THE WEST RAND AMATEUR RADIO CLUB

April 2002
Volume 2, Issue 10

ANODE

Inside this issue:

Editor's Comments

Time and the Amateur.

Ah the South African Winter, when the OM's thoughts turn to Amateur Radio. Well he might if he really thought that much about his hobby. The League apparently has been 'grass rooted' to reduce the subs. About time too. It should have happened 20 years ago. The league has to become a one party political organisation with only one aim in mind. That of keeping alive amateur radio in South Africa. Not the quiet spending spree some of its 'heads' have engaged upon in the past. Where has all the money gone, I was asked recently. Not being a member of the league, I couldn't tell him. That's the problem, not being a member of the league means you have no vote or no right to query what the subs are spent on. Hmm.

Its been a hectic, busy two months. Meaning that the generation of the Anode had to be postponed. This was not for lack of input on your part but available time on mine. Time is an e v e r - d i s a p p e a r i n g thing.

Recently I watched a BBC Tv program called Longitude which was rebroadcast on Mnet. This excellent mini-series tells the story of the creation of a sea-going clock to allow the

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WIDEBAND RF TRANSFORMERS

Michael Graham looks at Monofilar types.

Wideband RF Transformers are finding increasing use in a variety of communications systems. Schottky diode mixers, combiners and, in particular, the 'broadband amplifier' have all contributed to the increasing applications for such wideband transformers.

SUCK IT AND SEE

The essence of most design techniques involves a lot of trial and error, an approach that seems to be the one most commonly encountered amongst RF engineers.

As often as not an engineer will select a core that looks as if it 'might do', winds the transformer and installs it in the circuit. If its performance is unsatisfactory a tedious process of adding or removing turns ensues with perhaps changes in wire gauge or core size. Eventually something which will do the job results but rarely will this be a truly optimum design.

IN A TWIST

The most common approach to the implementation of a wideband transformer is the twisted line transformer, wound on a high permeability ferrite core. Beware of confusing ferrite with dust iron when it comes to toroids for while dust iron is ideal for EMI suppression and for resonant applications by virtue of its inherent air gap effect, the broadband transformer

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Special points of interest:

- Contact details on back page

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relies on a high permeability material to achieve the tight overall magnetic circuit required for optimum coupling at low frequencies. At high frequencies the transmission line effect of the tightly twisted conductors predominates while the effect of the cores permeability decreases.

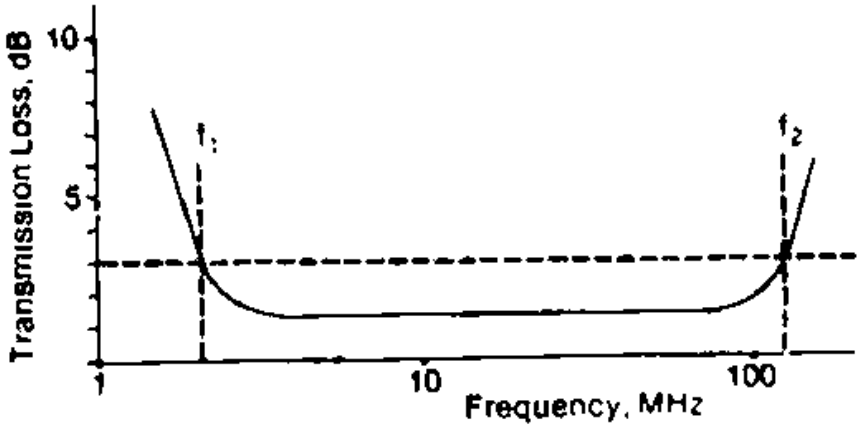
If the prospect of trying to estimate the impedance of twisted pairs of 32 SWG may leave you a shade less than enthusiastic however, then the wideband autotransformer may be a good place to start.

ONE WIRE WONDERS

Although apparently not widely recognised, it is not always necessary to employ multilayer windings in autotransformers. In low power applications, the core is often small enough to ensure adequate inter-turn winding 'intimacy' and a monofilar design can give excellent results. We'll look at some practical aspects of such designs later but first a look at some of the important parameters of RF transformers is in order.

SPECMANSHIP

One important measure of an RF transformers performance is its bandwidth, often graphically presented as a plot of the transformer's transmission loss vs. frequency. Fig. 1 shows a possible plot for a broadband



transformer, the bandwidth being F2 - F1.

