THE PROPAGATOR

Jan Part 1998

The Newsletter of the Illawarra Amateur Radio Society

Volume 97/98 No. 1 Printed approximately bi-monthly. Priceless.

EDITORIAL:

This is my first time as editor of the Propagator, a post which has been difficult to fill in past years. By taking on the job at our recent AGM I not only saved everyone the uncomfortable silence that ensues when the position is up for renewal but also afforded myself the luxury of getting myself in print. However, it is my intention to be a single-term editor only. Having made that clear, I will do my best to see your newsletter is well-presented, properly typeset and has as few spelling or literal errors as is humanly possible. As to how interesting it is...well, we shall come to that later in this editorial. The committee hopes to prepare between four and six issues during the 1997-98 year, so you can look forward to a few more (hopefully) thought-provoking editorials.

Before I continue, I should introduce myself. I'm Ned McIntosh - VK2AGV - and I have lived in the Illawarra since late 1977 after moving here from Canberra. I obtained my Novice licence in 1978, Limited licence in 1979 and full AOCP in late 1979. In 1981 I obtained the Radiocommunication Operator's General Certificate of Proficiency as well as an Associate Diploma in Marine Radiocommunications.(Page 2)

In This Issue:...

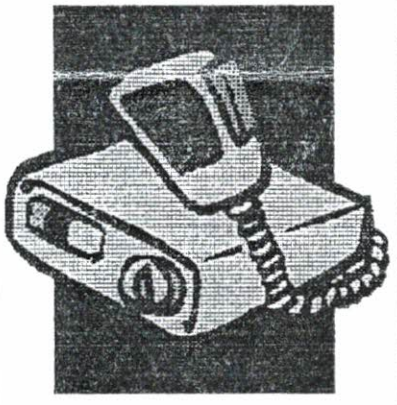
Disclaimer: The opinions expressed in the editorial and the rest of this publication are not necessarily those of the IARS or the committee.

Next Issue: - PC Basics part 3, and an article on Antarctic radio...you think you had antenna problems! Plus much more. **Don't miss it!**

WANTED!

Articles for the Propagator... they can be on practically any subject with the slightest relevance to amateur radio. Maybe a project with an IC like the one right here!

Or a single-valve circuit for those blokes who still have a single valve in the junk-box. (A handwarmer?)



Or maybe a neat conversion of a CB to a 70cm rig - whatever it is, send it to the editor NOW! We want your articles for the next issue - don't delay! Act Now! Limited Offer!

From 1982 to 1992 I was a Radio Officer in the Australian Merchant Navy. Since 1992 I've worked in Television production and engineering, notably in microwave links, outside broadcasts and (occasionally) satellite uplinks.

As you may surmise, I've dabbled in a lot of different areas of this "weird science" called radio - I jokingly say "from DC to daylight", having worked the MF, HF, VHF, UHF, SHF and microwave bands up to 21Ghz. As a result I've had to be "Jack of all trades" and must therefore truthfully claim to be master of none.

Like so many of my generation I came up from the ranks of CB radio, to which I readily admit my debt. I seem to have joined the IARS about 1978 or thereabouts and have been a member continuously since. There were quite a few very active amateurs in the Illawarra then - I used to listen to most of them on 2 metres - but very few of them are to be heard today. Sadly some are silent keys but many have simply faded away as other interests assumed greater priority.

So much for the potted biography of the new editor. Ah, yes, there's that word again..."Editor" - that's the key word here, isn't it?

Let's be quite clear about what an editor does. The dictionary says; "one who edits written material for publication; one who collects, prepares and arranges materials."

You will note that nowhere in those few words does it mention "create from thin air" or "conjure out of seeming nothingness". In other words, I will edit the newsletter but I WILL NOT CREATE IT. That's where you come in. You can send contributions to Simon (VK2XQX) or other committee members who are on packet. You can snail-mail your article to the editor at the IARS PO box (see the rear page). Unfortunately I am not directly accessible via Packet or email but there are plenty of ways to send material to someone in the club who knows how to get it to me. If it's text, a floppy disk (3-1/2" 1.4Mb and virus free, please!) with plain vanilla ASCII will do just fine. There is no excuse. Without your contributions, the Propagator will be mighty thin reading. Remember, we can print a title page and a back page on two sides of a single sheet if we have to!

In the coming year I will probably raise a few eyebrows with my editorials. If you disagree with what I've written, terrific! Set out your point of view and let's see it published in this, the forum for exchange of information, news and views within the IARS. Part of making our club active and vigorous means getting people to communicate. Sure, we've got several excellent repeaters for this, but don't neglect the Propagator in this respect either. Some of us can't listen to the repeaters as much as we'd like, but we can all read the Propagator.

Finally, I'd like to finish this editorial by acknowledging the achievement of the outgoing committee. The IARS has weathered another difficult year and emerged in good financial shape, a tribute to the Treasurer for decisions taken to reduce expenditure. Likewise, the Repeater Committee has performed exceptionally in maintaining the repeaters under sometimes difficult circumstances and with the ever-present consideration of financial constraint. The IARS has a well-deserved reputation for the quality of service and technical standard of its repeaters and this has continued, in spite of what we might politely refer to as occasional bureaucratic "impedance problems".

Lastly, the membership at large deserves thanks too. You renewed your subscriptions and in so doing you expressed your confidence in the IARS and helped keep it going for another year. The President and Committee thanks you for your continuing support, financially and by your attendance at club meetings and activities throughout the past year . Well done, everyone!

