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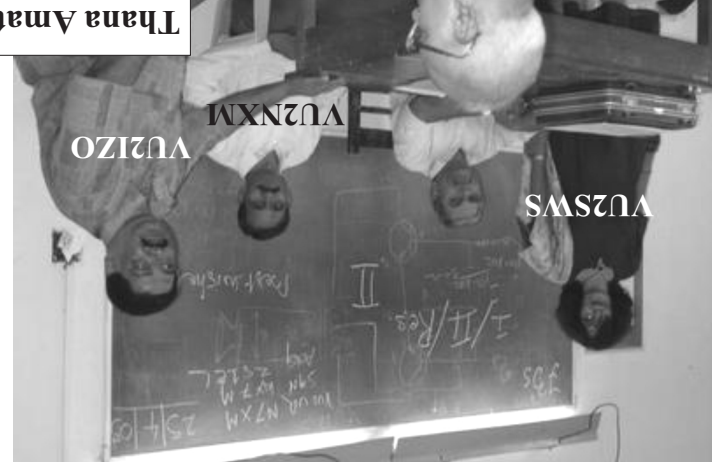
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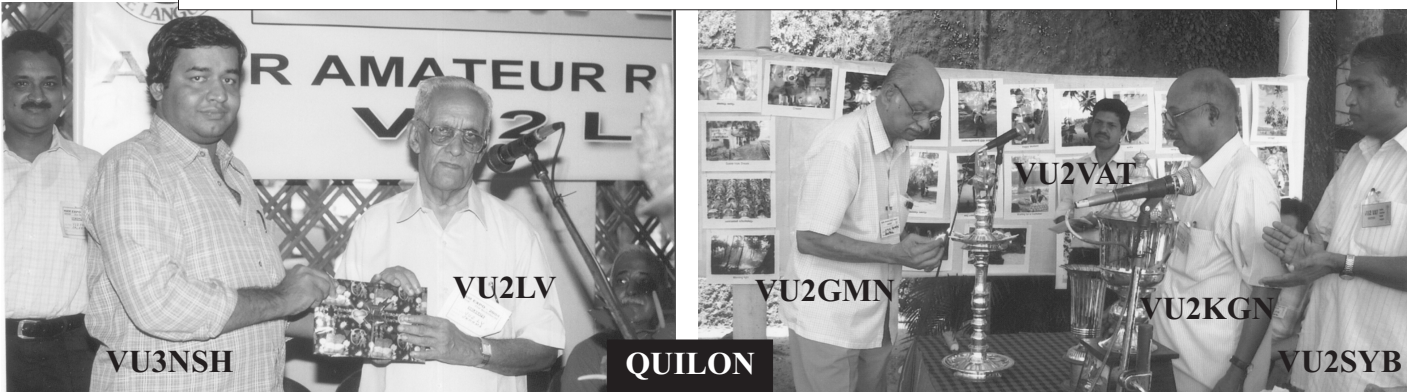
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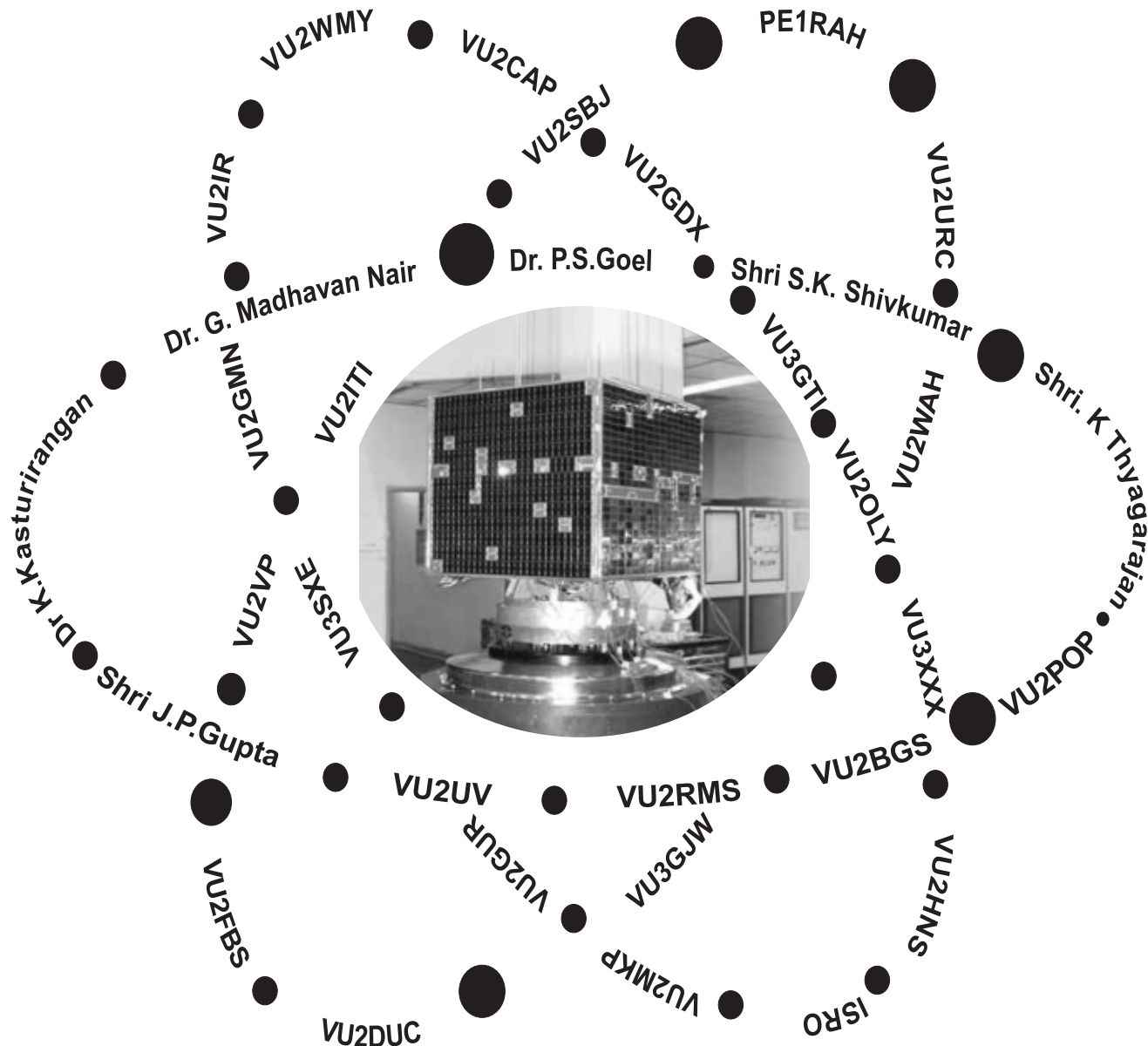
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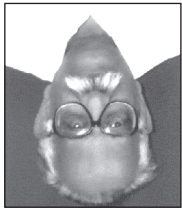
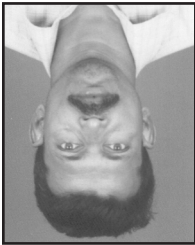
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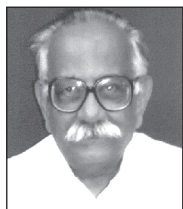
Unity Is The Motto



HAM RADIO NEWS

The Journal of Amateur Radio Society of India (Member of IARU)

PRESIDENT'S REPORT



Tsunami came and went. Many Hams in India and from South Asia spontaneously volunteered to set up emergency. It made all of us Hams proud to be part of such community. ARSI honored all hams who participated in emergency communication with certificates of appreciation.

Gopal VU2GMN, Ajoy VU2JHM and my self attended the seminar held in Chennai on emergency communication and Ham contribution. The Honorable Minister of communication Dayanidhi Marran who was to preside could not come. There were senior officers from the ministry and we were able to interact with them. We impressed on them that the Ham population in India can go up only if the rules governing licensing is simplified and easy to get. They agreed that Hams were an asset to the country especially during times of emergency and so agreed to look in to the matter.

The idea of HAMSAT which started during the HAMFEST of 1998 in Bangalore has become a reality. We congratulate all the Hams who participated in this project and thank ISRO for making it possible.

Six of our members have agreed to act as coordinators for ARSI. We thank them and request more volunteers from other places.

ARSI has reactivated its Call sign VU2ZH. WE have requested WPC to change it to VU2ARS and it is being processed.

SEANET is to take place on 7th, 8th and 9th of Oct. this year. Though this is not a ARSI program it will be nice if Hams can join in the festivities.

Q R Z

The International YL Meet
will be held in Mumbai
In October 2006.
Please visit the website
www.geocities.com/mumbaiylmeet

THE EDITOR SPEAKS:



This issue of HRN will be posted in my absence. By the time you receive it, I will be in W land visiting my son and daughter in law who live in Texas. I hope to be back before the next issue, the planning of which is being done along with the present issue. The wonderful world of internet connectivity lets you work from any corner of the world!!

