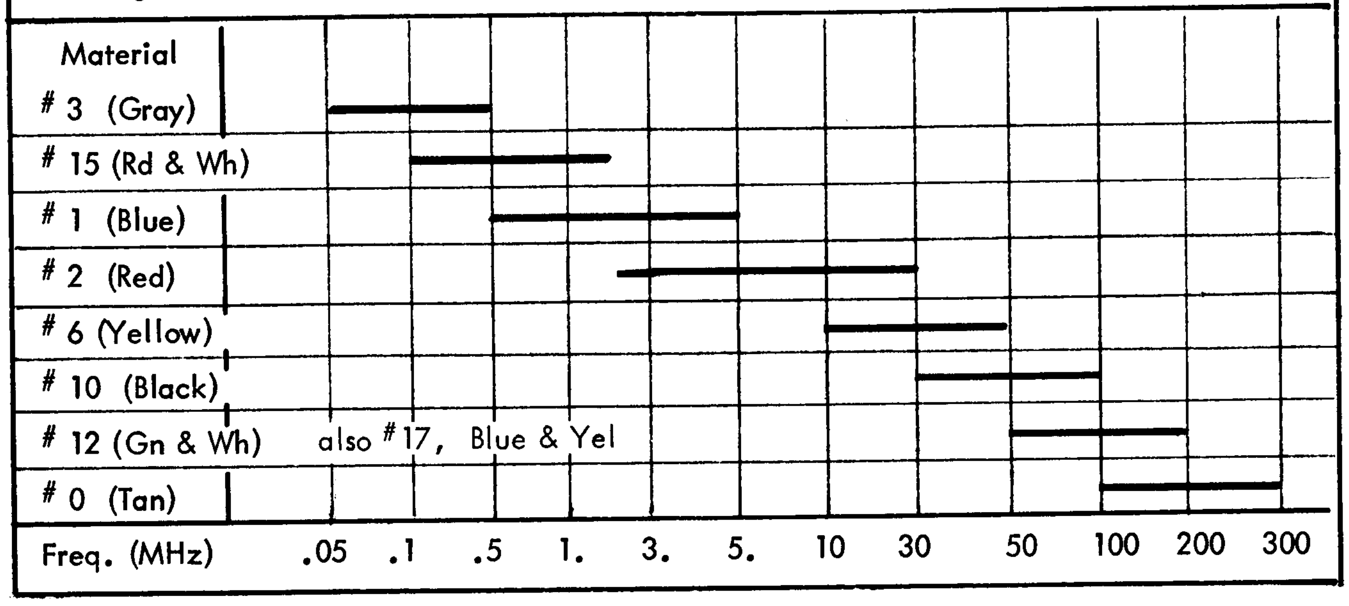
MATERIAL 26 See AC Line Filter and DC Choke section.

TEMPERATURE COEFFICIENT CHARTS



IRON - POWDER MATERIAL vs. FREQUENCY RANGE

Higher Q will be obtained in the upper portion of a materials frequency range when smaller cores are used. Likewise, in the lower portion of a materials frequency range, higher Q can be achieved when using the larger cores.



IRON POWDER TOROIDAL CORES

Physical Dimension											
Core	OD (in)	ID (in)	HGT (in)	Mean lgth. (cm)	Cross sect. (cm^2)	Core	OD (in)	ID (in)	HGT (in)	Mean lgth. (cm)	Cross sect. (cm^2)
T- 12	.125	.062	.050	.75	.010	T-130	1.30	.78	.437	8.29	.73
T- 16	.160	.078	.060	.95	.016	T-157	1.57	.95	.570	10.05	1.14
T- 20	.200	.088	.070	1.15	.025	T-184	1.84	.95	.710	11.12	2.04
T- 25	.250	.120	.096	1.50	.042	T-200	2.00	1.25	.550	12.97	1.33
T- 30	.307	.151	.128	1.83	.065	T-200A	2.00	1.25	1.000	12.97	2.42
T- 37	.375	.205	.128	2.32	.070	T-225	2.25	1.40	.550	14.56	1.50
T- 44	.440	.229	.159	2.67	.107	T-225A	2.25	1.40	1.000	14.56	2.73
T- 50	.500	.300	.190	3.20	.121	T-300	3.00	1.92	.500	19.83	1.81
T- 68	.690	.370	.190	4.24	.196	T-300A	3.00	1.92	1.000	19.83	3.58
T- 80	.795	.495	.250	5.15	.242	T-400	4.00	2.25	.650	24.93	3.66
T- 94	.942	.560	.312	6.00	.385	T-400A	4.00	2.25	1.000	24.93	7.43
T-106	1.060	.570	.437	6.50	.690	T-500	5.20	3.08	.800	33.16	5.46

A_L Values (µh/100 turns)

For complete part number, add Mix number to Core Size number.

Core Size	26 Mix Yel-Wh μ=75 Pwr Frq	3 Mix Gray μ=35 .05 -0.5	15 Mix Rd-Wh μ=25 0.1 - 2.	1 Mix Blue μ=20 0.5 - 5.	2 Mix Red μ=10 2 - 30	7 Mix White μ=9 1 - 25	6 Mix Yellow μ=8 10 - 50	10 Mix Black μ=6 30-100	12 Mix Grn-Wh μ=4 50-200	17 Mix Bl/Ylw μ=4 40-180	0 Mix Tan μ=1 100-300
Mhz											
T- 12-	na	60	50	48	20	18	17	12	7.5	7.5	3.0
T- 16-	145	61	55	44	22	na	19	13	8.0	8.0	3.0
T- 20-	180	76	65	52	27	24	22	16	10.0	10.0	3.5
T- 25-	235	100	85	70	34	29	27	19	12.0	12.0	4.5
T- 30-	325	140	93	85	43	37	36	25	16.0	16.0	6.0
T- 37-	275	120	90	80	40	32	30	25	15.0	15.0	4.9
T- 44-	360	180	160	105	52	46	42	33	18.5	18.5	6.5
T- 50-	320	175	135	100	49	43	40	31	18.0	18.0	6.4
T- 68-	420	195	180	115	57	52	47	32	21.0	21.0	7.5
T- 80-	450	180	170	115	55	50	45	32	22.0	22.0	8.5
T- 94-	590	248	200	160	84	na	70	58	32.0	na	10.6
T-106-	900	450	345	325	135	133	116	na	na	na	19.0
T-130-	785	350	250	200	110	103	96	na	na	na	15.0
T-157-	970	420	360	320	140	na	115	na	na	na	na
T-184-	1640	720	na	500	240	na	195	na	na	na	na
T-200-	895	425	na	250	120	105	100	na	na	na	na
T-200A-	1550	760	na	na	218	na	180	na	na	na	na
T-225-	950	424	na	na	120	na	100	na	na	na	na
T-225A-	1600	na	na	na	215	na	na	na	na	na	na
T-300-	800	na	na	na	114	na	na	na	na	na	na
T-300A-	1600	na	na	na	228	na	na	na	na	na	na
T-400-	1300	na	na	na	185	na	na	na	na	na	na
T-400A-	2600	na	na	na	360	na	na	na	na	na	na
T-520-	1460	na	na	na	207	na	na	na	na	na	na

na - not available.

COPPER WIRE TABLE

Wire size AWG	Diameter in inches (enamel)	Circular mil area	Turns per linear inch	Turns per sq.cm	Continuous duty current (amp) single wire, open air	Continuous duty, (amp) conduit or in wire bundles
8	.1285	16510	7.6		73	46.0
10	.1019	10380	10.7	13.8	55	33.0
12	.0808	6530	12.0	21.7	41	23.0
14	.0640	4107	15.0	34.1	32	17.0
16	.0508	2583	18.9	61.2	22	13.0
18	.0403	1624	23.6	79.1	16	10.0
20	.0319	1022	29.4	124.0	11	7.5
22	.0253	642	37.0	186.0	—	5.0
24	.0201	404	46.3	294.0	—	—
26	.0159	254	58.0	465.0	—	—
28	.0126	160	72.7	728.0	—	—
30	.0100	101	90.5	1085.0	—	—
32	.0079	63	113.0	1628.0	—	—
34	.0063	40	141.0	2480.0	—	—
36	.0050	25	175.0	3876.0	—	—
38	.0039	16	224.0	5736.0	—	—
40	.0031	10	382.0	10077.0	—	—

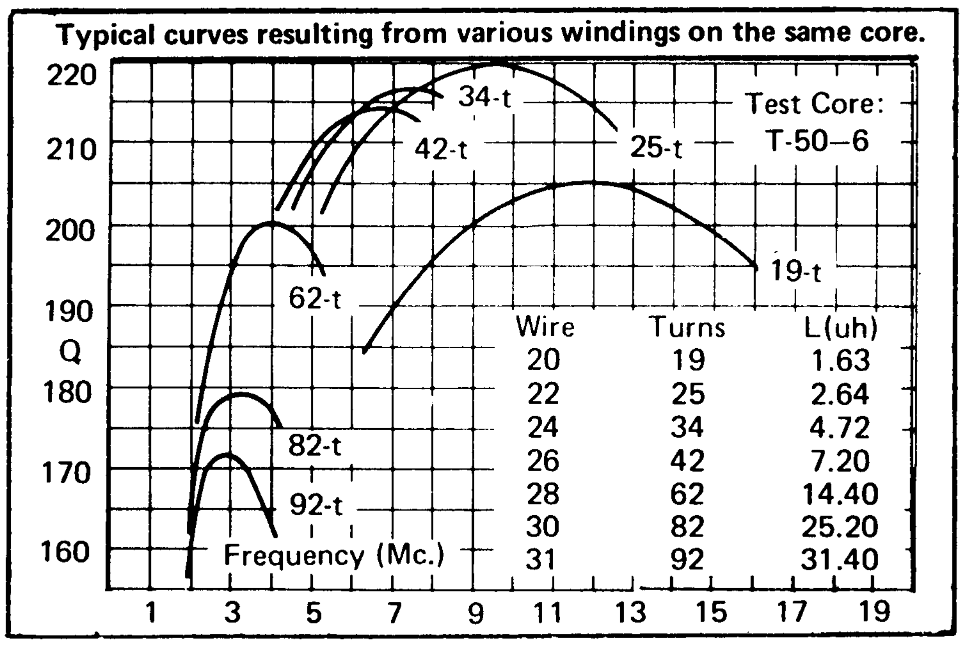
IRON POWDER CORE SIZE vs. TURNS and WIRE SIZE

Approximate number of turns for full single layer winding

Awg wire	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
Core Size																
T-12	0	0	0	1	1	1	2	4	5	8	11	15	21	29	37	47
T-16	0	0	1	1	1	3	3	5	8	11	16	21	29	38	49	63
T-20	0	1	1	1	3	4	5	6	9	14	18	25	33	43	56	72
T-25	1	1	1	3	4	5	7	11	15	21	28	37	48	62	79	101
T-30	1	1	3	4	5	7	11	15	21	28	37	48	62	78	101	129
T-37	1	3	5	7	9	12	17	23	31	41	53	67	87	110	140	177
T-44	3	5	6	7	10	15	20	27	35	46	60	76	97	124	157	199
T-50	5	6	8	11	16	21	28	37	49	63	81	103	131	166	210	265
T-68	7	9	12	15	21	28	36	47	61	79	101	127	162	205	257	325
T-80	8	12	17	23	30	39	51	66	84	108	137	172	219	276	347	438
T-94	10	14	20	27	35	45	58	75	96	123	156	195	248	313	393	496
T-106	10	14	20	27	35	45	58	75	96	123	156	195	248	313	393	496
T-130	17	23	30	40	51	66	83	107	137	173	220	275	348	439	550	693
T-157	22	29	38	50	64	82	104	132	168	213	270	336	426	536	672	846
T-184	22	29	38	50	64	82	104	132	168	213	270	336	426	536	672	846
T-200	31	41	53	68	86	109	139	176	223	282	357	445	562	707	886	1115
T-225	36	46	60	77	98	123	156	198	250	317	400	499	631	793	993	1250
T-300	52	66	85	108	137	172	217	274	347	438	553	688	870	1093	1368	1721
T-400	61	79	100	127	161	202	255	322	407	513	648	806	1018	1278	1543	2013
T-520	86	110	149	160	223	279	349	443	559	706	889	1105	1396	1753	2192	2758

IRON POWDER TOROIDAL CORES

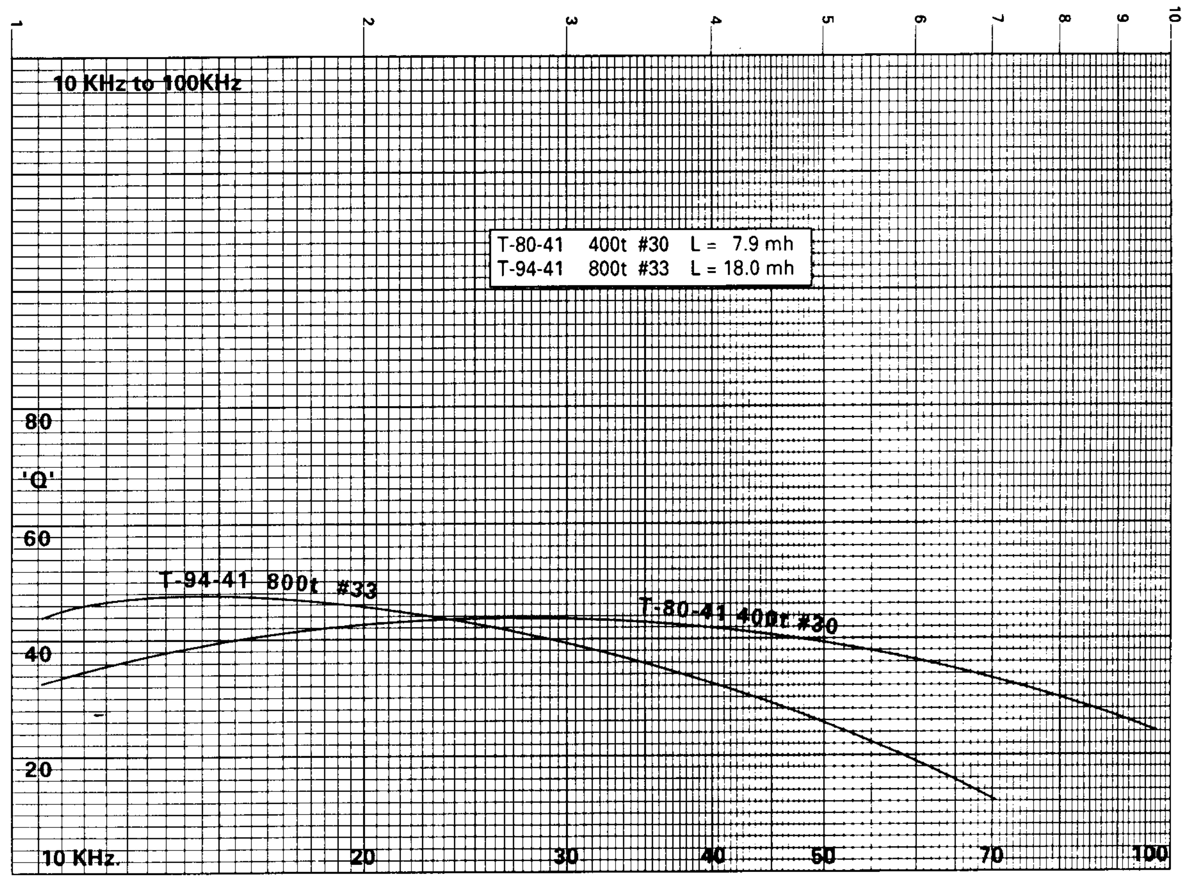
TYPICAL 'Q' CURVES
various windings, same core

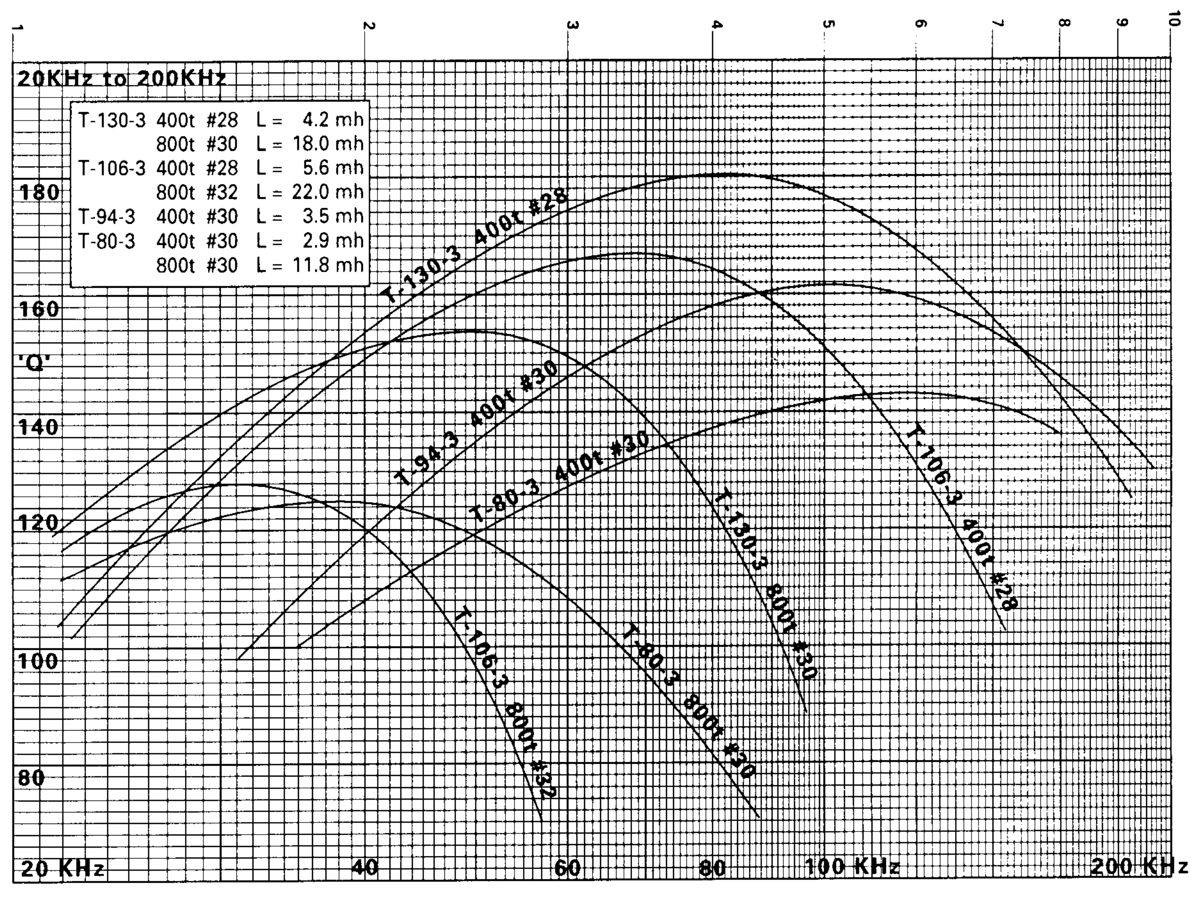


The above chart shows typical Q curves resulting from a number of various windings on the same toroidal core.

