THE WEST RAND AMATEUR RADIO CLUB


April 2011
Volume 11, Issue 10

# ANODE

**Inside this issue:**



**Special points of interest:**

- Contact details on back page (corrected & updated July 2010)
- Ham-Comp Latest on web site.

[I promise to have this updated ASAP. JB]

## Anode Editor's Comments

**Volume 11, Issue 10**
**April 2011**

**AM is "dead", Long live Double-Sideband!**

So read the article on page 6 and learn how you can transmit AM in future.

**Fox-Hunting is banned, ARDF is Not!**
Starting on this page is an article about a 'search' antenna/aerial for "Fox-Hunting". This original article has been used in Radio ZS some years ago.

Would you like to see the original article for the PIC based Fox?

**20 Years of Linux down, and the best is yet to come**
http://www.zdnet.com/blog/open-source/20-years-of-linux-down-and-the-best-is-yet-to-come/8613?tag=nl.e589

*(continued on page 10)*

## A TDOA Antenna Unit for Fox-Hunting

At some point in your hunt for the elusive "fox", you will (with luck) be so close that simple field-strength direction-finding techniques may no longer work. The "fox's" signal will be so strong that it will swamp your attenuator and leak through the plastic parts of your radio's case, resulting in "S9+" signal-strength readings in every direction, regardless of attenuator settings or antenna orientation. A "Time Difference of Arrival (TDOA)" antenna unit will put you back on the "hunt".

**(How big a truck will I need?)**
A TDOA antenna unit is simple and easy to build, and will work with any 2m FM mobile or handheld. There are many different designs of TDOA units, and some have additional "bells and whistles" (such as left/right indicators), but the basic design (which is all you really need) consists of a small dual-antenna array and an electronic antenna-switching unit.

The antenna array usually consists of two vertical dipole antennas separated 12 to 36 inches apart, often mounted on a T-shaped support so that the array can be rotated. The purpose of the antenna- switching unit is to alternately and rapidly switch the input of your FM receiver between the two dipoles. The switching rate is typically 1000 times per second. Switching is accomplished by a square-wave oscillator which alternately forward- or reverse-biases diodes connected in the circuit path between each dipole and the receiver. Common silicon switching diodes will work OK, but PIN diodes work best.

**(How does it indicate direction ?)**
The TDOA works by detecting the difference in the phase of the RF signal received by each dipole. If both dipoles

*(Continued on page 2)*

# A TDOA Antenna Unit for Fox-Hunting

*(continued from page 1)*

are exactly the same distance from the RF source (the "fox"), the phase of the RF signal will be the same at each antenna. If you rotate the array, or the RF source moves to the left or right, then one dipole will be closer to the source than the other one, causing a small phase difference between the signals received. Your FM receiver will then detect an abrupt change in the phase of the RF signal it receives as the antenna switching unit switches rapidly back and forth between the two dipoles. To the receiver, the signal looks like square-wave- modulated FM ! Your receiver's speaker will emit an audio tone at the antenna-switching frequency. As the phase difference increases, the tone becomes louder. When both dipoles are equidistant from the source, the tone almost completely disappears.

