SPECTRUM COMMUNICATIONS

Incorporating Garex Electronics & G2DYM Aerials

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Binocular cores for the Baffled

Normal toroidal cores are essentially the interior of a coil bent round into a circle. The magnetic field is concentrated into the core cross section, which is relatively small in relation to the diameter of the toroid. Magnetic field lines will be emitted by the turns also away from the core meaning that there will be ability to interact with other nearby inductive components.

The binocular core is wound with a wire passing through one tube and back down the other to form the single turn. By passing a wire down one tube only gives half a turn. The core area within a full turn is relatively large. Also because the wire passes within a ferrite tube, only where the ends curve around to pass into the other tube will there be external emitted field. The result is that the wire is enveloped with a large amount of ferrite concentrating the field lines and considerably magnifying the inductance.

There are two commonly used grades of ferrite used for these cores, the same grades as also commonly used for toroidal cores. Type 43 has the highest inductance factor and is generally used for wideband low power transformers, for RF chokes, and also for interference suppression. Type 61 with a lower inductance factor is generally used in amateur radio work for high power transformers and baluns, and also supply line RF chokes carrying high DC current.

The most common binocular cores used by amateur radio constructors are made by Fair-Rite in the USA. They are marketed by Amidon using their own coding but neither code bears any relation to the size or properties of the core.

To make it easier to identify a binocular core, I have now created a code for these devices in the same manner as toroids. Using the system, BN for binocular, width in mm, length in mm, and material type. Inductance factor is given in uH per 5 turns, being a realistic number. Furthermore in future cores supplied by Spectrum will have a paint mark yellow for type 43 and blue for type 61. You never need get them mixed up again.

Spectrum	Manu. Part No	Width	Length	Height	A_L(uH/5t)	Use
BN1307-43	2843001502	13.3	6.6	7.5	20 - 40	Low Q Balun
BN1310-43	2843000302	13.3	10.3	7.5	30 - 60	Low Q Balun
BN1313-43	2843000102	13.3	13.4	7.5	40 - 80	Low Q Balun
BN2025-43	2843010302	19.5	25.4	9.5	200 - 300	Low Q Balun
BN1307-61	2861001502	13.3	6.6	7.5	3.6 – 4.5	High Q HF
BN1313-61	2861000102	13.3	13.4	7.5	7.5 - 11	High Q HF
BN1414-K1	B62152A1X1	14	14	7.5	7.2 – 8.2	High Q VHF

To determine the number of turns for a required inductance use the formula;-

$$\mathbf{N = 5*\sqrt{(L_{uH}/A_L)}}$$

Example 1. A balun is required to provide bias for the bases of a push-pull wideband amplifier where the input impedance of each device is approximately 3 Ohms. The lowest operating frequency will be 1.8MHz and the reactance of the winding needs to be four times the load, hence 12 Ohms. $L = X_L/2\pi f$. $L = 12/2\pi 1.8*10^6$ H $L = 1.06$uH. Looking at the table, the core type BN1307-61 gives 3.9uH for 5 turns. So $N = 5\sqrt{(1/3.9)} = 2.5$ turns. Use three turns bifilar, connected in series thereby making a reactance of 1.4uH.

Example 2. The amplifier will be required to deliver 5W output into 50 Ohms. The collector load resistance for a transistor is $RL = V_{CC}^2/(2*P_O)$. On a 13.5V supply with a halfwave swing of 12V this will be $RL = 12^2/(2*5) = 14.4$ Ohms. Lets choose 12.5 Ohms because it gives a 1:2 turns ratio and a 1:4 step up to 50 Ohms.

To drive a 50 Ohm load the secondary reactance needs to be four times 50 Ohms, which is 200 Ohms at the lowest operating frequency of 1.8MHz. $L = X_L/2\pi f = 200/2\pi*1.8*10^6$ H. L = 17.7uH.

Looking at the table shows the BN1313-43 gives 40uH to 80uH for 5t so I will try that one first. I will try to achieve the required reactance of the secondary with just two turns, and for one turn on the primary. $N = 5\sqrt{(L/A_L)}$ $N = 5\sqrt{(17.7/40)} = 3.3$ turns. Even with an A_L of 80uH it would need 2.4 turn, so it is not adequate.

Lets turn the problem round by defining the secondary with two turns and calculating the necessary A_L factor. $A_L = (5/N)^2*L$. $A_L = (5/2)^2*17.7$uH = 110uH. There is a good chance that two BN1313-43 cores in series with two turns will produce a mid-range A_L value of 120uH. The alternative now commonly found in broadband amplifiers is to use two huge sleeve cores side-by-side.

Remarks

The result of these exercises reveals that for good high frequency performance a minimal number of turns is required. To achieve sufficient inductance from only 2 or 3 turns requires a large inductance factor from the core. This is best achieved using a large core with lower characteristic μ instead of a smaller core with higher μ.