The World Amateur Radio Day was celebrated in India and all over the world, in its usual fashion. This year is special for India as we have launched our own Ham Satellite. It is indeed an achievement for us and has created a new spurt of Hams working the satellite mode. May the tribe increase!

Editing the HRN has its own highs and lows. One repeated problem is the lack of original articles from VU hams. I have said it before and I repeat it now. The HRN is an Indian product. We need to showcase our talents, which are aplenty. In this connection, I must mention the immense support I have received from a few Hams and SWLs. VU3NSH, Hari is one OM who is constantly in touch with me and keeps the flow of articles coming. Then there is SWL Virendra Battu, and VU3ORN, Ray, who keep me informed through email about so many technical topics and other happenings in Hamdom. The various e groups of Indian Hams are another good source of information. Thank you my friends. And once again I appeal to all of you to contribute good articles for publication in the HRN.

Things seem to be moving at a regular pace at the WPC office in New Delhi. Mr Ahmed is trying his best to issue as many licences as possible every day. The new website is an interesting development, but the data is still to be fed for it to work. The new buzz is that there will be a World Bank funded, 4 ultra modern monitoring stations in India, which would take care of all aspects of hamradio, including licence issues. If this happens then waiting period for licences may reduce a great deal. Though this news has not been confirmed by New Delhi, we should all pray that it happens.

I wish you all good health and happiness and many happy hours of hamming.

73

Sarla

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HOMEBREW

A New weapon for Fox Hunting - By VU3NSH N.S.Harishankar

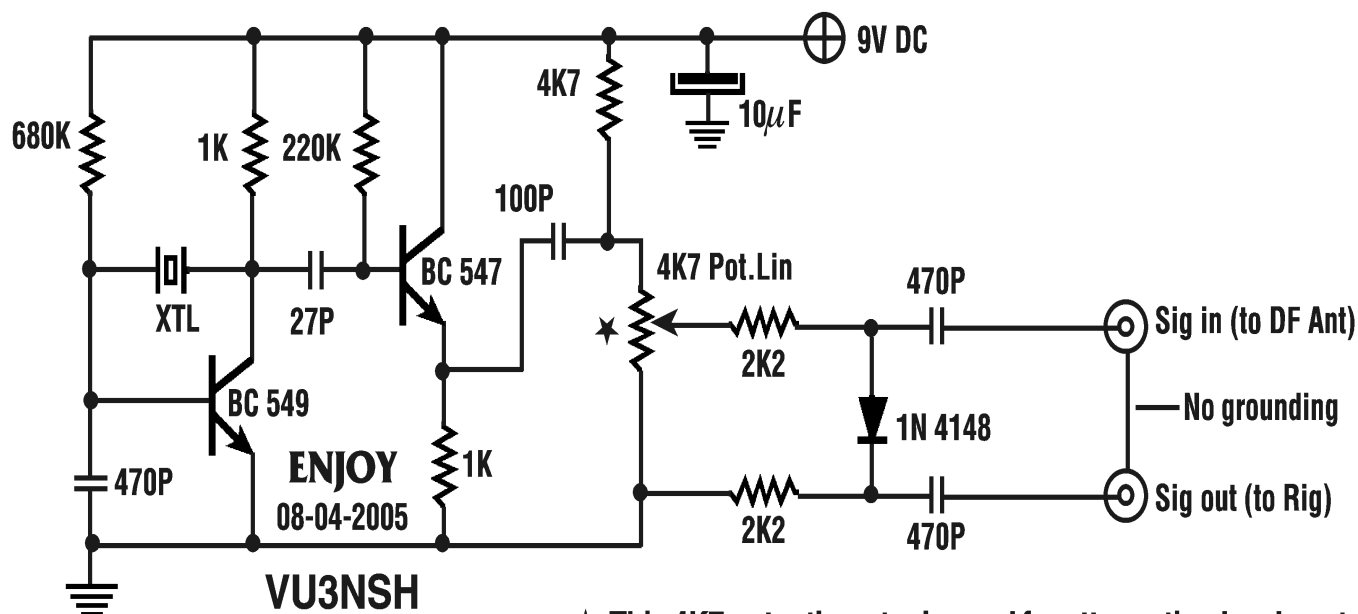
Ham clubs all over the world conduct Foxhunts, also known as Transmitter Hunting(T Hunt), or Treasure Hunting, this being a very interesting game in the Ham world. This game of Radio Direction Finding(RDF) helps Hams and SWLs to learn about radio signals, attenuation techniques and associated things like direct and reflected signal detection, orientation etc.

When a hidden transmitter(FOX) is at a distance of 30 kms, it is possible to find its direction by using a 2 element or 3 element beam antenna(yagi) as a direction finder to copy the FOX HOWL(Transmitted Signal direction) and get the exact orientation. But when we are close to the FOX, the S Meter reading in your hand held rig shows full scale reading, even with the Fox transmitting low power. Due to the poor shielding(case) of the handy, we cannot get the proper orientation or pinpoint the location of the Fox. Normally all hunters use resistive attenuators (passive attenuators) to reduce the signal level to the handy. But these passive attenuators cannot work in shorter distances. In short distances the handies will show full S meter reading without any antenna!!! In this clever design we are shifting the exact Fox Howl-receiving frequency and then controlling the signal level. Hence there is no direct penetration of signals into the hand held. In this circuit, there are two major sections. One is the Local Oscillator(LO) and the other is a diode

mixer with a level control. If we are selecting a LO frequency of 2 Mhz and the Fox Howl frequency is 145 Mhz, then the output from the circuit can be at 147 or at 143 Mhz..

This circuit, assembled by Pre College Science Academy students of NASA at Pasadena city College in California, built 20 attenuators and steel tape yagis during the Saturday morning session for their spring 2001 radio orienteering project in August. The origin of the circuit is from PA0ZR and K0 OV. In their design they used crystal controlled CMOS oscillator modules for LO frequency generation. This module oscillator is a bit expensive and other types are not available in VU markets. A few months ago, VU2ESH, Rajesh had given me the original article for reference. I reworked the LO frequency generation section to make it simple, flexible and cost effective. The LO frequency module has been changed to pierce oscillator with 2 Mhz crystal. The entire circuit is made on a small PCB(2cm/8cm), which can be mounted on a the boom of a direction finding antenna. For power supply use a 9V battery(6F 22). By attaching this circuit to your RDF antenna, you can easily control the signal level even one foot near the Fox. So try this new weapon in the next Fox Hunt!!!

Good Wishes for WARD 2005.



★ This 4K7 potentiometer is used for attenuation level control.

Use high frequency high speed diode for UHF and above frequencies

ON A LIGHTER VEIN



Hamradio on TV!!! Travails and tribulations!!

- By VU3PPL, P Jayaraman

My shack had a visitor. TV Programme coordinator Roshan. He listened to a few QSOs, took some notes and finally said that he would come later to shoot for a programme on hamradio to be aired on Kairali TV. I was ecstatic that I was the lucky ham to come on TV. I lost no time in spreading the word around in my morning qth and also requested many hams living closeby to be on standby at the appointed time and give me a helping hand.

On the morning of the day of the shooting, I entered my shack and switched on my BEL524 with trepidation and anticipation! Guess what happened? The rig went QRT!!! I called Anthony, VU2ANY on his lima lima for instructions to set the rig right, as he too was using the same one, but nothing happened. I then called OM Sunil who lived 50 kms away and requested him to lend me his rig. He agreed and I immediately took an autorickshaw to his home. While handing over his rig, he said I should give it a few knocks, in case it didn't fire!!!

By the time I got back home it was 12.50 p.m. I skipped lunch and switched on the borrowed rig and it was cold!!!! No response. Taking another rickshaw, I rushed to the qth of VU2EKJ, who also had a BEL524. But the problem was that it had no connectors and a few wires were hanging loose. I rushed home again and by then it was 2.25p.m!!

It was then that I had a brainwave. I removed the VFO from my rig and connected it Sunil's rig and hey presto, it worked, just as the TV crew made their appearance.

We went to my morning qth and made some recordings and returned home in the evening to record more. But I was not through with my phase of bad luck! This time the 50 cycle power supply went QRT. With no battery back up, I was in a dilemma. So another rickshaw trip to the battery shop, a trip to the supply office and cajoling the lineman to work and finally the supply was restored and the recording was done. I was able to have a few qsos and also talk about the service done by hams during the Tsunami. The programme was aired twice on TV much to my delight.

Apart from the expenses incurred (about Rs.500), the indescribable agony and suspense that I underwent, I am a happy man. This experience proves Murphy's law that in hamradio, if things can go wrong, it will certainly go wrong at the critical moment!!

Some notes on HA5CQ, Bandi's VFO

VFO for BEL GE 524 - By VU2DK, Zal

1) The circuit described is a design of Atlas Radios 210&215.