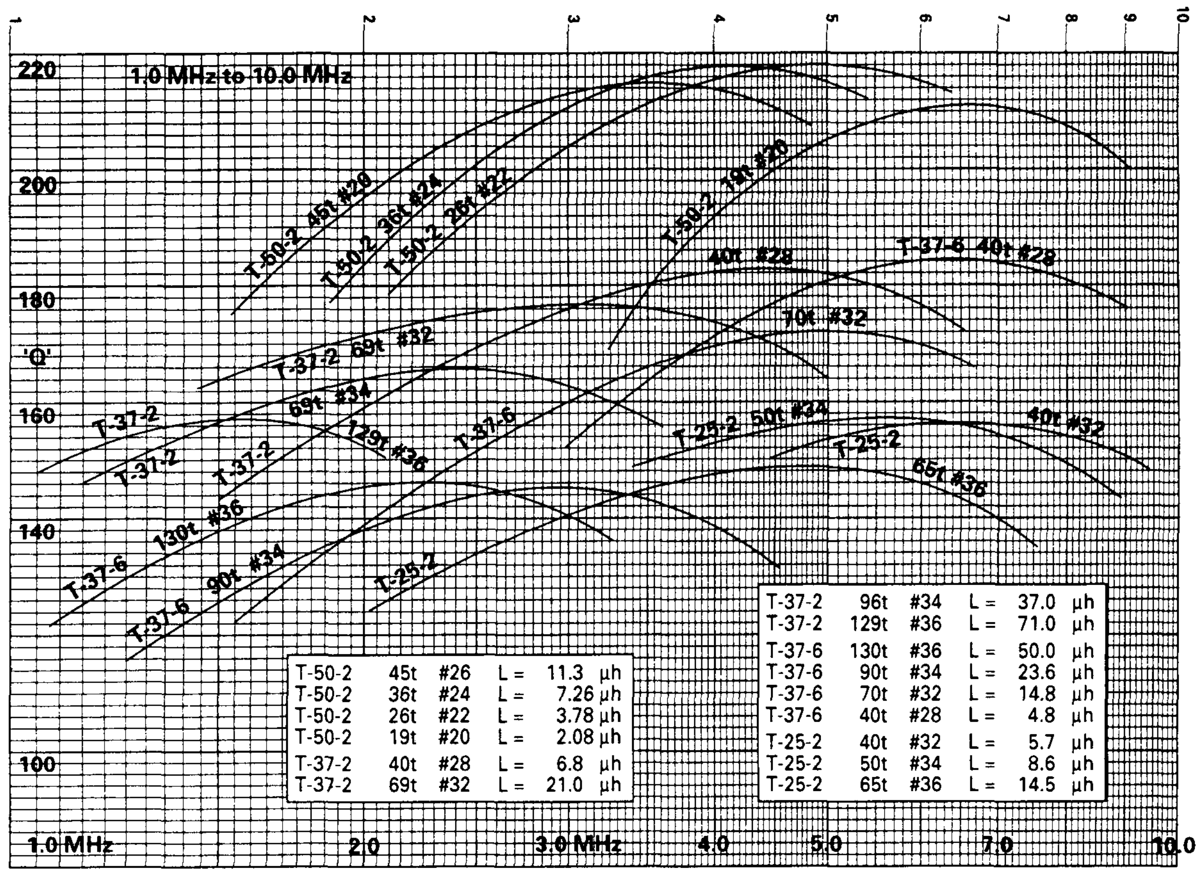
The next several pages contain a number of Q curves which were measured and plotted from actual windings.

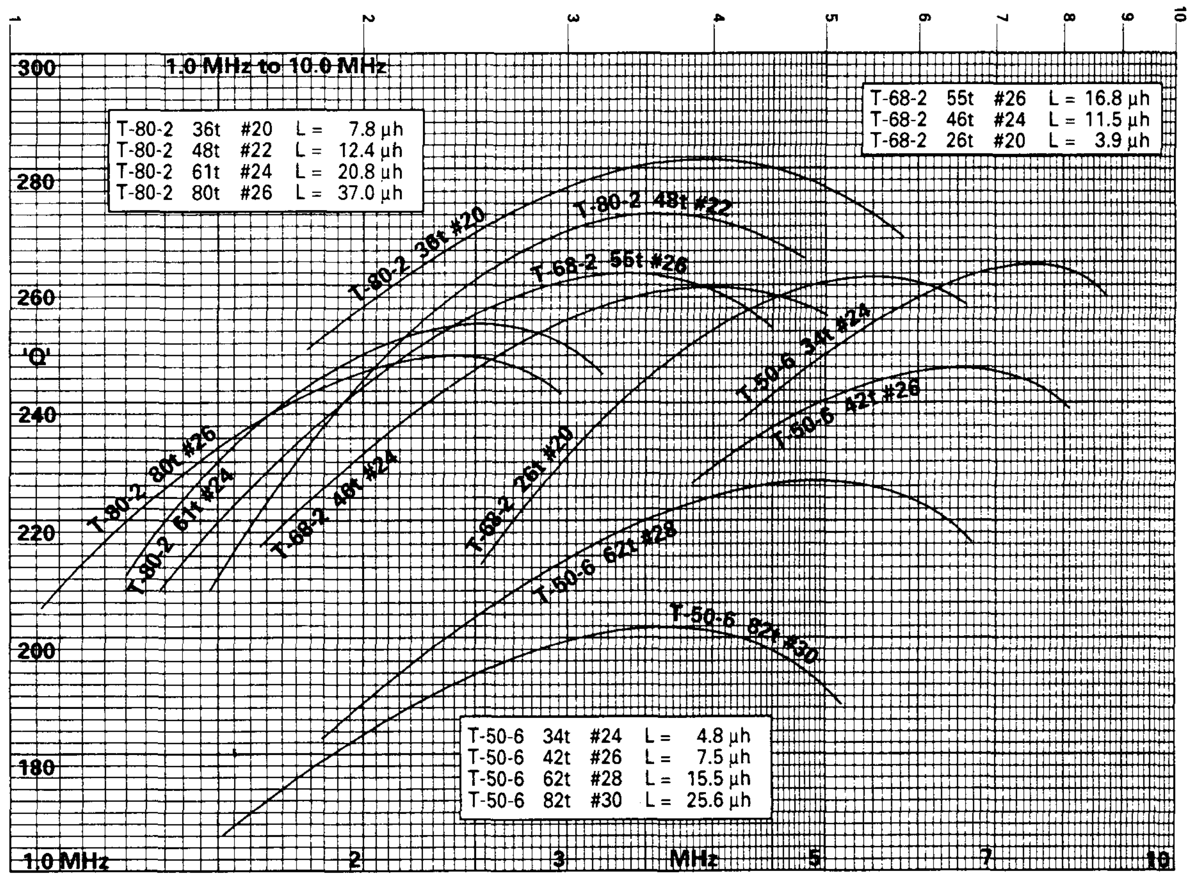
Inductance charts are given later on in this booklet which will help you choose a core for a specific inductance. Since the charts are in increments of ten turns, a more precise turns-count can be calculated with the turns vs. inductance equation once the core has been selected.


10 KHz to 100KHz
T-80-41 400t #30 L = 7.9 mh
T-94-41 800t #33 L = 18.0 mh
80
'Q'
60
40
20
T-94-41 800t #33
T-80-41 400t #30
10 KHz.
20
30
40
50
70
100


20KHz to 200KHz
T-130-3 400t #28 L = 4.2 mh
800t #30 L = 18.0 mh
T-106-3 400t #28 L = 5.6 mh
800t #32 L = 22.0 mh
T-94-3 400t #30 L = 3.5 mh
T-80-3 400t #30 L = 2.9 mh
800t #30 L = 11.8 mh
180
160
'Q'
140
120
100
80
T-130-3 400t #28
T-94-3 400t #30
T-80-3 400t #30
T-106-3 400t #28
T-130-3 800t #30
T-106-3 800t #32
T-80-3 800t #30
20 KHz
40
60
80
100 KHz
200 KHz

IRON-POWDER TOROIDAL CORES Q-CURVES





INDUCTANCE CHARTS (Iron Powder Toroids)

IRON POWDER TOROIDAL CORES

MATERIAL #0 Inductance (μh) vs. Size, Material and Number of Turns

Turns	10	20	30	40	50	60	70	80	90	100	110	120	130	140
Size														
T-106	.19	.76	1.70	3.0	4.8	6.8	9.3	12.0	15.0	19.0	23	27	32	37
T-94	.10	.40	.90	1.7	2.7	3.8	5.2	6.8	8.6	10.0	13	15	18	21
T-80	.08	.34	.77	1.4	2.1	3.0	4.2	5.4	6.9	8.5	10	12	14	-
T-68	.07	.30	.67	1.2	1.9	2.7	3.7	4.8	6.0	7.5	-	-	-	-
T-50	.06	.26	.57	1.0	1.6	2.3	3.1	4.1	-	-	-	-	-	-
T-37	.05	.20	.44	.7	1.2	-	-	-	-	-	-	-	-	-
T-25	.04	.18	.41	-	-	-	-	-	-	-	-	-	-	-
T-20	.03	.14	-	-	-	-	-	-	-	-	-	-	-	-
T-16	.03	.12	-	-	-	-	-	-	-	-	-	-	-	-
T-12	.03	-	-	-	-	-	-	-	-	-	-	-	-	-

IRON POWDER TOROIDAL CORES

MATERIAL #1 Inductance (μh) vs. Size, Material and Number of Turns

Turns	10	20	30	40	50	60	70	80	90	100	110	120	130	140
Size														
T-106	3.2	13.0	29	52	81	117	159	208	263	325	393	468	549	637
T-94	1.6	6.4	14	25	40	57	78	102	130	160	194	230	270	304
T-80	1.2	4.6	10	18	28	41	56	73	93	115	139	166	194	-
T-68	1.2	4.6	10	18	28	41	56	73	93	115	139	166	194	-
T-50	1.0	4.0	9	16	25	36	49	64	-	-	-	-	-	-
T-37	.8	3.2	7	13	20	-	-	-	-	-	-	-	-	-
T-25	.7	2.8	6	-	-	-	-	-	-	-	-	-	-	-
T-20	.5	2.0	-	-	-	-	-	-	-	-	-	-	-	-
T-16	.4	1.7	-	-	-	-	-	-	-	-	-	-	-	-
T-12	.4	-	-	-	-	-	-	-	-	-	-	-	-	-

IRON POWDER TOROIDAL CORES

MATERIAL #2 Inductance (μh) vs. Size, Material and Number of Turns

Turns	10	20	30	40	50	60	70	80	90	100	110	120	130	140
Size														
T-106	1.4	5	12	22	34	49	66	86	109	135	163	194	228	265
T-94	.8	3	8	13	21	30	41	54	68	84	101	120	131	142
T-80	.6	2	5	9	14	20	27	35	45	55	66	79	93	-
T-68	.6	2	5	9	15	21	29	38	48	59	-	-	-	-
T-50	.5	2	2	8	12	18	24	31	-	-	-	-	-	-
T-37	.4	2	4	6	10	-	-	-	-	-	-	-	-	-
T-25	.3	1	3	-	-	-	-	-	-	-	-	-	-	-
T-20	.3	1	-	-	-	-	-	-	-	-	-	-	-	-
T-16	.2	-	-	-	-	-	-	-	-	-	-	-	-	-
T-12	.1	-	-	-	-	-	-	-	-	-	-	-	-	-

INDUCTANCE CHARTS (Iron Powder Toroids)

IRON POWDER TOROIDAL CORES

MATERIAL #3 Inductance (μh) vs. Size, Material and Number of Turns

Turns	10	20	30	40	50	60	70	80	90	100	110	120	130	140
Size														
T-106	5	18	41	72	113	182	221	288	365	450	545	648	761	882
T-94	2	10	22	40	62	89	121	159	200	248	300	357	419	486
T-80	2	7	16	29	45	65	88	115	146	180	218	259	304	-
T-68	3	8	18	31	49	70	96	125	158	185	-	-	-	-
T-50	2	7	16	26	44	63	86	112	-	-	-	-	-	-
T-37	1	5	9	-	-	-	-	-	-	-	-	-	-	-
T-25	1	4	9	-	-	-	-	-	-	-	-	-	-	-
T-20	.9	4	-	-	-	-	-	-	-	-	-	-	-	-
T-16	.6	2	-	-	-	-	-	-	-	-	-	-	-	-
T-12	.6	-	-	-	-	-	-	-	-	-	-	-	-	-

IRON POWDER TOROIDAL CORES

MATERIAL #6 Inductance (μh) vs. Size, Material and Number of Turns

Turns	10	20	30	40	50	60	70	80	90	100	110	120	130	140
Size														
T-106	1.1	5.0	10	19	30	42	57	74	94	116	140	167	196	227
T-94	.7	3.0	6	11	18	25	34	45	57	70	85	100	118	137
T-80	.5	2.0	4	7	11	16	22	29	36	45	54	64	76	-
T-68	.5	2.0	4	7	11	17	23	30	38	47	-	-	-	-
T-50	.4	2.0	3	6	10	14	20	26	-	-	-	-	-	-
T-37	.4	1.0	3	5	7	-	-	-	-	-	-	-	-	-
T-25	.3	1.0	2	-	-	-	-	-	-	-	-	-	-	-
T-20	.2	.8	1	-	-	-	-	-	-	-	-	-	-	-
T-16	.2	-	-	-	-	-	-	-	-	-	-	-	-	-
T-12	.1	-	-	-	-	-	-	-	-	-	-	-	-	-

IRON POWDER TOROIDAL CORES

MATERIAL #10 Inductance (μh) vs. Size, Material and Number of Turns

Turns	10	20	30	40	50	60	70	80	90	100	110	120	130	140
Size														
T-94	.6	2	5	9	15	21	28	37	47	58	70	84	98	113
T-80	.3	1	3	5	8	12	16	21	27	33	40	48	54	-
T-68	.3	1	2	5	8	12	16	20	26	32	-	-	-	-
T-50	.3	1	3	5	8	11	15	20	-	-	-	-	-	-
T-37	.3	1	2	4	6	-	-	-	-	-	-	-	-	-
T-25	.2	.8	2	-	-	-	-	-	-	-	-	-	-	-
T-20	.1	.6	-	-	-	-	-	-	-	-	-	-	-	-
T-16	.1	.5	-	-	-	-	-	-	-	-	-	-	-	-
T-12	.1	-	-	-	-	-	-	-	-	-	-	-	-	-

INDUCTANCE CHARTS (Iron Powder Toroids)

IRON POWDER TOROIDAL CORES

MATERIAL #15 Inductance (μh) vs. Size, Material and Number of Turns

Turns	10	20	30	40	50	60	70	80	90	100	110	120	130	140
Size														
T-106	4	14	31	55	86	124	169	221	279	345	417	497	583	676
T-94	2	8	18	32	50	72	98	128	162	200	242	288	338	392
T-80	2	7	15	27	43	61	83	109	138	170	206	245	287	-
T-68	2	7	16	29	45	65	88	115	146	180	-	-	-	-
T-50	1	5	12	22	34	49	66	86	-	-	-	-	-	-
T-37	1	4	8	14	23	-	-	-	-	-	-	-	-	-
T-25	1	3	8	-	-	-	-	-	-	-	-	-	-	-
T-20	.5	3	-	-	-	-	-	-	-	-	-	-	-	-
T-16	.5	3	-	-	-	-	-	-	-	-	-	-	-	-
T-12	.5	-	-	-	-	-	-	-	-	-	-	-	-	-

IRON POWDER TOROIDAL CORES

MATERIAL #17 Inductance (μh) vs. Size, Material and Number of Turns

Turns	10	20	30	40	50	60	70	80	90	100	110	120	130	140
Size														
T-94	.3	1	3	5	8	12	16	20	30	32	39	46	54	63
T-80	.2	.8	2	4	6	6	11	14	18	22	27	32	37	-
T-68	.2	.8	2	3	5	7	10	13	17	21	-	-	-	-
T-50	.2	.7	2	3	5	7	9	12	-	-	-	-	-	-
T-37	.1	.6	1	2	4	-	-	-	-	-	-	-	-	-
T-25	.1	.5	1	-	-	-	-	-	-	-	-	-	-	-
T-20	.1	.4	-	-	-	-	-	-	-	-	-	-	-	-
T-16	.08	.3	-	-	-	-	-	-	-	-	-	-	-	-
T-12	.07	-	-	-	-	-	-	-	-	-	-	-	-	-

IRON POWDER TOROIDAL CORES

MATERIAL #26 Inductance (μh) vs. Size, Material and Number of Turns

Turns	10	20	30	40	50	60	70	80	90	100	110	120	130	140
Size														
T-106	9	36	81	144	245	324	441	576	729	900	089	1296	1521	1764
T-94	6	24	53	94	148	212	289	378	478	590	714	850	997	1156
T-80	5	18	41	72	113	162	221	288	365	450	545	648	761	882
T-68	4	17	38	67	105	151	206	269	340	420	508	605	710	823
T-50	3	13	29	51	80	115	157	205	259	320	387	461	541	627
T-37	2.7	11	25	44	69	135	176	223	-	-	-	-	-	-