As with any bandwidth figure, the two frequencies between which the bandwidth is quoted are rather arbitrarily determined, and any meaningful specification must be accompanied by the corresponding transmission loss limitation.

The other important quality of a transformer that must also be specified are its reflection characteristics. This specification defines the quality of the transformer's impedance transformation over the frequency range of interest.

Figure 2. shows a model of a transformer in terms of its 'lumped' constants.

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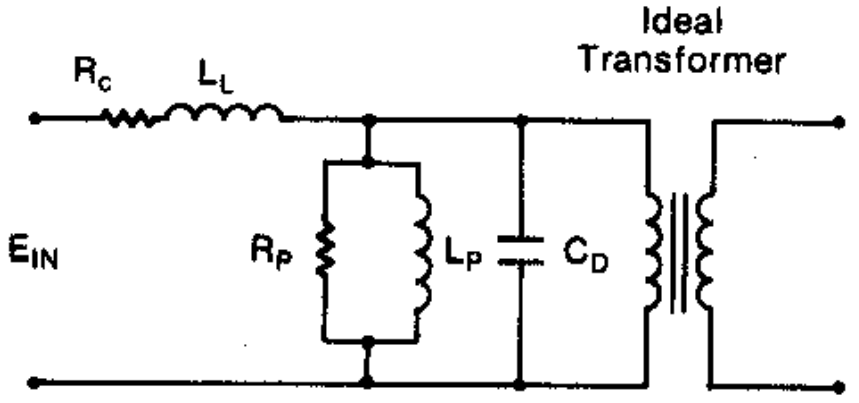
From this it can be seen that the transformer's low frequency performance will be determined by Lp and, to a lesser extent, by Rp. High frequency performance will be determined by the Li and Cd as, with increasing frequency the reactance of Li will increase while that of Cd will fall.



Over the majority of the transformer's bandwidth, its insertion loss will be due to Rp and Rc with Rp being the dominat-

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Editors Comments

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sailors of the day measure the longitude. This, as was shown early on in the series, was vital to the safety of their ships. A great many ships of the navy ended up on the rocks through bad navigation.

Today, in the time of GPS, we take it all for granted. What if the GPS satellite's were removed? Could we still cope? Road signs get swiped. Still think you can find your way to the shops or Lydenburg?

Development projects and time.

I have been rolling out a new program for a client which collects data from all over the country and emails it to head office. Whilst at the same time I have been supplying quite a few 'entry level' network servers to customers who persist in buying MS systems. Not that I am complaining.

The rapid roll-out of operating systems though seems to have slowed to a crawl. Most are re-using their existing NT (New Technology!) software on their new hardware. NT though will end its product life this year. Just as well that software doesn't wear out or rust!

New software products are being picked up very slowly by the corporates. XP office is being grudgingly purchased as is XP the operating system.

The exchange rate has made the take up even slower bringing tears to accountants eyes when he sees the cost of the new licences.

WindWoes 98

[Not enough memory to complete this operation] What! I'm just using notepad to type up some notes for the Anode. I can't insert any more text. Well I am using last century's software you know. Windows 98's notepad can't handle more text than 64k less a bit. Windows NT and 2000's Notepad can handle text files of several hundred megabytes. That's an awful lot of typing. I shall just have to use Wordpad. That can handle bigger files.

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ing factor.

COMPLEX NUMBERS

The parasitic elements of Fig. 2 do more than merely cause losses, as they will also affect the value of the impedance reflected from the secondary to the primary.

Figure 3 show an ideal 1:4 autotransformer and, with its secondary terminated with a 20OR load, the impedance measured at the primary terminals will be 50R.