2) I built an identical circuit some years ago for use with a homemade direct conversion receiver.

3) Since the tuned circuits are on quite a high frequency, the mechanical and electronic stability needs even more stringent care when designing this VFO.

4) The most critical part of the VFO is its Bandswitch. It has to be a sturdy, positive indexing type and only high quality ceramic insulation.

5) Each tuned tank circuit requires its own temperature compensating component. This in itself is a time consuming job and requires careful selection of capacitors and other parts.

6) A good slow motion geared drive is needed for

the main tuning.

Only if all of the above points are adhered to, does one come close to some acceptable degree of mechanical and electrical stability to compare with today's requirement for operating CW or SSB.

Personally I would build a good low frequency VFO and beat it with crystal frequencies to give the desired output to GE 524. Its much easier to control the design parameters with this kind of circuit and takes the bandswitch into a much lesser critical part of the design. Hence it can be quite an ordinary switch. If the mixing is done in a doubly balanced fashion, the output to GE-524 will be quite clean of any spurious responses. Biggest advantage is, you only have one VFO to play with and stabilize instead of 5 bandswitched LC Circuits.

CLUB NEWS

The Gwalior Amateur Radio Club has been reactivated after a long silence with its call sign VU2GWL. Once upon a time this club had more than 20 active licence holders. Most of them have QSYed from Gwalior, but those left have rejuvenated the club and the first meeting was held in March 2005. The following members have been nominated for the new body. President: OM Jayu.S.Bhide(VU2 JAU), Secretary: OM R.K.Khetan(VU2IG), Treasurer: SWL Ashok Agrawal, Members: OM G.D.Gupta(VU2OOG), OM S.N.Sharma(VU2WS), OM Pravin Gupta(VU2PGZ), OM Pankaj Khetan(VU3GAK) and SWL Avinash Asthikar. The club gave a live demonstration at the IT/EXPO/VISION fair held in Gwalior from 10th-14th April 2005. The demonstration was widely appreciated by the public and was very successful. It was a launching pad for amateur radio activities in this area. The club call sign was operated and many QSOs exchanged with other hams on the band who were on standby during the entire period. The station had eminent visitors like the GM of BSNL, who showed keen interest in the hobby.

A new ham station is setup at ISTRAC apart from the other Ham Station, VU2URC at ISAC. VU2WMY Mani (ISAC), VU2FBS Singh (ISTRAC) have been assigned the payload evaluation jobs from ISRO. The new Ham station at ISAC was contacted via the AO-51. Stations active here were VU2WMY, VU2FBS, VU3TYG, VU2GUR and VU2POP. ISTRAC ham station was setup by VU2WMY Mani and VU2FBS Singh within a couple of days with the FT-767, FT-726, FT-8800 new G-5500 rotator, 2 UHF, VHF cross yagis, NOVA tracker etc.

An international seminar on Amateur radio communication in disaster management was organized by the National Institute of Amateur Radio(NIAR) at Hotel Savera, Chennai on 18th April 2005. The seminar was well attended by Indian and foreign delegates.

To celebrate World Amateur Radio Day, the Quilon Amateur Radio League(QARL), conducted the HAM FAIR 2005 and the IX KERALA VHF FOX HUNT for the CSD Rolling shield on Sunday the 17th April, 2005 at Jaladarshini, Thevally, Kollam. The fox hunt started at 8 A.M. The team of VU2TBK and VU3SOP won the first prize. The second Prize winners were VU2MTL and VU2VML. The meeting started at 11.30.A.M., after the fox hunt. Shri Gopal Madhavan, VU2GMN lighted the traditional lamp. OM Vaidyan, VU2VAT, the general convener welcomed the gathering. OM Nadarajan, VU2KGN, in his presidential address congratulated the hams, who had worked day and night during the

Tsunami. He also pointed out the need for an early warning system to be established through the local ham clubs. Prof.Sadasivan, VU2VQL, in his address requested the QARL, which is celebrating its silver jubilee and has necessary infrastructure and man power, to conduct the next Hamfest at Kollam. VU2POP, VU2EGN and VU3SIO felicitated the gathering. OM Thyagarajan, VU2PTR released the special issue of the magazine, QARL NEWS. Prizes were distributed to the winners of the fox hunt and Lake City Phone contest. OM Surendran, VU2SYT, gave the vote of thanks. Exhibition stalls were arranged by VU3OJA. VU3SDN, VU2LBM, VU2POP and VU2PTR in addition to some commercial stalls. A beautiful photography exhibition was also arranged by Shri Naushad, VU2YNS. The participants enjoyed a boat trip on Ashtamudy Lake after Lunch.

The World Amateur Radio Day was celebrated on 18th April 2005 at Collector's Office, Ramanathapuram. The Chairman of Amateur Wireless Association of Ramanathapuram and the District Collector Thiru.K. Sellamuthu headed the function. During his address, he informed that World Amateur Radio Day is observed in commemoration of the invention of Radio in 1896 by Marconi. The Ham Operators provide emergency communications when all normal communications like Telephone and Cell Phone fail during natural calamities. The Ham services were utilised during the Nagapattinam Cyclone and in recent Tsunami affected area at Velankanni. The Ham population in India is about 15,000 against its total population of 103 crores whereas the Ham population in USA is about 6.5 lakhs against its population of 28 crores. Ramanathapuram being a coastal district the need for Ham Radio Operators is imperative. The Government servants and students should come forward to undergo HAM training including more women trainees. The Collector presented wireless equipments to the association to a tune of Rs. 19,000/-. Funds will be sought for from the MPLAD Scheme, further he added. V.Ravichandran, VU2FBI, Secretary, explained the growth of HAM Radio and its uses to the Govt. He appealed that camp clubs should be started in each and every High School and he requested to utilise the human resources available with Ham Radio Operators. Ramesh, VU3VRF, the operator who participated in Tsunami Relief Operation at Velankanni, nailed from Rajapalayam, exposed his experiences during relief operations. Different type of HF and VHF sets were displayed. Balasundaram, VU2NBU, Joint Secretary and Mandra Selvam, VU3RRU, Treasurer contacted the

Ham Operators of various parts of the country through wireless equipments. Brochures, pamphlets handouts and Press clippings were exhibited. Sreenivasan, District Revenue Officer, Muthukaruppan, Personal Assistant (General) to the Collector, Kadar Hussain, Revenue Divisional Officer, Saravanan, Deputy Superintendent of Police were also participated. A large gathering of Government Servants attended the function. Arrangements for the function were made by Vimal Lakshman, VU3CPE and Ramamoorthy, SWL, the active members of the club. Vote of thanks was given by Mandra Selvan, VU3RRU, the Treasurer of the club.

The Thane Amateur Radio Association, (TARA) conducted Amateur Radio classes at the Dynansadhna College, Thane. Classes were held every Sunday for eight weeks. The moving force behind this whole effort was VU2IZO, OM Milind (Mickey). Other licenced Hams like VU2JPN, VU2IES, VU2SWS, VU2NXM, VU2NKS, VU2HVK, VU2AXN and others pitched in by teaching electronics and morse code. The exams were conducted on 25th April and about 50 candidates appeared. Out of these 34 secured grade 1 and 18 grade 2. The whole group went for a picnic to Gorai Beach on the 15th of May. They put up an HF and VHF station and everybody had their first experience of band activity, besides dancing and singing. TARA has great plans of having a fully equipped club station soon. They are ably supported in this effort by VU2PDT, Mr Satish Pradhan, the local MLA. The next session of classes with 65 aspirants has already begun.

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INTERNATIONAL NEWS

CELEBRATING THE ITU

IA team of 16 Australian radio amateurs in V-K-3 will activate special event call sign AX3ITU on Tuesday 17th of May, to mark the 140th birthday of the International Telecommunications Union.

Amateur Radio Victoria aims to have the have AX3ITU on air virtually the entire 24 hours. The station will be available on CW, Phone, PSK31 and an amateur satellite on the day. Three of the team, VK3QL, VK3ANJ and VK3YR, will concentrate on CW on the 40, 30 and 20 meter bands. Phone operation will be on the 80, 40, 20 and 2-metre bands, while PSK31 is to target 80 and 40 meters.