(Well, that's the end of the editorial. If you've got this far, you'll really love what's coming up on page 3!)

(Left:) The new editor ready to prepare the next Propagator.

THAT WAS THE YEAR...1983

In our somewhat disjointed wanderings through last decade we've arrived at 1983. What was new then? What did we think was really the latest hot stuff?

In personal computers we were still solidly entrenched in 8-bit machines. The Dick Smith Super 80 was still selling well at a price of about $445, for which you got the board, a power supply, 16K of RAM, cassette interface, TV modulator and a keyboard mounted on the main board itself. No case, no disk drive, but at least you had a machine that worked once you had built it.

The Microbee was also making a name for itself . Their owners were always very enthusiastic about them although by today's standards anything 8-bit is pure stone-age and fit only for use as a door-stop. Nonetheless, the Bee, as it was called, became a classic and a lot of them went to schools. How many of today's young information technology wizards started their computer careers using a Bee in secondary school. I wonder?

Printers were still at the daisy-wheel stage, and some were dammned expensive, even in 1983 dollars. A top-of-the-line Dick Smith unit was a fraction under two thousand dollars, and a dot-matrix printer came at a price of nearly a thousand. Not for the faint-hearted! Now it's getting rather difficult to buy a new dot-matrix printer - the inkjet has supplanted it. However, for printing multi-part carbonless invoices and so on, the dot-matrix still finds a use in many businesses.

What about 1983 computer prices? A Commodore 64 cost $699 - today you can't give one away. Last time I saw one advertised in the "Trading Post" it - and a heap of software - was going for a whopping $25! If you wanted to really spend money on a computer then the machine for you was the Apple "Lisa", developed at a cost of over 200 million US dollars. Apple had high hopes this exceptionally advanced machine would sweep the opposition away. There was just one slight snag - the Lisa cost an absolute fortune (in excess of 10,000 US dollars!) and buyers stayed away in droves. So the Lisa died - but from the ashes the Macintosh would arise. Perhaps they should have called it the Phoenix?

The Lisa did not expire in vain, for it pioneered what we now call the graphic users interface. Today we simply call it "Windows", and refer to whichever flavour we happen to be using. (Some less-than-impressed users also call it "Widows" or "Curtains".) By the way, don't think the windows-type interface is exclusively the property of Apple and the IBM. The Xerox company pioneered it but sold it to Microsoft. There is also an excellent Windows-style interface for Unix called the X Windows System, or X for short. Install Linux on your hard drive and try it!

As far as the soon-to-be-ubiquitous IBM-PC was concerned, the beginning of the PC-compatible market emerged as the Challenger, sold in Australia by Dick Smith Electronics made its debut. (I think it was actually made in the UK by Ferranti) It was priced at about half the cost of the IBM, came with 128K of RAM and had both Centronics and RS232 ports supplied as standard. You could even get it with twin disk drives (320K per disk!). For just $2000 you could have it all, including the "expansion unit". The Challenger was a portent for the future of personal computing. Now the clones have out-evolved the original.

Stereo kits were naturally big sellers in the 80s and the electronic enthusiast magazines were full of advertisements. There were kits for echo and reverberation amps, stereo pre-amps, bigger and beefier crossover networks, DIY loudspeakers by the gross, graphic equalisers and so on. These were evergreens in the kit field and most gave more than adequate results. Some also became "classic kits". and survive to this day, suitably updated to reflect advances in semiconductor technology. Who remembers the "Musicolour" kit, or the "Playmaster" kits? There are a lot of them still out there,

working away.

A United States semiconductor company, Acrian Inc. announced the development of power FETs capable of producing tens of watts at frequencies in the Gigahertz range. Bipolar devices already existed for such applications, but their inherent tendency to thermal runaway was a disadvantage. The power FETs didn't suffer from this undesireable effect and the military were very interested for radar and electronic warfare applications. Today we accept power FETs as just another useful lump of silicon to plug into the circuit and see what comes out, but back in the 80s this was pretty hot stuff.

Space scientists were beginning to sound the alarm about "space-junk" - small and not-so-small pieces of man-made materials in orbit around the earth which were capable of doing enormous damage to orbiting spacecraft. The smallest particles were the size of microscopic paint flakes, the largest were old, burnt-out rocket stages and expired satellites. The disabling of orbiting spacecraft by collision with space-junk was a consequence of what was known as the "Kessler Syndrome" - a rain of space-junk from higher orbital levels towards lower levels after which these particles eventually re-enter the atmosphere and burn up. In effect it was a sort of continuous rain of space-junk through which all the earth-orbit satellites had to pass - a sort of "American & Russian Roulette". What prompted this research was a few unexplained - and very embarrassing - losses of satellites.

These days there is a sophisticated organisation which does nothing but track space-junk - but technology dictates only items over a certain size can be tracked. Even so, that's over 5000 objects with an estimated 5000 more which are un-trackable. How can orbiting paint-flakes of sub-millimetre size damage satellites? Well, they might not have much mass but their collision velocities are eye-watering - anything up to 15Km per second! To make it worse, a collision between such a small particle and an orbiting satellite creates a secondary rain of new fragments of all sizes which can collide with other orbiting bodies, perpetuating the effect. It seems we've now polluted our near-space environment as well as the planet (to say nothing of the QRM we pump into the ionosphere).

