Ottawa Amateur Radio Club

Groundwave

P.O. Box 8873, Ottawa, Ontario, Canada, K1G 3J2

*Check out our Web Page: **www.oarc.net***

April 2007

Ernie Brown, VA3OEB, has agreed to be our elections committee for the upcoming June executive elections. If you are interested in running or wish to nominate someone please contact Ernie at va3oeb@rac.ca. At the moment the Membership director position is available.

Harold Hamilton has agreed to organize Field Day again this year. Thanks to Harold for undertaking this. Please contact him to volunteer.

New OARC members and existing members who have not already done so, may order a club name badge with their name and call sign engraved. The price is FREE. Others members can order additional badges at a price of $7 to $10. See the web page for further details.

Don't forget the April meeting is Home Brew Night. So bring in your construction projects and be eligible for great prizes and glory.

See you at the meeting.

Ian Jeffrey, VE3IGJ

APRIL MEETING 7:30 pm, April 11th
in the Honeywell Room at Ottawa City Hall

In This Issue....

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VE3TEN

Tuning in the beacon so that it makes sense requires you tune to **28.175** on **cw** and read the tone that is there . The spaces between the elements are the higher tone. If that doesn't work, tune to **28.175.28** on **lower sideband** for better results.

Articles may be submitted for use in this publication provided that they portray events or activities that promote Amateur Radio. Letters and comments are also welcome. Submissions may be made by mail addressed to the Editor care of the OARC, or by e-mail to "ve3igj@rac.ca". Deadline for submissions occurs three days after the regular monthly meeting of the OARC.

Please support your local radio organisations. They support you!

Club Information

The Ottawa Amateur Radio Club Inc. is an association of Radio Amateurs devoted to the promotion of interest in Amateur Radio communications in the National Capital Area and to the advancement and achievement of club members.

Regular Meetings of the OARC Inc. are held on the second Wednesday of each month (except July and August) in the Honeywell Room (2nd floor of the Old Teacher's College) of Ottawa City Hall (formerly Regional Municipality of Ottawa Carleton Headquarters) on Lisgar Street. Meetings commence at approximately 19:30 hours. Further details about each meeting is elsewhere in this publication.

Executive Meetings of the OARC Inc. are normally held on the first Wednesday of each month at 19:30 hours. Contact the President to confirm the date, time and place of the next meeting.

The CAPITAL CITY FM Net meets every Monday at 20:00 hours on the club repeater **VE2CRA** to pass traffic and to make announcements of interest to Amateurs in the National Capital Region.

The SWAP Net is a service provided and conducted by Ed Seib, VA3ES. This feature appears on theCapital City FM Net. To list items and make inquiries, call Ed at 613-738 8924 or e-mail him at va3es@rac.ca. Also available on the web: http://www.igs.net/~swap.

The POT-HOLE Net is a SSB/HF net sponsored by the Ottawa Valley Mobile Radio Club and is conducted every Sunday at 10:00 hours on **3.760 MHz**. All amateurs are welcome to check in.

The POT-LID CW Net is an informal slow-speed **CW** net sponsored and conducted by Ed Morgan, VE3GX, and meets every Sunday, except during July and August, at 11:00 hours on **3.620** MHz, to promote interest in CW and CW procedures.

The QCWA CHAPTER 70 Net meets every Thursday evening at 20:00 hours on repeater VE3TWO **147.300+.** You do not have to be a QCWA member to participate.

The Ottawa Valley VHF/UHF SSB Net is sponsored by the West Carleton ARC. Look for it every Tuesday night (except the first Tuesday of the month) around 21:00 on **144.250,** (roll calls after net on 50.150, 432.150, 222.150, and 1296.100.) Horizontal polarization is preferred.

The Ottawa Amateur Radio Club bulletin "Groundwave" is published and distributed to club members by mail. Publication dates may vary but it is hoped that the bulletin arrives at its destination before the events listed in it have expired. The bulletin is not published for July and August when meetings do not occur. Every effort is made to provide accurate information in the bulletin, however we are all human and mistakes can be made. The OARC accepts no responsibility for any damages that may result from this. The opinions expressed in this bulletin are those of the author.

Voice (VHF) 146.94/146.34 100Hz output tone
(UHF) 443.300/448.300

VE3TVA Amateur Fast Scan Television Repeater
Video/audio beacon & input 439.25 MHz (audio sub. 443.75)
Video/Audio output 914 MHz (FM)

IRLP Node 2040 146.94/146.34 (VE2CRA/VE3RC)
(Code 411 for info) (Code 204 for activity)
(Code 88 for time)
For further information please contact the Repeater Chair.