A commemorative QSL card will be available for contacts. Cards go direct to VK3WI or via the bureau. A dozen junior high students in Japan used Amateur Radio May 9 to quiz NASA International Space Station Science Officer and US astronaut John Phillips, KE5DRY, about life in space. The contact between NA1SS in space and 8N3H at Hosokawa Junior High School in Ikeda was arranged by the Amateur Radio on the International Space Station (ARISS <<http://www.rac.ca/ariss>>) program. Working in microgravity, the training necessary to become an astronaut and food were the focus of several of the more than 20 questions asked and answered. Phillips told the youngsters that he was surprised at how beautiful the Earth appears from space and that he never tires of watching the planet from the ISS. Responding to another student's question, he nearly waxed poetic in describing Earth's beauty. "It's absolutely true that the Earth looks beautiful from space," Phillips replied. "The blue of the oceans, the green of the forests and the white snow of the mountains create a beautiful and continuously changing picture." He told the next questioner that his first impression of space was that the view was magnificent "and that I knew that I would like it up here and that I would like to stay longer." read more @

<http://www.arrl.org/news/stories/2005/05/17/3/?nc=1>

Good news for UK's radio hams: communications regulator Ofcom plans to replace annual amateur radio licences with a new electronic licence that lasts for life. The regulator says it is seeking a balance between maintaining regulatory control and reducing expensive and unnecessary bureaucracy. The proposed new system would mean licences only need to be changed if the licence holders' details - such as home address - changes. Updating the licence could also be done online, making it faster and cheaper for everyone. Although the new licensing system would be web-based, with licences issued for free to those using the online system, Ofcom says it will continue to offer licences by post (Contn. to page 16.)

HOMEBREW

A Surprisingly Accurate Digital LC Meter

- By Phil Rice VK3BHR

Almost as published in "Amateur Radio", the monthly magazine of The Wireless Institute of Australia in April 2004.

Why?

Several years ago, I built a "one transistor oscillator", which I used to measure small inductance values (by measuring the frequency of oscillation and applying the formula for resonant frequency of an LC circuit).

Following from the frequency meter project published in the September 2002 issue of AR, I wondered if I could combine the oscillator and frequency meter to make a direct reading inductance/capacitance meter. I had seen an instrument that did exactly this on the web at <http://www.aade.com/lcmeter.htm> for \$120US and thought "I'd like one of them".

How?

The AADE web site gave details of how their design worked and a circuit diagram. This led me to propose a design using their oscillator, but in a slightly different way. Like theirs, mine would measure the free running frequency of an LC oscillator, then successively apply a known capacitance then the unknown inductor (or capacitor). After that, the maths used to calculate inductance or capacitance would be quite different. A brief play with the required formulas (see fig 1) showed that it was COMPLICATED! At this time the maths all seemed too hard.

Capacitance	Inductance
$F_1 = \frac{1}{2\pi\sqrt{LC}} \dots\dots(1)$	$F_1 = \frac{1}{2\pi\sqrt{LC}} \dots\dots(5)$
$F_2 = \frac{1}{2\pi\sqrt{L(C + C_{cal})}} \dots\dots(2)$	$F_2 = \frac{1}{2\pi\sqrt{L(C + C_{cal})}} \dots\dots(6)$
$F_3 = \frac{1}{2\pi\sqrt{L(C + C_u)}} \dots\dots(3)$	$F_3 = \frac{1}{2\pi\sqrt{(L + L_u)C}} \dots\dots(7)$
$C_u = \frac{\left(\frac{F_1}{F_3}\right)^2 - 1}{\left(\frac{F_1}{F_2}\right)^2 - 1} \times C_{cal} \dots\dots(4)$	$L_u = \left[\left(\frac{F_1}{F_3}\right)^2 - 1\right] \times \left[\left(\frac{F_1}{F_2}\right)^2 - 1\right] \times \frac{1}{C_{cal}} \times \left(\frac{1}{2\pi F_1}\right)^2 \dots\dots(8)$

Fig. 1

A lucky find!

Then I discovered Microchip Application Note - "AN575 IEEE754 Compliant Floating Point routines" (add subtract, divide and multiply). It didn't take long to load the code into a PIC 16F84, but the 32 bit floating point routines nearly filled the entire chip. This left no room for the frequency measuring, inductance/capacitance calculations and display formatting instructions. At this stage, I found that I could use the Microchip 24 bit Floating Point code and, by being a little careful, could fit it all in and achieve a numerical error of less than 0.1%. Overall accuracy would then be limited by the oscillator behaviour and one "calibration capacitor".

The Hardware!

This is a combination of two designs. The oscillator design originally came from the AADE LC meter web page. It uses an LM311 comparator with positive feedback to make a parallel LC oscillator with digital output. It seems to oscillate readily over a wide range of L and C values. Hopefully, it follows the "well known formula for resonant frequency". The frequency measuring part is a cut down version of the September 2002 Frequency Meter article. The original idea for this came from the web pages of Eamon Skelton, EI9GQ.

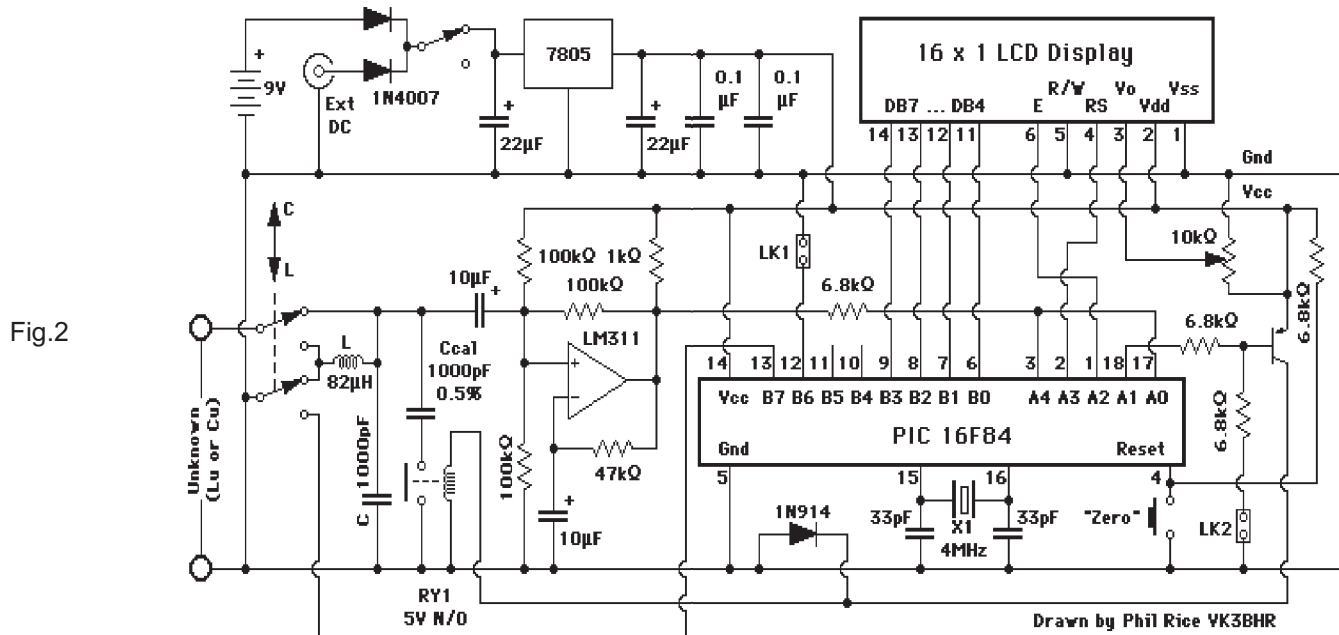
The Software

This was the hard part (and the fun part) of the project. Luckily, it's easy to duplicate and the copies work as well as the original. You can get copies of the "hex" code from the web page

<http://ironbark.bendigo.latrobe.edu.au/~rice/lc/index.html>

The program takes two measurements when "zeroed". First the oscillation frequency is measured using only the internal inductor and capacitor (F1). Then a standard capacitor ($C_{cal}=1000\text{pF} \pm 1\%$) is added in parallel and the frequency is measured again (F2).

The software then goes into a repeating loop where it measures the frequency of the oscillator using the internal inductor and capacitor and whatever unknown external inductor or capacitor is connected (F3). Some serious maths (formulae 4 and 8) is performed each time to calculate the unknown external component value. This value is then scaled in engineering units and formatted for display.



Getting Started

To aid initial troubleshooting, the PIC program includes a test mode which is entered by shorting link LK1 and pressing "zero". The PIC will now repeatedly count oscillator cycles for 0.1 second and display the result. With just the 82uH inductor and 1000pF in circuit (no external component, no calibration capacitor), the oscillator will run at about 550KHz and the display will show around 55000 (remember, it's counting for a tenth of a second). If the frequency is too high (anything over 655.360KHz), the display will show "Over Range". If the oscillator isn't running, the display will show "0". For best accuracy, the free running frequency should be 10% to 15% below 655KHz. If it is too close, it may accidentally overflow the PIC's internal 16 bit count. A second link, LK2, connects the calibration capacitor. The oscillator should then run at about 394KHz. A third link, from pin 10 of the PIC 16F84 to ground (LK3), caters for "badly behaved" displays. If your display only ever shows 8 characters (ie. no pF, nF or uH as appropriate) then try grounding pin 10 of the PIC.