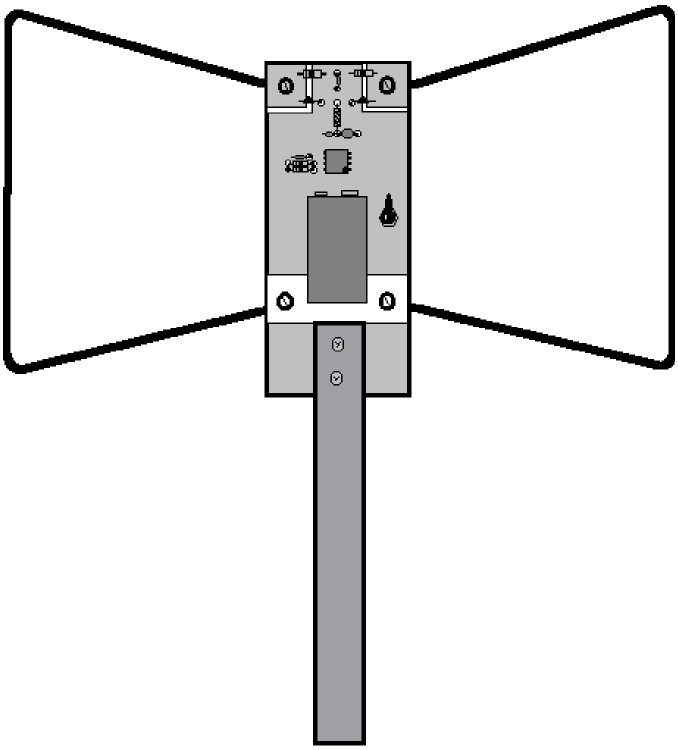

Fig. 1 - The assembled TDOA antenna unit - coaxial cable to receiver runs behind the PCB and through the PVC pipe handle.

One disadvantage of the TDOA is that when you have found the "null" or antenna position where the tone disappears, you cannot tell if the source is directly in front of you or directly behind you. Fortunately, there are other ways to determine this. A quick way, if you are using a handheld, is to use the "body shield" method - disconnect the antenna, hold the handheld close to your chest so that you can see the signal strength indicator, and turn your body. When the indicated signal strength is minimum, the source is somewhere behind you. Another technique involves converting the TDOA antenna to one which has a cardioid or heart-shaped radiation pattern - the null (which corresponds to the "notch" in the heart-shape) can be used to point a rough bearing to the source.

**A quick (1-2 evening) TDOA antenna unit**

You can build a simple TDOA unit in an evening or two for about $10 or less (depending on the size of your junk-box). The circuit, shown in Fig. 2, is based on one in an article by Paul Bohrer (ref 1). U1 is a 555 timer powered by a 9V battery, oscillating at about 1 kHz. R1, R2 and C1 determine the frequency of oscillation. The output of U1 is a square-wave from +9V to ground. C2 allows the square-wave to be level-shifted to between +4.5V and -4.5V. The positive half of the square-wave's cycle turns on (forward-biases) D1 and turns off (reverse-biases) D2; the negative half of the cycle does the opposite. R3 and R4 limit the forward bias current for each diode to about 9 mA. When the diode is turned on, the RF signal received by that diode's dipole is conducted through the diode and coupled through C4 to the coaxial cable to the receiver. When the diode is turned off, the RF signal (from that diode's dipole) is blocked. RFC1 presents a high impedance to the RF signal so that it is not shunted by the oscillator circuit, but passes the relatively low-frequency square-wave to the diodes. RFC1 together with C3 also comprise a low-pass filter to prevent the high-frequency components of the square-wave from getting into the antenna circuit and the receiver. If you forget to install C3 (I did), you'll hear a continuous "hash" of switching noise.

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# A TDOA Antenna Unit for Fox-Hunting

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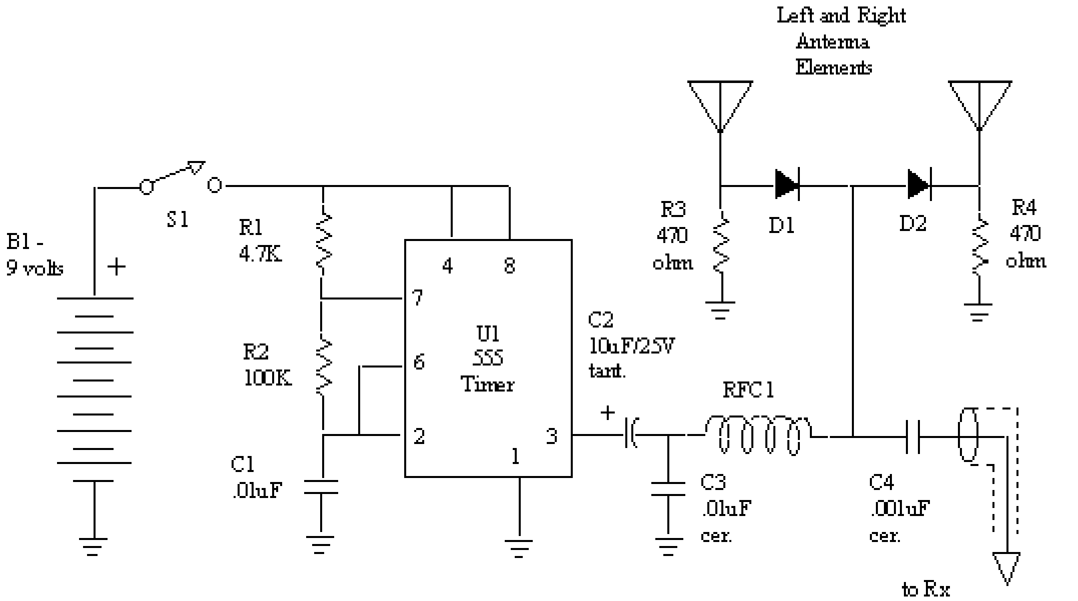