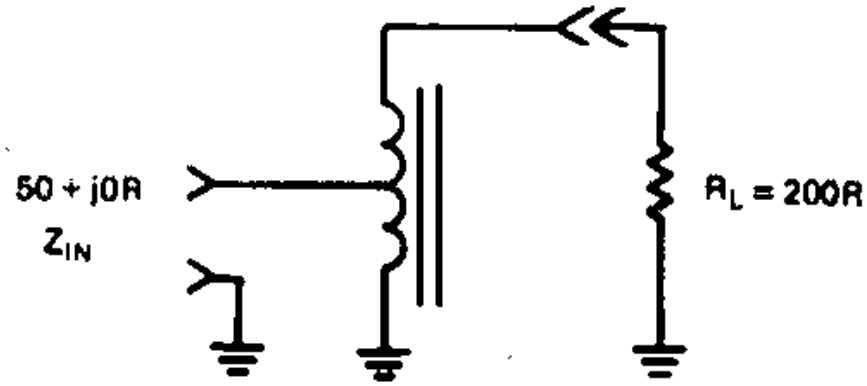

Figure 4 shows the same 1:4 transformer but has the parasitic elements of Fig. 2 lumped into a single network. With the 20OR secondary load, the impedance seen at the primary will now no longer be a resistive 50R, but a complex impedance. the scaling factor of the transformer is no longer 4, but some complex factor a+jb. The object of the transformer designer is to Set W as close to 4 as possible and b as close to zero.

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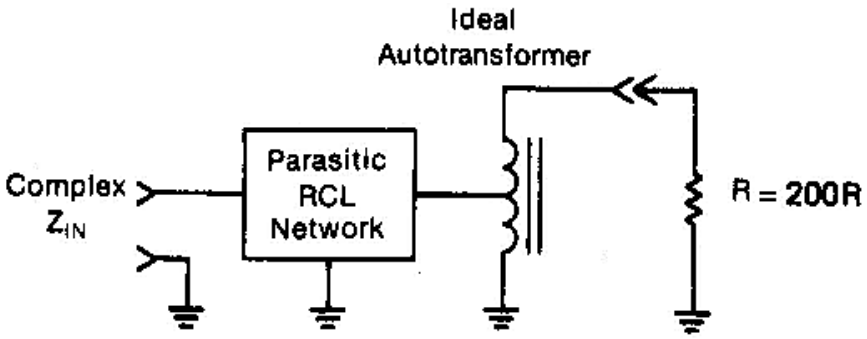
NOTHING'S PERFECT



A practical transformer thus exhibits an insertion loss and variation in the impedance scaling factor. In order to specify the performance of a transformer some means of measuring the variations of then 'qualities' with frequency is needed.

Any analysis of complex impedances would not be complete without the ubiquitous Smith Chart and an autotransformer's reflection characteristics could be specified by measuring the complex impedance at various frequencies and plotting the results as in Fig. 5 (pass the network analyser).

A more practical approach would be to assess the transformer's reflection profile from VSWR measurements at various frequencies. A practical autotransformer may have a VSWR of, say 1.5. This would define a locus of points on the Smith Chart as shown in Fig 5. The exact point on the VSWR circle that represents the complex impedance cannot be determined however, as this would require details of the phase angle of the voltage with respect to current. Back to the network analyser.

From transmission line theory we know that the voltage reflection coefficient (theta) is given as

rho = Zr - Zo / Zr + Zo

Where Zr = The autotransformer's input impedance
and Zo = Reference impedance

As Zr is a complex quantity, rho is likewise complex. Zo is assumed to be real.

The magnitude is given by

|rho| = r - 1 / r + 1

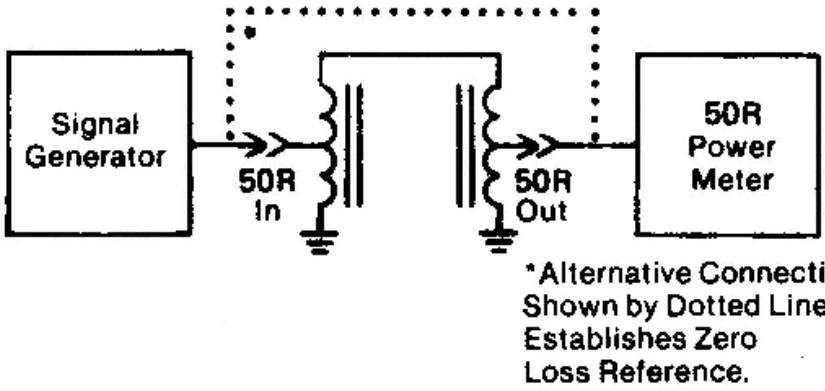
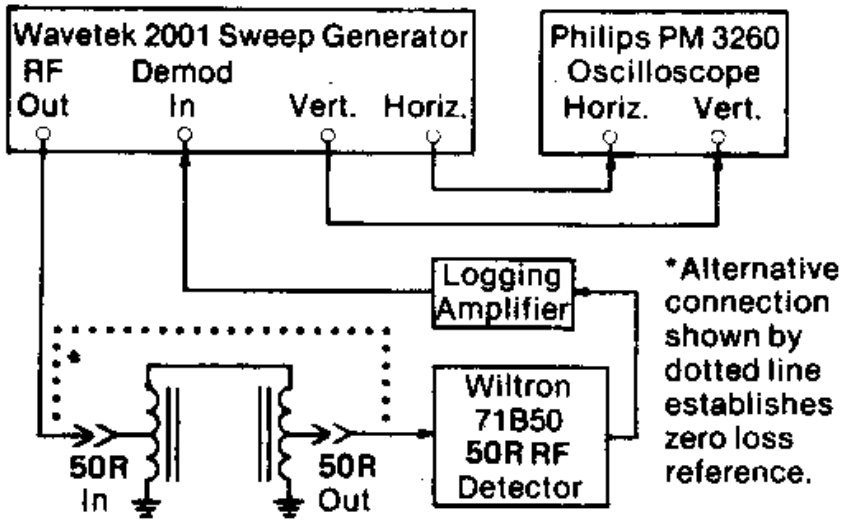