July 1983 marked the 35th anniversary of the announcement of the development of the bipolar transistor by John Bardeen and Walter Brattain, working under the guidance of William Shockley in the Bell Telephone laboratories. Of course, everybody knows that transistor was a contraction of the words "transfer resistor", the original name for the new device. By 1956 there were 164 different types of transistors available. Valve manufacturers couldn't believe it.

One magazine printed an article on EMP (Electro-Magnetic Pulse) resulting from nuclear detonations and some of the possible effects. A large Hydrogen bomb (are there any small ones?) is capable of generating an electrical field intensity of 50Kv/m at the surface of the earth - a huge lightning strike, effectively. Telephone wires, underground cables and so on form effective antennas for such a field, resulting in huge induced voltages (megavolts) and current flows of 10KA for a period of approximately one microsecond. Such spikes are virtually impossible to stop and you can readily imagine what they do to any of the billions of semiconductor junctions they might encounter on their way to earth! Interestingly enough, those creaking, ancient, stone-age devices called valves are highly resistant to EMP (a valve may suffer a short-duration flashover with little or no damage) which is one of the reasons why the military still find many uses for them. Most Soviet military avionics was all-valve and they had developed some tiny and very efficient little bottles which showed how seriously the problem of EMP was taken. The Americans spent billions on "hardening" their solid-state electronic systems. To date they have been very tight-lipped about how successful that work has been.

Car computers were starting to make themselves popular about 1983 and there was a unit available from Jaycar for about two hundred dollars. The technology to build these devices and install them in every passenger vehicle has been around for a long time yet we are still stuck with conventional

analogue driving instruments. What about drive-by-wire cars?

Ever heard of the supercap? NEC developed them. They began appearing in 1983 as backup power supplies for CMOS RAM etc. With a capacitance of one Farad (yes, that's right, a whole Farad!) and a voltage rating of 5 volts, they were the size of four 20-cent pieces stacked on top of each other. Unlike Nicads, the supercap had a practically indefinite life and was tolerant of varying charge rates. Furthermore, it was non-polarised. Whatever happened to them?

What about amateur radio? The Yaesu FT-707 HF transceiver cost about $700. The FRG-7 receiver had been replaced by the FRG-7700SW at a mere $520. Kenwood's TS-430S was pretty much the same cost as the FT-707 and they were affordable rigs. Less affordable was the top-of-the-line Kenwood TS-930S - about $1800 - and Yaesu's FT-ONE out-priced the Kenwood by a couple of hundred dollars! They established the precedent for the all-singing, all-dancing general coverage HF transceivers which today cost several thousand dollars. For those on a budget, Yaesu had the FT-77 for a mere $800. A second-hand TS-520S or FT-101 could be had for just a few hundred - both lovely rigs but starting to show their age by 1983. Today a second-hand TS-520S or FT-101 still gets many an amateur on the air and they sound beautiful. Valves still have their uses!

On the regulatory front, a draft of the Radiocommunications Act of 1983 had been released, intended to replace the old Wireless Telegraphy Act of 1905 (!!). Although overdue for change, the new draft Act also left much to the interpretation of the regulators of the day. Transmitters were so vaguely defined that anything which was capable of radio transmissions, irrespective of its use or function, became a transmitter and therefore subject to the provisions of the Act. (A microwave oven or a spark-plug would have fallen within these definitions!) On the other hand, some of the vagueness of the wording may have been deliberate, to allow the regulators to extend their tentacles into areas where they had no real business in the first place, after a suitable pretext had been found.

Another contentious issue was the requirement for receivers to be licensed - all except broadcast receivers, that is. The inevitable result was signifiant sections of the proposed Act were practically unenforcable and subject to the interpretation of either the Minister or the Governor-General (question: does anyone know if any of our Governors-General were radio amateurs?). The proposed new Act also appeared to be riddled with legalistic Parliamentary jargon so beloved of our legislators who obviously think unintelligibility is a virtue when it comes to legislation. Perhaps this is no surprise since it helps justify the existence of the legal profession and - surprise, surprise, - most politicians are drawn from that very self-same profession. Yet again, our administrators demonstrated the only thing they did really well was doing things very badly! Perhaps things haven't changed all that much since then.

CD players were beginning to make inroads on the home stereo market, but Mitsubishi went one better with a car CD-player. Perhaps a little ahead of its time? They're not bad now, but back in 1983 what happened if you went over a large bump? Not a happy sound, I'll bet.

Finally, on yet another front of the consumer electronics battlefield, Sanyo announced the first full-size cassette Betamovie video camera. This was a real camcorder as we know them today, loading a full size Betamax cassette for a maximum 3 hours and 40 minutes of recording time - significantly more than available with VHS units. They cost thousands then. Today, you might see one of these in a pawnshop for about $125. Old technology, but if you're a Betamax fan (damn good system; technically superior to VHS) it's one way to make your own movies. You'll just have to get used to editing-in-camera. Mind you, if the imaging tube is gone or the lens is damaged then it's a paperweight. Spare parts will be hard to find but it might make a nice conversation piece.

All right, that's about all I could dig up from the files for 1983...1984 is next, unless there are so

many contributions I have to hold it over. - **Ned McIntosh VK2AGV**

NEWS REPORT

In which we inform our members of coming events, important dates, field days, conferences, meetings, dinners, barbeques, Christmas parties and all that sort of stuff.