Operation

In practice, it's a bit like an ohm meter. For an inductor, just short the leads and press the zero button, then connect the unknown inductor. For a capacitor, zero it with the leads open, then connect the unknown capacitor. The meter can be zeroed with an unknown component connected. For subsequent components, it then indicates the difference (+ or -) from the original component value. Great for matching parts!

How Accurate?

Accuracy depends on the user doing the "right thing" and on the unknown component being of fairly high Q. The PIC's internal program relies on the setting of the L/C switch being appropriate for the component. Since all the PIC is doing is

measuring the frequency of the oscillator, any strange component that allows the oscillator to work will be reported as an inductor or a capacitor depending on the L/C switch. For example a 22 Ohm resistor is reported as a 3.14uH inductor or a 119nF (0.119uF) capacitor. This isn't even remotely correct!

When the unknown component has high Q (as you usually want in a tuned circuit) AND the L/C switch is set correctly, the prototype generally shows errors of less than 1%.

I checked the accuracy of the LC Meter against an old Marconi bridge, for capacitors of 33pF to 0.22uF. For inductors, I only checked values from 475uH down to 60uH. Below that value, the Marconi bridge was a bit "cranky".

While the LC Meter is self calibrating, errors depend a little on the components used in the oscillator LC tank (L and C on the circuit diagram) and on the "standard" capacitor (Ccal), which should be 1000pF to within 1% or better.

The worst errors occurred when using a ferrite bobbin style choke from a switchmode power supply for "L". Here the error was less than 1% for capacitors below 3300pF and 2% for inductors less than 475uH. The error climbed to 3% for 0.22uF capacitors.

Surprisingly, the best accuracy used a "moulded" choke scrounged from an old TV. Here, the error was less than 1% for capacitors less than 0.22uF and less than 1% for inductors less than 475uH.

In all cases, I used a 1000pF styrofoam capacitor for the oscillator tank "C". A "greencap" would be a suitable substitute but a ceramic capacitor may not be a good

choice. Some of these can have high losses.

I have no reason to suspect any strange non linearities in the readings for low value components. Small component values are, in theory, directly proportional to frequency difference (when the part is added to the oscillator). The only way I can verify this is to construct some small L/C tuned circuits and measure their resonant frequency - and I haven't got round to doing that yet.

Conclusion

With the aid of a little easily copied FREE software, you can have your own (possibly) accurate inductance and capacitance meter. With the worst possible set of components from the junk box, accuracy should be better than 3%. If you are lucky, accuracy should generally be better than 1%.

It's now possible to design a tuned circuit, construct it and have it resonate on the right frequency first time, every time.

References

1. The original idea and the oscillator came from <http://www.aade.com/lcmeter.htm>
2. The frequency measuring code came from <http://ironbark.bendigo.latrobe.edu.au/~rice>
Also <http://homepage.tinet.ie/~ei9gq/stab.html>
3. Microchip's Web Site provided the Floating Point code essential to the working of the meter. See <http://www.microchip.com> - search for An575
4. Details of my PIC programmer can be found at <http://ironbark.bendigo.latrobe.edu.au/~rice/pic/index.html>
<http://ironbark.bendigo.latrobe.edu.au/~rice>

Kudos Korner

The Guinness World Records Ltd. awarded a certificate to Finnish radio amateur OH2BR. This, for a record number of contacts made by an individual from one location in one year. Operating as VP6BR from Pitcairn Island, OH2BR made 56,239 contacts between 25 January and 21 April 2000. A world record according to Guinness.

D.O.T.

DoT's website "www.dotindia.com" is now "www.dot.gov.in. User (Applicant) can register to this Web site and can perform various activities. A Registered user can file applications for: Network Licences, Non-Network Licenses, Coordination Licenses, Certificates Type Approval, Amateur Licenses. For more details Visit:
<http://210.212.79.13/wpcweb/udefault.asp>

HOMEBREW

Mult purpose VFOs for your rigs - By VU3 NSH, Harishankar

Frequency instability in the VFO stage is a common problem. It occurs in VFOs due to low "Q" of the tank circuit, capacitor's real value, power supply regulation, stray capacitance, lead inductances and over feedback levels etc.

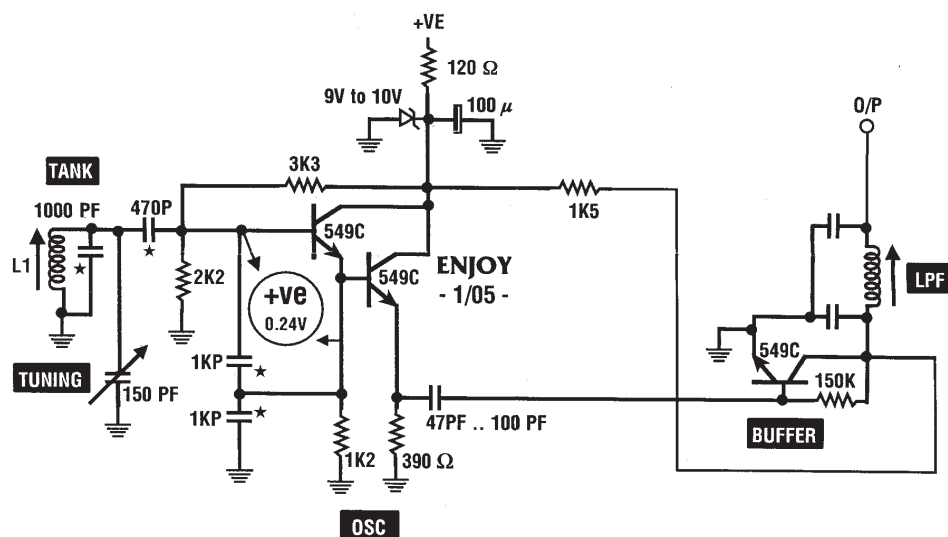
Few months ago, I had a discussion on VFOs and Oscillators with a veteran home brewer, a senior Ham, working in the communication field. He observed that the first transistor emitter-base voltage of an oscillating bi-polar transistor based VFO should show as a negative volt, and this is an indication of a healthy operation. He also proved it with a practical demo.

I started work on my 7Mhz/AM/SSB/CW RX project, encouraged by fellow Hams and SWLs, with an intention to release the circuits and the PCB during the Adoor Ham Expo of 2004. My aim was to provide new licence holders and enthusiasts some practise on systematic receiver assembling. At his time, I discussed with VU2ARA about VFO's on the Kodai repeater and he was firm that the first transistor emitter base voltage must be a positive volt!!! Due to these conflicting opinions, I decided to study the issue further. I could not procure

any information on the subject from anywhere. Prof T.K.Mani, VU2ITI supported the opinion of positive volt and reminded me that the first transistor is in 'class A' mode. I then realized why the positive voltage should keep at E-B junction. In articles from abroad, they are using FETs for stability, which cannot achieve the goal. I also studied the Colpitts Oscillator with its parameters and problems.

I selected the L&C combination in my own way. Generally it is not possible to homebrew high value inductance with high 'Q', but low inductance with high 'Q' is possible. I started with the basic structure of the RM 96 VFO. It resulted in a great performance with the stability of the frequency at just 1hz tolerance like a DDS. DDS is widely used for stability, but costs more than Rs.2500 and this according to me is a waste on a single band transceiver.

I then tested with different inductance combinations for getting different frequencies (refer table). If you are using 2J or 2X gang, then connect a series capacitor to reduce the total gang capacitance to get the proper spread. This modification will give excellent stability for



long duration working. Another beauty of this design is that, no shielding is used and hence no temperature influence. An important tip for the stability in a VFO is that the emitter base voltage of the first transistor should be A+ve like 0.2 to 0.5V. If it is zero or negative, then the frequency may drift or result in a lot of harmonics, due to the change in the amplifier classification A, AB, B or in C mode. The negative voltage occurs when the feed back level is too high. Had I followed the negative voltage principle of my senior friend, then I may have been digging the grave of my bi-polar VFO project!!! With the right guidance from VU2ARA and experimenting and discussing, I was on the right path.

The L&C combination in this table are evaluated in my shack, the inductance former being 10mm, 10mm based IFT slug can core type which is very popular in the RM 96 project. The tank capacitor and the feed back capacitors are 1000 PF styroflex and the coupling capacitor from the tank section is also styroflex. Before assembling, check all capacitors and resistors thoroughly as the available components nowadays have a big problem with tolerance levels. The core up and down movement will give 1 Mhz shift in this circuit. For getting sufficient RF output level you can change the coupling capacitor 47PF to 100 PF at OSC output to Buffer Amplifier input.

The Happy Halfsquare : Inexpensive gain in a compact package. - By Jim Gray W1XU

Antenna Evolution

Nearly everyone has heard of the quad antenna or the cubical quad array. The plain quad consists of a full wavelength of wire laid out in a rectangle, usually a square. A single quad loop has 1 to 2 db of gain over a dipole, making it worth obtaining. A cubicle quad array is merely two quad loops in a "space cube" figure. The array produces even more gain, something on the order of 5 to 6db over a half-wave dipole.

