Ferrite Cores and Materials

NICKEL ZINC ferrite cores exhibit high volume resistivity, moderate 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 and wideband applications. Permeability range 125 mu to 850 mu.

The MANGANESE ZINC group of ferrites, have permeabilities ranging from 850 to 5000 mu. They have fairly low volume resistivity and moderate saturation flux density. High 'Q' factors for the 1 KHz to 1 MHz frequency range. Widely used for switched mode power conversion transformers operating in the 20 KHz to 100 KHz frequency range. Frequency attenuation range 20 MHz. to 400 MHz and above.

Turns formula

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

Key to part number

FT	-	50	-	61
ferrite toroid		OD		material

MATERIAL 33 (u=850) Manganese-zinc. Low volume resistivity. Suitable for 1 KHz to 1 MHz. applications. Most commonly used for antenna rods.

MATERIAL 43 (u=850) Nickel-zinc. High volume resistivity. Widely used for medium frequency inductors and wideband transformers up to 50 MHz. Very good frequency attenuation from 30 MHz to 400 MHz. Toroids and Ferrite Beads.

MATERIAL 61 (u=125) A nickel-zinc material. Moderate temperature stability and high 'Q' for frequencies 0.2 MHz to 15 MHz. Also commonly used for wideband transformers up to 200 MHz. Toroids, Rods, and Two-hole Baluns.

MATERIAL 63 (u=40) High volume resistivity and low permeability. High 'Q' for frequency range of 15 MHz to 25 MHz. Toroidal form only.

MATERIAL 64 (u=250) A nickel-zinc material. High volume resistivity. Frequency range for resonant application up to 4 MHz. Good attenuation of unwanted frequencies up to 1000 MHz. Available in Ferrite Beads only.

MATERIAL 67 (u=40) Nickel-zinc. Very similar to the 63 material but has a greater saturation flux density. Lower volume resistivity but good temperature stability. High 'Q'applications 10 MHz to 80 Mhz. Wideband up to 200 MHz.

MATERIAL 68 (u=20) A nickel-zinc material having high volume resistivity and excellent temperature stability. High Q' resonant circuits 80 MHz.to 180 MHz, also wideband amplifiers and linear power amplifiers. Toroidal form only.

MATERIAL 72 (u=2000) Low volume resistivity. High 'Q' to 500 KHz. Very good attenuation for unwanted frequencies from 500 KHz through 50 MHz. Toroids only.

MATERIAL 73 (u=2500) Primarily a ferrite bead material. Very good attenuation properties from 0.5 MHz. through 50 MHz. Available in Ferrite Bead form only.

MATERIAL 'J'/75 (u=5000) Low volume resistivity and low core loss from 1 KHz.to 1 MHz. Pulse transformers, low level wideband transformers, and for noise attenuation from 0.5 MHz to 20 MHz. Toroids and Ferrite Beads.

MATERIAL 77 (u=2000) High saturation flux density at high temperature. Low core loss in the 1 KHz to 1 MHz range. Suited for power conversion and wideband transformers. Widely used for noise attenuation in the 0.5 Mhz. to 50 MHz. frequency range. Toroidal cores, Pot cores, E-cores, and Ferrite Beads.

MATERIAL 'F' (u=3000) Similar to the 77 material but has greater initial permeability. High saturation flux density at high temperature. Used for power conversion transformers. For noise attenuation in the 0.5 MHz. to 50 MHz. frequency range. Available in toroidal core form only.

FERRITE TOROIDAL CORES

Physical Dimensions - Ferrite Toroids

core size \/	OD inches	ID inches	Hgt inches	Mean length cm	Cross Sect cm^2	Volume cm^3
FT-23	.230	.120	.060	1.34	.021	.028
FT-37	.375	.187	.125	2.15	.076	.163
FT-50	.500	.281	.188	3.02	.133	.402
FT-50 -A	.500	.312	.250	3.18	.152	.483
FT-50 -B	.500	.312	.500	3.18	.303	.963
FT-82	.825	.520	.250	5.26	.246	1.294
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-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-A	1.932	1.250	.750	12.31	1.460	18.000
FT-240	2.400	1.400	.500	14.40	1.570	22.608

A_L Values (mH / 1000 turns) - Ferrite Toroids

To complete the part number add the Mix number to the Core size number

The 63 & 72 materials are being superseded by the 67 & 77 materials respectively.