JOTA Weekend: The JOTA weekend is coming up in October (the 18th & 19th) and our usual helpers are both unavailable. We like to do our best to make JOTA a success for our local scout groups so some volunteers would be greatly appreciated. We'll provide more details as they become available. Stay tuned!

VK2AMW-9 Lives!: Due to a donation by a member of the Society, a TNC has been obtained for installation at Maddens Plains to ensure VK2AMW-9 continues to serve the coverage area to the standard which we have come to expect. The Committee takes this opportunity to express its sincere appreciation. (More info in the repeater report)

Advertisers: The contribution towards production costs of the Propogator made by our regular advertisers is greatly appreciated. All they ask in return is for your custom. Please take the opportunity to visit them for workshop supplies, tools, consumables and so on. You'll be pleasantly surprised at their prices and friendly service.

REPEATER REPORT (August & September 1997)

VK2RMP (Maddens Plains) 146.850 - No probs with the Rptr itself, but we're still occasionally suffering the intermod interference from Communication Site Rental's TXers. The tower owners are still planning refurbishment of the tower, which will result in the removal of all unused antennas & feedlines (at least half of them are unused) & removal or replacement of all rusty & corroded brackets. All involved believe (& hope), this will stop the interference.

For the past month or so, we've been suffering from low-level interference from packet transmissions on the WIA Broadcast on Sundays. The interference sounds like a low-level buzz on & off intermittently. At first we thought it may have been some form of deliberate interference to the Broadcast (like what happened a few years ago with the "A" & "B" team crap). It turned out the interference is due to a combination of transmissions at the Rptr site mixing together & allowing the Broadcast RX to "hear" a second frequency - in this case a well used packet frequency. Work is progressing in trying to eliminate the problem.

438.725 - No problems, useage of the Rptr appears to be increasing as users discover the bliss of pager-free reception. (8725's coverage is very similar to 6850's).

VK2RUW (Knights Hill)

438.225 - No problems with the Rptr or the link to Goulburn & Canberra. The VK1 WIA Broadcast is fed up the link on Sunday evenings at around 8pm (they're sometimes a bit late). Their Broadcast is quite interesting & presented in a totally different style to the VK2 Division's. Listening to the VK2 Broadcast in the morning & the VK1 in the evening, provides a broader view on Amateur activities.

29.620 - Still no immediate plans for installation of the 10m Rptr. I know this has been dragging on but there is a fair bit of control equipment to be built for the RX site at Mt Murray & besides, there isn't much activity on 10m just yet, but it is slowly increasing.

VK2RIS (Saddleback Mtn)

146.975 - This Rptr has now been on the air for about 2 years (time's gone fast, eh?). In that time the Rptr has had only one problem & that was in the first few months when the RF output transistor (a BLY89A) failed. It's about time for it's 100,000Km service & tune-up, but we've been putting this off while waiting for the new tower to be erected & for us to also move buildings. Unfortunately, this was supposed to happen back in February; we're still waiting! When the Rptr is finally removed, some new boards will be installed to give full DTMF remote control, plus allow for linking the 10m Rptr with it.

South Coast WICEN has offered to pay the site fees for this Rptr, for this year & the future. Present cost is $130/annum, so this is a very generous offer & greatly appreciated.

VK2AMW-7 (Mt Murray)

147.575 - This digipeater has been performing very well, you only have to down-load the Heard & Node lists to see what it can "hear". There is a heap of BBS traffic at night from as far away as Newcastle, the Blue Mtns, Goulburn & the South Coast. There appear to be no power problems, despite most of its work being at night when the solar panels are ineffective.

VK2AMW-9 (Maddens Plains)

144.700 - This digipeater is also working very well, perhaps too well (according to some Sydney packet ops). No BBSs use this frequency or system (although it can be used as a link back-up). Once again, a check of its Heard & Node lists can be very interesting, with some very long distances being involved. Also, typing "BBS" on either VK2AMW-7 or 9, gives access to the best darn BBS in Australia, even if you can't remember VK2XGJ. (I'll collect my $20 later John).

Please be aware that VK2AMW-7 is shut down during the morning & evening VK2 Broadcasts on Sundays. The digi recently had its loaned TNC replaced by a donated one. An Amateur down the coast who was so happy with the installation & coverage of VK2AMW-9 very kindly bought & donated a new TNC to the IARS to show his appreciation. This was a very generous offer, his only condition was that he remain anonynmous. Thank-you...

The planned Batemans Bay Rptr system is still underway. We are presently awaiting the proposed site's owners to get back to us regarding our access request. (We are fairly optimistic). The Rptr will be a 50w Philips 814, probably using a simple yet reliable commercial folded-dipole. The Rptr is planned to be linked back up to the Illawarra, possibly onto 8225...

For those not at the September IARS meeting wondering why we are looking at installing a Rptr out of our area, the reasons are many & varied but here are a few. The area presently has no real Rptr service; we have many members who visit the area to holiday not forgetting the many VK1s who holiday there as well; we have the resources (enthusiasm/technical ability/experience); good PR for the IARS & good for Amateur Radio in general & besides, it is planned not to cost the IARS anything. South Coast WICEN & some local Amateurs have offered their support in this regard.

Well that's it for this Propagator, till next time - Rob VK2MT.