Fig. 2 - Schematic of the TDOA antenna unit.

A rough PCB layout with approximate dimensions is shown in Fig. 3. Layout is not critical, but try to keep the wiring between the antenna elements, diodes and coax as short as possible. I also tried to keep the battery and coaxial cable exactly centred so that they would not affect one antenna element more than the other, but I'm not certain if this is really necessary. The coaxial cable lead to the receiver runs down the back of the PCB and through the PVC-pipe handle.

The PCB can be "etched" using a sharp exacto-knife (watch your fingers!) and a drill-bit. Score around the areas of copper-clad that you want to remove with the exacto-knife, then peel away the copper. I use a pad-cutter tool to isolate pads in the copper, but you can clear the copper around holes with a sharp 1/8" drill bit - for a handle, use a 1/8"-shaft knob with set-screws. This prevents shorts between the copper ground-plane and component leads which pass through holes in the PCB.

I made a "bow-tie" antenna based on the "Handi-Finder" article (ref 2). Each element is a square "U", 6 inches across the bottom with 6-1/2" long arms. Each arm has a loop at each end for mounting to the PCB with #6 nuts and screws. It does not give as loud a tone or as sharp a null as two dipoles spaced 3 feet apart, but it's a lot smaller. I used coat-hanger wire, but stiff #12 copper wire or brass brazing rod would probably be better. The handle can be anything, preferably non-metallic, such as a short length of PVC pipe, wooden dowel or broomstick with a slot sawed in one end for the PCB.

Any 555 timer IC will work with this unit (there must be over 15 different semiconductor companies making them) but the CMOS part will nearly double your battery life. You can adjust R1 and C2 to vary the oscillator frequency (if you find a particular tone annoying). RFC1 is not especially critical, figure 1 kOhm impedance or better at 144 MHz. If you have something in your junk-box, try it out by tuning your rig to a QSO in progress with the TDOA antenna unit connected but not switched on, then touch the leads of the RFC between ground

*(Continued on page 4)*

# A TDOA Antenna Unit for Fox-Hunting

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and the connection between D1 and D2. If the signal strength drops appreciably, then the RFC does not have a high enough impedance at VHF.

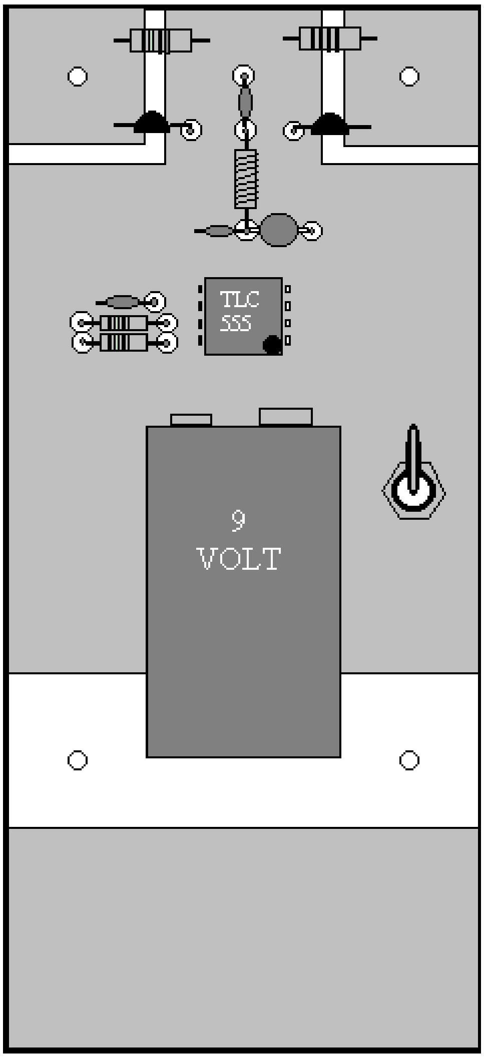


Fig. 3 - PCB component layout.