Figure 6: Swept VSWR test nt-up.

Where there's VSWR there's



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The Objectives of a Club Construction Project

One of the main aspects of Amateur Radio as a hobby is the construction of electronic items for use by either the amateur or interested parties. Quite often a "gadget" spins off to become a best selling product. Amateurs have been responsible for innovative products in areas such as security, radio reception and the motor industry. For example, Volvo now fits as standard an aerial based on one developed by an amateur using the rear windscreen demister.

Electronics as a hobby can be incredibly rewarding and not just financially. Imagine being able to help a deaf person 'hear' or a quadriplegic write a book.

- It must have an application or benefit to the amateur. It could be a useful item in the shack or a teaching aid.
- It must be low cost. Sufficiently low so as not to be prohibitively expensive in component cost
- It must use readily available components or parts that can easily be fabricated. We (in SA) are a small market for components relative to overseas so our components are generally expensive.
- To ensure maximum take-up, the project should appeal to the majority of radio amateurs.
- The project construction or design does not have to be simple. If a complete set of assembly instructions, diagrams and checklists are

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Category	Subject	Notes	Article reference
Antennas	Antenna measurement	phase detector	
Antennas	Antenna measurement	Automatic SWR	
Antennas	Antenna measurement	Noise bridge	
Antennas	2 Metre dipole antenna	Use of readily available materials	
Antennas	Trap construction for inverted V's	High voltage capacitors & Construction	
Antennas	Balun construction	ferrites and other materials	
Antennas	Fox Hunt antenna construction	Switched antennas vs directional types	
Audio	Audio speech processor		
Audio	Rtty terminal		
Audio	Audio tone generator	for testing microphones & modulation/ deviation	
Component measurement	L Meter / Q Meter		
Component measurement	Capacitor meter		
Computer Hardware	Printer port project		Article for Anode
Computer Software	Morse training program		Software
Computer Software	Club database - cross platform	Member details etc	

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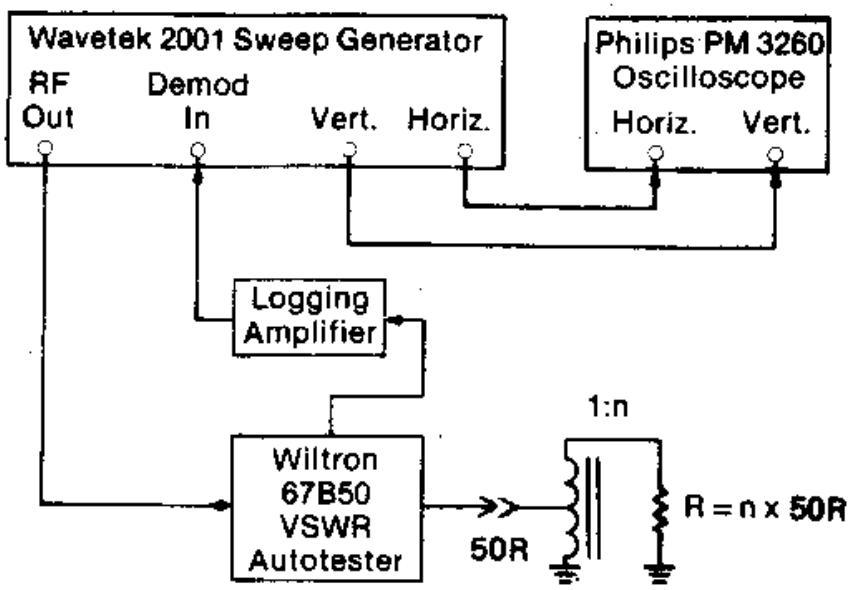
return loss and this is given by