UNFINANCIAL "MEMBERS":- I have to admit the title is something of a contradiction, like "military intelligence" or "competent authority" but what I really wanted to say was this. Did you see a funny sort of mark on the envelope this Propagator arrived in? You did? Congratulations - YOU'RE UNFINANCIAL! A freeloader. A pan-handler. A moocher. In short, this will be the last Propagator you'll ever see unless you renew your membership, pronto! So get those membership renewals in the post as quickly as you can. By the way, those who wish to see the Treasurer light up like a TNC immediately following a direct hit by lightning can pay their renewals at the next meeting. We don't mind how we get your money, just as long as we get it!

Lets Discuss PHASE-LOCK LOOPS FOR FREQUENCY SYNTHESIS

You have all heard about frequency synthesisers and the place they have in many modern amateur radio units, but if you are in the position of not really having understood them, or you need a bit of a brush up, then the following notes may hopefully help.

Let's start by asking ourselves how a "baseband" signal, (the nominal operating frequency) can be generated. There are a number of methods in detail, but nearly all of them rely on an RLC (resistance-inductance-capacitance) circuit effectively tuned to the frequency of interest. Remember, a parallel RLC circuit offers maximum impedance at the frequency of resonance, whilst a series RLC circuit offers minimum impedance at the frequency of resonance. If the RLC circuit is connected to an active device such as a transistor, and if some of the output of the transistor is fed back to the RLC circuit, oscillations at the resonant frequency may occur.

Construction of an RLC circuit may be by winding a coil and placing it in series or parallel with a capacitor (often, the coil windings resistance becomes the 'R' in the circuit). According to the ARRL Handbook, these sorts of circuits may be used at frequencies up to about 5 MHz, after which the drift in values of the inductor and capacitor become unacceptable. This of course affects the frequency stability -- the measure of how well a tuned circuit holds a desired frequency. Coil/capacitor combinations may of course be built with typically variable capacitors enabling the operator to select the frequency of interest with ease. Of particular interest to us, and easily capable of operation at 146 MHz, is a special case involving the varicap diode - a semiconductor diode that changes junction capacitance with a change in applied voltage -- the heart of the "voltage-controlled oscillator". The varicap acts a part of the total capacitance in a tuned circuit.

Quartz crystals behave like tuned RLC circuits when appropriate voltages are impressed upon them. They have distinct advantages of high "Q" (low 'R'), good frequency stability and can be manufactured to resonate at far higher frequencies than coil/capacitor combinations. Unlike coil/capacitors, the resonant frequency cannot be readily altered, even when teamed up with coils or capacitors, for which theoretically, we may change the operating frequency.

Of course, most will have seen or know that with the older style valve AM wireless sets, tuning was acheived by turning the rotor of a large variable capacitor. (By the way, if you have one these increasingly rare capacitors, keep for them for antenna tuning projects, the wider plate spacing handles the RF voltages well in such applications!) Now as we go up in frequency to the "short waves", we quickly reach the 5 MHz limit mentioned above, after which we need to use frequency multipliers in order to reach our operating frequency whilst still having variable capacitor tuning. In theory, we could extend this process as far as we like, but realize that any *change* in our variable tuned circuit frequency is also multiplied as we go up the frequency multipliers.

So then, what does a phase-locked loop (PLL) do for us? Well, based on just a few crystal oscillators, many PLL's will allow the generation of many discrete frequencies

over a wide range, e.g. the Icom IC-4E handheld 70cm tranceiver (of which I have a copy), is capable of producing 2000 channels between 430 and 440 MHz with a channel spacing of 5 kHz. A crystal controlled rig would cost hundreds of dollars in crystals alone to perform a comparable task!

For the purposes of these notes, I am going to concentrate on the PLL 02A IC which is the heart of the Dick Smith "Explorer" project of 1983. Understanding this one should readily enable understanding of virtually any PLL frequency synthesiser.

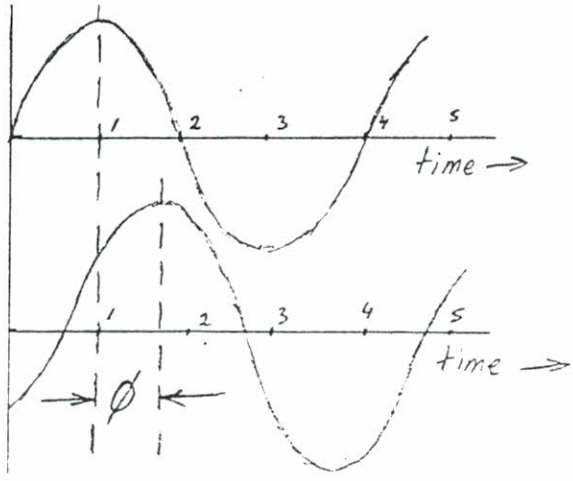
What is a phase-locked loop? We can understand that we may describe such as based on a circuit which compares the phase of an incoming signal with that of a reference signal and outputs an "error" voltage in response to any difference. See Figure 1. The circuit becomes a loop if the error voltage is fed back to the incoming signal. It is phase-locked if the incoming signal becomes tied to the reference by means of the looped error voltage.

For use in frequency synthesisers, PLL's need a reference oscillator, frequency division circuits, in addition to frequency mixing circuits, filters, and power supplies, not forgetting of course the varicap based voltage controlled oscillator. The PLL 02A also has an output which stays in a low voltage state until a "locked" condition exists whereupon the output goes to a high voltage state and may be used to control transmitter stages to avoid generation of unstable and unwanted transmissions. A block diagram of the transmitter frequency synthesis on "Explorer Ch 1" (438.025 MHz) is shown in Figure 2. Only the transmitter frequency synthesis is shown for simplicity.