Note: The IRLP link is not connected to ECHOLINK. Please do not try to connect using the alpha keys on your keypad. It just confuses the operator.
Note: The IRLP link is disabled during the Capital City Net each Monday. It is disabled from 2000 to 2145 Mondays except for May to August when the link is disabled from 2000 to 2020.

Ottawa Amateur Radio Club
Groundwave

April 2007

Dates to Remember

2007	
Feb. 10,11	Canada Ski Marathon
Apr. 11	Homebrew Night
Jun. 13	OARC AGM and Elections
Jun. 23,24	Field Day
Jul. 1	RAC Canada Day Contest
Sep. 1	OARC Hamfest and RAC Forum
Sep. 30	Membership Renewal Deadline
Nov. 1	Joe Norton Award Subm. Due
Dec. 29	RAC Winter Contest

March Minutes

The OARC monthly meeting was held on March 14th, 2007 at Ottawa City Hall, Ottawa, ON and was called to order at 19:30 by President Diane, VA3DB. There were 34 people including 3 guests. The guests were: Al VE3ALO, Bob VE3MPG, and Ted VE3OJU.

Diane VA3DB asked for any changes or errors from the last meeting. The minutes were accepted.

Richard awarded pins to the following Canadian Ski Marathon volunteers:

Greg VE3YTZ
Ian VE3IGJ
Al VE3ZTU
Mike VE3FFK
Rick VE3IHI
Richard VE3UNW
Dave Harris, VE3KMV
Dave Goodwin, VE3AAQ (Not present to accept his pin, but mentioned)

Dave introduced Ray Pelletier from the Institute for National Measurement Standards at the National Research Council as the presenter for tonight's meeting. Ray gave a talk on CHU, the shortwave station which broadcasts Canada's official time signal.

Announcements:

VE3FFK announced that work will continue on the club project March 31st at 09:00.

Canadian Tire is selling a battery charger/kit for approx $20. The battery and 'wall wart' inside the unit make this an appealing parts purchase especially for the club project.

There will be a Bunny hunt on April 7th in the afternoon organized by VE3WEH, Larry Wilcox.

George announced that the Quarter Century Wireless Association (QCWA) is holding a contest March 31st and April 1st.

The Tour Nortel (http://cheofoundation.com/tournortel) is happening Sunday, May 6th. Dave, VE3KMV is looking for operators for the event.

The QCWA is meeting Thursdays for breakfast at the Summer Hays Grill.

On a sad note, Bill Hall, VE3JMC, is a silent key.

Ken Willing, VE3CV is battling cancer in the hospital. Best wishes.

Al, VE3ANO, won $20 in the 50/50 draw.

The meeting adjourned at approximately 20:32 for coffee.

Mathew Petch

Several years ago when Senator Hillary Clinton visited Iraq, the Army Blackhawk helicopter used to transport the Senator was given the call sign “Broomstick One”. And they say the Army has no sense of humour.