INDUCTANCE CHART

LARGE SIZE IRON POWDERS

LARGE CORES Inductance (μh) vs. Size, Material and Number of Turns

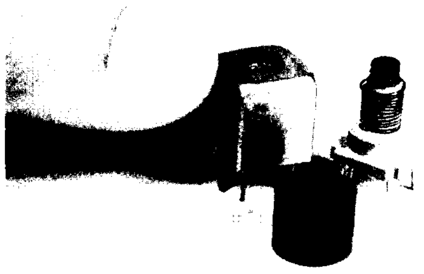
Turns	10	20	30	40	50	60	70	80	90	100	110	120	130
Core Number													
T-400A-26	26	104	324	416	650	936	1274	1664	2106	2600	3146	3744	4394
T-400A-2	4	14	32	57	90	130	176	230	292	360	436	518	608
T-400-26	13	53	119	211	330	475	646	845	1069	1320	1597	1900	2231
T-400-2	2	7	17	27	46	67	91	118	150	185	224	266	313
T-300A-26	16	64	144	256	400	576	784	1024	1296	1600	1936	2304	2704
T-300A-2	2	9	20	36	57	82	118	146	185	228	276	328	385
T-300-26	8	33	74	132	06	297	404	528	668	825	998	188	1394
T-300-2	1	5	10	18	29	41	56	74	93	115	139	166	194
T-225A-26	16	64	144	256	400	576	784	1024	1296	1600	1936	2304	2704
T-225A-2	2	9	19	34	54	77	105	138	174	215	276	310	385
T-225-26	10	38	86	152	238	342	466	608	770	950	1150	1368	1607
T-225-2	1	5	11	19	30	43	59	79	97	120	145	173	203
T-225-3	4	17	38	68	106	153	208	272	344	425	514	612	718
T-225-6	1	4	9	16	25	36	49	64	81	100	121	144	169
T-200A-26	16	62	136	248	388	558	760	992	1256	1550	1875	2418	2619
T-200A-1	5	18	41	73	114	164	223	291	369	455	551	655	764
T-200A-2	2	9	19	35	55	78	107	140	177	218	264	314	368
T-200A-3	5	18	41	74	115	165	225	294	373	460	557	662	777
T-200A-6	2	7	16	29	45	65	88	115	146	180	218	259	304
T-200-26	9	36	81	143	224	322	439	573	725	895	1082	1289	1513
T-200-1	3	10	23	40	63	90	123	160	203	250	303	360	423
T-200-2	1	5	11	19	30	43	59	79	97	120	145	173	203
T-200-3	4	17	38	68	106	153	208	272	344	425	514	612	718
T-200-6	1	4	9	16	25	36	49	64	81	100	121	144	169
T-184-26	16	66	148	262	410	590	804	1049	1328	1640	1984	2362	2772
T-184-1	5	20	45	80	125	180	245	320	405	500	605	720	845
T-184-2	2	10	22	38	60	86	118	154	194	240	290	396	406
T-184-3	7	29	65	115	180	259	353	461	583	720	871	1039	1217
T-184-6	2	8	18	31	49	70	96	125	158	195	236	281	330
T-157-26	10	34	87	155	243	349	475	621	786	970	1174	1397	1639
T-157-1	3	13	29	51	80	115	157	205	259	320	387	461	541
T-157-2	1	6	13	22	35	50	69	90	113	140	169	202	237
T-157-3	4	17	38	67	105	151	206	269	340	420	508	605	710
T-157-6	1	5	10	18	29	41	56	74	93	115	139	166	194
T-157-15	4	14	32	58	90	130	176	230	292	360	436	518	608
T-130-26	8	31	71	126	196	283	385	502	636	785	950	1130	1327
T-130-1	2	8	18	32	50	72	98	128	162	200	242	288	334
T-130-2	1	4	10	18	28	40	54	70	89	110	133	158	186
T-130-3	4	13	36	56	88	127	172	224	284	350	424	504	592
T-130-6	1	4	9	15	24	35	47	61	78	96	116	138	162
T-130-15	3	10	23	40	63	90	123	160	203	250	303	360	423

3

IRON POWDER SHIELDED COIL FORMS

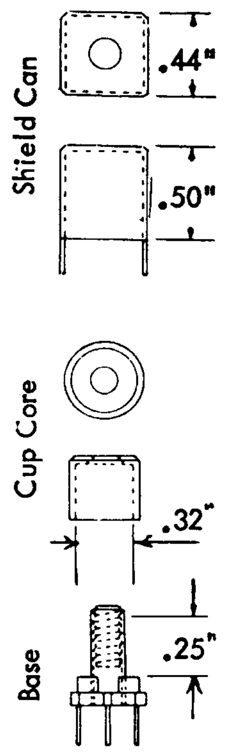
Adjustable / Slug Tuned

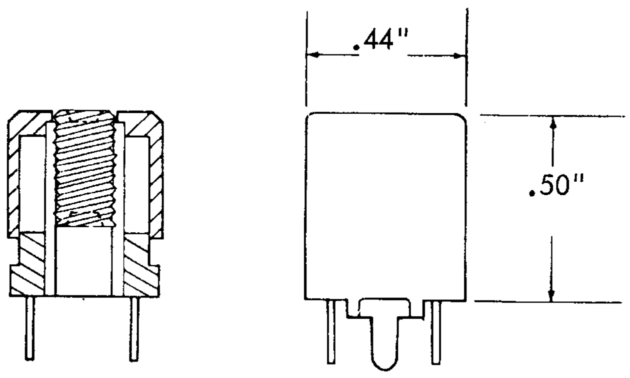
L-43 Coil Forms (Specify material)



- Miniature in size
- Slug tuning
- Copper shield can, tin plated
- Easy to wind
- Good Q
- Frequency range .2 to 200 MHz.
- Inductance range .02 to 700 uh.

L-43





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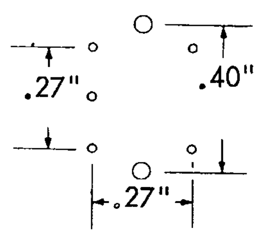


pin spacing

Part number	Frequency range (MHz)	A_L (μh/100 t) at max L	L ratio max to min	Typical Winding (mid-freq.) Wire	Turns	L (μh)	Q max
L-43-1	0.30 - 1.0	115	1.6 - 1	3/44	75	42.50	80
L-43-2	1.00 - 10.0	98	1.6 - 1	9/44	21	4.00	120
L-43-3	0.01 - 0.5	133	1.8 - 1	3/44	223	600.00	90
L-43-6	10.00 - 50.0	85	1.4 - 1	26	6	0.30	30
L-43-10	25.00 - 100.0	72	1.3 - 1	24	5	0.14	150
L-43-17	50.00 - 200.0	56	1.2 - 1	22	3	0.05	200

Solid magnet wire may be substituted for the Litz wire, but somewhat lower Q may result.

Most efficient when tuning slug is set at maximum L. For Tuning flexibility calculate so that slug will be about 90% maximum L when at operating frequency.

$$\text{Turns} = 100\sqrt{\frac{\text{desired 'L' } (\mu h)}{90\%\ A_L\ (\mu h/100\text{ turns})}}$$

IRON POWDER TOROIDAL CORES

FOR
DC CHOKES and AC LINE FILTERS

For many years Iron Powder has been used as the core material for RF inductors and transformers when stability and high 'Q' are of primary concern. Because of the growing need for energy storage inductors for noise filtering, new materials have been developed for these applications

High 'Q' inductors are no longer required, in fact low 'Q' actually helps in damping high frequency oscillations. The #26 Iron Powder material is ideally suited for these applications since it combines low 'Q', good frequency response, and high energy capabilities.

Energy storage , expressed in microjoules, is calculated by multiplying one-half the inductance in µh times the current in amperes squared. The amount of energy that can be stored in a given inductor is limited either by saturation of the core material or temperature rise of the wound unit, resulting in copper loss and/or core loss.

In typical DC chokes, the AC ripple flux is normally small in comparison to the DC component. Since the DC flux does not generate core loss, our primary concern becomes saturation and copper loss. The DC saturation characteristics of the #26 material are shown in Fig. A on the following page.

Using this information, DC energy storage curves have been developed and presented in the chart on the 2nd following page. A table of energy storage limits vs. temperature rise is included in the chart. The table at the bottom of the page is for single layer winding.

In 60 Hz. line filter applications, the high frequency to be filtered falls into two categories: (1) Common-mode noise and (2) Differential-mode noise. The common-mode noise is in relation to earth ground and is common to both lines. Differential mode noise is the noise between the two lines.

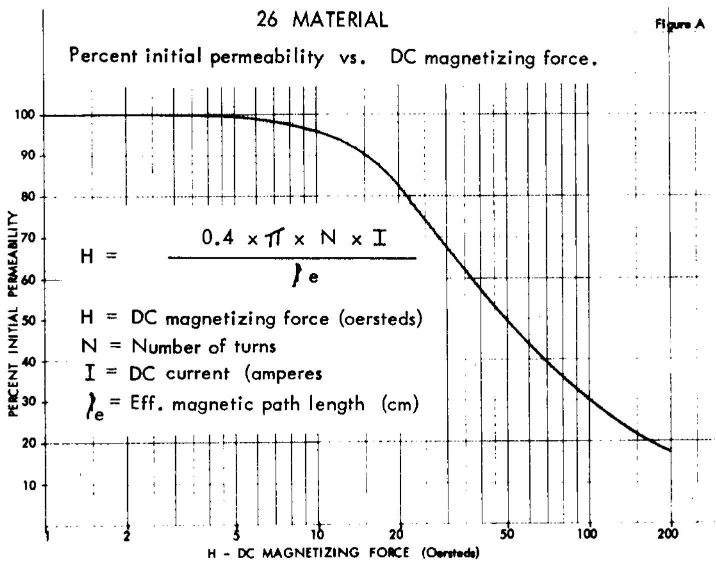
The Common-mode noise filter is usually constructed on a high permeability ferrite type core with a bifilar type winding. This type of winding allows the 60 Hz. flux generated by each line to cancel within the core, thus avoiding saturation. If the #26 Iron Powder material were to be used, the large core size necessary to accommodate the required number of wire turns for the required inductance makes this option unattractive.

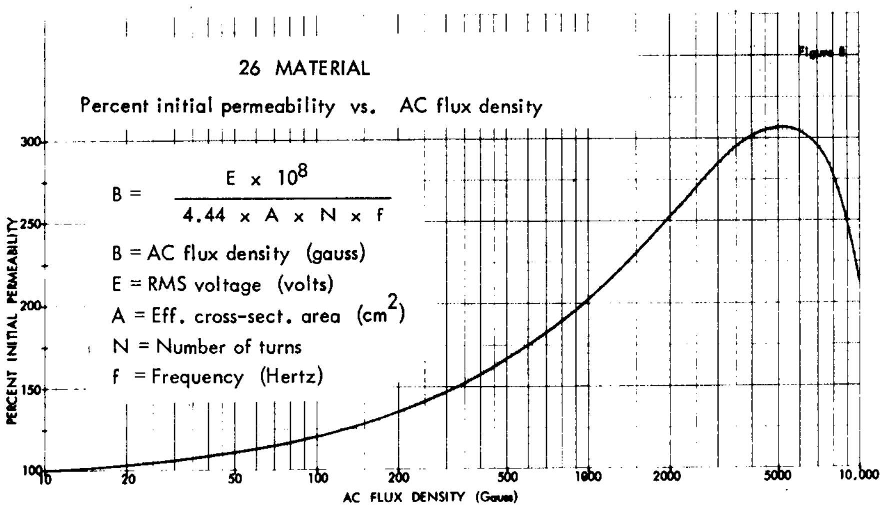
The Differential-mode filters must be able to support a significant amount of 60 Hz. flux without saturating. The AC saturation characteristics of the #26 material (Fig. B) and core loss information (Fig. C) can be seen on the following page. Notice how the permeability initially increases with AC excitation. This effect allows greater energy storage in 60 Hz. applications.

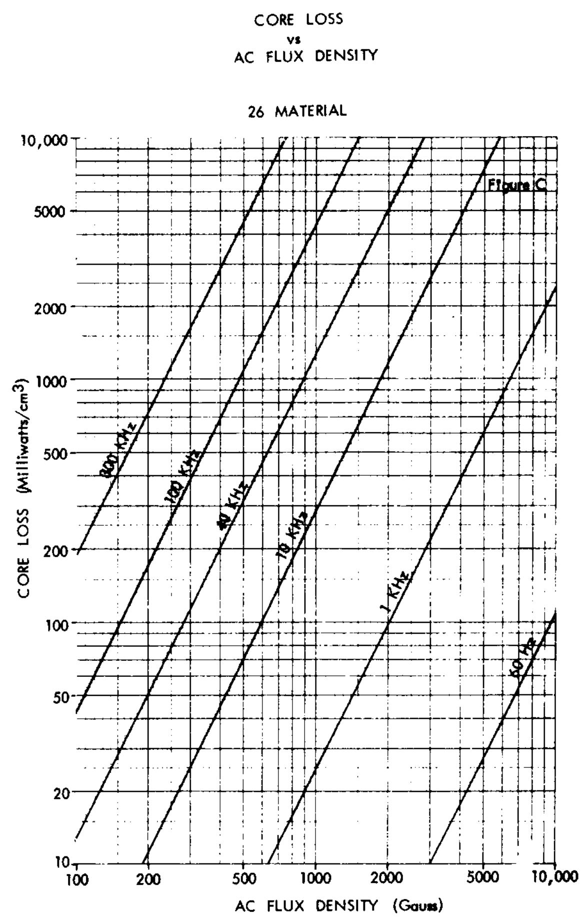
Energy storage curves have been developed for line filter applications as shown on the 3rd following page. The energy storage limit table is now taking into account both the core and the copper loss. In order to guarantee a minimum inductance over a wide current range, the design engineer may wish to calculate the required turns based on the listed A_L value of the core.

CORES FOR DC CHOKES AND AC LINE FILTERS

MATERIAL 26		Permeabilty 75		DC to 1 MHz (Low 'Q')		Color - Yellow & White	
Core number	O.D. (inches)	I.D. (inches)	Hgt. (inches)	ℓ_e (cm)	A_e $(cm)^2$	V_e $(cm)^3$	A_L Value μh/100 turns
T-30-26	.307	.151	.128	1.83	.065	.119	325
T-37-26	.375	.205	.128	2.32	.070	.162	275
T-44-26	.440	.229	.159	2.67	.107	.286	360
T-50-26	.500	.303	.190	3.03	.121	.367	320
T-68-26	.690	.370	.190	4.24	.196	.831	420
T-80-26	.795	.495	.250	5.15	.242	1.246	450
T-94-26	.942	.560	.312	6.00	.385	2.310	590
T-106-26	1.060	.570	.437	6.50	.690	4.485	900
T-130-26	1.300	.780	.437	8.29	.730	6.052	785
T-157-26	1.570	.950	.570	10.05	1.140	11.457	970
T-184-26	1.840	.950	.710	11.12	2.040	22.685	1640
T-200-26	2.000	1.250	.550	12.97	1.330	17.250	895
T-200A-26	2.000	1.250	1.000	12.97	2.240	29.050	1525
T-225-26	2.250	1.405	.550	14.56	1.508	21.956	950
T-225A-26	2.250	1.485	1.000	14.56	2.730	39.749	1600
T-300-26	3.058	1.925	.500	19.83	1.810	35.892	800
T-300A-26	3.048	1.925	1.000	19.83	3.580	70.991	1600
T-400-26	4.000	2.250	.650	24.93	3.660	91.244	1300
T-400A-26	4.000	2.250	1.300	24.93	7.432	185.280	2600
T-520-26	5.200	3.080	.800	33.16	5.460	181.000	1460







POWER CONSIDERATIONS (Iron Powder and Ferrite)

How large a core is needed to handle a certain amount of power? This is a question often asked. Unfortunately, there is no simple answer.

There are several factors involved such as: cross sectional area of the core, core material, turns count, and of course the variables of applied voltage and operating frequency.

Overheating of the coil will usually take place long before saturation in most applications above 100 KHz. Now the question becomes 'How large a core must I have to prevent overheating at a given frequency and power level'?

Overheating can be caused by both wire and core material losses. Wire heating is affected by both DC and AC currents, while core heating is affected only by the AC content of the signal. With a normal sinewave signal above 100 KHz, both the Iron Powder and Ferrite type cores will first be affected by overheating caused by core losses, rather than saturation.

The extrapolated AC flux density limits (see table below) can be used for BOTH Iron Powder and Ferrite type cores as a guideline to avoid excessive heating. These figures may vary slightly according to the type of the material being used.

Operating frequency is one of the most important factors concerning power capability above 100 KHz. A core that works well at 2 MHz. may very well burn up at 30 MHz. with the same amount of drive.

Core saturation, a secondary cause of coil failure, is affected by both AC and DC signals. Saturation will decrease the permeability of the core causing it to have impaired performance or to become inoperative. The safe operating total flux density level for most Ferrite materials is typically 2000 gauss, while Iron Powder materials can tolerate up to 5000 gauss without significant saturation effects.

Iron Powder cores (low permeability) are superior to the Ferrite material cores for high power inductors for this reason: fewer turns will be required by the Ferrite type core for a given inductance. When the same voltage drop is applied across a decreased number of turns, the flux density will increase accordingly. In order to prevent the flux density from increasing when fewer turns are used, the flux drive will have to be decreased.

Either core material can be used for transformer applications but both will have 'trade-offs'. Ferrite type cores will require fewer turns, will give more impedance per turn and will couple better, whereas the Iron Powder cores will require more turns, will give less impedance per turn, will not couple as well but will tolerate more power and are more stable.

Frequency:	100 KHz	1 MHz	7 MHz	14 MHz	21 MHz	28 MHz
AC Flux Den.	500 gauss	150 gauss	57 gauss	42 gauss	36 gauss	30 gauss

POWER CONSIDERATIONS *(cont')*

The equation for determining the maximum flux density of a given toroidal core is as follows:

$$B_{max} = \frac{E \times 10^8}{4.44 \times A_e \times N \times F}$$

E_{pk} = applied RMS volts
A_e = cross-sect. area (cm^2)
N = number of wire turns
F = frequency (Hertz)

The safety factor may be increased by using the peak AC voltage in the equation. This is a standard practice among many RF engineers who design broadband RF power transformers.

The above equation may be changed as shown below to make it more convenient during calculations of B_{max} at radio frequencies.

$$B_{max} = \frac{E \times 10^2}{4.44 \times A_e \times N \times F}$$

E_{pk} = applied RMS volts
A_e = cross-sect. area (cm^2)
N = number of wire turns
F = frequency (MHz)

The sample calculation below is based on a frequency of 7 MHz, a peak voltage of 25 volts and a primary winding of 15 turns. The cross-sectional area of the sample core is 0.133 cm^2. From previous guidelines we know that the maximum flux density at 7 MHz should be not more than 57 gauss.

$$B_{max} = \frac{25 \times 100}{4.44 \times 0.133 \times 15 \times 7} = 40.3 \text{ gauss}$$

This hypothetical toroid core will have a flux density of 40 gauss according to the above formula and when operated under the above conditions. This is well within the guidelines as suggested above.

Temperature rise can be the result of using an undersized wire gauge for the amount of current involved as well as magnetic action within the core. Both will contribute to the overall temperature rise of the transformer. This can be calculated with the following equation:

$$\text{Temperature Rise (°C)} = \left[\frac{\text{Total Power Dissipation (Milliwatts)}}{\text{Available Surface Area } (cm^2)}\right]^{.833}$$

If the operating temperature (ambient temperature + temperature rise) is more than 100°C when used intermittently, or more than 75°C if used continuously, a larger size core and/or a heavier gauge wire should be selected.

IRON POWDER CORE LOSS CHARACTERISTICS

The Iron Powder Q-curves section of this booklet can be very useful for designing high-Q, low power inductors and transformers, but additional consideration must be given to higher power applications.