The Halfsquare.

The half-square antenna is just a single quad loop, opened up and stretched out to give greater gain and a lower radiation angle.(Fig.1) In the half-square configuration, that simple wavelength of wire is good for about 4 dB of gain. How does it happen? Simple. The source of the quad's gain is the separation between portions of the antenna having in-phase currents. By opening the loop and increasing the separation between the in-phase segments to a half wavelength we more than double the gain of the quad loop. That's the secret of the half square.

Fig1(diagram)

Cutting the quad loop and opening it out produces the half square. The half-wave spacing more than doubles the gain over the quad loop and the higher feedpoint gives a lower angle of radiation.

There's another advantage to the halfsquare method of using a wavelength of wire. Typically, a full-wave loop has a feedpoint impedance of 100 ohms. That requires some sort of matching system. But if the half-square is fed at the right point, it has a perfect match to common 50 ohm coaxial cable.

Corner Feed. Lets return to the quad loop as a comparison. Since it is a complete loop, it will have the same impedance no matter where you feed it. But once you cut the loop and stretch it out, creating a half-square, the impedance seen by a feedline will depend on where

you attach it to the wire. If you place the feedpoint at one end of the wire, the impedance will be on the order of a thousand ohms. But if you feed the half-square at a quarter wave from the end at either of the corners, you will see an impedance of about 50 ohms- a nice match to coax without any tuner or matching transformers..

Corner feed has practical advantages too. You can support your feedline with the antenna support itself, so you can bring the antenna closer to the house or shack. You can also use lighter supports.

To understand why corner feed works this way, think of the half-square as a pair of half-wave dipoles. Old-time antenna manuals used to feature the "quarter-up quarter-over dipole. This consisted of a dipole with one vertical and one horizontal leg. Imagine two of these end to end and fed in phase.

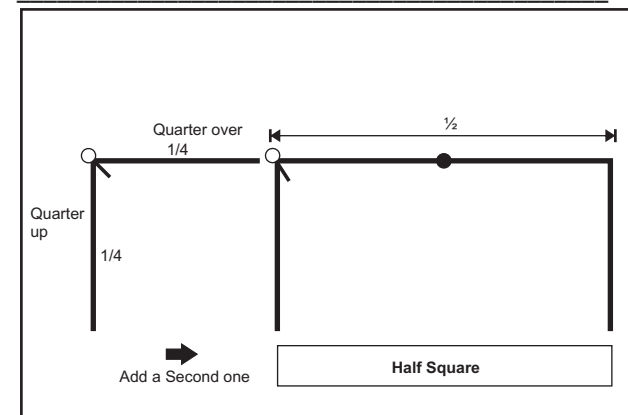
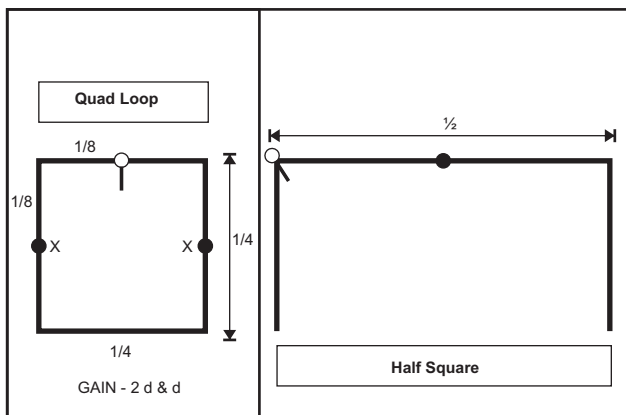
The horizontal legs would have the same potential at their ends, so they might as well be joined. If joined, there is no need for two feedpoints, one is sufficient. The resulting antenna is the half-square. The radiation from the horizontal legs is self canceling, but the radiation from the vertical legs is additive. The result is 4 dB of gain from an antenna that's the same length as a simple dipole.(Fig.2)

More important than the gain is the lower angle of radiation from the half-square. In fact at the low angles that favour DX, the half-square has given me up to two S-units of signal improvement over a dipole at the same height. The drooping ends, the half-wave spacing, and the corner-feed system are the secrets of the half-square's great performance and good impedance matching.

Fig 2.

Evolution of the Half-square from a phased dipole pair. Connecting two quarter-up/quarter-over dipoles eliminates need for second feedpoint. Gain over a single dipole is on the order of 4dB

(73 AMATEUR RADIO TODAY - APRIL 1991)



COVER STORY

HAMSAT Making of a Satellite - A report by Amsat India regd.

The most frequently asked question by the Indian Hams for the last years was when would the HAMSAT fly. Now the "HAMSAT" is about 628 Kms above all of us in space, in very good health. The project "HAMSAT" and organisation "AMSAT-INDIA (Regd)" and everything else that followed thereafter was all due to one highly motivating statement made by the great visionary Dr K.Kasturirangan, then Chairman ISRO during the HAMFEST INDIA 98 at Bangalore. In his inaugural address he said, "This is the right time that Indian Hams should think in terms of putting a payload in the Space". But, a real and meaningful thought was given only on 28th October 2001. This day, a few Satellite pioneers, real home-brewers and senior hams mostly from Bangalore, to name few- Subby VU2UV, Ramesh VU2RMS, Kumar VU2BGS, Prathap VU2POP, Bindu VU2IR, Mani VU2WMY, Shankar VU2CAP, Bob VU2MKP, Guru VU2GUR, Sandeep VU3SXE, Gopal VU2GMN, Ved VU2VP and others came together with a primary objective of having a platform for developing Amateur Satellite payloads, complete amateur Satellites, related ground segments and amateur Satellite activities in India. Thus the AMSAT-INDIA (Regd) was formed which was successful in associating and co-ordinating with the Indian Space Research Organisation (ISRO) in realising the "First ever Indian Amateur Satellite HAMSAT".

The first project of AMSAT-INDIA was to have Indian payload in the polar orbit. But at the instance of some individuals an offer was made to Inter-National Ham Community for flying one from the Dx land. Thus two proposals, Dutch and another, Italian were received. To honour the commitment, it was decided that the first Indian Amateur Satellite "HAMSAT" would fly with a Dx transponder meeting the specifications. Hence, the proposal for two payloads, one Indian and one from Dx land were projected to ISRO for consideration and it was accepted.

To realise the project at the earliest, various committees were formed. One such very important committee, the technical Committee consisting of Prathap VU2POP, Mani VU2WMY, Mani VU2ITI, Srikanth VU2SBJ with Kumar VU2BGS as the team Leader was constituted and entrusted to make a detailed report on design, development, testing and fabrication of various systems of the payload. Subsequently, the following proposals were made by the individual committee members for various systems of the payload.

1. Kumar, VU2BGS Linear, inverting, bent-pipe transponder with 60 Khz bandwidth with

U / V mode and an interactive Voice, CW, SSTV and Digital modes beacon (With Provision to change the contents of message, text & pictures through ground command).

2. Mani, VU2ITI - CW Telemetry beacon

3. Srikanth VU2SBJ - FM Voice Message beacon

4. Prathap VU2POP - FM Transmitter for the above beacon.

All the above-mentioned elements of Indian payload including the one of the Dx transponder were submitted to ISRO. The first hurdle faced by the technical team was with the proposal of U/V mode, Since ISRO's Tele-command frequency was very close to the payload down link that would be sure to de-sensitise the Tele-Command receiver. So there was a strong opposition from ISRO for U/V mode but insisted on us to go in for V/U mode. But the technical committee had explained in detail about various problems most important one being 10 db more downlink path loss meaning increase in the on board power @ UHF frequencies and secondly, the QRM from the long-range cord-less telephones. Kumar offered a solution to solve the issue by incorporating a notch filter providing a minimum of -80db attenuation and agreed to design and demonstrate the same. It was also made clear by ISRO that until it is proved, the proposed U/V mode would be rather impossible. Kumar had designed and demonstrated the notch filter providing attenuation of 80 db thereby paving the way for the U/V mode.

In the mean time, both the transponders one made by Williams (Dutch) PE1RAH and the Italian--- were received by AMSAT-INDIA and presented to ISRO for evaluation. It was decided by ISRO to put both transponders for initial test and specification checks and subsequently, the AMSAT-INDIA technical Committee was requested to conduct the test and submit the test reports. Accordingly the technical team comprising VU2BGS, VU2POP and VU2WMY worked out a detailed test procedure and tests were conducted on both the DX transponders and POP's Fm Transmitter in the presence of ISRO's, Deputy Project Director-RF-TTC & Payload. The test reports were later sent to both the Dx designers by ISRO.