mk's Words

Trap Dipole Revisited

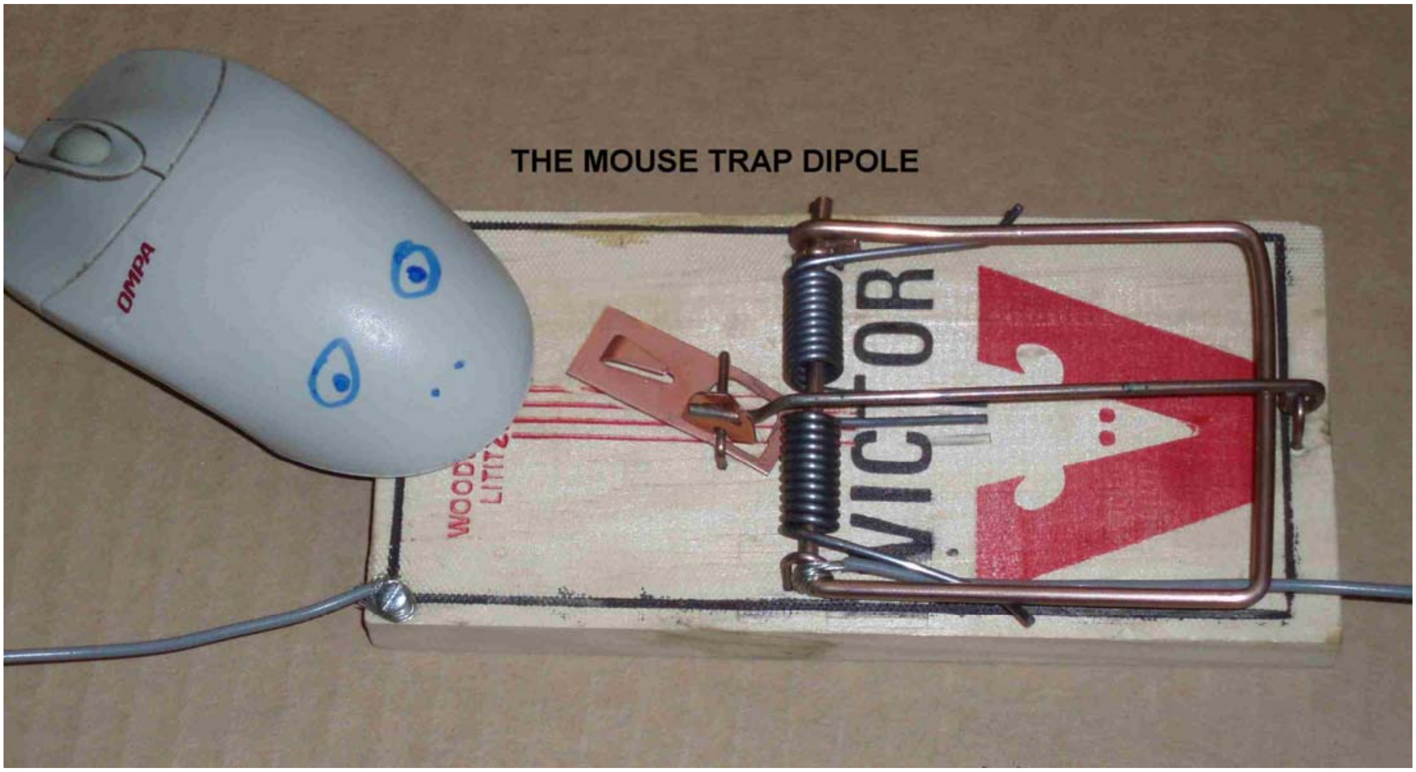
It seemed like a good idea at the time.

I was looking at different designs for trap dipoles, especially for 80-40 and 40-30 recently. Most of the designs seem to have at least one weak point. Either the traps are too heavy, or too lossy, or just too big to hang out in the middle of the dipole. If the wire has to be increased to 10 gauge to support the traps, then the supports and their guy ropes get bigger and soon it looks like a ... Well, maybe I don't need two bands after all. But the idea of being able to get an antenna to work on two bands was just too good to give up on so I put it on the back burner. It only smouldered for a little while. Then, in a walk through my favourite store "Everything a Buck can Buy") I saw the answer. Of course! The way to make a perfect trap dipole is to start with the perfect trap.

I immediately purchased a six pack of these classic engineering marvels and rushed back to the hamshack. Before too long they were wired up and ready to test on the 40 - 30 metre pair. 30m was in good shape. The dipole tuned up just fine. Now for the big test, a switch to 40m.

It's here that the first problem arose. No mice. Fortunately, I have a well stocked junk box, and was able to find a suitable mouse. Once trained, it was a simple matter of releasing the mouse at the bottom of the feedline. (Mice love feedlines, especially if there is some feeding to be had.) Anyhow, release the mouse and it's up to the traps. Two "SNAPs" later, you are on 40. By the way, don't worry about the mouse. They never get caught in the trap - well not twice, anyway. No retuning was necessary back at the shack. Life was good, for a while. It was only the next morning at the time for my 30m sked that the flaw in the plan revealed itself... Does anyone have any idea how I can get back to 30?

73 and hava foolish April
-mk



Brainteaser

This month's puzzle:

Big Number!

What is the remainder of $(5^{9999})/7$? This is due to Fermat (but not his famous last theorem). It can be done with high-school math. [Thanks to Brice Wightman for this one.]

Send your answers to editor@oarc.net.

Last month's puzzle:

Who's on First?

Since the probability of either team winning a game is ½ , and since all four games are independent, the probability of the first team sweeping the series is ½ * ½ * ½ * ½ , or 1/16. The same for the second team. So the probability of a sweep by either team is 2 * ½ or 1/8.