Excessive temperature rise due to Iron Powder core loss at high frequencies will occur before saturation and is usually the primary limiting factor in the operation of an Iron Powder core inductor at high frequency.

The following charts show core loss information in milliwatts per cubic centimeter of core material as a function of peak AC flux density for various frequencies. The Faraday Law is used to calculate the peak AC flux density. The effective cross-sectional area and volume for each core size can be found on previous pages of this booklet.

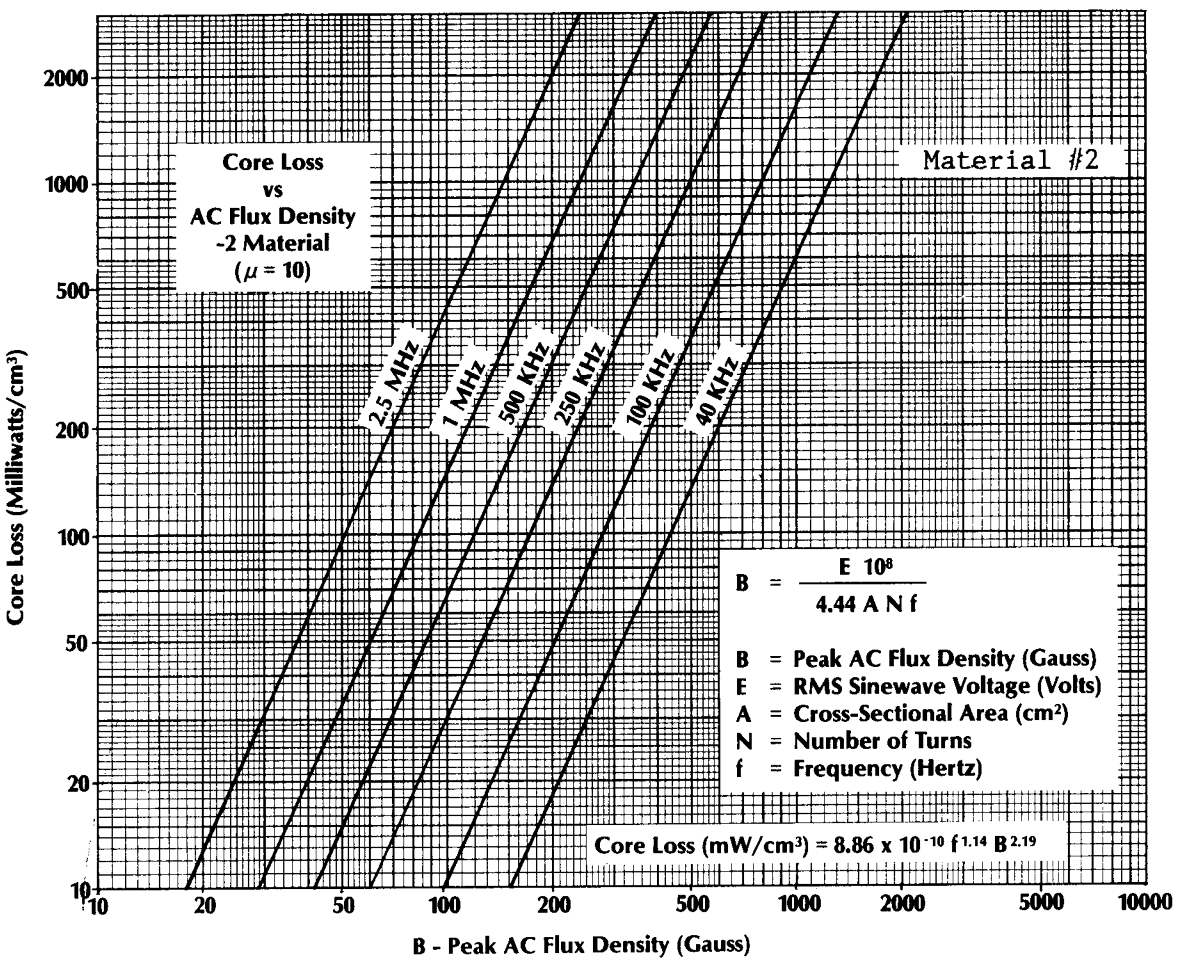
The following formula provides a reasonable approximation for the temperature rise of a core in free standing air.

Temperature Rise (°C) =

$$\left[\frac{\text{Total Power Dissipation (Milliwatts)}}{\text{Available Surface Area (cm}^2\text{)}}\right]^{.833}$$

The surface area of a toroid increases at approximately a squared rate with the outside diameter, while the volume increases at approximately a cubed rate. The result is that a small diameter core can dissipate more power per unit volume than a larger diameter core for the same temperature rise.

Each of the three following graphs show core loss results in milliwatts per cubic centimeter as a function of frequency and AC flux density. These can be useful in projecting losses for frequencies not shown.



POWDER DISSIPATION vs. TEMPERATURE RISE

Power dissipation (mw/cc)as a function of temperature rise				Power rating for 25°C temperature rise due to core loss. No. 2 material, frequency 1 MHz.	
Core Size	10 °C	25 °C	40 °C	Core Size	Watts
T-30	400	1148	2026	T-30	24
T-37	412	1170	2065	T-37	26
T-44	310	884	1556	T-44	37
T-50	307	874	1535	T-50	49
T-68	234	664	1167	T-68	88
T-80	212	602	1056	T-80	125
T-94	160	454	802	T-94	160
T-106	114	322	566	T-106	236
T-130	117	331	582	T-130	331
T-157	94	266	468	T-157	515
T-200	87	260	436	T-200	794
T-300	62	186	327	T-300	1127
T-400	43	130	228	T-400	2108

Additional information about power dissipation upon request

PROPERTY CHART - IRON POWDER

Iron Powder Material	Basic Iron Powder	Material Permeability μ_o	Temperature Stability (ppm/°C)	Resonant Circuit Frequency Range (MHz)	Color Code
0	Phenolic	1	0	100.0 - 300.0	Tan
1	Carbonyl C	20	280	0.5 - 5.0	Blue
2	Carbonyl E	10	95	2.0 - 30.0	Red
3	Carbonyl HP	35	370	0.05 - 0.5	Grey
6	Carbonyl SF	8	35	10.0 - 50.0	Yellow
7	Carbonyl TH	9	30	5.0 - 35.0	White
10	Carbonyl W	6	150	30.0 - 100.0	Black
12	Synthetic Oxide	4	170*	50.0 - 200.0	Green/White
15	Carbonyl GS6	25	190	0.10 - 2.0	Red/White
17	Carbonyl	4	50	50.00 - 200.0	Blue/Yellow
26	Special	75	882	LF filters, chokes	Yellow/White

* Non Linear
Material # 17 has been developed as a temperature stable alternative to the #12.
Frequency ranges shown are for best 'Q'. Useful over broader frequency range with lower 'Q'.

SECTION II: FERRITE CORES

Ferrite Cores are available in numerous sizes and several permeabilities. Their permeability range is from 20 to more than 15,000. They are very useful for resonant circuit applications as well as wideband transformers and they are also commonly used for RFI attenuation. We can supply sizes from 0.23 inches to 2.4 inches in outer diameter directly from stock.

Ferrite toroidal cores are well suited for a variety of RF circuit applications and their relatively high permeability factors make them especially useful for high inductance values with a minimum number of turns, resulting in smaller component size.

There are two basic ferrite material groups: (1) Those having a permeability range from 20 to 800 μ_i are of the Nickel Zinc class, and (2) those having permeabilities above 800 μ_i are usually of the Manganese Zinc class.

The Nickel Zinc ferrite cores exhibit high volume resistivity, moderate temperature stability and high 'Q' factors for the 500 KHz to 100 MHz frequency range. They are well suited for low power, high inductance resonant circuits. Their low permeability factors make them useful for wide band transformer applications as well.

The Manganese Zinc ferrites, having permeabilities above 800 μ_i, have fairly low volume resistivity and moderate saturation flux density. They can offer high 'Q' factors for the 1 KHz to 1 MHz frequency range. Cores from this group of materials are widely used for switched mode power conversion transformers operating in the 20 KHz to 100 KHz frequency range. These cores are also very useful for the attenuation of unwanted RF noise signals in the frequency range of 20 MHz to 400 MHz and above.

A list of Ferrite toroids, including physical dimensions, A_L values, and magnetic properties will be found on the next few pages. Use the given A_L value and the equation below to calculate a turn count for a specific inductance.

$$N = 1000\sqrt{\frac{\text{desired 'L' (mh)}}{A_L \text{ (mh/1000 turns)}}} \qquad L(\text{mh}) = \frac{A_L \times N^2}{1{,}000{,}000} \qquad A_L(\text{mh/1000 turns}) = \frac{1{,}000{,}000 \times \text{'L' (mh)}}{N^2}$$

N = number of turns L = inductance (mh) A_L = inductance index (mh)/1000 turns)

To improve voltage breakdown, coatings of ferrite cores are available for the F, J, W and H materials. Typical coatings are parylene C, Gray Coating and Black Lacquer. Parylene C coating has a thickness of 0.5 mils to 2 mils with a voltage breakdown of 750V. Gray coating has a thickness of 4 mils to 8 mils with voltage breakdown of 500V. Black Lacquer coating has a thickness of 0.5 mils to 2 mils with no increase in voltage breakdown.

All items in this booklet are standard stock items and usually can be shipped immediately. Call for availability of non-stock items.

- **For standard stocking items of Inductors, Chokes, Transformers and other wound ferrites, please see section V.**
- **For custom design of Inductors, Chokes, Transformers or Special Coil Windings, please call or fax your specifications today.**
- **Amidon provides engineering designs, prototyping and manufacturing. Low to high volume production capability with the most competitive pricing.**

FERRITE MATERIALS

MATERIAL 33 (μ = 850) A manganese-zinc material having low volume resistivity. Used for low frequency antennas in the 1 KHz to 1 MHz frequency range. Available in rod form only.

MATERIAL 43 (μ = 850) High volume resistivity. For medium frequency inductors and wideband transformers up to 50 MHz. Optimum frequency attenuation from 40 MHz to 400 MHz. Available in toroidal cores, shield beads, multi-aperture cores and special shapes for RFI suppression.

MATERIAL 61 (μ = 125) Offers moderate temperature stability and high 'Q' for frequencies 0.2 MHz to 15 MHz. Useful for wideband transformers to 200 MHz and frequency attenuation above 200 MHz. Available in toroids, rods, bobbins and multi-aperture cores.

MATERIAL 63 (μ = 40) For high 'Q' inductors in the 15 MHz to 25 MHz frequency range. Available in toroidal form only.

MATERIAL 64 (μ = 250) Primarily a bead material having high volume resistivity. Excellent temperature stability and very good shielding properties above 400 MHz.

MATERIAL 67 (μ = 40) Similar to the 63 material. Has greater saturation flux density and very good temperature stability. For high 'Q' inductors, (10 MHz to 80 Mhz). Wideband transformers to 200 MHz. Toroids only.

MATERIAL 68 (μ = 20) High volume resistivity and excellent temperature stability. For high Q' resonant circuits 80 MHz to 180 MHz. For high frequency inductors. Toroids only.

MATERIAL 73 (μ = 2500) Primarily a ferrite bead material. Has good attenuation properties from 1 MHz through 50 MHz. Available in beads and some broadband multi-aperture cores.

MATERIAL 77 (μ = 2000) Has high saturation flux density at high temperature. Low core loss in the 1 KHz to 1 MHz range. For low level power conversion and wideband transformers. Extensively used for frequency attenuation from 0.5 MHz to 50 MHz. Available in toroids, pot cores, E-cores, beads, broadband balun cores and sleeves. An upgrade of the former 72 material. The 72 material is still available in some sizes, but the 77 material should be used in all new design.

MATERIAL 'F' (μ = 3000) High saturation flux density at high temperature. For power conversion transformers. Good frequency attenuation 0.5 MHz to 50 MHz. Toroids only.

MATERIAL 'J'/75 (μ = 5000) Low volume resistivity and low core loss from 1 KHz to 1 MHz. Used for pulse transformers and low level wideband transformers. Excellent frequency attenuation from 0.5 MHz to 20 MHz. Available in toroidal form and ferrite beads as standard off the shelf in stock. Also available in pot cores, RM cores, E & U cores as custom ordered parts with lead time for delivery.

MATERIAL K (μ = 290). Used primarily in transmission line transformers from 1.0 MHz to 50 MHz range. Available from stock in a few sizes in toroidal form only.

MATERIAL W (μ = 10,000). High permeability material used for frequency attenuation from 100 KHz to 1 MHz in EMI/RFI filters. Also used in broadband transformers. Available in toroidal form from stock. As custom ordered parts for pot cores, EP cores, RM cores.

MATERIAL H (μ = 15,000). High permeability material used for frequency attenuation under 200 KHz. Also used in broadband transformers. Available in toroidal form only.

MAGNETIC PROPERTIES OF FERRITE MATERIALS

Material type	**33**	**43**	**61**	**64**	**67**	**68**	**73**
Initial Perm.	800	850	125	250	40	20	2500
Max. Perm.	1380	3000	450	375	125	40	4000
Max Flux den. @ 10 oer, (gauss)	2500	2750	2350	2200	3000	2000	4000
Residual Flux density, (gauss)	1350	1200	1200	1100	1000	1000	1000
Vol. Resist. (ohms-cm)	1×10^2	1×10^5	1×10^8	1×10^8	1×10^7	1×10^7	1×10^2
Temp. Coeff. -20°C - 70°C (%/°C)	.10%	1%	.15%	.15%	.13%	.06%	.80%
Loss Factor	3×10^{-6} @ .2 MHz	120×10^{-6} @ 1 MHz	32×10^{-6} @ 2.5 MHz	100×10^{-6} @ 2.5 MHz	150×10^{-6} @ 50 MHz	400×10^{-6} @ 0.1 MHz	7×10^{-6} @ 0.1 MHz
Coercive Force (Oersteds)	.30	.30	1.6	1.4	3.0	10.	.18
Curie Temp. °C	150	130	350	210	500	500	160
Resonant Cir. Freq. (MHz)	.01 to 1 MHz	.01 to 1 MHz	.20 to 10 MHz	.05 to 4 MHz	10 to 80 MHz	80 to 180 MHz	1 KHz to 1 MHz
Wideband Freq. (MHz *)	1 to 30 MHz	1 to 50 MHz	10 to 200 MHz	50 to 500 MHz	200 to 1000 MHz	.5 to 30 MHz	.2 to 15 MHz
Attenuation RF Noise, (MHz)	20 to 80 MHz	30 to 200 MHz	300 to 10,000 MHz	200 to 5,000 MHz	Above 1000 MHz	Above 10,000 MHz	1 to 40MHz

* Based on low power, small core application. Listed frequencies will be lower with higher power.

MAGNETIC PROPERTIES OF FERRITE MATERIALS

Material type	**77**	**83**	**F**	**J**	**K**	**W**	**H**
Initial Perm.	2000	300	3000	5000	290	10,000	15,000
Max. Perm.	6000	3600	4300	9500	400	20,000	23,000
Max Flux den. @ 10 oer, (gauss)	4600	3900	4700	4300	330	4300	4200
Residual Flux density, (gauss)	1150	3450	900	500	250	800	800
Vol. Resist. (ohms-cm)	1×10^2	1.5×10^3	1×10^2	1×10^2	20×10^7	$.15 \times 10^2$	$.1 \times 10^2$
Temp. Coeff. -20°C - 70°C (%/°C)	.25%	.4%	.25%	.4%	.15%	.4%	.4%
Loss Factor	4.5×10^{-6} @ 0.1 MHz	50×10^{-6} @ 0.1 MHz	4×10^{-6} @ 0.1 MHz	15×10^{-6} @ 0.1 MHz	28×10^{-6} @ 1 MHz	7×10^{-6} @ 10 KHz	15×10^{-6} @ 10 KHz
Coercive Force (Oersteds)	.22	.45	.20	.10	1	.04	.04
Curie Temp. °C	200	300	250	140	280	125	120
Resonant Cir. Freq. (MHz)	1 KHz to 2 MHz	1 KHz to 5 MHz	1 KHz to 1 MHz	1 KHz to 1 MHz	0.1 to 30 MHz	1 KHz to 250 KHz	1 KHz to 150 KHz
Wideband Freq. (MHz *)	.5 to 30 MHz	1 to 15 MHz	.5 to 30 MHz	1 to 15 MHz	50 to 500 MHz	1 KHz to 1 MHz	1KHz to 1 MHz
Attenuation RF Noise, (MHz)	1 to 40 MHz	0.5 to 20 MHz	1 to 20 MHz	0.5 to 10 MHz	200 to 5,000 MHz	100 KHz to 1 MHz	1 KHz to 500 KHz

* Based on low power, small core application. Listed frequencies will be lower with higher power.