**Using the TDOA antenna unit**
TDOA antenna units are not designed for transmitting. If your handheld has a "TX inhibit" feature, it's a good idea to enable it when foxhunting with a TDOA. Transmitting into the TDOA may damage your HT, the TDOA, or both.

The TDOA works best with a strong, vertically-polarized signal. Strong multipath reflections caused by nearby vehicles, buildings, fences, power lines, steel lamp-posts, etc. can make the null difficult to detect, or even appear on a wrong bearing. (Note that wily foxes look for places just like these to hide). If possible, look for open areas clear of obstructions and reflectors when taking bearings. If the bearing appears to change as you move around, your location may be affected by multipath. With practice, you'll be able to tell from the tone whether you have a good signal or one distorted by multipath.

**Parts List for the TDOA Antenna Unit (Fig. 1)**
1. U1 - CMOS 555 timer
2. R1 - 4k7, 1/4W, 5%
3. R2 - 100K, 1/4W, 5%
4. R3,4 - 470R, 1/4W, 5%
5. C1 - 0.01uF, 50V ceramic
6. C2 - 10uF, 25V tantalum
7. C3 - 0.01uF, 50V ceramic
8. C4 - 0.001uF, 50V ceramic
9. D1,2 - PIN diode, MPN3404
10. RFC1 - RF choke, 8 turns magnet wire space-wound over 1/4W carbon comp resistor (100k or greater).
11. S1 - Switch SPST (toggle or slide)
12. Misc. - PCB, 9volt battery, battery holder, stiff wire (for ant.), RG-58 coax and BNC connector.

Parts Sources - Toronto Area
Electro Sonic, 1100 Gordon Baker Rd., Toronto
-- PIN diodes : Motorola MPN3404
-- 555 timer : National LMC555CN, Motorola MC1455P1
-- 9V battery holder : Keystone No. 1291
-- switches : Mode Electronics
Double-H Electronics, 3800 Victoria Park Ave., Toronto
Daiwa Semitron, 3800 Victoria Park Ave., Toronto
-- copper-clad PCB (single- and double-sided)
Radio Shack
-- 555 timer : Texas Instr. TLC555
(all locations listed above carry the resistors and

*(continued on page 5)*

# A TDOA Antenna Unit for Fox-Hunting

*(Continued from page 4)*
capacitors).

**References and related articles**

1. "Foxhunt Radio Direction Finder", Paul Bohrer, W9DUU, 73 Magazine Jul '90, pp.9-11, (construction article for TDOA unit with left/right indicators).
2. "Build the HANDI-Finder!", Bob Leskovec, K8DTS, QST May '93, pp.35-38, (construction article). See also "Sense the Right Way to Go with the Handi-Finder", by Joe Moell, K0OV, QST Oct '93 Technical Correspondence, pp.77-78, for cardioid pattern modification.
3. "The HANDI-Finder", Dave Martin, W6KOW, 73 Magazine Dec '93, pp.26-27, (product review).
4. "Homing DF Units", Chapter 8, "Transmitter Hunting - Radio Direction Finding Simplified", Joseph D. Moell K0OV and Thomas N. Curlee WB6UZZ, TAB Books, 1987.
5. "Monitoring and Direction Finding", Chapter 38, The ARRL Handbook - 1993 (70th Edition), the Amateur Radio Relay League.
6. "Direction Finding Antennas", Chapter 14, The ARRL Antenna Handbook - 1991 (16th Edition), the Amateur Radio Relay League.
7. See also the "Homing In, Radio Direction Finding" column by Joe Moell, K0OV, every month in 73 Magazine.
[73 Magazine is no more. But you could try:-
http://www.homingin.com/hmgindx.html]