The reference oscillator operates at 8.5333 MHz. A signal from this oscillator is fed to an input of the PLL 02A. Depending upon the condition, (high or low voltage) applied to another pin on the PLL 02A IC, the 8.5333 MHz signal is divided by either 1024 or 2048. In the "Explorer", it is set to divide by 1024. Thus the PLL uses an internal reference frequency of 8.5333 MHz / 1024 = 8.3333 kHz. Why do this? Now if the 8.5333 MHz reference oscillator was to drift in frequency, then the internal reference would drift by less than one thousandth part of the original. Given that the 8.5333 MHz reference oscillator is a typically stable crystal oscillator, we will thus have a very, very stable internal reference and hence should be able to consequently generate similarly highly stable output signals.

The PLL will be in a locked and desired condition if the signal *derived* from the voltage controlled oscillator is also operating at a frequency of 8.3333 kHz internally within the PLL 02A. To see how this is achieved, let us trace out the path of the signals assuming that a lock condition exists and that the output frequency is 438.025 MHz. (Follow Figure 2.)

The "Explorer" does not generate 438.025 MHz directly, but rather derives this particular signal from the voltage controlled oscillator outputting a signal at 146.0083333 MHz and then tripling the frequency of this latter signal. (146.0083333 X 3 = 438.025 MHz). Hence we operate the PLL to generate frequencies actually within the 2 m amateur band rather than directly within the 70 cm band.



Two similar signals (frequency and amplitude the same but differing in phase.

Phase difference occurs in time but is measured as an angle ø., usually in degrees.

360° is one complete cycle.

Phase difference is a measure of the time difference between similar parts e.g. peaks, of similar frequency signals.

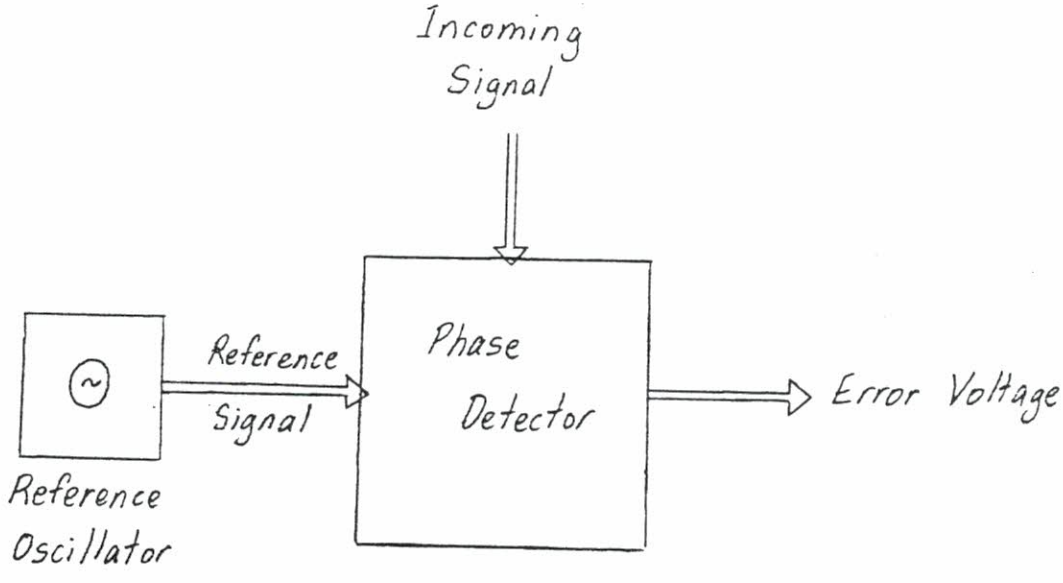


FIGURE 1. A Description of "Phase" & A Block Diagram of the "heart" of a Phase-Locked Loop.