Material > core size \/	43 u=850	61 u=125	63 u=250	67 u=40	68 u=20	72 u=2M	75 u=5M	77 u=2M	F u=3M	J u=5M
FT-23	188	24.8	7.9	7.8	4.0	396	990	356	NA	NA
FT-37	420	55.3	17.7	17.7	8.8	884	2210	796	NA	NA
FT-50	523	68.0	22.0	22.0	11.0	1100	2750	990	NA	NA
FT-50 -A	570	75.0	24.0	24.0	12.0	1200	2990	1080	NA	NA
FT-50 -B	1140	150.0	48.0	48.0	12.0	2400	NA	2160	NA	NA
FT-82	557	73.3	22.4	22.4	11.7	1170	3020	1060	NA	3020
FT-87 -A	NA	NA	NA	NA	NA	NA	NA	NA	3700	6040
FT-114	603	79.3	25.4	25.4	12.7	1270	3170	1140	1902	3170
FT-114-A	NA	146.0	NA	NA	NA	2340	NA	NA	NA	NA
FT-140	952	140.0	45.0	45.0	NA	2250	6736	2340	NA	6736
FT-150	NA	NA	NA	NA	NA	NA	NA	NA	2640	4400
FT-150-A	NA	N	NA	NA	NA	NA	NA	NA	5020	8370
FT-193-A	NA	NA	NA	NA	NA	NA	NA	NA	4460	7435
FT-240	1240	173.0	53.0	53.0	NA	3130	6845	3130	NA	6845

Magnetic Properties - Ferrite Materials

Material >	43	61	63	67	68	72	75	77	F	J
Initial Perm.	850	125	40	40	20	2000	5000	2000	3000	5000
Max Perm.	3000	450	125	125	40	3500	8000	6000	4300	9500
Max Flux den. 14 oer, gauss	2750	2350	1850	3000	2000	3500	3900	4600	4700	4300
Residual flux density, gauss	1200	1200	750	1000	1000	1500	1250	1150	900	500
Vol. Resist. ohms/cm	$1x10^5$	$1x10^8$	$1x10^8$	$1x10^7$	$1x10^7$	$1x10^2$	$5x10^2$	$1x10^2$	$1x10^2$	$1x10^2$
Temp. Co-eff. 20-70 deg. C	1%	.15%	.10%	.13%	.06%	.60%	.90%	.60%	.25%	.4%
Curie Temp. C	130	350	450	500	450	150	160	200	250	140
Resonant Cir. Freq. MHz	.01 to 1 MHz	.2 to 10 MHz	15 to 25 MHz	10 to 80 MHz	80 to 180 MHz	.001- 1 MHz	.001- 1 MHz	.001- 1 MHz	.001- 1 MHz	.001- 1 MHz
Wideband Freq. MHz. *	1 to 50 MHz	10 to 200	25 to 200	50 to 500	200- 1000	.5 to 30 MH	.2 to 15 MHz	.5 to 30 MHz	.5 to 30 MHz	1 to 15 MHz
Attenuation RF Noise, MHz	20- 600	200- 1000	500- 2000	350- 1500	1000- 5000	1 - 50	.5- 20	1 - 50	1 - 50	.5 - 20

* Based on low power, small core applications: Listed frequencies will be lower with high power.

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 lo-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 be 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 will increase in relation to the number of turns squared.

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' or materials for everything lower than the amateur band.

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 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 there will be noticeable effect. 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-75 cores with about 20 turns each of #26 enamelled 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-140-J ferrite toroidal core.

FERRITE CORES FOR RFI SUPPRESSION

Following is a list of a few of the larger 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 power cords, telephone cables, computer cables, etc.

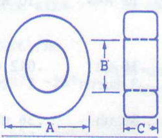
The 43 material is a good all around material for most RFI problems. However the lower frequencies from .5 to 10 MHz. can best be served with the 'J' or 75 material. The 77 material can provide excellent attenuation of RFI caused by amateur radio frequencies from 2 to 30 MHz. and the 43 material is best 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 small ferrite bead material having a permeability of 2500 and can provide RF attenuation very similar to the 77 ferrite core material.

When a number cores are strung on the same conductor, the total impedance will be the sum impedance of all cores. When a conductor is passed through the center hole of a toroidal core a number of times, the impedance will increase in proportion to the number of turns squared.

Split beads and bars (2X) are now available and can 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. For greater attenuation use additional cores.

Below are a few of the most widely used cores for RFI, showing typical `Z' in ohms for one turn at 25 MHz and 100 MHz. Most sizes are available in 43, and 77 materials. Those sizes availabale in the J material are marked with *

Part number	A dim. (in)	B dim. (in)	C dim. (in)	25 MHz	100 MHz
* FT-50A-75	.500	.312	.250	below 10 MHz	
FT-50B-43	.500	.312	.500	56	90
FT-50B-77	.500	.312	.500	74	60
* FT-87A-75	.870	.540	.500	below 10 MHz	
* 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
2X-43-251	.590	.250	1.125.	171	275
2X-43-151	1.020	.500	1.125	159	245
FB-43-1020	1.000	.500	1.120	155	235
FB-77-1024	1.000	.500	.825	166	135
FB-43-5621	.562	.250	1.125	171	250
FB-77-5621	.562	.250	1.125	270	215
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 cable			90	250



Two turns Illustrated