return loss (dB) = 20 log 10 . 1 / |rho|

Although measurements of VSWR the voltage reflection coefficient and return loss do not provide any phase information, they do provide a convenient way of specifying reflection characteristics, and they can be measured with the sort of test equipment that is more accessible to engineers and enthusiasts.



MEASURING UP.

The most convenient way of measuring transmission quality is to place two identical auto-transformers in a back-to-back configuration as shown in Fig. 6 the equipment required is a signal generator and a 50R power meter. First the generator is connected directly to the power meter to determine the zero loss reference level P1.

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Editors Comments

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Our first 'Afronaut' has been into space.

Rather than spend his money on wine and women, he went to the International Space Station.

Guess who set up the all the communications for the school kids question time? A lot of amateurs talk to satellites, it seems they just don't like to tell us about it.

The weather continues to be pleasant. A winters day here is like a summers day in England. That's usually last Thursday when there was a pause in the rain. It's 24C in the shack at 11:30 and time to listen to the bulletin.

Upcoming Events

Its also that time of year for the AGM and an afternoon get together . The 29th of June is the date.

It also seems we are going to have another Boot Sale on the 27th of July. This one is going to be "Vendor Friendly" with outside parking and attendants.

73 from OM John

_____

CAR WARS

The largest underground car park in Europe has opened at Gunwharf Quays, an ultra-modern leisure complex in Portsmouth. In fact its so modern that cars have been suffering from nervous breakdowns, sulking in corners and refusing to come out doors locked and intruder alarms wailing. Even the computer controlled barriers have come out in sympathy. So-called 'experts' appear to be baffled by this situation and it falls upon Zygote to solve the mystery.

Fact one: remote car locks

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The Objectives of a Club Construction Project

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provided, the constructor will have no difficulty in building the project.

Category	Subject	Notes	Article reference
Computer Software	Database of design software		
Oscillators & Signal sources	Two Metre Synthesizer		
Oscillators & Signal sources	UHF sweep generator	for 70cm antenna measurement	
Oscillators & Signal sources	Grid Dip Oscillator	for antenna and resonant circuit measurement	
Receivers	Bulletin receiver	2 Metre, 30 Metre, 14.165MHz SSB	
Receivers	Field strength meter		
Receivers	Lightning monitor/ warning system		
Receivers	Noise factor measurement		
Receivers	1296MHz scanner		
Transmitters	Beacon transmitter		
Transmitters	Deviation Meter for fm	Automatic Modulation Meter	R&EW Nov/Dec 1981
Transmitters	25Watt Transmitter for 20 Metres		
Transmitters	The design of HF linears	Broadband transistor vs Valve narrow band power amplifiers	
Power Supplies	power supply for 2m rig/ hf rig	10 to 30 Amps	

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The back-to-back transformers are then interposed between the generator and power meter and a second power level, P2, is noted. The insertion loss for each autotransformer is given by

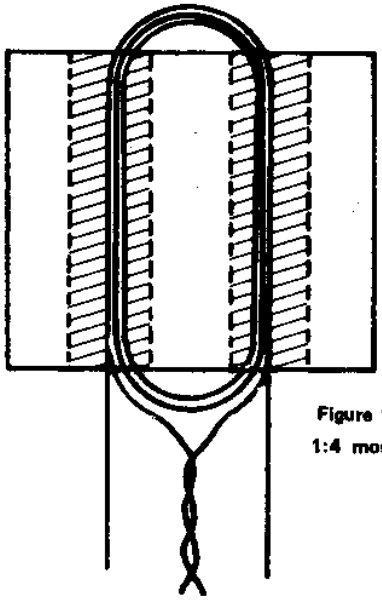

Figure 12: Cutaway drawing of 1:4 monofilar autotransformer.