# Suppressed Carrier Double Sideband Systems

By G. W. SHORT

## METHODS OF CONTROLLING PHASE OF REINSTATED CARRIERS

FROM time to time one sees references., in American technical literature., to a communications system which is known as d.s. b.s.c. (double-sideband suppressed carrier) - Although some details of this were published nearly four years ago, it appears to be almost unknown in Britain. This is a pity, since an essential part of the d.s.b.s.c. system is a new kind of radio receiver which can be regarded as a synchrodyne with its main limitation (the method of locking the oscillator) removed. As such, it should have applications to normal a.m. reception as well as to single sideband reception.

In 1956 the American Institute of Radio Engineers held a symposium on single sideband communications systems. At that time s.s.b. was being, tried for ground-to-air working and for military purposes. J. P. Costas pointed out that, as a matter of practical politics. the expected increase in usable channels due to the narrower bandwidth requirements of s.s.b. could not always be realized (1).

Serious interference by the nominally suppressed sideband can occur. Suppose, for instance, that an aircraft a few miles from an airfield is transmitting on the channel adjacent to that of a very distant aircraft, and that the distant transmission occupies the same band of frequencies as the suppressed sideband of the near transmission. The distant transmission may suffer an attenuation of, say, 60dB more than the near transmission. If the suppressed sideband of the near transmission is attenuated only 50dB (a typical figure in this kind of application) then it will arrive at the airfield at a level of 10dB greater than the distant signal, completely blotting out the latter.

Even if there is not much point in s.s.b. on a bandwidth-saving basis, however, there would seem to be a good case for it on the grounds of power economy. Why transmit all that useless carrier power? Why, indeed! At this point Mr. Costas comes up with an idea that has every appearance of being a winner. Why not transmit

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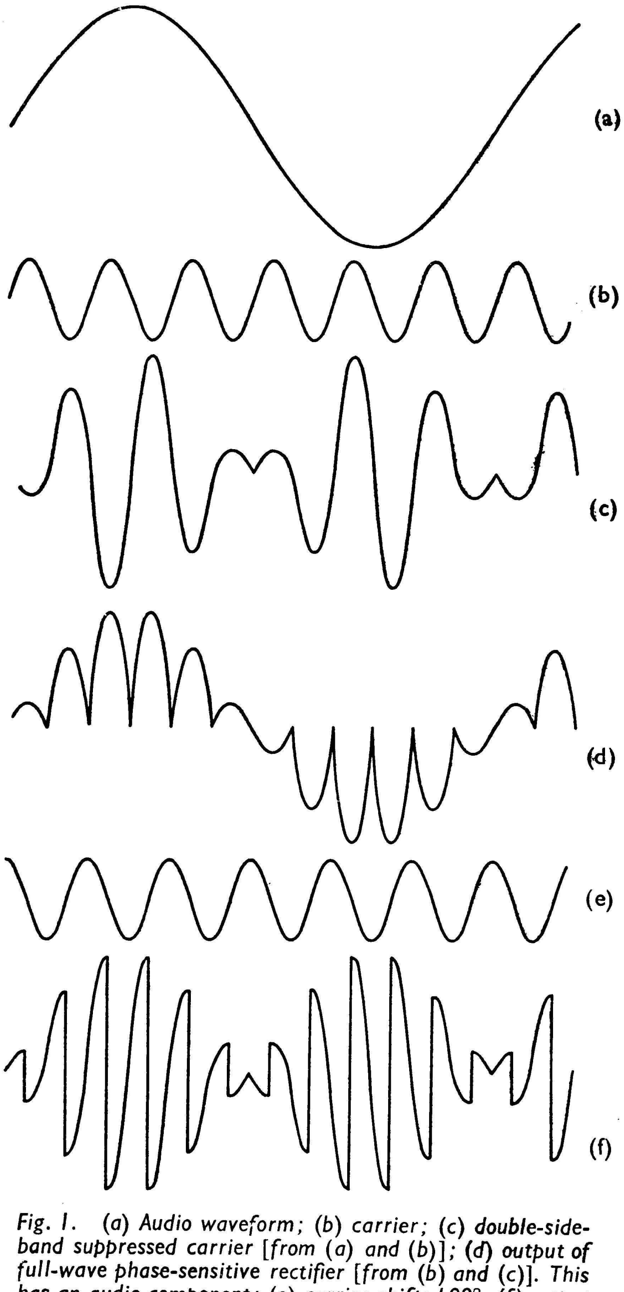