All the other explanations have flaws of one sort or another.

Brice Wightman solved this correctly and even provided the answer when the probability of a team winning is something other than ½.

Elmer Wanted

Wanted: An Elmer with extensive HF tower antenna, transmission line and microwave experience to help me get started.

I need to see and understand the intimate details of antenna installations and learn from the experience of others hams. I am trying to get my tower populated with some HF and microwave antennas so that I can get on the air.

I have my advanced ticket, but never been on the air. I am somewhat boat-anchor (HF and microwave) literate.

My QTH includes a taller than normal erected tower .

My interests are:
1] DX (160 - 6 M),
2] Oscars, EME, microwaves(10 & 24 Ghz), space station AM, FM, CW, SSB ... & later on, some digital modes.

a) I would like to put up a modest Yagi beam & rotator. A Hi-Gain TH3 & Ham IV (both used) have been suggested to me.

b.) I would like to add an extra boom on for my helix & microwave dishes with elevation control (altitude and azimuth).

c.) An inverted 'V' hung (RG-8U) off the tower for 160, 80 & 40 has been suggested.

I am not interested in repeaters at the present time .

If you or perhaps some other experienced DX or Microwave Elmer can help me with some practical knowledge, this would be appreciated.

73
Rick 613-991-6928

Ottawa Amateur Radio Club
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April 2007

Understanding SWR

We worry a lot about Standing Wave Ratio (SWR) in amateur radio since SWR is one indication of how well our antenna system is working. Most HF transceivers and antenna tuners have built in SWR meters.

SWR is a measure of a transceiver's output power (P_f) verses the portion of that power reflected by the antenna system (P_r). If the antenna system is working well, most of the forward power will be radiated by the antenna with very little power reflected back to the transceiver. That is, the reflected power will be much less than the forward power ($P_r << P_f$). The difference between the forward power and the reflected power is the actual or true power (P_t) radiated by the antenna ($P_t = P_f – P_r$), assuming that losses in the transmission line are negligible.

If the output impedance of the transceiver, the characteristic impedance of the transmission line, and the impedance of the antenna itself are all equal (if we have a perfectly matched system), then the SWR will be 1:1. This is the best or ideal case in that all of the transceiver's output power P_f will be radiated by the antenna ($P_r = 0$). In practice, this case is rarely achieved. Normally the antenna system will reflect some power back to the transceiver. Typically then, the first number in the SWR ratio will be greater than 1. If SWR is represented as S:1, then S > 1 in most cases. From a practical point of view, SWR numbers in the range from 1:1 to 1.5:1 (1 < S < 1.5) are very good, meaning that the antenna is radiating most of the power sent to it.

The term Standing Wave Ratio, SWR, relates to the variation in the voltage (or current) along the length of the transmission line from the transceiver to the antenna. If the antenna is perfectly matched to the transmission line, there will be no variation in the voltage. The voltage measured at each point along the transmission line will be the same. However, if the antenna impedance is different from that of the transmission line, then some of the forward power will be reflected by the antenna and travel back toward the transceiver. The forward power traveling in one direction along the transmission line and the reflected power traveling in the opposite direction creates an interference pattern along the length of the transmission line. Because of this interference pattern, the voltage measured at various locations along the transmission line will no longer be the same. At some point the measured voltage will be V_m. A short distance from that point the voltage will be less than V_m. A little further on the voltage will be even less. As we continue to move away from that point toward the antenna, the voltage will reach a minimum value and then start increasing again. If we measure the voltage along the entire length of the transmission line, we find that the voltage varies sinusoidally. Furthermore, this sinusoidal voltage waveform is stationary, it does not move, it appears frozen in place along the length of the transmission line. Thus the name standing wave. The ratio of the highest voltage (V_h) to the lowest voltage (V_l) along the transmission line is called the standing wave ratio (SWR). Thus SWR = $V_h : V_l$. If the impedance of the antenna and the transmission line are the same, there is no reflected power, there is no standing wave, and the voltage everywhere along the transmission line is the same. That is $V_h = V_l$, and SWR = $V_h : V_l = V_l : V_l$ = 1:1, a perfect match. If the impedance of the antenna and the transmission line are not the same, some of the forward power will be reflected by the antenna, a sinusoidal voltage interference pattern will develop along the transmission line, and V_h will not equal V_l . In this situation $V_h = SV_l$, where S is some number greater than 1. Thus in this case the SWR = $V_h : V_l = SV_l : V_l = S : 1$.