Insertion Loss = P2 - P1 / 2

The back-to-back method may not be very 'pure' in theory, but in practice the results obtained with this technique show good agreement with other, more direct, means of insertion loss measurement.

Figure 7 shows a practical set-up for swept transmission loss measurements and providing all lead lengths are kept to a minimum, excellent results over a wide range of frequencies can be obtained.

TIME TO REFLECT

Reflection measurements are made by using a set-up similar to that shown in Fig. 8. As discussed earlier, these are based on VSWR measurements and the one unusual component shown in Fig. 8 is the VSWR auto tester, a device that produces a DC output voltage proportional to rho (shades of the R&EW 'Autobridge' published last month). The logging amplifier is included to display the return loss in dB as a function of frequency.

THEORY INTO PRACTICE

The type of core best suited to monofilar autotransformer de-

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and other safety devices operate around the 433MHz radio frequency and there is no chance of the world's car manufacturers changing that.

Fact two: the Ministry of Defence Dolphin Mobile network operates around the 433MHz frequency and there is no chance of the MoD changing that.

Fact three: H M S Dolphin is smack opposite the computerised car park, separated by a narrow neck of water. The car park costs two quid an hour, whether or not the vehicles are talking to their owners.

Nuff said.

[Extracted from 'Zygote' in Computer Shopper]

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signs is a two-hole ferrite balun core.

Note: "Primary" refers to number of turns from tap to ground. -Secondary- refers to number of turns on entire winding.

In such designs, to obtain different impedance transformation ratios it is only necessary to select a turns ratio according to the formula:

Zt = [Ns / Ns] ^ 2

MATERIAL MATTERS

Referring back to Fig. 2 we note that the important factors when selecting a particular material on which to wind an autotransformer are, not the traditional initial permeability and loss factor figures as these are the result of measurements on a core expressed as though it were a resistor and inductor in series. The type of information required concerns the behaviour of the core when treated as a resistor and inductor in series.

The figure often referred to as the material cut off frequency is also of little concern in wideband autotransformers. This figure is the point at which series permeability has dropped a significant amount from its low frequency value. For wideband transformers the important quantity is the parallel inductive reactance (LP) which is, to a good approximation, the series permeability multiplied by frequency. Thus although permeability becomes less with increasing frequency, Lp either increases or remains constant and the material still

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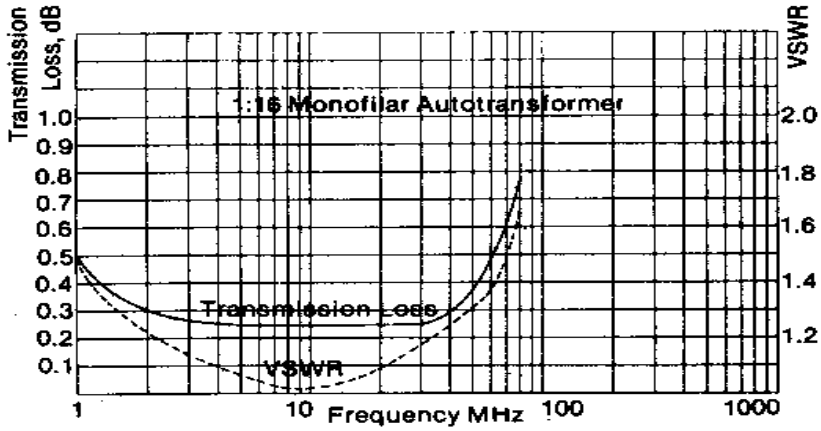

Figure 13: Transmission loss and VSWR.

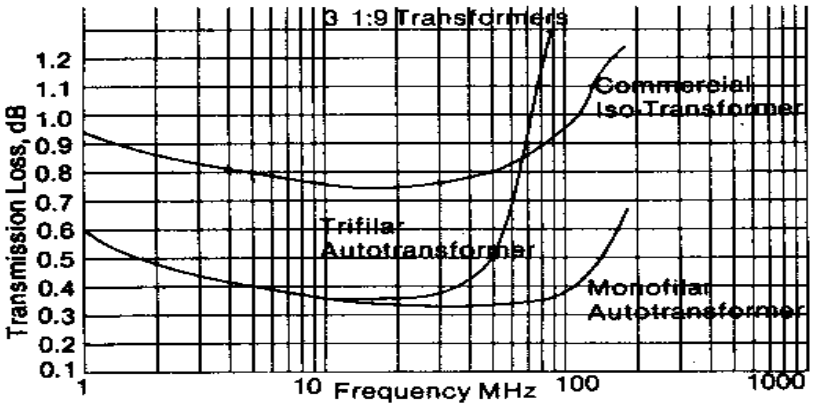

Figure 14: Transmission loss comparison.