*Fig. 1. (a) Audio waveform; (b) carrier; (c) double-sideband suppressed carrier [from (a) and (b)]; (d) output of full-wave phase-sensitive rectifier [from (b) and (c)]. This has an audio component; (e) carrier shifted 90°; (f) output of rectifier derived from (c) and (e). This has no audio component, since successive half-waves sum to zero*

# Suppressed Carrier Double Sideband Systems

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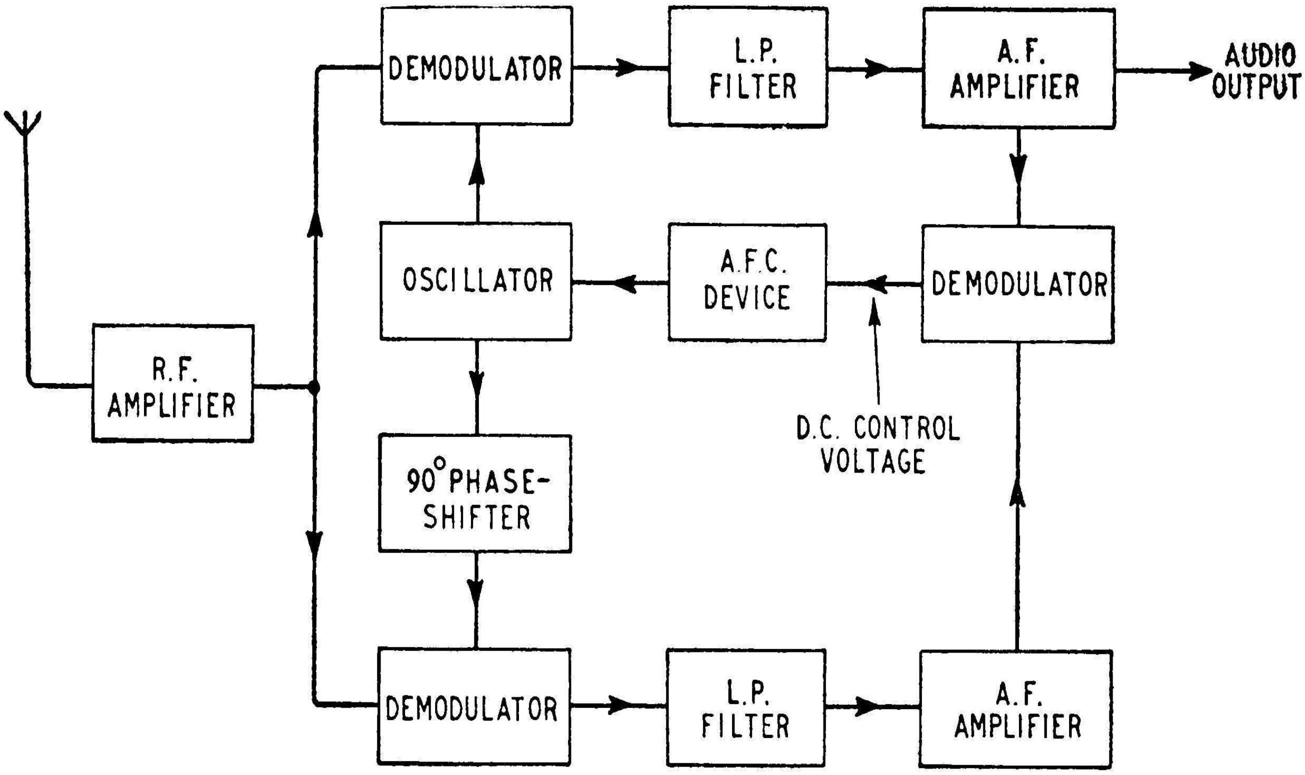
both sidebands, but no carrier? Each sideband contains useful information; so no power is wasted, and it is far easier to produce a double-sideband suppressed carrier signal than a single-sideband signal.