The output impedance of commercially available amateur radio transceivers is 50 ohms. The characteristic impedance of the various types of coax cable transmission lines used in amateur radio is also approximately 50 ohms. However, the impedance of the antenna is rarely 50 ohms. The radiation resistance of a quarter wavelength vertical antenna with a very good ground plane is about 35 ohms.

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The radiation resistance of a half wavelength center fed dipole is about 70 ohms. In each case, this is the approximate impedance of the antenna at its resonant frequency. In both cases the antenna impedance is pure resistive (the antenna appears to be a resistor). Above its resonant frequency, the antenna's impedance is inductive (the antenna appears to be an inductor in series with a resistor). Below the resonant frequency, the antenna impedance is capacitive (the antenna looks like a capacitor in series with a resistor). The impedance of the antenna is not equal to 50 ohms in any of these situations. As a result, part of the transmitted power will be reflected by the antenna back to the transceiver.

In terms of SWR ratios, the reflected power $P_r = [(S-1)/(S+1)]^2 P_f$ and the power radiated by the antenna (P_t) is given by $P_t = [1 - [(S-1)/(S+1)]^2]P_f$. As an example, suppose that the power output of a transceiver is P_f = 100 watts and the antenna system is perfectly matched with an SWR of 1:1 (S = 1), then

$$P_t = [1 - [(S-1)/(S+1)]^2]P_f = [1 - 0] P_f = P_f = 100 \text{ watts.}$$

That is, all of the transceiver's output power is actually radiated by the antenna. As a second example, suppose that the SWR of the antenna is 3:1 (S = 3). In this case

$$P_t = [1 - [(S-1)/(S+1)]^2]P_f = [1 - [(3-1)/(3+1)]^2] 100 = [1 - [1/2]^2] 100 = 75 \text{ watts.}$$

In this example only 75 watts of the transceiver's output is actually radiated by the antenna. The remaining 25 watts is reflected by the antenna back to the transceiver. Expressing the true power P_t actually radiated by the antenna relative to the transceiver's output power P_f as a db power gain (or loss if a negative number) we have

$$db = 10 \log (P_t / P_f) = 10 \log [1 - [(S-1)/(S+1)]^2].$$

If the antenna system SWR = 3:1 then the gain = 10 log [0.75] = -1.25 db. Since the gain is negative, the antenna system will actually produce a loss which is what would be expected. What is interesting is that an SWR of 3:1 is considered to be a high undesirable SWR, and yet it results in a loss of only 1.25 db, hardly noticeable to anyone receiving the transmission. Remember that a 3 db gain or lost in power is required at the transmitter before a person receiving the signal will notice any change in received signal strength. However, there is more to the SWR story.

Power reflected by the antenna will travel back through the transmission line and arrive at the output of the transceiver. Modern day semiconductor transceivers do not handle this reflected power well. If the reflected power is sufficiently high, it can severely damage the transceiver's power output transistors. To avoid damage, manufacturers design protective circuits into the power output stage. The protective circuit reduces the transceiver's output until the magnitude of the reflected power is below that which would cause damage to the transceiver. In terms of SWR ratios, transceiver's typically operate at their full nominal output power P_n, for example 100 watts, at SWR values of less than 1.5: 1 ($S < 1.5$). For SWR values greater than 1.5:1, the transceiver's protective circuitry kicks in, typically limiting the transceiver's forward output power P_f to approximately $P_f = [1/(S-0.5)^2] P_n$, where $S > 1.5$. If the antenna system SWR is 3:1 and the transceiver's nominal output power P_n = 100 watts, the output power of the transceiver will be limited to $P_f = [1/(S-0.5)^2] P_n = [1/(3-0.5)^2]100 = 16$ watts! In terms of db change, the protective circuitry drops the transceiver's power output by

$$\text{Power reduction} = 10 \log [P_f / P_n] = 10 \log [1/(S-0.5)^2] \text{ for } S > 1.5.$$

For an SWR of 3:1, the power reduction = 8 db. This power reduction will clearly be noticeable at the receiving end.

The total loss in power due to a high SWR is the sum of the db power reduction imposed by the

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transceiver's protective circuitry and the loss resulting from reflection at the antenna. Thus:

Total SWR loss = 10 log [$1/(S-0.5)^2$] + 10 log [1 – [$(S-1)/(S+1)]^2$] , for S > 1.5.