During the course of interaction, all the elements of the Indian payload proposed by AMSAT-INDIA came for the Preliminary Design Review by the ISRO and only the transponder and Interactive beacon proposed by Kumar VU2BGS and the Dutch transponder by Williams PE1RAH was accepted. The other three elements

proposed were dropped off from payload configuration for reasons mentioned below:

1. Mani, VU2ITI - CW Telemetry beacon

Reason: ISRO believed there is no much scope in receiving the telemetry by Hams and also it was not willing to share any of the Spacecraft health related telemetry data by Hams.

2. Srikanth VU2SBJ - FM Voice Message beacon

Reason: ISRO believed that there is no point in receiving the same voice message repeating throughout the life of the Satellite.

3. Prathap VU2POP - FM Transmitter for the above beacon.

Reason: Since, the telemetry & voice message beacon was dropped off from the configuration.

In the mean time, the technical committee headed by Kumar VU2BGS along with Prathap VU2POP and Mani VU2WMY were involved in various other activities at ISRO in testing the proto type elements, formulation of test procedures, finalisation of Uplink and Down link frequencies, VHF output filters for de-sense of Tele-command receiver, band pass filters, Cavity filters, final power module etc those were designed by kumar at his Home Q'th. Within months, the complete project report presented by Kumar with all relevant circuit diagrams and details were reviewed by a very high Critical Design Review Committee and subsequently accepted and approved for the fabrication of proto-model of the transponder to be followed by Flight Model. But, the most difficult issue for the AMSAT-INDIA technical team was in locating the source and procuring the most critical device ie. 21.4 Mhz crystal filter for 60 Khz bandwidth. A considerable time was spent as there is not a single source in India and very few abroad. Around this time, the HAMSAT project at ISRO was also speaking with a few Upagrah Amateur Radio Club, VU2URC (ISRO Club) members working with various other systems and areas. Most of the systems were ready and waiting for integration with the Spacecraft to be followed by series of tests and evaluations. At this point, due to the non-availability of some critical components within the required time, doubts were raised about delivering the transponder to ISRO within the specified time limit. Time was really running out and we had no other go but to express the inability to deliver the payload to ISRO in time. It was a real difficult situation, either it would not be wise or would be next to possible to ask for extension and thereby delaying the whole mission. Nevertheless, the situation was clearly explained to ISRO. To our surprise, the Space Premier of the Country could understand the problems and difficulties faced by the individual hobbyist

trying to fulfil the high aims and dreams of putting the first Indian ham transponder in the Space. The sincere efforts and hard work put in by the technical team always had the good recognition and support of ISRO. In their usual generous way, ISRO again came forward to supplement the dreams of Indian Hams of having our own Indian payload. Thus a decision was taken to fabricate the Indian payload within ISRO.

Within months the Indian transponder by ISRO was ready. Again it was Upagrah Amateur Radio Club and the AMSAT-INDIA technical team which jointly conducted the On-Air-Test. Within few weeks the proto-model of the transponder by Kumar was also ready though it missed the flight. Nevertheless, successful On-Air-test was conducted with the help of Upagrah Amateur Radio club meeting all the specifications. Thereafter a request was made to ISRO to provide and extend the test facilities for conducting various test on this model and subsequently approved by ISRO. Ever since the first meet, the AMSAT-INDIA technical committee is in constant touch with ISRO and represented at various levels till the recently held pre-launch user meet at ISRO Satellite Centre, Chaired by Dr. G. Madhavan Nair Chairman ISRO, Dr. P.S.Goel, Director ISRO Satellite Centre and Shri S.K. Shivkumar, Director ISRAC. The AMSAT-INDIA was again associated with newly set up HAM Station at ISTRAC by VU2WMY Mani and VU2FBS Singh for purpose of testing and evaluation of In-Orbit-Testing of the payload. The presence of AMSAT-INDIA President, Air Cmdr Subby VU2UV as the Distinguished VIP on the invitation of ISRO to witness the launch of PSLV-C6-HAMSAT at Satish Dhawan Space Centre, Shriharikota is one such example of the relations and recognition of ISRO with AMSAT-INDIA.

To express our gratitude and thanks for fulfilling the dreams of Indian Hams in having our own Amateur Satellite in the Space, a felicitation function was organised by AMSAT-INDIA. On the occasion, Dr. K Kasturirangan, former Chairman, ISRO Dr. G.Madhavan Nair, Chairman, ISRO, Dr.P.S.Goel, Director ISAC, Shri. K Thyagarajan, Programme Director, Shri J.P.Gupta Project Director were presented with greetings and flower bouquets. During the brief meeting we had with Chairman ISRO and Director ISAC, they expressed their happiness about the relations with AMSAT-INDIA and we were assured of all the possible help and hoped to associate themselves with us in the next HAMSAT missions. Already we have geared up for the next mission with some major improvements and addition of newer things incorporated and finalised the dates for testing at ISRO. We all at AMSAT-INDIA hope in realising a still more " Sensitive, Strong, Innovative and Always a Easy SAT" At this juncture, everyone in AMSAT-

INDIA joins me in thanking and complimenting OM.Kumar VU2BGS for his hard efforts in providing the required technical inputs, exhibiting high degree of technical and professional competence and exemplary skills at every stages of testing and in realising the transponder. At the same time, we also thank and compliment the efforts put in by Mani VU2WMY, Prathap VU2POP, Mani VU2ITI, Srikanth VU2SBJ and all others in realising the project. Never to forget, the tireless efforts and unmatched leadership quality of our President, AMSAT-INDIA (Regd) OM.Subby VU2UV finds on the top of records while, VU2RMS Ramesh's contribution can never be measured in any terms.

Undoubtedly, it would not have been a success at all without the wholehearted support and encouragement of the "Mighty Man"-The HAMSAT Project Director Shri J.P Gupta. It would be simply impossible for any one of us even to imagine the efforts, hard work and dedication put in by him in this project. Sir, we salute you and your Deputy Project Directors, Managers and entire staff of your esteemed organisation for gifting one of the best Amateur Satellite to World of Amateur Radio proving India is second to none in Satellite technology. We Indian Hams are proud of our ISRO and HAMSAT.

Though it was a regular official job for few of the Upagrah Amateur Radio Club VU2URC Hams worked on this project, but it was altogether a new different role they played in this HAMSAT project. It was seen from the beginning, every VU2URC Ham worked on this project was so attached to it with a very sentimental feeling. Rather "HAMSAT" was their Dear little baby nurtured deep in their Hearts. It would be a great mistake on our part, if we do not introduce some of them worked on this project. Here are few of them whom we remember immediately, Mani VU2WMY, Durai VU2DUC, Amal VU2GDX, Raghavendra VU3GTI, Raju Sagi VU2OLY, Subramanyam VU3GJW, Jagadesh VU2WAH, Arvind Kumar VU3XXX, Suresh VU2HNS and many more. We also take this opportunity to thank all the staff of other ISRO centres who played a very vital role. Last but not least, every AMSAT-INDIA (Regd) member had his important role to play in this project and we express our sincere thanks to each one of them. We all at AMSAT-INDIA look forward to see our HAMSAT-2 orbiting in Space at the earliest. 73's de AMSAT INDIA regd.

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Questions & Answers

Q1. I know HAMSAT is capable UHF/VHF operations. I would like to know if we would be able to work HAMSAT with a UHF/VHF Dual Bander handy /Base station especially on FM mode?

I guess why not. dual band Handies should work but if it has dual Rx then it will be even better as it is suggested good practice to hear your own downlink first and then try calling CQ or start a qso. No point in doubling some one else's QSO.

Q2. If only SSB/CW operations, then which is the cheapest (Cost effective) radio available through which one can work HAMSAT?

Most of the multimode multiband base/mobile rig are US \$ 1000+. Instead of dedicated rig like IC910 I would recommend Kenwood TS2000 which has more features and is user upgradeable firmware. Kenwood regularly issues newer version of firmware program that we can download from internet and upload it into the radio very easily. This radio has Sat mode built in and software like Satscape can Doppler shift the rig automatically. Costs approx 1400 US\$.

Important Announcement

Dot frees airwaves for Amateurs

Mountaineers, trekkers, aero-modellers and hobbyists sporting radio-controlled models will no longer need licences to use the airwaves. The Department of Telecommunications (DoT) on Thursday gave the go-ahead for these low-power devices that work in the so-called 'Citizen Band' of spectrum, to operate without licences. These low-power devices, so long as they radiate less than 5 watts of power and don't have external antennae, can share the Citizen Band freely, without causing interference, the DoT's Wireless Planning Cell has decided. A notification is likely to be issued shortly to formalise the decision, the DoT has said. In addition, licences to operate amateur radio channels have been deregulated, giving the license period a 15-year extension to twenty or life time, as applicants would like.