FERRITE TOROIDAL CORES

MATERIAL 43							Permeability 850
Core number	O.D. (inches)	I.D. (inches)	Hgt. (inches)	ℓ_e (cm)	A_e $(cm)^2$	V_e $(cm)^3$	A_L Value mh/1000 turns
FT-23 -43	.230	.120	.060	1.34	.021	.029	158
FT-37 -43	.375	.187	.125	2.15	.076	.163	350
FT-50 -43	.500	.281	.188	3.02	.133	.401	440
FT-50A -43	.500	.312	.250	3.68	.152	.559	480
FT-50B -43	.500	.312	.500	3.18	.303	.963	965
FT-82 -43	.825	.516	.250	5.26	.246	1.290	470
FT-114 -43	1.142	.750	.295	7.42	.375	2.790	510
FT-140 -43	1.400	.900	.500	9.02	.806	7.280	885
FT-240 -43	2.400	1.400	.500	14.80	1.610	23.900	1075

MATERIAL 61							Permeability 125
Core number	O.D. (inches)	I.D. (inches)	Hgt. (inches)	ℓ_e (cm)	A_e $(cm)^2$	V_e $(cm)^3$	A_L Value mh/1000 turns
FT-23 -61	.230	.120	.060	1.34	.021	.029	24.8
FT-37 -61	.375	.187	.125	2.15	.076	.163	55.3
FT-50 -61	.500	.281	.188	3.02	.133	.401	69.0
FT-50A -61	.500	.312	.250	3.68	.152	.559	75.0
FT-50B -61	.500	.312	.500	3.18	.303	.963	150.0
FT-82 -61	.825	.516	.250	5.26	.246	1.290	75.0
FT-114 -61	1.142	.750	.295	7.42	.375	2.790	80.0
FT-114A-61	1.142	.750	.545	7.42	.690	5.130	145.0
FT-140 -61	1.400	.900	.500	9.02	.806	7.280	140.0
FT-240 -61	2.400	1.400	.500	14.80	1.610	23.900	171.0

MATERIAL 67							Permeability 40
Core number	O.D. (inches)	I.D. (inches)	Hgt. (inches)	ℓ_e (cm)	A_e $(cm)^2$	V_e $(cm)^3$	A_L Value mh/1000 turns
FT-23 -67	.230	.120	.060	1.34	.021	.029	6.0 Min
FT-37 -67	.375	.187	.125	2.15	.076	.163	18.0
FT-50 -67	.500	.281	.188	3.02	.133	.401	22.0
FT-50A -67	.500	.312	.250	3.68	.152	.559	24.0
FT-50B -67	.500	.312	.500	3.18	.303	.963	48.0
FT-82 -67	.825	.516	.250	5.26	.246	1.290	24.0
FT-114 -67	1.142	.750	.295	7.42	.375	2.790	25.4
FT-140 -67	1.400	.900	.500	9.02	.806	7.280	45.0
FT-240 -67	2.400	1.400	.500	14.80	1.610	23.900	55.0

MATERIAL 68							Permeability 20
Core number	O.D. (inches)	I.D. (inches)	Hgt. (inches)	ℓ_e (cm)	A_e $(cm)^2$	V_e $(cm)^3$	A_L Value mh/1000 turns
FT-23 -68	.230	.120	.060	1.34	.021	.029	4.0
FT-37 -68	.375	.187	.125	2.15	.076	.163	8.8
FT-50 -68	.500	.281	.188	3.02	.133	.401	11.0
FT-50A -68	.500	.312	.250	3.68	.152	.559	12.0
FT-82 -68	.825	.520	.250	5.26	.246	1.290	11.7
FT-114 -68	1.142	.750	.295	7.42	.375	2.790	12.7

FERRITE TOROIDAL CORES

MATERIAL 77 (upgrade of the 72 material)							**Permeability 2000**
Core number	O.D. (inches)	I.D. (inches)	Hgt. (inches)	ℓ_e (cm)	A_e $(cm)^2$	V_e $(cm)^3$	A_L Value mh/1000 turns
FT-23 -77	.230	.120	.060	1.34	.021	.029	396
FT-37 -77	.375	.187	.125	2.15	.076	.163	884
FT-50 -77	.500	.281	.188	3.02	.133	.401	1100
FT-50A -77	.500	.312	.250	3.68	.152	.559	1200
FT-50B -77	.500	.312	.500	3.18	.303	.963	2400
FT-82 -77	.825	.520	.250	5.26	.246	1.294	1170
FT-114 -77	1.142	.750	.295	7.42	.375	2.783	1270
FT-114A-77	1.142	.750	.545	7.42	.690	5.120	2340
FT-140 -77	1.400	.900	.500	9.02	.806	7.270	2250
FT-240 -77	2.400	1.400	.500	14.40	1.570	22.608	3130

MATERIAL 'F'							**Permeability 3000**
Core number	O.D. (inches)	I.D. (inches)	Hgt. (inches)	ℓ_e (cm)	A_e $(cm)^2$	V_e $(cm)^3$	A_L Value mh/1000 turns
FT-87A -F	.870	.540	.500	5.42	.315	1.710	3700
FT-114 -F	1.142	.750	.295	7.42	.375	2.783	1902
FT-150 -F	1.500	.750	.250	8.30	.591	4.905	2640
FT-150A-F	1.500	.750	.500	8.30	1.110	9.213	5020
FT-193 -F	1.932	1.250	.625	12.31	1.360	16.742	3640
FT-193A-F	1.932	1.250	.750	12.31	1.620	19.942	4460

MATERIAL 'J' (75)							**Permeability 5000**
Core number	O.D. (inches)	I.D. (inches)	Hgt. (inches)	ℓ_e (cm)	A_e $(cm)^2$	V_e $(cm)^3$	A_L Value mh/1000 turns
FT-23 -J	.230	.120	.060	1.34	.021	.029	990
FT-37 -J	.375	.187	.125	2.15	.076	.163	2110
FT-50 -J	.500	.281	.188	3.02	.133	.401	2750
FT-50A -J	.500	.312	.250	3.68	.152	.559	2990
FT-87 -J	.870	.540	.250	5.42	.261	1.414	3020
FT-87A -J	.870	.540	.500	5.42	.315	1.710	6040
FT-114 -J	1.142	.750	.295	7.42	.375	2.783	3170
FT-140A-J	1.400	.900	.590	9.02	.806	7.270	6736
FT-150 -J	1.500	.750	.250	8.30	.591	4.905	4400
FT-150A-J	1.500	.750	.500	8.30	1.110	9.213	8370
FT-193 -J	1.500	1.250	.625	12.31	1.360	16.742	6065
FT-193A-J	1.932	1.250	.750	12.31	1.620	19.942	7435
FT-240 -J	2.400	1.400	.500	14.40	1.570	22.608	6845
FT-337 -J	3.375	2.187	.500	— Available on Request Only. —			

All items are standard stock. All orders placed by 2:00 pm shipped the same day.

FERRITE TOROIDAL CORES

Physical Dimensions - Ferrite Toroids

Core Size	OD (inches)	ID (inches)	Hgt (inches)	Mean length (cm)	Cross Sect (cm2)	Volume (cm3)
FT-23	.230	.120	.060	1.34	.021	.029
FT-37	.375	.187	.125	2.15	.076	.163
FT-50	.500	.281	.188	3.02	.133	.401
FT-50 -A	.500	.312	.250	3.68	.152	.559
FT-50 -B	.500	.312	.500	3.18	.303	.963
FT-82	.825	.520	.250	5.26	.246	1.294
FT-87	.870	.540	.250	5.41	.261	1.414
FT-87 -A	.870	.540	.500	5.42	.315	1.710
FT-114	1.142	.750	.295	7.42	.375	2.783
FT-114-A	1.142	.750	.545	7.42	.690	5.120
FT-140	1.400	.900	.500	9.02	.806	7.270
FT-140A	1.400	.900	.590	9.00	.810	7.300
FT-150	1.500	.750	.250	8.30	.591	4.905
FT-150-A	1.500	.750	.500	8.30	1.110	9.213
FT-193	1.932	1.250	.625	12.31	1.360	16.742
FT-193-A	1.932	1.250	.750	12.31	1.620	19.942
FT-240	2.400	1.400	.500	14.40	1.570	22.608

A_L Values (mH/1000 turns) - Ferrite Toroids

For complete part number add mix number to core size below

Material >	43	61	63	67	68	75	77	F	J
core size	μ=850	μ=125	μ=40	μ=40	μ=20	μ=5000	μ=2000	μ=3000	μ=5000
FT-23 ( )	188	24.8	7.9	7.8	4.0	990	356	NA	NA
FT-37 ( )	420	55.3	17.7	17.7	8.8	2210	796	NA	NA
FT-50 ( )	523	68.0	22.0	22.0	11.0	2750	990	NA	NA
FT-50A- ( )	570	75.0	24.0	24.0	12.0	2990	1080	NA	NA
FT-50B- ( )	1140	150.0	48.0	48.0	12.0	NA	2160	NA	NA
FT-82 ( )	557	73.3	22.4	22.4	11.7	3020	1060	NA	NA
FT-87 ( )	NA	NA	NA	NA	NA	NA	NA	180	3020
FT-87A- ( )	NA	NA	NA	NA	NA	NA	NA	3700	6040
FT-114 ( )	603	79.3	25.4	25.4	12.7	3170	1140	1902	3170
FT-114A ( )	NA	146.0	NA	NA	NA	NA	NA	NA	NA
FT-140- ( )	952	140.0	45.0	45.0	NA	6736	2340	NA	6736
FT-150- ( )	NA	NA	NA	NA	NA	NA	NA	2640	* 4400
FT-150A ( )	NA	NA	NA	NA	NA	NA	NA	5020	8370
FT-193- ( )	NA	NA	NA	NA	NA	NA	NA	* 3640	* 6065
FT-193A ( )	NA	NA	NA	NA	NA	NA	NA	4460	7435
FT-240 ( )	1240	173.0	53.0	53.0	NA	6845	3130	NA	6845

INDUCTANCE-TURNS CHART, FERRITE TOROIDS

MATERIAL #43

turns count > core number	A_L*	10	20	30	40	50	60	70	80	90	100
					Inductance in millihenries						
FT-23 -43	188	.018	.075	.169	.300	.470	.677	.921	1.20	1.52	1.88
FT-37 -43	420	.042	.168	.378	.672	1.050	1.510	2.060	2.69	3.40	4.20
FT-50 -43	523	.052	.209	.471	.836	1.300	1.880	2.560	3.35	4.24	5.23
FT-50A -43	570	.057	.228	.513	.912	1.430	2.050	2.790	3.65	4.62	5.70
FT-50B -43	1140	.110	.456	1.030	1.820	2.850	4.100	5.590	7.30	9.23	11.4
FT-82 -43	557	.056	.224	.503	.894	1.400	2.010	2.740	3.58	4.53	5.59
FT-114 -43	603	.060	.241	.543	.965	1.510	2.170	2.950	3.86	4.88	6.03
FT-140 -43	953	.095	.380	.857	1.520	2.380	3.430	4.660	6.09	7.71	9.52
FT-240 -43	1239	.123	.494	1.110	1.970	3.090	4.440	6.050	7.90	9.96	12.3

MATERIAL #61

turns count > core number	A_L*	10	20	30	40	50	60	70	80	90	100
					Inductance in millihenries						
FT-23 -61	24.8	.002	.010	.022	.040	.063	.089	.122	.159	.201	.248
FT-37 -61	55.3	.006	.022	.050	.088	.138	.199	.271	.354	.448	.553
FT-50 -61	68.8	.007	.028	.062	.110	.172	.248	.337	.440	.557	.688
FT-50A -61	75.0	.008	.030	.068	.120	.186	.270	.366	.480	.608	.750
FT-50B -61	150.0	.015	.060	.135	.240	.375	.540	.735	.960	1.220	1.500
FT-82 -61	73.3	.007	.029	.066	.117	.183	.264	.359	.469	.594	.733
FT-114 -61	79.3	.008	.032	.071	.127	.198	.285	.389	.508	.642	.793
FT-114A-61	146.0	.015	.058	.131	.233	.365	.526	.715	.934	1.180	1.460
FT-140 -61	140.0	.014	.056	.126	.224	.350	.504	.686	.896	1.130	1.400
FT-240 -61	171.0	.017	.068	.154	.274	.428	.616	.838	1.090	1.390	1.710

MATERIAL #67

turns count > core number	A_L*	10	20	30	40	50	60	70	80	90	100
					Inductance in millihenries						
FT-23 -67	7.9	—	.003	.007	.013	.020	.028	.038	.051	.064	.079
FT-37 -67	19.7	.002	.008	.018	.032	.049	.071	.097	.126	.160	.197
FT-50 -67	22.0	.002	.009	.020	.035	.055	.079	.108	.141	.178	.220
FT-50A -67	24.0	.002	.020	.033	.038	.060	.086	.112	.154	.194	.240
FT-50B -67	48.0	.005	.019	.043	.077	.120	.173	.235	.307	.389	.480
FT-82 -67	22.4	.002	.009	.020	.036	.056	.081	.110	.143	.181	.224
FT-114 -67	25.4	.003	.010	.023	.041	.064	.091	.124	.163	.206	.254
FT-140 -67	45.0	.005	.018	.041	.072	.118	.162	.220	.288	.365	.450
FT-240 -67	53.0	.005	.021	.048	.084	.133	.199	.260	.339	.430	.530

MATERIAL #68

turns count > core number	A_L*	10	20	30	40	50	60	70	80	90	100
					Inductance in millihenries						
FT-23 -67	7.9	—	.003	.007	.013	.020	.028	.038	.051	.064	.079
FT-23 -68	4.0	—	.002	.004	.006	.010	.014	.020	.026	.032	.040
FT-37 -68	8.8	—	.006	.008	.014	.022	.032	.043	.056	.071	.088
FT-50 -68	11.0	.001	.004	.010	.018	.028	.040	.054	.070	.089	.110
FT-50A -68	12.0	.001	.005	.011	.019	.030	.043	.059	.077	.097	.117
FT-82 -68	11.7	.001	.005	.011	.019	.029	.042	.057	.075	.095	.117
FT-114 -68	12.7	.001	.005	.011	.020	.032	.046	.062	.081	.123	.127

* A_L value in mh/1000 turns

FERRITE BEADS

A Ferrite bead is a dowel-like device which has a center hole and is composed of ferromagnetic material. When placed on to a current carrying conductor it acts as an RF choke. It offers a convenient, inexpensive, yet a very effective means of RF shielding, parasitic suppression and RF decoupling.

The most common noise generating suspects in high frequency circuits are power supply leads, ground leads and connections, and interstage connections. Adjacent leads and unshielded conductors can also provide a convenient path for the transfer of energy from one circuit to another. A few ferrite beads of the appropriate material placed on these leads can greatly reduce or completely eliminate the problem. Best of all, they can be added to most any existing electronic circuit.

The amount of impedance is a function of both the material and the frequency, as well as the size of the bead. As the frequency increases, the permeability declines causing the losses to rise to a peak. With a rise in frequency the bead presents a series resistance with very little reactance. Since reactance is low there is little chance of resonance which could destroy the attenuation effect. Impedance is directly proportional to the length of the bead, therefore impedance is additive as each similar bead is slipped onto the conductor. Since the magnetic field is totally contained within, it does not matter if the beads are touching or separated. Ferrite beads do not have to be grounded and they cannot be detuned by external magnetic fields.

We recommend the #73 or the #77 ferrite bead material for the attenuation of RFI resulting from transmissions in the amateur band. The #43 material will provide best RFI attenuation from 30 to 400 MHz, and the #64 material is most effective above 400 MHz. The #J material is recommended for RFI from 0.5 to 10 MHz, but it can also be quite effective even below the AM broadcast band.

Ferrite beads are usually quite small and as a result only one pass, or a small number of turns are possible. On the other hand, a toroidal core usually has a much larger inner diameter and will accept a greater number of turns. The greater number of turns can be an advantage in some cases where a large amount of impedance is required. The increase in impedance is proportional to the square of the number of turns.

The number of turns on a single hole Ferrite bead or a toroidal core is identified by the number of times the conductor passes through the center hole. To physically complete one turn it would be necessary to cause the wires to meet on the outside of the device, however the bead or core does not care about the termination of each end of the wire and considers each pass through the center hole as one turn. (This does not apply to multihole beads)

When winding a six-hole bead, the impedance depends upon the exact winding pattern. For instance, it can be wound clock-wise or counter clock-wise progressively from hole to hole, or crisscrossed from side to side, or each turn can be completed around the outside of the bead. Each type of winding will produce very different results. The impedance figures for the six-hole bead in our chart are based on the current industry standard, which are two and one half turns threaded through the holes, crisscrossing from one side to the other side.

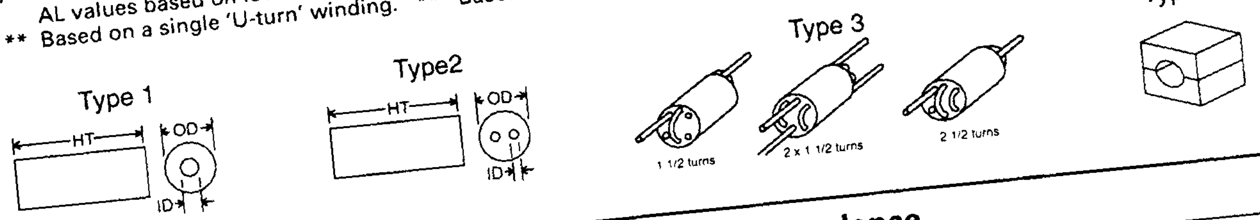
Temperature rise above the Curie point will cause the bead to become non-magnetic, rendering it useless as a noise attenuating device. Depending on the material, Curie temperature can run anywhere from 120°C to 500°C. See 'Magnetic Properties' chart for specifics.

The #73 and #J materials, as well as other very high permeability materials are semi-conductive and care should be taken not to position the cores or beads in such a manner that they would be able to short uninsulated leads together, or to ground. Other lower permeability materials with higher resistivity are non-conductive and this precaution is not necessary.

FERRITE SHIELDING BEADS

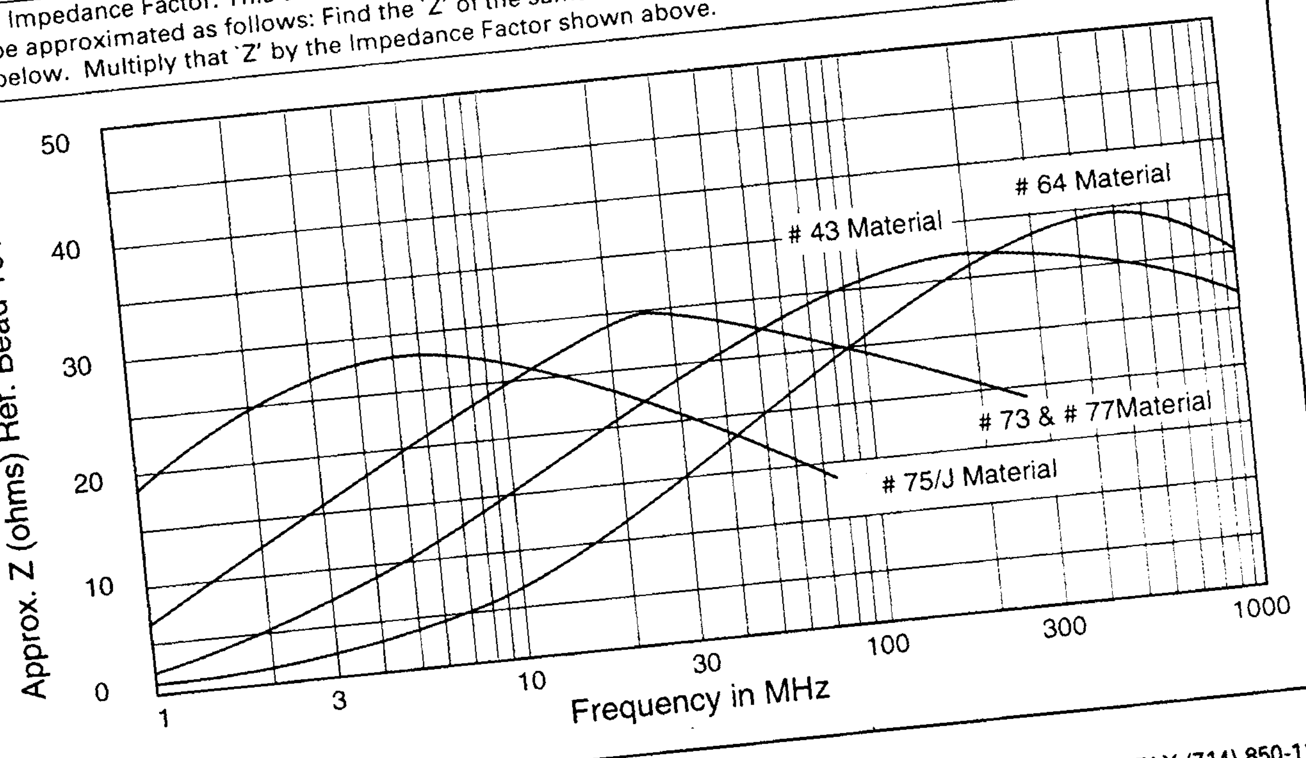
Part number	Bead type	Dimensions (inches) OD	ID	Hgt	A_L of Materials (µh/1000 turns) 43	64	73	75	77	Impedance factor*
FB-(__)-101	1	.138	.051	.128	510	150	1500	3000	—	1.00
FB-(__)-201	1	.076	.043	.150	360	110	1100	—	—	0.70
FB-(__)-301	1	.138	.051	.236	1020		3000	—	—	2.00
FB-(__)-801	1	.296	.094	.297	1300	390	3900	—	—	2.60
FB-(64)-901	2	.250	.050	.417	—	1130	—	—	—	7.50 **
FB-(__)-1801	1	.200	.062	.437	2000	590	5900	—	—	3.90
FB-(__)-2401	1	.380	.197	.190	520	—	1530	—	—	1.02
FB-(__)-5111	1	.236	.032	.394	3540	1010	—	—	—	6.70 ***
FB-(__)-5621	1	.562	.250	1.125	3800	—	—	—	9600	6.40
FB-(__)-6301	1	.375	.194	.410	1100	—	—	—	2600	1.70
FB-(43)-1020	1	1.000	.500	1.112	3200	—	—	—	—	6.20
FB-(77)-1024	1	1.000	.500	.825	—	—	—	—	5600	3.70
2X-(43)-151	4	1.020	.500	1.125	Splitbead, 43 Mat. Z=159 @ 25 MHz. Z-245 @ 100 MHz.					
2X-(43)-251	4	.590	.250	1.125	Splitbead, 43 Mat. Z=171 @ 25 MHz. Z-275 @ 100 MHz.					