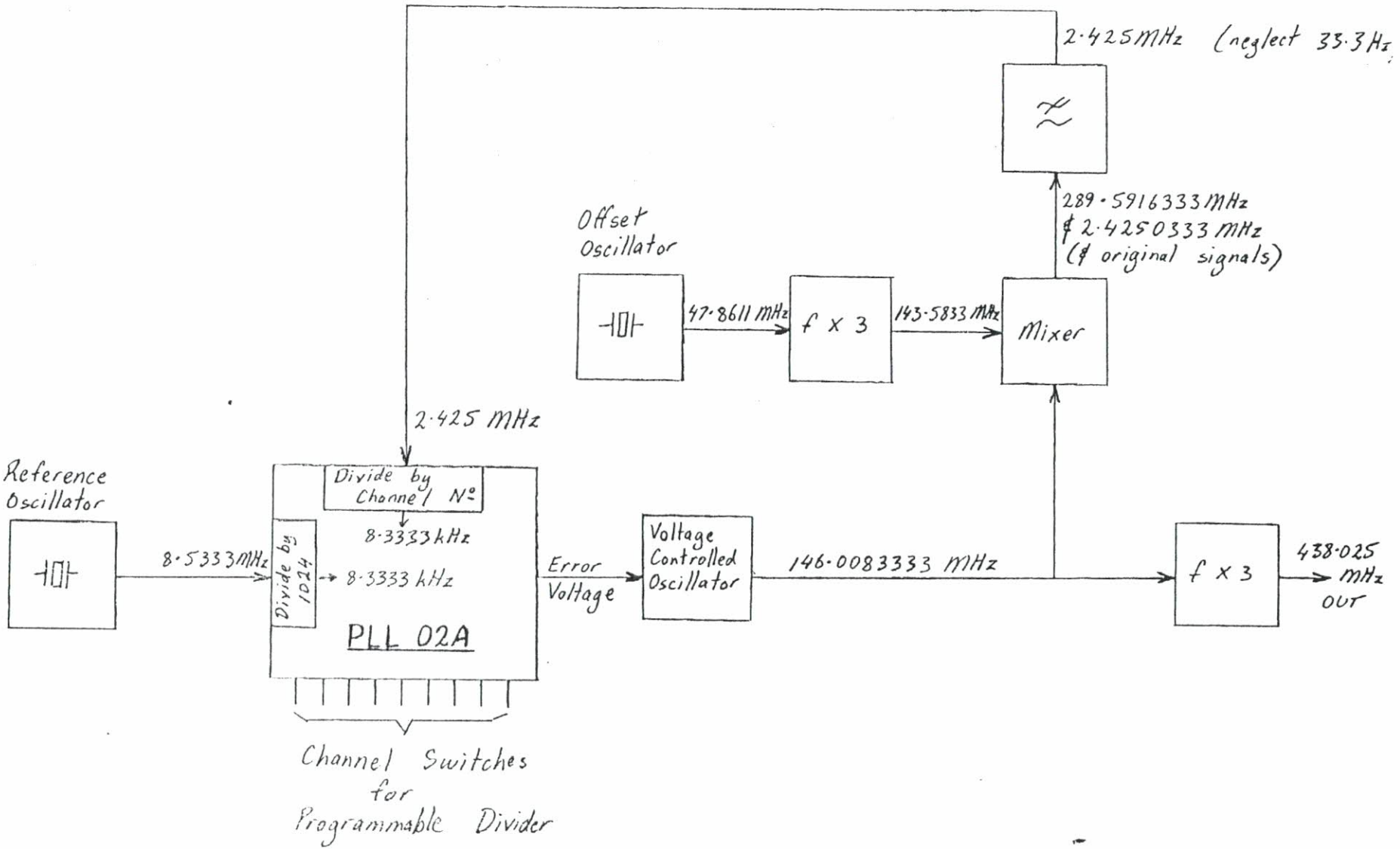


FIGURE 2. General Layout of Dick Smith UHF "Explorer" Transmit Frequency Synthesis

OK, so the voltage controlled oscillator is working at 146.0083333 MHz. To be able to get the PLL internally working at 8.3333 kHz, we need to do several things. Part of the 146.0083333 MHz signal is hived off and is mixed with the *tripled* output of what is known as an *offset oscillator* operating at 47.8611 MHz. Now, 47.8611 MHz X 3 = 143.5833 MHz. *Mixing* is a process of combining two signals from which we obtain the *sum* and the *difference* frequencies. By mixing our voltage controlled oscillator signal at 146.0083333 MHz and the tripled offset oscillator signal at 143.5833 MHz we will obtain 146.0083333 MHz + 143.5833 MHz = 289.5916333 MHz as well as 146.0083333 MHz - 143.5833 MHz = 2.4250333 MHz. (In practice, the output of the mixer also yields signals at the original frequencies as well.)

Now of this rather complex result in mixing signals, it is only the signal at 2.425 MHz that we want. (We will now neglect the last 33.3 Hz.) We obtain this signal by passing the output of the mixer through a low pass filter thus eliminating the higher frequency components, including the original signals.

We now pass the 2.425 MHz signal to an input on the PLL 02A. At the same time, the PLL 02A has an inbuilt *programmable* divider. We may program what division takes place, and in the case of the "Explorer", this is done by means of a forty position rotary switch. "Channel 1" on the "Explorer" is actually channel 291 (of a possible 512 channels) on the PLL 02A. Dividing 2.425 MHz by 291 gives us 8.3333 kHz (or very close to it!). We now have the signal derived from the voltage controlled oscillator the same as that derived from the reference oscillator! The PLL 02A outputs a voltage known as the "error voltage" (no, this does not mean a mistake!) which is fed to the varicap diode at the heart of the voltage controlled oscillator operating at 146.0083333 MHz.

If the output frequency of the voltage controlled oscillator drifts, a phase detector internal to the PLL 02A will see this and will change the error voltage, changing the voltage applied to the varicap diode and thus altering the frequency of the voltage controlled oscillator to its nominal value.

Suppose we now move the channel selector to "Ch 2". This will correspond to channel 292 on the PLL 02A. The PLL 02A phase detector will see a difference between the reference signal and that derived from the voltage controlled oscillator and output an error voltage to adjust the signal derived from the voltage controlled oscillator to that of the reference. Working backwards, we will see that the desired signal from the mixer in this case will be 8.3333 kHz X 292 = 2.433 MHz. Add this to the tripled offset oscillator signal at 143.5833 MHz and we get 146.0163 MHz which in turn, when tripled gives close to 438.05 MHz which is of course the desired Channel 2 of the "Explorer".