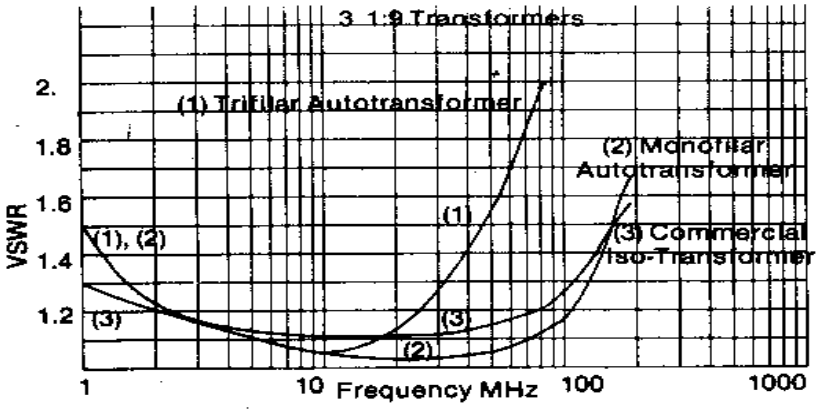

Figure 15: VSWR comparison.

British standard copper wire table

					Turns		per	linear	inch		Turns	per	square	inch	Nearest
Diame-ter				Current											American
SWG		Resistance	Length	rating	Enamel	Single	Double	Single	Double	Enamel	Single	Double	Single	Double	wire
(inches)		(a)	(b)	(c)		silk	silk	cotton	cotton		silk	silk	cotton	cotton	gauge
10	0.128	1.866	6.67	15.442	7.48	—	—	7.35	7.0	56	—	—	54	49	10
12	0.104	2.826	10.23	10.194	9.09	—	—	8.8	8.4	82.6	—	—	77.4	70.6	12
14	0.080	7.776	17.16	6.032	11.78		—	11.2	10.5	139	—	—	125.4	110	14
16	0.064	7.463	26.86	3.86	14.8	14.7	14.5	13.9	12.0	219	216	210	193.2	169	16
18	0.048	13.27	47.66	2.1715	19.7	19.8	19.4	18.0	16.8	388	392	376	324	282	19
20	0.036	23.59	85.00	1.2215	26.0	26.0	25.3	23.5	21.0	676	676	640	552	441	21
22	0.028	38.99	140.6	0.73	33.0	33.0	31.9	29.1	25.4	1089	1089	1018	847	645	23
24	0.022	63.16	228.3	0.4561	41.6	42.1	40.0	36.7	31.0	1731	1772	1600	1347	961	2S
26	0.018	94.4	340.0	0.3054	50.2	51.2	48.3	43.0	35.4	2520	2621	2333	1849	1253	27
28	0.0148	139.6	503.0	0.2064	61.0	61.7	57.4	50.2	38.6	3721	3807	3295	2520	1490	28
30	0.0124	199	716.6	0.1450	72.5	72.4	66.6	57.1	44.4	5256	5242	4436	3260	1971	29
32	0.0108	262	943.3	0.1099	82.7	81.9	74.6	62.8	47.8	6839	6708	5565	3944	2285	31
34	0.0092	361	1300	0.0798	97	94.3	84.7	69.9	51.7	9409	8892	7174	4886	2673	32
36	0.0076	529	1903	0.0545	116	111	97.9	85.4	59.9	13456	12321	9584	7293	3588	34
38	0.0060	849	3056	0.0340	145	135	113	99	67.7	21025	18225	12769	9801	4583	36
40	0.0048	1327	4766	0.0217	178	161	131	112	75.1	31684	25921	17161	12544	5640	38

(a) Ohms per 1000 yards at 60°F, (b) Yards per lb.; (c) Amps at 1200 amps per square inch.

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forms a useful wideband transformer.