Notes: Complete the part number by adding material number in space (__) provided.
AL values based on low frequency measurements. (µh/1000 turns) = nanohenries/turn²
** Based on a single 'U-turn' winding. *** Based on a 2 1/2 turn, side to side winding.



Material vs Frequency vs Impedance

* Impedance Factor: This chart is based upon the '101' size bead. Impedances for other size beads may be approximated as follows: Find the 'Z' of the same material at your operating frequency in the chart below. Multiply that 'Z' by the Impedance Factor shown above.



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FERRITES FOR RFI

Ferrite toroidal cores, as well as beads, can be very useful in attenuation of unwanted RF signals but we do not claim them to be a cure-all for all RFI problems. There are different types of noise sources, each of which may require a different approach. When dealing with any noise problem it is helpful to know the frequency of the interference. This is valuable when trying to determine the correct material as well as the maximum turns count.

RFI emanating from such sources as computers, flashing signs, switching devices, diathermy machines, etc..are very rich in harmonics and can create noise in the high and very high frequency regions. For this type of interference, the #43 material is probably the best choice since it has very good attenuation in the 20 MHz to 400 MHz. region. Some noise problems may require additional filtering with hi-pass or low-pass filters. If the noise is of the differential-mode type, an AC line filter may be required. See section on AC line filters and DC chokes.

In some cases the selected core will allow only one pass of the conductor, which is considered to one turn. In other cases it may be possible to wind several turns on to the core. When installing additional cores on the same conductor, impedance will be additive. When multiple turns are passed through a core, the impedance increases proportional to the square of the number of turns.

Keep in mind that because of the wide overlap in frequency range of the various materials, more than one material can provide acceptable results. Normally, the 43 material is recommended for frequency attenuation above 30 MHz., the 77, and 'F' materials for the amateur band, and the 'J' material for frequencies lower than the amateur band. 'W' and 'H' materials are for very low frequencies (below 1 MHz).

Computers are notorious for RF radiation, especially some of the older models which were made when RFI requirements were quite minimal. RFI can radiate from inter-connecting cables, AC power cords and even from the cabinet itself. ALL of these sources must be eliminated before complete satisfaction can be achieved. First, examine the computer cabinet to make sure that good shielding and grounding practices have been followed. If not, do what you can to correct it. If you suspect that RF is feeding back into the AC power system from your computer, wrap the power cord through an FT-240-77 or F toroidal core 6 to 9 times. This will act as an RF choke on the power cord and should prevent RF from feeding back into the power system where it can affect other electronic devices.

It is possible for an unwanted RF signal to enter a piece of equipment by more than one path, If so, ALL of these paths must be blocked before a noticeable effect is detected. Don't overlook the fact that RFI may be entering the equipment by radiation directly from your antenna feed line due to high SWR. This, of course, can be checked with an SWR meter, and can be corrected by installing an antenna balun, or by placing a few ferrite beads, or sleeves, over the transmission line at the antenna feed point. This should prevent RF reflection back into the outside shield of the coax feed line, which could radiate RFI.

Split bars are especially designed for computer flat ribbon cables. Two or more cores can be placed on the same cable, in which case the impedance will be additive. See following page for more specific information.

RFI in telephones can be substantially reduced with the insertion of an RF choke in each side of the talk circuit. Wind two FT-50A-J cores with about 20 turns each of #26 enameled wire. If possible, place one in each side of the talk circuit within the telephone base. If this is not possible, try mounting them in a small box with phone modular input and output jacks mounted in each end. This can now be used 'in-line' between the phone and the wall jack. Similar results can be achieved by winding 6 to 9 turns of the telephone-to-wall cable through an FT-140A-J ferrite toroidal core.

FERRITE CORES FOR RFI SUPPRESSION

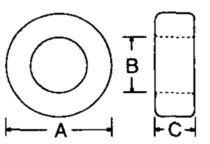
Following is a list of large size Ferrite Beads (FB), Ferrite Toroidal Cores (FT), and Split Ferrite Cores (2X), all of which are extensively used for RFI problems involving multiple wire bundles, coaxial cables, microphone cables, AC cords, and computer ribbon cables. These larger ferrite beads and toroidal cores can provide larger ID to accommodate the larger diameter coaxes and wire bundles.

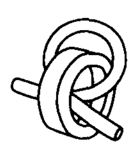
The 43 material is a good all around material for most RFI problems. However the lower frequencies from .5 to 10 MHz. can best be served with the 'J' material. The 77 material can provide excellent attenuation of RFI caused by amateur radio frequencies from 2 to 30 MHz. and the 43 material is best for everything above 30 MHz. However, it is still very effective across the entire amateur band but not quite as good as the 77 material. The 73 material is specifically a ferrite bead material having a permeability of 2500 and can provide RF attenuation very similar to the 77 core material.

When more impedance is needed (with any bead or core) use additional cores on the same conductor or a core with a large enough ID to accommodate multiple wire turns. When additional cores are added, the impedance will be additive, but when additional wire turns are added the impedance increases as to the number of turns squared.

Split beads and 'bars' are also available so that they may be installed without removing the end connector from the cable. Split bars are especially designed for computer ribbon cables. They are presently available for 1.3", 2.0" and 2.5" computer ribbon cables. Two or more may be used on the same cable to increase the impedance.

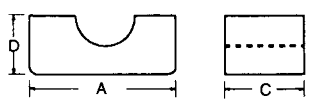
Shown below are typical impedances in ohms at 25 and 100 MHz with only one pass through the core.

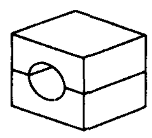




Part Number	A dim. (in)	B dim. (in)	C dim. (in)	25 MHz	100 MHz
FT-50B-43	.500	.312	.500	56	90
FT-50B-77	.500	.312	.500	74	60
FT-114-43	1.142	.750	.295	27	47
FT-114-77	1.142	.750	.295	35	29
FT-140-43	1.400	.900	.500	47	75
FT-140-77	1.400	.900	.500	62	50
FT-193- J	1.930	1.250	.625	below 10 MHz	
FT-240-43	2.400	1.400	.500	58	108
FT-240-77	2.400	1.400	.500	76	66

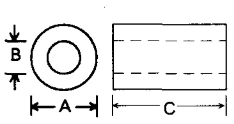
Note: All of the above size cores are available in the 'J' material which will be most effectivce if the troublesome frequency is below 10 MHz.

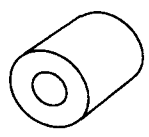




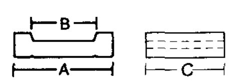
2X-43-251	.590	.250	1.125	171	275
2X-43-151	1.020	.500	1.125	159	245

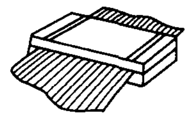
Also see page 60 on "Round Cable Suppression Cores" for more selection





FB-43-1020	1.000	.500	1.120	155	235
FB-77-1024	1.000	.500	.825	25	-
FB-43-5621	.562	.250	1.125	171	250
FB-77-5621	.562	.250	1.125	50	-
FB-43-6301	.375	.194	.410	55	48
FB-77-6301	.375	.194	.410	73	59





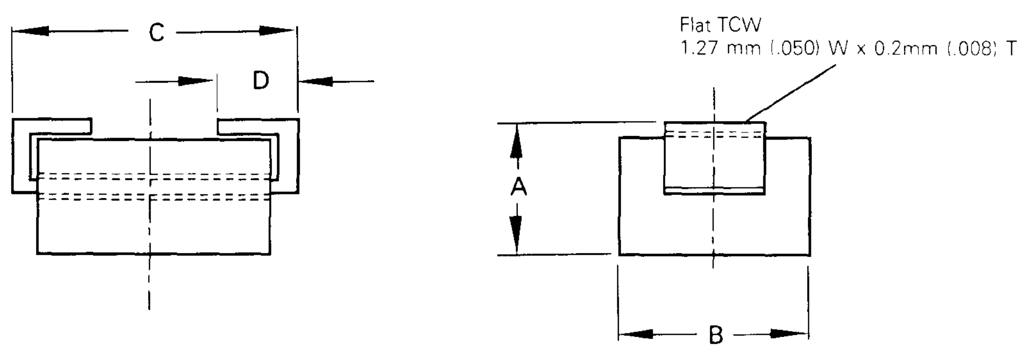
2X-43-651	for 1.3" ribbon cable	97	200
2X-43-951	for 2.0" ribbon cable	105	285
2X-43-051	for 2.5" ribbon calbe	90	250

SURFACE MOUNT BEADS

Surface mount beads in Amidon #43 material are available in two sizes. These SM Beads are constructed with a solid flat copper conductor with a 95/5 tin/lead coating. This rugged construction decreases dc resistance and increases current carrying capacity compared with plated beads.

Notes:

- *Supplied in taped and reeled in carriers, per EIA Standard 481A*
- *Also available in bulk packed. Change end of Part number from 7 to 6*
- *For more information, see next page*
- *Meet solder requirements of EIA-186-10E, temperature 260 ± 5 °C and time 10 ± 1*
- *Beads are controlled for impedance limits only*



Dimensions (in millimeters)

Part Number	A	B	C	D	Weight (gm)	Tape Width	25 MHz Min. (Ω)	100 MHz Min. (Ω)	Max† DC (Ω)
SMB43-9447	2.85±0.2	3.05±0.1	5.1±0.85	1.35±0.65	0.15	12.0	23	47	0.6×10^{-3}
SMB43-1447	2.85±0.2	3.05±0.1	9.6±0.95	1.35±0.65	0.30	16.0	45	95	0.9×10^{-3}

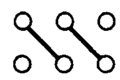
*Impedance (in ohms) measured using a HP 4191A with spring clip fixture HP 16092A
†Maximum DC resistance

PC BEADS

Multiple single turn printed circuit beads or multi-turn printed circuit beads are available in different sizes in Amidon #43 materials. The beads are supplied with tinned copper jumper wires which complete the desire winding configuration on the printed circuit board.

Similar beads are also available for surface mount board. The jumper wires are oxygen free high conductivity copper with a 95/5 tin/lead coating. Note that the beads are controlled for impedance limits only.

Typical
Printed Circuit Board Layouts



PCB43-0308
Figure 1-A 3 Turns

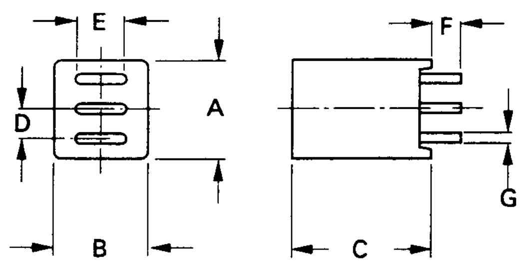
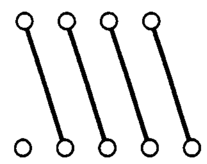
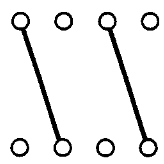


Figure 1



PCB43-0428
Figure 2-A 4 Turns



PCB43-0428
Figure 2-B 2 x 2 Turns

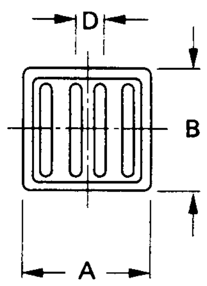


Figure 2

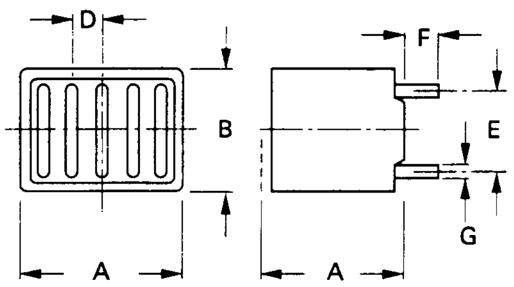
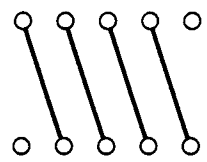


Figure 3



PCB43-0528
Figure 3-A 5 Turns

Dimensions *(Bold numbers are in millimeters, bottom numbers are in inches)* Impedance⁺ (Ω)

PART NO.	Fig.	A	B	C Max.	D	E	F Min.	G	25 MHz Min.	100Mhz Min.
PCB43-0308	1	**8.0-.35** .308	**7.5-.25** .290	**11.4** .450	**2.54±.1** .100	**2.54±.1** .100	**2.3** .090	**.65** 22 AWG	150	230
PCB43-0428	2	**11.2-.50** .428	**11.2-.50** .430	**11.4** .450	**2.54±.1** .100	**7.6±.2** .300	**2.3** .090	**.65** 22 AWG	175	270
PCB43-0528	3	**13.45±.25** .528	**11.2-.50** .430	**11.4** .450	**2.54±.1** .100	**7.6±.2** .300	**2.3** .090	**.65** 22 AWG	175	270

⁺Impedance specification applies for any one jumper wire, using a HP 4193A.

TRADITIONAL BROADBAND TRANSFORMERS

Broadband Transformers, as the name implies, are transformers which will operate over a broad frequency range. They can also provide a step-up or a step-down impedance transformation, match an unbalanced source to a balanced load, or serve both purposes

The two-hole, or 'binocular' type, ferrite core, known as the multi-aperture core, is very popular for low power applications. Multi-aperture cores were developed to provide maximum impedance per length of turn in order to better serve the broadband transformer. Two-hole multi-aperture cores are widely used as 75 ohm and 300 ohm matching transformers for receivers and low power UHF and VHF applications.

The bandwidth of a broadband transformer has practical limitations. The functions which control the low frequency performance are parallel inductance and parallel resistance. This combination must remain sufficiently high in order to maintain an acceptable match. Unless a very low 'Q' core is used these will be the dominant factors. Normally, the inductive reactance at the lowest frequency should be four times greater than the source impedance. However, in order to achieve this ratio, we may find that excessive turns may be required which will adversely affect the high frequency performance. Using a core of high permeability will minimize the number of required turns.

The factors which limit the high frequency response are distributed capacitance and inductance leakage due to uncoupled flux. The more the distributed capacitance and the flux leakage can be minimized, the better will be the high frequency performance of the transformer. The best compromise between distributed capacitance and leakage inductance can be obtained by twisting the conductors together prior to winding. This greatly minimizes the leakage inductance in small transformers.

In applications which generate minimal flux, such as in low power applications and one to one ratio transformers, the goals can best be accomplished by using a high permeability core in order to minimize turns at the lowest frequency. This in turn, will minimize the distributed capacitance which will improve the high frequency response.

Generally, ferrite cores are preferred for broadband transformers because of their high permeability factors. However, in power applications the high permeability ferrite cores can be easily saturated, and care must be taken to keep the induced flux density well below the maximum flux density rating of the core in order to confine the signal energy to the linear portion of the flux density curve. Detailed information can be found in the 'Ferromagnetic Design and Applications Handbook' by Doug DeMaw.

The main concern in power applications is core loss generated by the net induced flux. In this case, iron powder cores are generally preferred because of their higher maximum flux density rating. Core loss increases at a squared rate with flux density at any given frequency. When extremely high voltages are encountered, such as in a high impedance ratio step-up transformer, we recommend that the core first be wrapped with glass-electrical tape before winding, such as 3M-27, This will provide added protection against voltage breakdown and arcing.

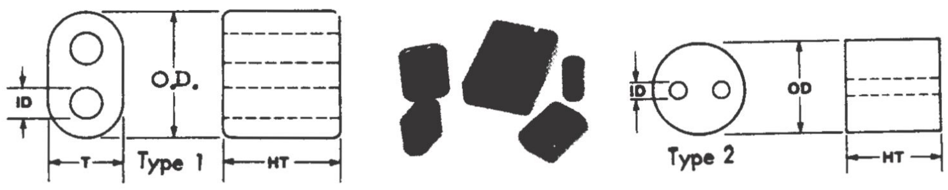
A high grade of wire insulation is required when operating with high voltages. We recommend 'Thermoleze' insulated wire. This is a very tough vinyl-like insulation having a voltage breakdown potential of better than 2000 volts and a temperature rating of 200°C.

- **Amidon now offers High Power Transmission Line Baluns and Ununs (unbalanced to unbalanced) transformers. Please call for brochure.**
  - **1 MHz to 50 MHz frequency range**
  - **2 KW to 10 KW power level**
  - **0.2dB loss (98% efficient)**
  - **Baluns: 50Ω:12.5Ω; 50Ω:50Ω; 50Ω:75Ω; 50Ω:100Ω; 50Ω:200Ω; 50Ω:300Ω; 50Ω:450Ω; 50Ω:600Ω**
  - **Ununs: Range from 50Ω:3Ω up to 50Ω:800Ω**

MULTI-APERTURE CORES

The two-hole multi-aperture core is commonly used for wideband transformers and impedance matching devices. The primary concern, when designing a wideband transformer, is to extend the bandwidth with a minimum of loss. The limiting factors are inductive reactance and core loss.