The interesting observation from this equation, and the above discussion, is that the power reduction imposed by the transceiver's protective circuitry is considerably greater than the loss at the antenna due to mismatch reflection. At an SWR of 3:1, the total SWR loss is 9.25 db, a considerable loss. However, the total SWR loss at an SWR of 2:1 is approximately 4db, which is just barely perceptible at the receiving end. For an SWR less than 1.5:1, power loss is negligible since the transceiver operates at full output power and the mismatch reflection loss at the antenna is less than 0.18 db.

So far the discussion has assumed that the transmission line loss is negligible. But suppose this is not the case. Suppose that there is 3 or 4 db of loss in the transmission line, as might be experienced at UHF frequencies. How will this loss affect SWR readings? A transmission line with loss will cause the SWR measured at the transceiver to be better than the actual SWR at the antenna. It is easy to see why this is the case. The transceiver determines the SWR it sees by comparing the amount of power that it transmits to the antenna verses the reflected power that it receives back from the antenna. However, some of the power that it transmits is consumed by the lossy transmission line, so the power actually reaching the antenna is less than that output by the transceiver. Part of the power arriving at the antenna is then reflected by the antenna. However, since the power arriving at the antenna is lower, because of the lossy line, the amount reflected is also lower. The reflected power is then attenuated by the lossy transmission line as it travels back to the transceiver. The result is the amount of reflected power actually arriving back at the transceiver may be quite small, indicating to the transceiver that the SWR is better than it really is. Working through the numbers illustrates this point. Suppose that the forward output power of the transceiver P_f = 100 watts, the actual SWR at the antenna is 3:1 (S = 3), and the loss of the transmission line L = 4 db. What is the SWR of the antenna system seen by the transceiver? The actual power arriving at the antenna $P_A = \log^{-1} [-L/10]\ P_f$ = 40 watts. The amount of power reflected by the antenna is $P_{rA} = [(S-1)/(S+1)]^2\ P_A$ = 14.4 watts. This reflected power travels back to the transceiver being attenuated by the lossy transmission line as it goes. The amount of reflected power that arrives back at the transceiver is $P_{rT} = \log^{-1} [-L/10]\ P_{rA}$ = 5.7 watts. The SWR equation seen by the transceiver is $P_{rT} = [(S-1)/(S+1)]^2\ P_f$. Rearranging this equation and solving for S yields a value of S = 1.6. So while the actual SWR at the antenna is 3 : 1, the SWR seen by the transceiver is only 1.6 : 1. The antenna system looks a lot better to the transceiver than it actually is. In the chapter on transmission lines (Chapter 24) of the 15th Edition of The ARRL Antenna Book (1988), there is a nice chart (Fig. 18) that allow you to figure out all of this graphically. I assume that this chart has been retained in more recent versions of the antenna book.

This example raises an interesting situation. When perfect no loss transmission line was used, the transceiver saw the real antenna SWR of 3 : 1. As a result of this high SWR, the transceiver's protective circuitry kicked in limiting the transceiver's output to 16 watts. Since the transmission line was lossless, 16 watts was delivered to the antenna. In the above example, the antenna SWR is still 3 : 1, but the transceiver sees the SWR as only 1.6 : 1. The transceiver thinks the antenna system is great, its protection circuitry does not kick in, and it pumps a full 100 watts into the transmission line. Of that 100 watts, 40 watts actually reaches the antenna. With the lossy line over twice as much power is delivered to the antenna. The lossy line actually produces a 4 db system gain! Building a poor antenna and then trying to compensate for it by using lossy coax is no way to design an antenna system. However, it does point out the fact that when designing a system, you have to consider all the parameters. There are broadband applications in which a 3 : 1 antenna SWR may not be avoidable. In such a situation, the system designer may have to look more closely at the loss characteristics of the transmission line.

The conclusion that can be drawn from this is that the threshold SWR, as seen by the transceiver, is about 2:1. An SWR above 2:1 will result in a power loss that will be noticeable at the receiving end. An SWR of less than 2:1 will not create a noticeable drop in power. In terms of perfection, tuning your antenna system for an SWR of less than 1.5:1 will result in full output power from your transceiver and negligible reflection losses at the antenna. Spending a lot of time trying to reduce your SWR from 1.5:1 to a perfect match of 1:1 is generally not time well spent. From a practical stand point, an SWR of 1.5:1 is indistinguishable from a perfect match of 1:1.