To select a material it is thus necessary to have information on the parallel components of the magnetic parameters such as parallel inductive reactance, Lp and parallel resistance, Rp, as a function of frequency. Figs. 9 to 11 show such curves for Fairrite 65 material (Neosid F16, Philips 4C6).

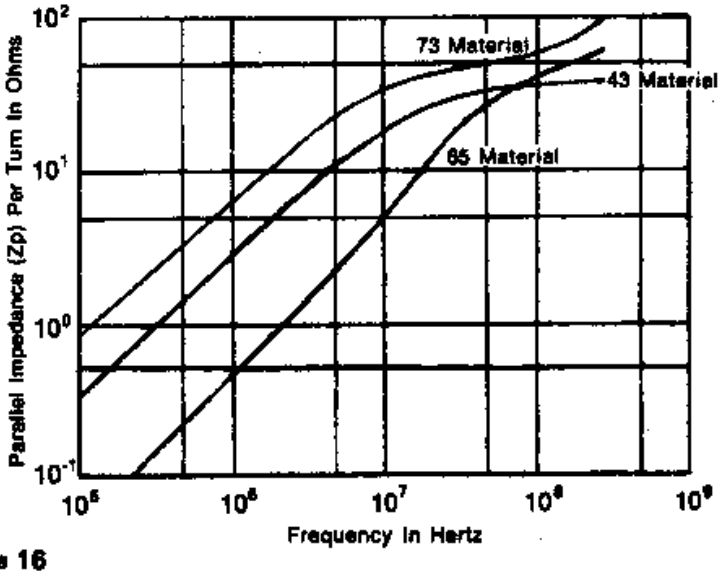

Figure 16
Parallel impedance per turn for a Balun Core in three materials.

THE SHAPE OF THINGS

It has been mentioned that the most suitable core for a monofilar autotransformer is the two hole balun core (Fig. 12). It would be useful to have a measure of any particular core's value as a wideband transformer. Such a number can be generated and is known as the core's Form factor. The lower this number, the wider the frequency range of the finished transformer.

The form factor is defined as

FORM FACTOR = Lw Le / Ae

Lw = length of one turn of wire
Le = effective magnetic path length
Ae = effective magnetic area

CLOSING TIME

A graph of a typical monofilar autotransformer's performance is shown in Rg. 13 while Figs 14 and 15 compare the performance of three different forms of construction. It can be seen that the monofilar autotransformer offers superior performance to those employing standard toroids and multifilar windings.

The above has hopefully shown, that with the right information to hand, the design of an autotransformer need not owe anything to guess work. A systematic approach to the design should enable an optimum transformer design to be realised in a fraction of the timee needed for a 'suck it and see exercise'. It's also a lot easier on the nerves.

Taken from E R & EW

The West Rand Amateur Radio Club
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Roodepoort
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Phone: +27 11 726 6892
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Bulletins (Sundays at …)
11h15 Start call in of stations
11h30 Main bulletin start

Frequencies
145,625 MHz (West Rand Repeater)
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Radio Amateurs do it with more frequency!

We are going on the Web
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Please note this has been just been registered. Our site will be up in the new year.

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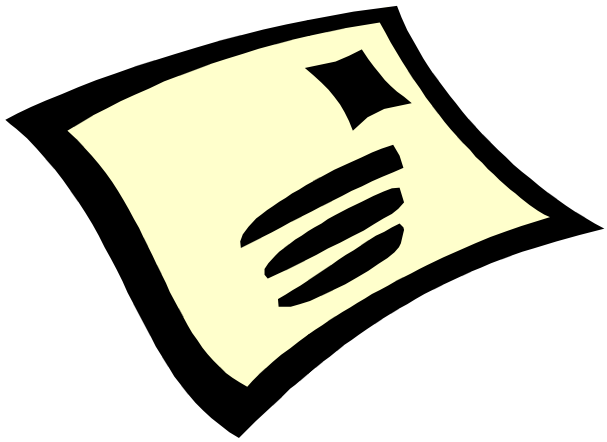
West Rand members input - we need your input!

To make this the best ham radio magazine in South Africa we need your input. Please submit articles, comments, suggestions etc.

Please send plain text with no formatting to the email address below.

In November, we published an Anode Compendium on CD. It has the issues from July 2000 until November this year. This included IE5.5 and the new Adobe reader.



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