By winding through both holes of the binocular type two hole core, a higher inductance per turn can be obtained than would otherwise be possible with a single hole core.

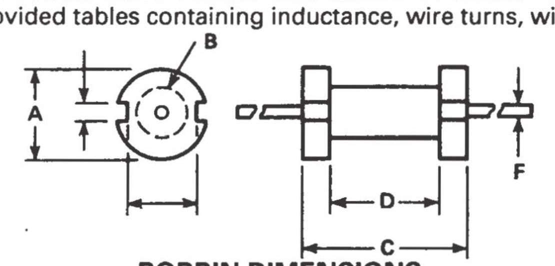


Dimensions in inches; **A_L value in mh/1000 turns**

Part No.	OD	ID	Hgt	Th	Type	Part No.	OD	ID	Hgt	Th	Type	A_L
BN-43-202	.525	.150	.550	.295	1	BN-61-2302	.136	.035	.093	.080	1	60
BN-43-2302	.136	.035	.093	.080	1	BN-61-2402	.280	.070	.240	.160	1	160
BN-43-2402	.280	.070	.240	.160	1	BN-61-1702	.250	.050	.470	—	2	440
BN-43-3312	.765	.187	1.000	.375	1	BN-61-1802	.250	.050	.240	—	2	310
BN-43-7051	1.130	.250	1.130	.560	1	BN-73-202	.525	.150	.550	.295	1	
BN-61-202	.525	.150	.550	.295	1	BN-73-2402	.275	.070	.240	.160	1	

FERRITE BOBBIN CORES

Ferrite Bobbin cores provide a convenient means of winding RF chokes. Because of their open magnetic path, they can handle more current than toroids of similar effective area. To aid in the design of such chokes, we have provided tables containing inductance, wire turns, wire size and maximum current for each type of bobbin.



Winding table: number of turns to completely fill bobbin

Wire Size	20	22	24	26	28	30	32	34	36
B-77-1111	9	14	23	35	56	88	164	205	400

Wire Size	20	22	24	26	28	30	32	34	36
B-77-1011	24	39	60	93	148	230	425	535	1050

BOBBIN DIMENSIONS **A_L value in mh/1000 turns**

Part Number	A	B	C	D	F	A_L	NI
Bobbin #B-77-1111	.196″	.107″	.500″	.400″	#22	17	60
Bobbin #B-77-1011	.372″	.187″	.750″	.500″	#20	39	130

BOBBIN #B-77-1111		**AL = 17**	**NI=60**	**BOBBIN #B-77-1011**		**AL = 39**	**NI = 130**
Inductance	wire turns	wire size	I (max)	Inductance	wire turns	wire size	I (max)
10 µh	24	24	2.50	25 µh	25	20	5.20
25 µh	38	26	1.60	50 µh	36	22	3.60
50 µh	38	26	1.60	100 µh	50	24	2.60
100 µh	77	30	0.78	250 µh	80	26	1.60
250 µh	121	31	0.50	500 µh	113	27	1.10
500 µh	171	32	0.35	1.0 mh	160	28	0.80
1.0 mh	243	34	0.25	2.5 mh	253	30	0.50
2.5 mh	383	36	0.16	5.0 mh	358	32	0.36
5.0 mh	542	37	0.11	10.0 mh	506	34	0.25
10.0 mh	762	38	0.08	25.0 mh	800	36	0.16

BALUNS & TUNING CORES

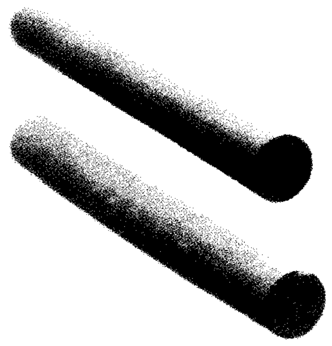
CORE CONFIGURATIONS

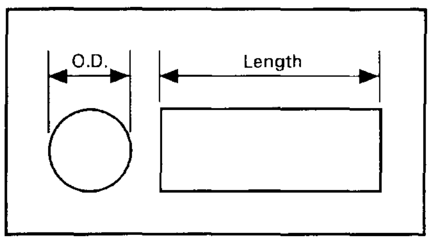
Slug cores	All popular sizes
Threaded cores	All popular sizes
Coil Forms	All popular sizes
Stud Cores	All popular sizes
U Cores	Call for tooled parts list

NOTES:
1) Parts available in all materials and in different lengths.
2) Bobbins and coil forms available with or without leads.
3) Special machining for custom shapes available.

FERRITE RODS, BARS, PLATES AND TUBES

Ferrite rods, bars, plates and tubes are primarily used in radio antennas and chokes. They are available in materials from permeability of 20 to 10,000. However, only rods with #61 (μ_i = 125), and #33 (μ_i = 800)materials are standard stocking items. All other materials are custom manufactured, but readily available with lead time for delivery.





Standard Stocking Rods

Part number	Material	Permeability	Diameter (in)	Length (in)	A_L value mh/1000 t	Ampere turns
R61-025-400	61	125	.25	4.0	26	110
R61-037-300	61	125	.37	3.0	32	185
R61-050-400	61	125	.50	4.0	43	575
R61-050-750	61	125	.50	7.5	49	260
R33-037-400	33	800	.37	4.0	62	290
R33-050-200	33	800	.50	2.0	51	465
R33-050-400	33	800	.50	4.0	59	300
R33-050-750	33	800	.50	7.5	70	200

Other Dimensions and materials are available. Please call for your other requirements.

FERRITE RODS are available as standard stocking item in various sizes in the #33 and #61 materials. Ferrite rods of other materials are available with lead time. The most common use of a ferrite rods is for antennas and choke applications.

ANTENNAS: Ferrite Rods are widely used as loop antenna such as broadcast-band receivers, direction-finder receivers, etc. The #61 material rods are widely used for commercial AM (550 KHz to 1600 KHz) radio antenna and by radio amateurs (2 MHz to 30 MHz). The #33 material rods are more suitable for very low frequency range (100 KHz to 1 MHz). The table on next page lists the recommended frequency range for a few different materials.

To calculate the inductance or number of turns, please use the formula below:

$$N = 1000\sqrt{\frac{\text{desired 'L' (mh)}}{A_L \text{ (mh/1000 turns)}}} \qquad L(\text{mh}) = \frac{A_L \times N^2}{1{,}000{,}000} \qquad A_L(\text{mh/1000 turns}) = \frac{1{,}000{,}000 \times \text{'L' (mh)}}{N^2}$$

N = number of turns   L = inductance (mh) A_L = inductance index (mh)/1000 turns)

Loop antenna has a height factor called effective height, h_e (in m), which when multiplied with field strength, F (in μV/m), provides the loop-induced voltage (in μV).

$$h_e = \frac{2\pi N A \mu_e}{\lambda}\text{, in meter.}$$

$$\text{Loop Induced Voltage} = Fh_e = \frac{2\pi N A \mu_e F}{\lambda}\text{, in μV.}$$

Where N = no. of turns
A = area in square meter (m^2)
λ = wavelength in meter
μ_e = effective permeability of rod
and where $d/\lambda < 1$, d = diameter of rod

It can be seen from the equation that the highest induced voltage occurs when the windings occupied the entire rod (when N is largest).

Initial Permeability, μ_i	Maximum Permeability, μ_m	Saturation Flux Density, Bs, at 13 Oe	Recommended Frequency *Range (MHz)	Amidon Material
20	—	2000 at 40 Oe	80-100	68
40	—	3000 at 20 Oe	10-80	67
125	450	2350	5.0-30	61
250	375	2200	0.05-4	64
300	3600	3900	0.001-5	83
800	3000	2750	0.01-7	33
2000	4600	1150	0.001-2	77

* Frequency ratings are for optimum Q in narrow-band tuned circuits.

CHOKE Applications: Both the #33, and the #61 rods are used extensively in choke applications. The #33 material should be selected for the 3.75 - 7.5 MHz (40-80 meters band). The #33 rods are also often used in speaker cross-over networks. The #61 material is most suitable for the 7.5-30 MHz (10-40 meters band) range. Due to the open magnetic structure of the rod configuration, considerable current can be tolerated before it will saturate.

There are several factors that have a direct bearing on the effective permeability of a ferrite rod, which in turn will effect inductance and 'Q', as well as the A_L value of the rod and its ampere-turns rating. These are: (1) Length to diameter ratio of the rod, (2) Placement of the coil on the rod, (3) Spacing between turns and, (4) Air space between the coil and the rod. In some cases, the effective permeability of the rod will be influenced more by a change in the length to diameter ratio than by a change in the initial permeability of the rod. At other times, just the reverse will be true.

Greatest inductance and A_L value will be obtained when the winding is centered on the rod rather than placed at either end. The best 'Q' will be obtained when the winding covers the entire length of the rod.

Because of all of the above various conditions it is very difficult to provide workable A_L values. However we have attempted to provide a set of A_L and NI values for various types of rods in our stock. These figures are based on a closely wound coil of #22 wire, placed in the center of the rod and covering nearly the entire length. Keep in mind that there are many variables and that the inductance will vary according to winding technique.

EFFECTIVE PERMEABILITY

Coil placements and the length of windings on the rods, bars, plates and tubes affect the effective permeability of these devices. The corrected permeability for variation in coil length versus rod length is:

$$\mu' = \mu_e \sqrt[3]{(\ell_r / \ell_c)}$$

Where μ' = corrected μ,
μ_e = effective permeability from the chart
ℓ_r = rod length in cm or inches
ℓ_c = length of coil windings in cm or inches

EFFECTS ON 'Q'

The spacing between the turns has a significant effect on the 'Q', and the inductance of the rods. The best values of 'Q' are obtained when the coil turns are spaced one wire diameter apart, with the windings located at the center of the rod. Litz wire provides the highest level of 'Q'.

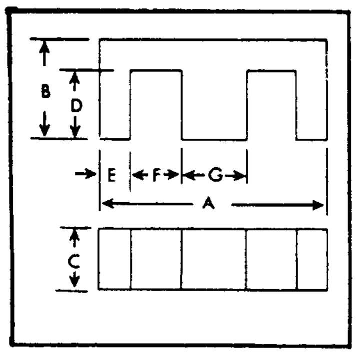
Reference: "Ferromagnetic Core Design Handbook " by Doug DeMaw.

FERRITE 'E' CORES

E-Cores are available in the 77 (stocking) and J (non-stocking) Material.

TYPE 77 FERRITE MATERIAL
permeability 2000

These are ideally suited for low power applications up to 200 watts. A nylon bobbin is supplied for easy winding. Please see section IV on "Toroid Mounts & E-Core Bobbins" for more information on different types of E-Core Bobbins.



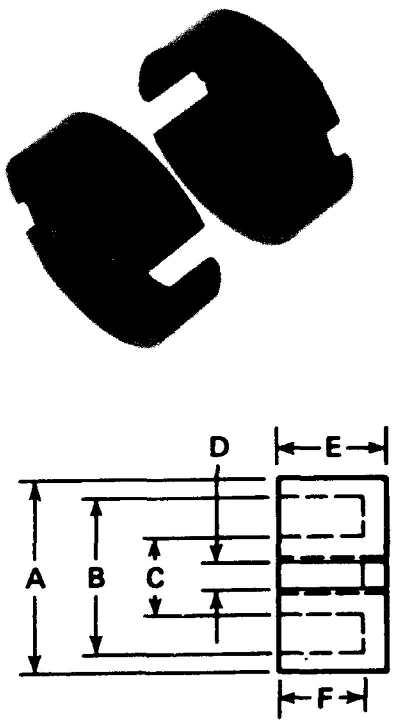
E-Core Physical Dimensions (inches)								
Part No.	A	B	C	D	E	F	G	Power
EA-77-188	.760	.318	.187	.225	.093	.192	.187	10 watts
EA-77-250	1.000	.380	.250	.255	.125	.250	.250	20 watts
EA-77-375	1.375	.562	.375	.375	.187	.312	.375	70 watts
EA-77-500	1.625	.650	.500	.405	.250	.312	.500	100 watts
EA-77-625	1.680	.825	.605	.593	.234	.375	.468	200 watts

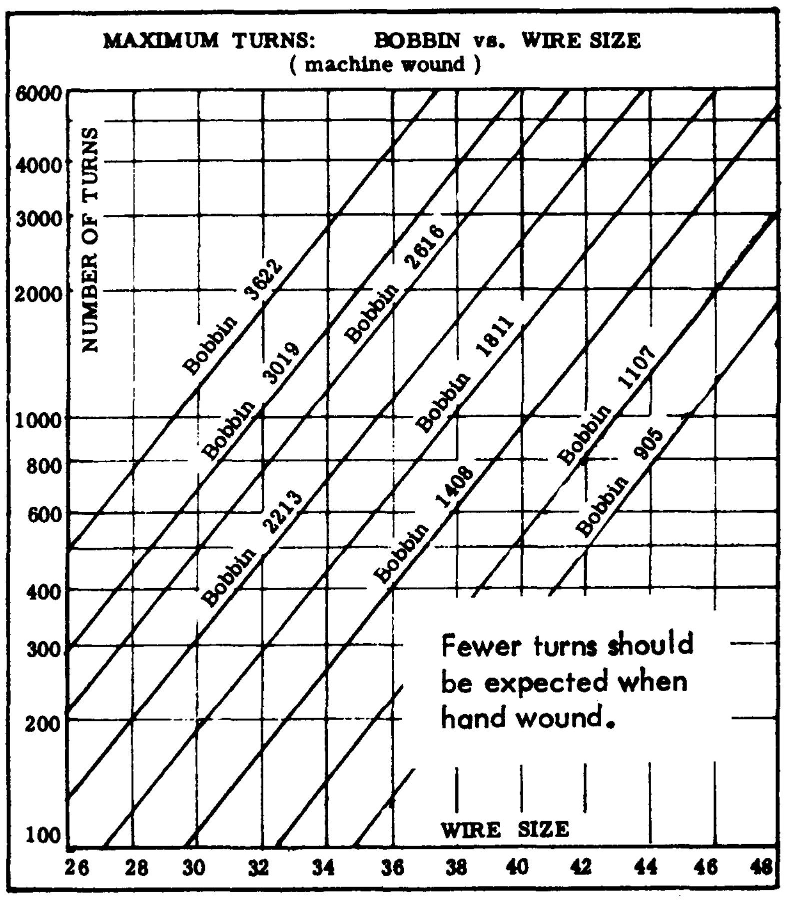
E-Core Magnetic Properties							
	A_e	ℓ_e	V_e	A_s	A_w	$A_c x A_w$	A_L value
Part No.	mm^2	mm	mm^3	mm^2	mm^2	mm^4	mh/1000 turns
E-77-188	22.5	40.1	900	1050	55.7	1250	1060
E-77-250	40.4	48.0	1930	1700	80.6	3250	1660
E-77-375	90.3	68.8	6240	3630	151.0	13700	2760
E-77-500	160.0	76.7	12300	5410	163.0	26100	4470
E-77-625	184.0	98.0	18000	7550	287.0	52900	5300

Wire Size vs. Number of Turns											
Part No.	18	20	22	24	26	28	30	32	34	36	38
EA-77-188	21	33	50	79	125	196	293	439	669	1046	1548
EA-77-250	34	62	93	147	232	364	532	814	1240	1938	—
EA-77-375	63	94	149	235	372	582	868	1302	1984	—	—
EA-77-500	50	141	212	335	532	829	1236	1855	—	—	—
EA-77-625	159	250	375	593	939	1470	2191	—	—	—	—

FERRITE POT CORES

Ferrite Material #77, 2000 Permeability





$$\text{Turns} = \sqrt{\frac{\text{desired 'L' (mh)}}{A_L \text{ (mh/1000 turns)}}} \times 1000$$

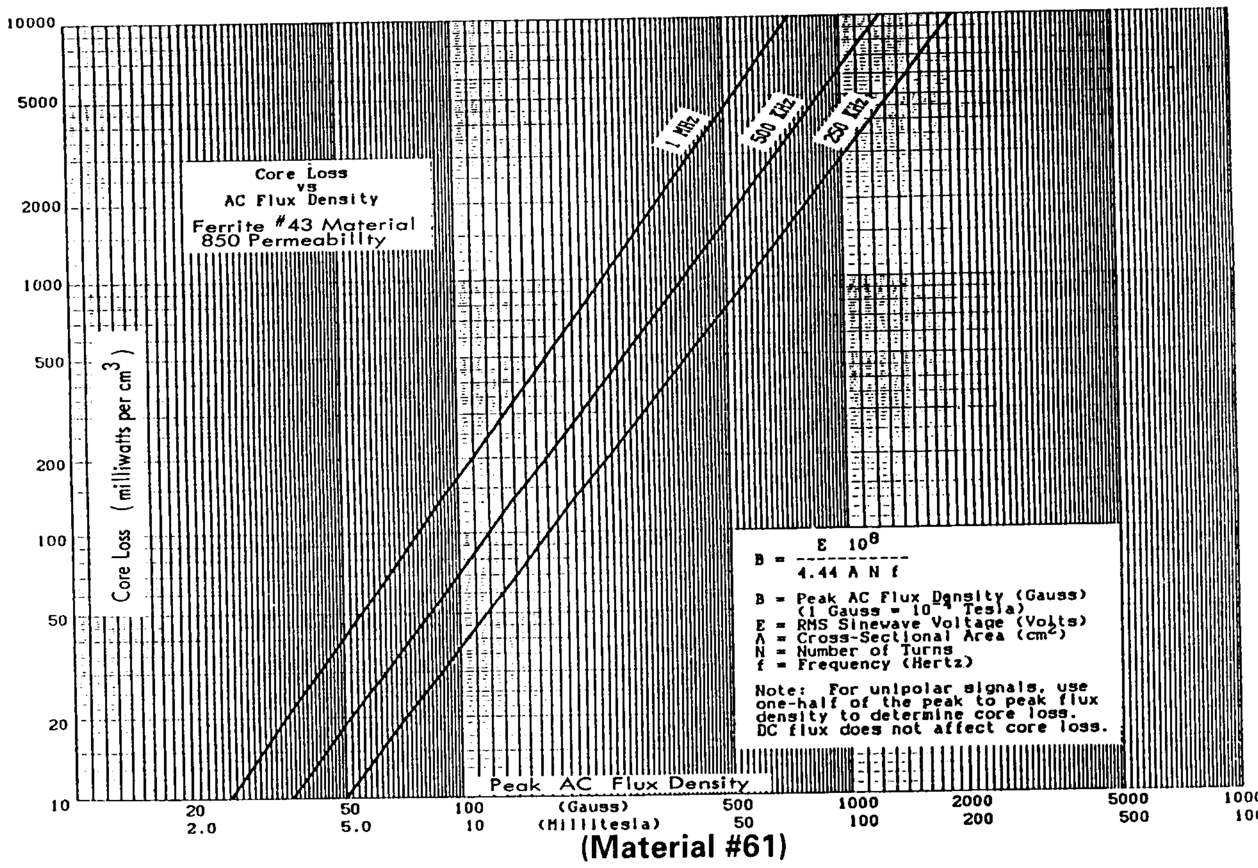
Physical Dimensions (In millimeters)						
Part number	A	B	C	D	E	F
PC-1107-77	11.10	9.20	4.60	2.10	3.21	2.27
PC-1408-77	14.05	11.80	5.90	3.10	4.18	2.90
PC-1811-77	18.00	15.25	7.45	3.10	5.27	3.70
PC-2213-77	21.60	18.70	9.25	4.55	6.70	4.70
PC-2616-77	25.50	21.60	11.30	5.55	8.05	5.60
PC-3019-77	30.00	25.40	13.30	5.55	9.40	6.60
PC-3622-77	35.60	30.40	15.90	5.55	10.85	7.40