Ken Larson, KJ6RZ

MEMBERSHIP APPLICATION / RENEWAL

Ottawa Amateur Radio Club, Inc.
Box 8873 Ottawa, Ontario K1G 3J2

O Renewal **O** New **O** New Ham (FREE if licensed in current membership year)
O Single ($25, $20 after Feb. 1) **O** Family ($30) **O** Junior ($15)
O Emailed PDF Copy **O** Mailed Copy ***Add $5.00 for mailed copy of Groundwave***.

(**Please note**: membership year is September 1 to August 31.)

Family Name:____________________________ First Name/Initials: ________________________

Address: ____

City: _____________________________________ Prov: _____________ Postal Code: ____________

Home Phone: ________________ Work Phone: _________________ Ext ________

E-mail address: ___________________@________________________________ (***For Groundwave mailing***)

Callsign(s): |______________| |______________| |______________| Fax: __________________

Qualifications: **O** Basic **O** Advanced **O** Grandfathered

Year Licenced: ___________

Other Family Members

Name: _________________________ Callsign(s): |____________| |____________| |____________|
Qualifications: **O** Basic **O** Advanced **O** Grandfathered
Year Licenced: ___________

Name: _________________________ Callsign(s): |____________| |____________| |____________|
Qualifications: **O** Basic **O** Advanced **O** Grandfathered
Year Licenced: ___________

Name: _________________________ Callsign(s): |____________| |____________| |____________|
Qualifications: **O** Basic **O** Advanced **O** Grandfathered
Year Licenced: ___________

Interests: ____

____

Comments/Suggestions: ____

____

Spring Cleaning Sale

Durham Radio is running out of space! Rather than move, we have decided to clean out our warehouse and balance our stock. The items shown below are just some of the great deals waiting for you. Visit our web site for great pricing on overstocks, demo units and one-of-a-kind items offered at the lowest prices ever!

CLICK ON THE IMAGES BELOW TO GO DIRECTLY TO THE PRODUCT PAGES.

25% Off

All in-stock Tigertronics SL1+ (non-USB versions only)

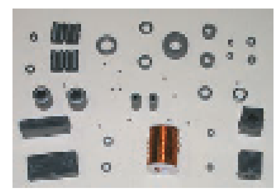
Connect between your PC's sound card and rig's mic, data or accessory port for PSK-31, SSTV, MT-63, CW, RTTY, AMTOR and Packet & more.

20% Off

All in-stock RT Systems radio cloning software

15% Off

All in-stock Amidon parts including torroids, beads and balun kits.



Alinco DX-70TH HF+6m Base/Mobile

A full 100W output on HF plus 6 metres. RX from 150 kHz to 30 MHz. Built-in narrow filters and CTCSS encode.

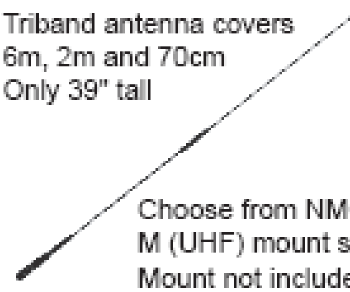
Reg. $999.00 Sale $839.97

10% Off

All in-stock Heil mics and accessories

Maldol EX-510B/NMO

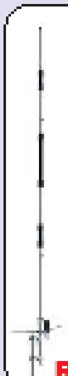
Triband antenna covers 6m, 2m and 70cm
Only 39" tall



Choose from NMO or M (UHF) mount styles. Mount not included.

Reg. $79.00 Sale $48.97

Cushcraft AR270B



This high-performance dual-band vertical base antenna is only 7.7 feet (2.35m) high yet offers a generous 5.5/7.5 dB gain. It is broadbanded for minimum SWR on both bands. It is easy to assemble and features factory-sealed coils for best performance.

Reg. $189.00 Sale $148.97

DXLB 160/80/40m Dipole

Built with insulated 12 gau wire and stainless steel hardware. Use as a dipole or an inverted vee. Comes fully assembled. Only 100 feet overall length!

Reg. $209.00 Sale $179.97

Durham Radio Facts

Since 1993 Durham Radio has been owned and operated by Alma and Keith Carcasole. There are no other shareholders or investors. We are not affiliated with any other store in Canada. This allows us to choose products that we believe represent the best value for our customers rather than items that will make the most money for investors.

All items subject to availability. Prices in effect until April 30th, 2007

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