**Receiving Techniques**

The snag-and in the past it has always seemed a very big snag-is in the requirements which have to be met at the receiver. Single-sideband reception is bad enough, since it requires the reinsertion into the signal of a carrier equal, or very nearly equal, in frequency to the original carrier*. To receive a double-sideband suppressed-carrier signal, the locally generated carrier frequency must be exactly equal to the original carrier frequency, and, in addition, it must be approximately in phase. Considering that the receiver has not got a sample of the original carrier to use as a yardstick, the position seems hopeless. However, the very exacting nature of these requirements contains the key to their solution. Suppose that by some feat of design and operating skill, the receiver can be made to provide the right carrier frequency and phase.

What happens when the frequency starts to drift? The answer is that, as the phase angle between the required carrier and the actual oscillation increases, the audio output decreases, falling to zero at 90 degrees phase difference and then rising to a maximum of 180 degrees, and so on. This is illustrated by the

(Continued on page 8)

# Suppressed Carrier Double Sideband Systems

(Continued from page 7)
waveforms of Fig. 1, which shows how there is no audio output for the quadrature condition.

Now, the phase of the audio output reverses as the carrier phase passes through 90 degrees.

This provided Mr. Costas with the answer to the problem, for by incorporating an audio-frequency phase detector in the receiver a voltage suitable for automatic frequency control of the oscillator can be produced.
[*In a superhet receiver the sum or difference of the local oscillator and intermediate frequencies must equal the required carrier frequency.]

The receiver is shown in block diagram form in Fig. 2. There are two demodulators, supplied with locally generated carriers in phase quadrature. One of these (say the upper one) is in the main channel. If the phase angle between the original and the local carrier supplied to this demodulator is 0 degrees, then the audio output is a maximum. The audio output from the lower demodulator is then zero. If the phase angle changes, owing to frequency drift, the audio output from the main channel is reduced, and an audio output appears in the second channel, its polarity (compared with that of the main channel) depending on whether the phase error is a lag or a lead. These two audio outputs are combined in a third demodulator, which, being "phase sensitive," yields an a.f.c. voltage of the required polarity with a magnitude depending on the phase error.

**System Advantages**

The beauty of the arrangement, which resembles the synchrodyne, is that the selectivity is independent of the r.f. bandwith. Only the wanted signal gives rise to an intelligible audio output. Other signals give rise to supersonic outputs, if they are remote in frequency, or "monkey chatter" if they are close.

In the first case, they can be got rid of entirely by a low-pass filter, and in the second, a low-pass filter will usually reduce the annoyance. As a matter of fact, it is claimed that by combining the audio outputs of the two channels in particular ways with the aid of phasing networks certain types of interference can be reduced even if they yield audio-frequency outputs.

Although this system of reception has been developed, out of necessity, for double-sideband suppressed-carrier working it is not limited to this. Ordinary a.m. signals and s.s.b. signals can also be received.

The only obvious deficiency of the system is the absence of a.g.c. It is not possible to derive an a.g.c. voltage in terms of the carrier amplitude, since, even if the carrier is transmitted, the resulting d.c. output from the demodulator is not passed by the audio stages. It mIght be possible to obtain a.g.c. from a normal a.m. signal by interposing a modulator in the r.f. part of the receiver (Fig. 3). All signals would then be varied at the modulating frequency, but only the wanted signal would give rise to an audio output at this frequency. A filter could therefore be used to separate the a.g.c. frequency, the filter output signal being amplified and detected. (This scheme was originally suggested by D. G. Tucker(2) as a means of receiving c.w. signals with a synchrodyne.)

Alternatively, the audio output could be rectified and used as a.g.c. This is not ideal in that there is no output during silent intervals. On the other hand, the audio and carrier levels are related in that the maximum peak audio voltage is fixed by the maximum depth of modulation permitted at the transmitter. There seems to be no reason why this "peak possible" audio voltage should not be stored in a capacitor and employed to operate an a.g.c. device.