Magnetic Dimensions					
Part No.	A_e mm^2	ℓ_e mm	V_e mm^3	A_L value mh/1000 turns	Power Based on 20 KHz
PC-1107-77	15.9	15.9	252	1420	Max 3 watts
PC-1408-77	25.0	20.0	500	1960	Max 5 watts
PC-1811-77	43.0	25.9	1120	2880	Max 10 watts
PC-2213-77	63.0	31.6	2000	3660	Max 20 watts
PC-2616-77	93.0	37.2	3460	4700	Max 50 watts
PC-3019-77	136.0	45.0	6100	5900	Max 70 watts
PC-3622-77	202.0	53.0	10600	7680	Max 90 watts

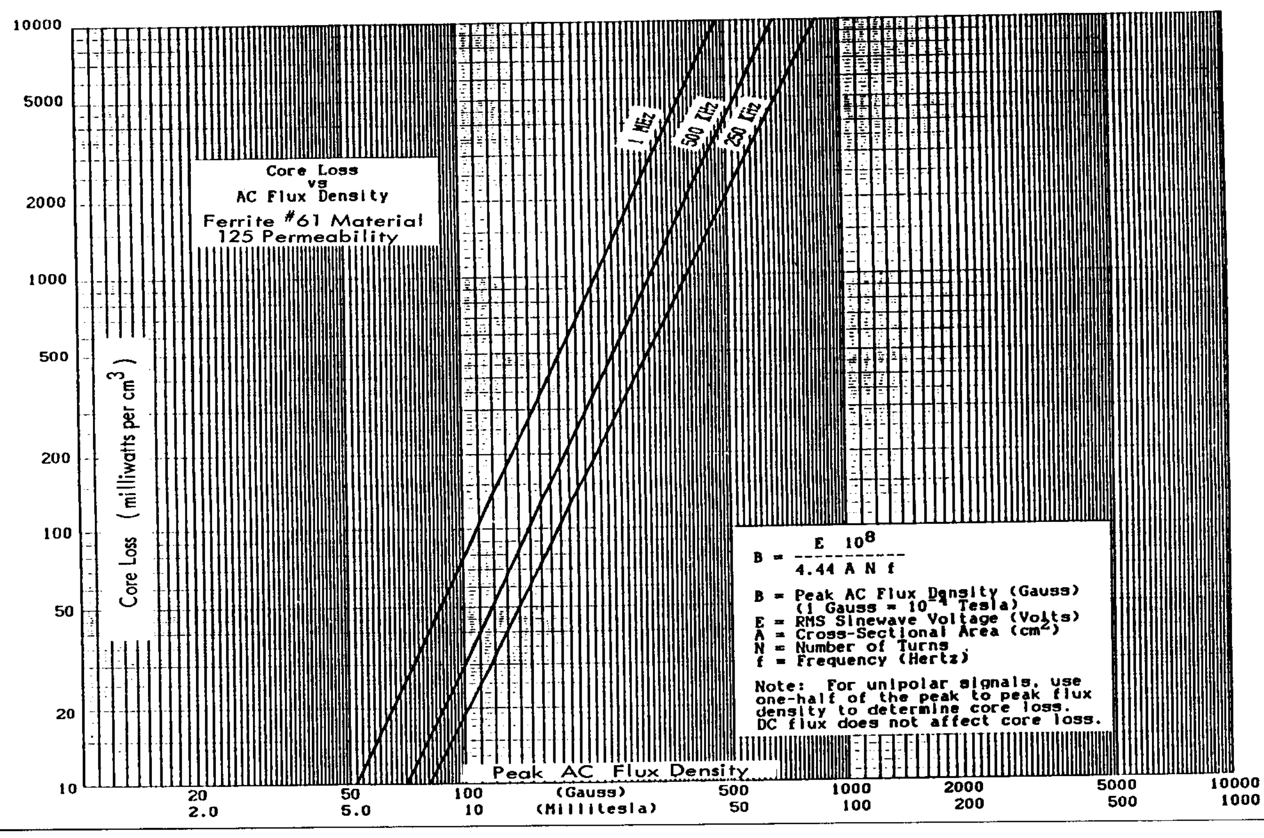
Note: Power ratings are conservative, based on 20 KHz. switching frequency.

CORE LOSS vs. AC FLUX DENSITY

(Material #43)



(Material #61)



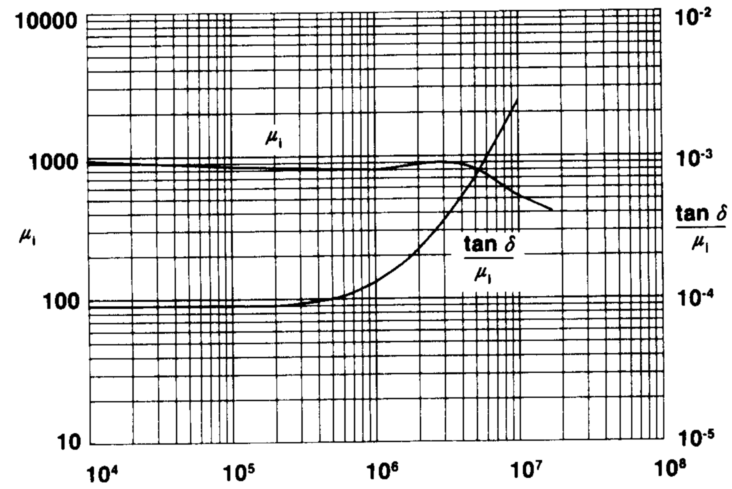
FERRITE MATERIAL 43

Primary Characteristics
High impedance
High resistivity

Applications
Optimum suppression of unwanted signals above 40 MHz

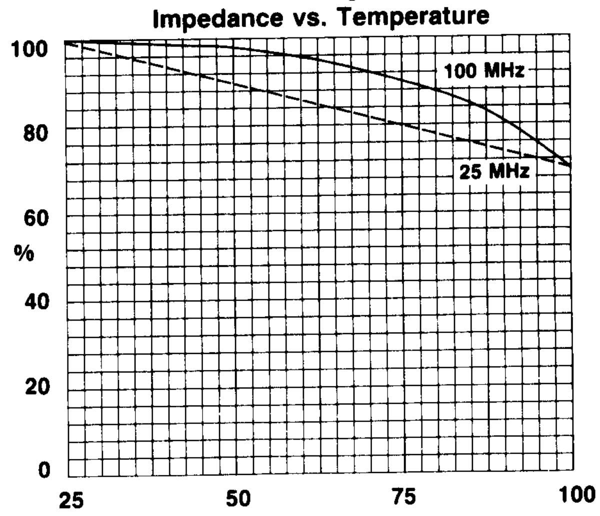
Available Core Shapes
Shield Beads
Multi-aperture and broadband transformer cores
Special shapes for EMI suppression

Initial Permeability & Loss Factor vs. Frequency



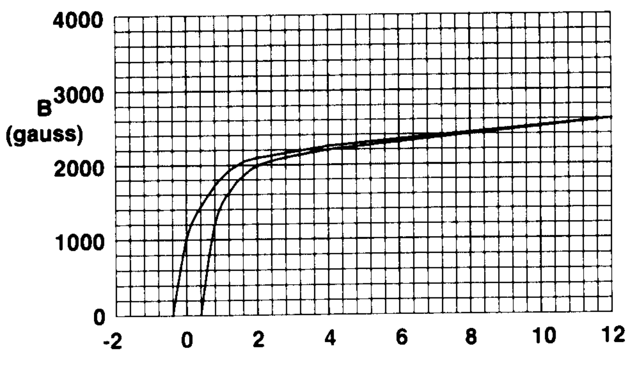
Measured on a **25.4mm** OD toroid using HP 4275A and HP 4191A.

Percent of Original 25°C Impedance vs. Temperature



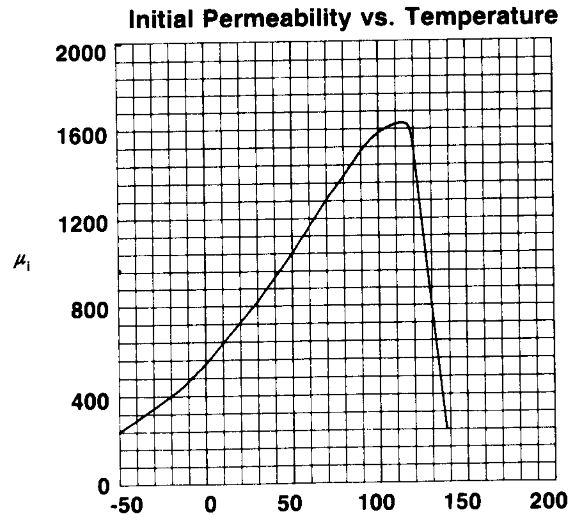
Measured on a **25.4mm** OD toroid using a HP 4191A

Hysteresis Loop



Measured on a **25.4mm** OD toroid.

Initial Permeability vs. Temperature

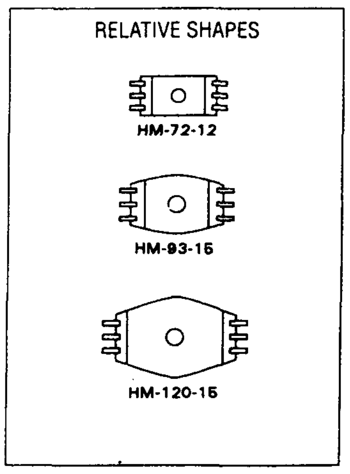


Measured on a **25.4mm** OD toroid at 100 kHz using a HP 4275A.

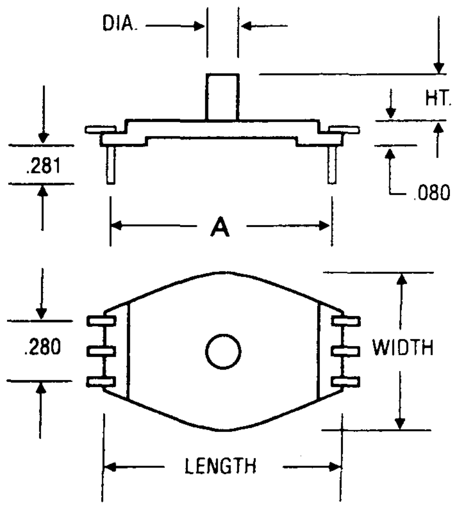
HORIZONTAL MOUNT FOR TOROID

The HM horizontal mounts for toroids are made of Nylon 6/6 material and rated at UL94-V0. It has 6 brass terminals. Each terminal is tin plated. These mounts are used for low profile horizontal mounting of wound toroids with outside diameter (OD) of 0.4" to 1.0".

Solderability: MIL-STD-202, Method 208
Terminals: 0.025" x 0.01", 60/40 tin plated



Not to scale
±.010 inches



(All Dimensions are in inches)

Part No.	Length	Width	Ht.	Dia.	A	Toroidal Core Size
HM-72-12	.720	.460	.163	.120	.638	O.D. up to 0.5"
HM-72-00	.720	.460	.000	.000	.638	FT-23, FT-50
						T-25 → T-50
HM-93-00	.937	.600	.000	.000	.848	O.D. up to 0.825"
HM-93-15	.937	.600	.250	.156	.848	FT-82, T-68, T-80
HM-120-00	1.208	.850	.000	.000	1.130	O.D. up to 1.0"
HM-120-15	1.208	.850	.250	.156	1.130	FT-82, T-68, T-80

VERTICAL MOUNT FOR TOROIDS

The VM vertical mounts for toroids are made of Nylon 6/6 material and rated at UL94-V0. They are available either with no terminals or with 4, 10 or 14 terminals. Those with no terminals have four through holes of diameter 0.048" for mounting.

Solderability: MIL-STD-202, Method 208
Terminals: 0.04" diameter, 100% tin plated

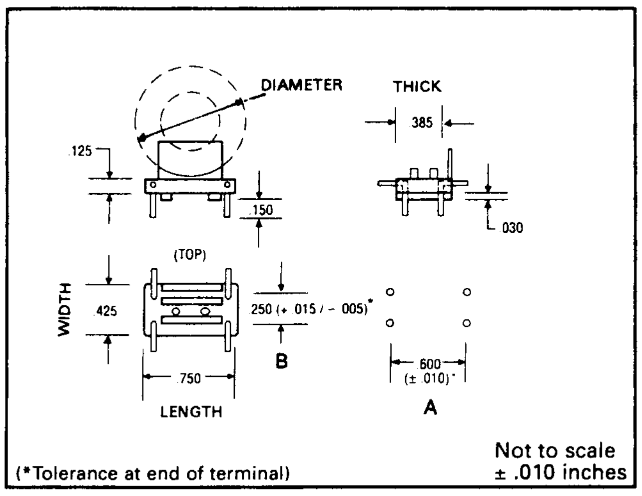


Figure 1

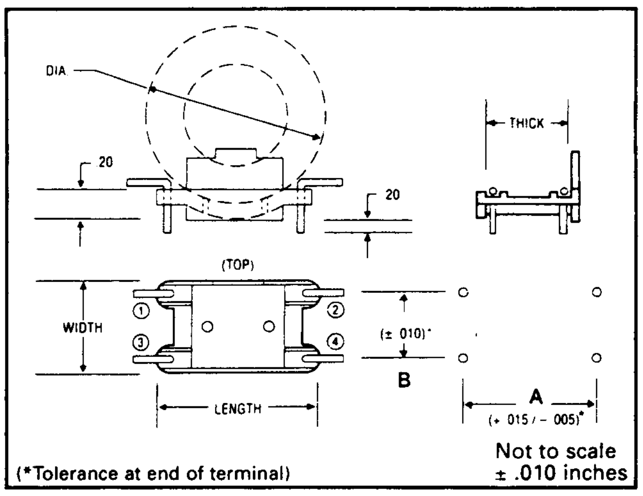


Figure 2

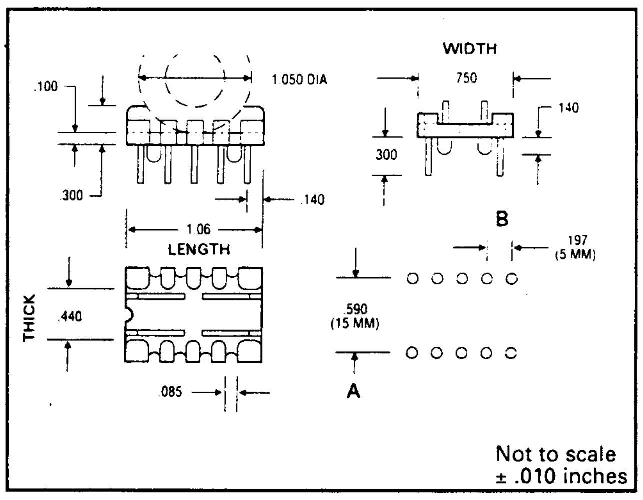


Figure 3

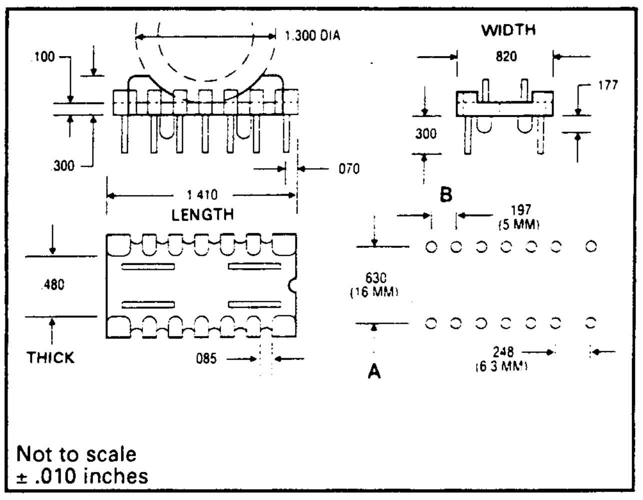


Figure 4

(All Dimensions are in inches)

VERTICAL MOUNT FOR TOROIDS

Part No.	Figure	Length (inches)	Width (inches)	Thick (inches)	Toroid Diameter (inches)	A (inches)	B (inches)	Toroidal Core Size
VM-750-4	1	.75	.425	.385	1.00	.60	.250	4 terminals, 0.04", AWG #18, for toroid up to O.D.=1.15"
VM-750-0	1	.75	.425	.385	1.00	.60	.250	No terminal - 0.048" through hole for toroid up to O.D.=1.15"
VM-100-4	2	1.00	.60	.51	1.20	.80	.400	4 terminals, 0.050", AWG #16, for toroid up to O.D.=1.20"
VM-100-0	2	1.00	.60	.51	1.20	.80	.400	No terminal - 0.048" through hole for toroid up to O.D.=1.20"
VM-110-4	2	1.10	.80	.71	1.60	.90	.600	4 terminals, 0.05", AWG #16, for toroid up to O.D.=1.60"
VM-110-0	2	1.10	.80	.71	1.60	.90	.600	No terminal - 0.048" hole for toroid up to O.D.=1.60"
VM-140-4	2	1.40	.90	.81	2.54	1.20	.700	4 terminals, 0.050", AWG #16, for toroid up to O.D.=2.5"
VM-140-0	2	1.40	.90	.81	2.54	1.20	.700	No terminal - 0.048" hole for toroid up to O.D.=2.5"
VM-106-10	3	1.06	.75	.440	1.05	.59	.197	10 terminals, 0.04", AWG #18, for toroid up to O.D.=1.1"
VM-140-14	4	1.40	.82	.48	1.30	.63	.197	14 terminal - 0.04" AWG #18, for toroid up to O.D>=1.3"