Amateur radio operators also need not approach the DoT to renew their licences, as the process has been made automatic. In January 2005, DoT had delicensed the indoor and outdoor use of wireless equipment (in the frequency band 2.4 to 2.4835 GHz with effective radiated power up to 4 watts), in line with international Practices. The indoor use of low power equipment in the Wi-Fi frequency band has also been delicensed, as with the low power Radio Frequency Identification Devices (RFID) using the 865-867 MHz frequency spectrum.

RAGCHEWING

With VU2MKP - Robert Kohli

How I got in ham radio is really funny. Coming home one evening from work, it was in Germany in 1968, just wanted to relax before dinner, turned the stereo on to enjoy some music. From the speakers came a sound I could make out as a male voice, loud but somehow nothing to understand (read I would say today). Having noticed earlier a wire going from our apartment building to the one opposite and a cable disappearing in neighbours window went to next door and rang the bell. Upon my request if this wire could have anything to do with my distorted evening pleasure he asked me in, explained he

was doing ham radio, fortunately the subject not entirely new to me. The transceiver, if my memory is right a Hallicrafters SR150, was shown in action with a few QSOs. We talked on for 2 or 3 hours and my neighbour suggested that there wouldn't be any problem for a foreigner to get a ham radio licence as for the technical part of the test my professional qualification would be sufficient

by far and for rules and operational skills he could provide with enough books.

Next day he stood in front of our door, told me he already got in touch with the government authority doing the tests and that I was really lucky, next week would be a test held in our city Bremen and he already informed the people concerned about one more candidate wanting to participate. Not long before the new VHF class without CW was introduced, so the nights were spent with rules, prefixes, operation technics. The next week six hours of written test followed by oral part, then in the late afternoon the passed verdict.



That's how DJ2FR (sk) solved his bci problem! A few weeks later DJ0UDX was on air, AM, crystal controlled with vertical dipole on two meters. Then 70 cm, SSB, real antennas in those days most homebrew. It was only in 1974 that we went back to Switzerland where I got my HB9MKP call and with the assignment 1976 in Bangalore also the present call VU2MKP.

Today the activity is on the HF bands with a 3 element SteppIR Yagi that works from 6 to 20 m, a wire to the next coconut tree for 40 meters. As long as AO-10 was

working about 900 contacts were made over that bird and later some 600 QSOs on AO-40, few with FO-20 whose footprint was good for 3 to 4 minutes with European stations. The 2 m and 70 cm crossyagis are homemade with local materials, the remaining antennas commercial products. The six meter season during the peak of the last cycle had exciting openings with dx

contacts of more than 18'000 km, this with a homemade 6 element yagi, that antenna now being disassembled, it became too crowded on the tower.

The transceivers now in use are IC-746 giving 100 W from 2 m to 160 m, the two low bands idle as there is an antenna for them. For the satellites IC-910 plus downconverter for 13 cm, now rarely used as there are no satellites in high elliptical orbits. FO-29 is still working well, but no takers over Asia, now with the latest addition of hamsat there came more life in the sky, a very good training ground for satellites to come even in spite of the short time the bird is available during a pass.

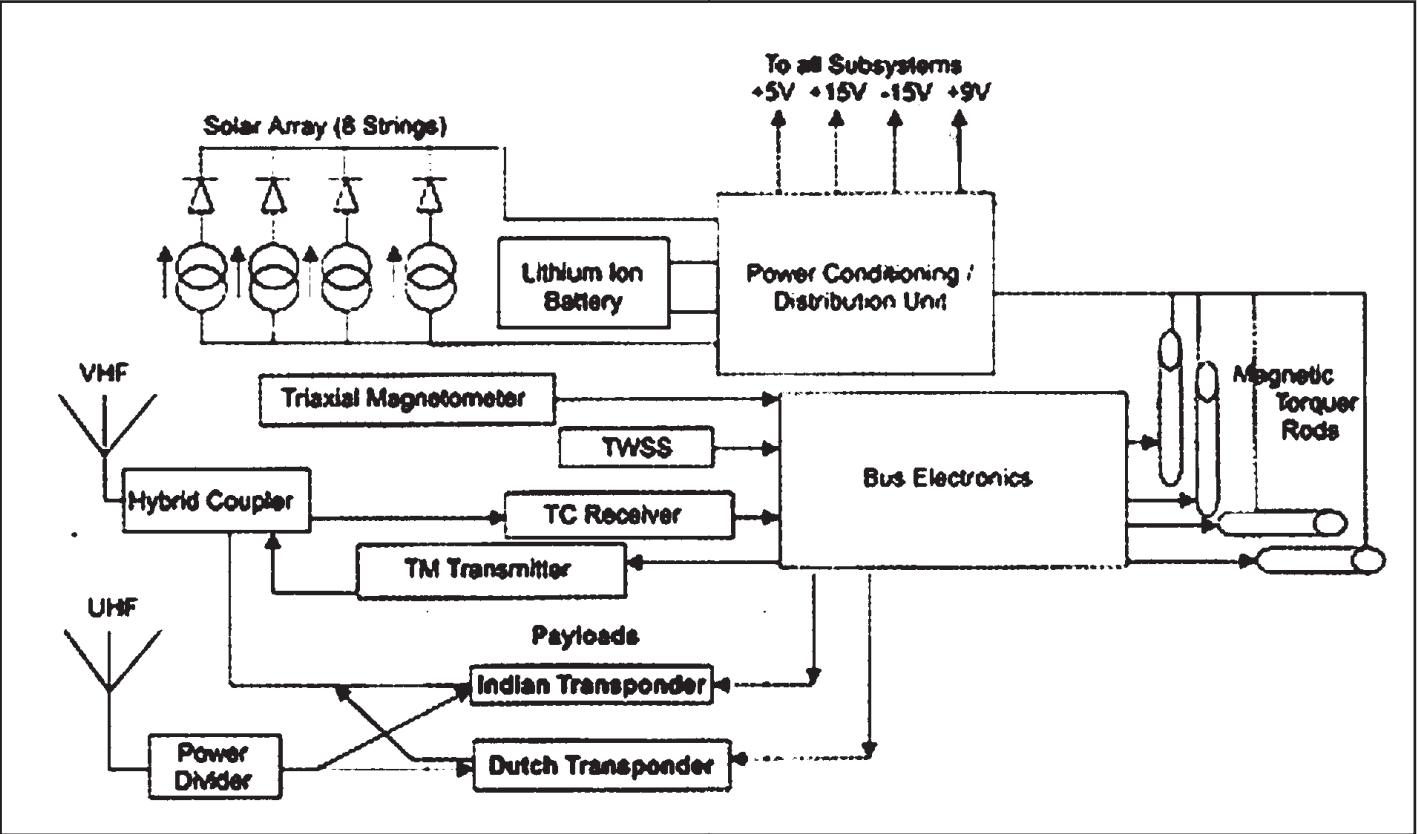
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to those who either don't want to use a computer, or who don't have access to the internet. Postal applications will be subject to an administration fee, but Ofcom promises that disabled licence holders will not be disadvantaged. The terms of the licence will not change, however, and the access rights granted will remain the same: Ofcom will still hold a database of names and addresses, and anyone who wants a licence will still have to pass the Radio Amateur Examination, and will need a valid Pass Certificate. The licence would still come with the same conditions, and could be revoked by Ofcom if the holder is deemed to have broken the rules. The regulator will continue to monitor frequencies and will deal with undue interference as it

always has done.

THE CQ IDX AWARD FOR VOIP CONTACTS CQ Amateur Radio magazine has announced the introduction of the first ever award program for contacts made using Voice Over IP technology. Called the CQ IDX Award, the program recognizes confirmed contacts with 25 to 100 different countries made using remote bases or repeaters linked with Voice over Internet Protocol networks, such as IRLP or Echolink.

According to CQ, the award is aimed at developing a DX'ing mindset among newer hams. CQ DX Awards Manager Billy Williams, N4UF, notes that there is now a blurring of the line between wired and wireless technology. Also, that this has already reached amateur radio in several ways.



Dimensions	630mm x 630mm x 550mm Cuboid
Mass	42 Kgs
Orbit	Near Circular Polar Low Earth Orbit
Structure	Aluminium Honey Comb Structure
Thermal Control	Passive Thermal Control
Solar Panels	Body mounted Gallium Arsenide Solar Panels
Power Source	Lithium Ion COTS Battery
Bus Electronics	MAR31750 Processor based providing telecommand, Telemetry, ACS & Sensor Electronics functions
Spin Rate	4 0.5 RPM
Spin Axis	3 Deg.
Stabilization	Spin stabilisation with on board autonomy for SRC, MBC and auto SAOC

Sensors	Tri-axial Magnetometer and Twin Slit Sun Sensor
Actuators	Magnetic Torquers
Communications	VHF for TM and TC
Antennae	UHF Turnstile, VHF Turnstile
Transponders	Mode B (UV)
Transponder Uplink	435.250 Mhz
Transponder Downlink	145.900 Mhz
Ground Station Support	Minimal.