So the above is a description of how the frequency synthesiser built into the "Explorer" works. Other PLL frequency synthesisers will differ in detail, but will be the same in principle. Details for the "Explorer" receiver are only slightly complicated by the need for a 10.7 MHz intermediate frequency, whilst only the offset oscillator frequency is different if transmitted output around 433 MHz is required for repeater operation. All of the above notes can easily be verified with a multimeter and a frequency counter on an "Explorer" unit.

Other uses for phase-locked loops, apart from frequency synthesisers, include the detection of modulation in FM signals.

Well, I hope the above notes serve a purpose in assisting in the understanding of PLL frequency synthesisers, brief as they are. Feel free to call us if any clarification might be needed.

73s

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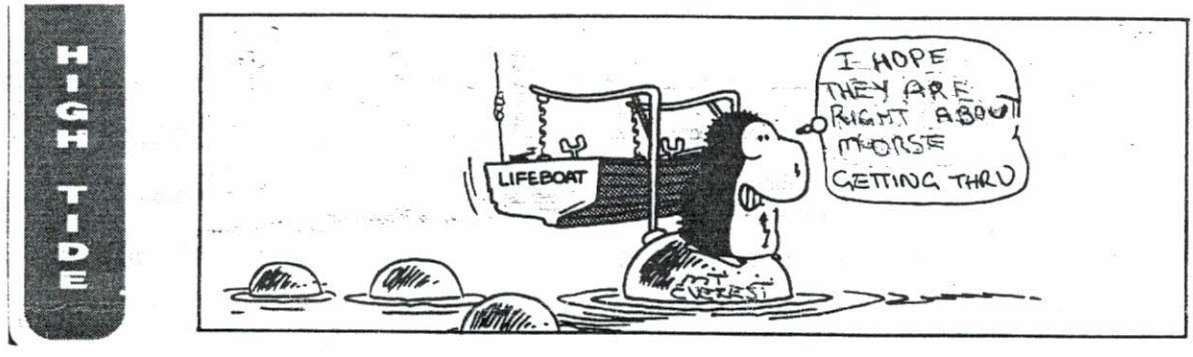
LETTERS TO THE EDITOR:

As the graphic suggests, the editor sits poised to include your correspondence - all that is now required are some letters. Get your word-processors out and start typing. You can correspond on anything to do with amateur radio, no matter how tenuous the connection. Got any ideas for club activities? Send them in and we'll publish them. Got any good, humorous stories about ham radio? Let's have them! Got any gripes about the current editor and editorial content of the Propagator? Excellent - send them in. We'll accept any constructive criticism and do our best to act on it. We'd especially like the humourous stories. - if we get enough we'll put a special page put aside for them. If any of you are budding cartoonists, have a go! Remember VK2KING?



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Interested? For any or all of the above items, contact Ted Hawkins (VK2HCC) on TF 42572136.

(We have room for more ads right here - a free service to all IARS members! Who said you can't get something for nothing?)

A radio amateur was scheduled to depart on a DXpedition and decided to buy a pet for company whilst he and his companions were on the island. As it happened they were travelling by ship since it meant they could keep all their gear with them and supervise its loading and unloading - they knew what happened to airline luggage.

A day before the ship was due to sail the amateur searched the town near the dockyard for a pet shop, and as the day drew to a close finally found one. It was a week after Christmas and, predictably enough, the pet shop was somewhat depleted in stock.

After some discussion the amateur bought a blue budgie in a cage with the usual accessories for water, birdseed and so on. He hadn't owned a pet budgie before so the shopkeeper told him the bird needed a piece of cuttlefish bone so it could dress its beak properly, otherwise it wouldn't be able to crack the seed and eventually it would starve. The problem was the shop was right out of cuttlefish bone - none to be had, and the amateur was sailing that night.

"Breeders use a tiny file to dress the beaks, but I haven't any of those either", said the shopkeeper.

"Well, what can we do?, the amateur replied, somewhat concerned.

The shopkeeper looked at him carefully. "I've got a rasp out the back - but it's way too big, you'd kill the bird! It's all I can think of but I don't think even a breeder could get away with it..."

"No, that'll be all right - I'm used to soldering tiny parts onto things, I'm good with my hands, it will work", said the amateur. With great misgivings the shopkeeper added the rasp to the package and watched the amateur leave.

Months later the amateur returned. Since the sale was rather unusual the shopkeeper recognised him immediately and enquired after the health of the budgie.

"Oh, it died...I was dressing it's beak at the time..." the amateur replied, sheepishly.

"I told you the rasp was too big, didn't I?" said the shopkeeper.

"No, it wasn't the rasp...I think I must have tightened the vice too much!"

The Illawarra Amateur Radio Society Inc.

PO Box 1838 WOLLONGONG NSW 2500

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Callsign	Freq	Mode	Location	Linked to:
VK2RMP	146.850	Voice	Maddens Plains	VK2RMU
VK2RMP	438.725	Voice	Maddens Plains	
VK2RIS	146.975	Voice	Saddleback Mtn	(future)
VK2RUW	438.225	Voice	Knights Hill	VK2RGN, VK1RGI
VK2RUW	29.620	Voice	Knights Hill	(off-air)
VK2AMW-7	147.575	Packet	Mt Murray	Netrom
VK2AMW-1	144.625	Packet	Woll. University	
VK2XGJ	144.700	Packet	Dapto (& 147.575)	
VK2XGJ	439.075	Packet	Dapto	
VK2AMW-9	144.700	Packet	Maddens Plains	Netrom

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