**REFERENCES**

1 Costas, J. P., "Synchronous Communications,"
(continued on page 9)

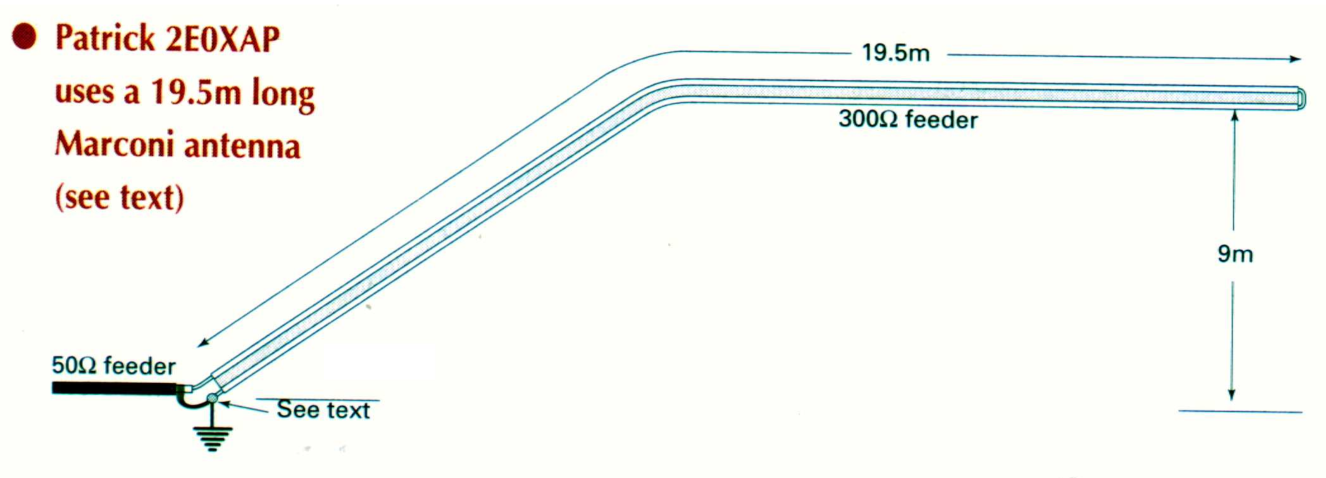
# Suppressed Carrier Double Sideband Systems

*(Continued from page 8)*

Proc. I.R.E. Vol 44 Part 2; December 1956, p. 1713.
2 Tucker. D. G., `Re Synchrodyne," Electronic Engineering. Vol. 19, November 1947, p. 366.

**Taken From:**
Page 242, 243 WIRELESS WORLD, MAY 1961

**Interesting 'short' aerial.**




**I have an interference complaint. Who do I complain to? Search Google…**

# Anode Editor's Comments

(Continued from page 1)

**Granny "hacker" takes down web in two countries**
http://www.pcpro.co.uk/news/broadband/366607/granny-hacker-takes-down-web-in-two-countries#ixzz1IpYJpaAL

**Arctic ozone levels in never-before-seen plunge**
http://www.bbc.co.uk/news/science-environment-12969167

**Morse Code Generation from Text**
http://www.codeproject.com/KB/PHP/MorseCodeGen.aspx

**Recent work on the Quad by club members.**

**Don't Forget this web site:-**
http://www.homingin.com/
For the 'Fox-Hunting' interested parties…

**QSL Communications to close**
[sad news]
After trading for 27 years, Amateur Radio dealer QSL Communications is to close as the owners have decided to retire.

They will be closing their doors for the last time at 4 pm on Thursday, April 21, 2011.

Jayne writes that they will be in again after May 10 until the end of the month hopefully selling the last little bit off and clearing the site - Bargains to be had.

QSL Communications
http://www.qslcomms.f9.co.uk/qsl/

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KG33XU 26.14122 South - 27.91870 East

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**Web page: www.zs6wr.co.za**

**Bulletins** (Sundays at …)
11h15 Start of call in of stations
11h30 Main bulletin start

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Input: 431.4MHz (West Rand Repeater)
145,625 MHz (West Rand Repeater)
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Please send plain text with no formatting to the email address below.

See Club website at www.zs6wr.co.za for all ANODE back issues.

**We need your input! Email us articles, comments and suggestions please. zs6wr.club@gmail.com**