QEX 15

April-May 1983

The ARRL Experimenters' Exchange

Ninth Annual Eastern VHF/UHF Conference

The 9th annual Eastern VHF/UHF Conference will be held May 13-15, 1983 at the Sheraton Tara, located in Nashua, NH at Exit 1, U.S. Rte 3, about 30 minutes north of Boston. On Friday night there will be a hospitality room hosted by the Northeast VHF Association. Saturday's program will feature well-known vhfers speaking on antennas, receivers, transmitters, microwaves, and other topics of interest to vhfers. There will also be "rap sessions" for each of the bands, chaired by persons active on the respective bands. On Saturday evening there will be a banquet (banquet food at the Sheraton is generally excellent), followed by a talk; speaker's name to be announced. Sunday's program consists of the noise-figure and antenna-gain measurement contests, weather permitting. Any i-f up to 1500 MHz can be accommodated, so bring converters as well as preamps. The antenna range will be set up for 432, 902, 1296 and 2304 MHz.

Preregistration is $13.50 before May 9. After that, $20.00. Banquet reservations must be made by May 9; the price is $14.00. For registration information, contact Rick Commo, K1LOG, 3 Pryor Rd., Natick, MA 01760.

If you plan to stay at the Sheraton, mention the conference when making your reservations directly with the hotel; ask about the "Weekender" package. Be sure to request written confirmation of your reservation. There are other, lower-priced hotels within a ten-minute drive of the conference.

A special activity is planned for YLs on Saturday. - Thanks, W1GXT.

Newington Bound

I had an opportunity to overlap with Doug DeMaw, W1FB in a recent trip to ARRL Hq. So, the present plans are to report for duty on/about May 9. As mentioned in the last issue, the move precludes publication of an issue of QEX for May. So the next issue that you will see will have the cover date of June 1983. Subscribers will not lose any copies due to this break because QEX subscriptions run for 12 issues (not months). Please mark any correspondence concerning your subscription "QEX Circulation."

All manuscripts and correspondence for publication in QEX should be marked to the attention of "Editor, QEX." All correspondence concerning QEX should be addressed to American Radio Relay League, 225 Main Street, Newington, CT USA 06111.

Call for Articles

Technical manuscripts for publication in QST or QEX are welcome at this time. Articles on how to get on the 30-meter band and AMTOR radioteletype are of high interest now due to recent FCC rules changes permitting them. Articles on construction projects and advanced experimental technology are always needed. If you have designed a computer-radio, hardware/software interface for a popular microcomputer, consider sharing that information with your fellow amateurs.

Second ARRL Packet Radio Conference

The Second ARRL Amateur Radio Computer Networking Conference, held in San Francisco on March 19, was a great success, thanks in large part to Hank Magnuski, KA6M (pictured below) and other members of the Pacific Packet Radio Society.

The conference was opened by ARRL Pacific Division Director, Bill Stevens, W6ZM. Papers on the Tucson Amateur Packet Radio (TAPR) terminal node controller (TNC) were presented by Lyle Johnson, WA7GXD; David Henderson, KD4NL; Margaret Morrison, KV7D; and, Harold Price, NK6K. Terry Fox, WB4JFI talked on the AX.25 level 2 protocol, network-level alternatives and his Packet Assembler/Disassembler (PAD). Den Connors, KD2S outlined the PACSAT project, and Phil Karn, KA9Q discussed PACSAT modulation and access techniques. Bob Richardson, W4UCH described his software approach to packet radio. Adding an International note to the conference, Robert Forchheimer talked about the SOFTNET project at Linkoping University in Sweden. Paul Rinaldo, W4RI reviewed work done on the Packet Adaptive Modem (PAM).

Printed proceedings of the conference are available at the cost of $9.00 per copy, post paid, payable in U.S. funds to "ARRL" addressed as follows:

American Radio Relay League
2nd Packet Conference Proceedings
Newington, CT 06111

In addition to the papers mentioned above, the proceedings include one by Bob Neben, K9BL on packet radio for emergency communications. Those who attended the conference were treated to a film of a computer simulation of a nationwide packet network prepared within the past two weeks by Ward Cunningham, K9OX and the computer animation group in a Tektronix-sponsored Explorer Post. Thanks go to all who gave papers, demonstrated packet systems and otherwise contributed to the conference.

Correspondence

Abbreviations

A copy of IEEE Transactions on Communications some time ago contained articles in which the key words, being acronyms, were not comprehensible to me. Nowhere in the articles were the titles explained. I note that in your Feb. 1983 issue, the first item first names, then abbreviates, such things as Terminal Node Controller (TNC). This is a good style. However, I don't recognize PROM, so (Peripatetic Read Only Memory) or whatever would be helpful at the start. - Alex McKenzie, P.O. Box 38, Eaton Center, NH 03832.

Ed. Note: The rule used for QEX is to just to use (without expansion) abbreviations such as "PROM" (meaning programmable read-only memory) and other standard ones which are published in the December QST each year. Others which are not listed in the "QST Abbreviations List" are to be introduced each time.

Freedom to Listen

At least one European country taxes, via the Post Office, radio and television receivers. The United States of America so far does not tax, charge for, or license reception of radio waves. The airwaves are free. And contributions to listener-supported and non-profit educational broadcasting networks and stations are not required for the reception of the station's or network's programming. Those commercial entertainment services of a clearly pay-as-you-look/listen nature which are specifically cable distributed do not use the through-the-air radio-frequency emissions, and should not I think, as the retail customer link: the airwaves are still free.

My understanding from QEX 13 for February 1983 P.10, "VHF+ Technology," is that some commercial retail entertainment distrubition systems now use microwave-band broadcasting on a rental or subscription basis; the rental fee providing a special antenna-converter-receiver and possibly decoder of some kind. As explained to me, proposed direct-satellite-subscription-reception will function in much the same way: the rental fee defraying the cost of microwave and decoding gear in addition to any satellite amortization and broadcast programming costs.

If the airwaves are still free, it seems to me that an experimenter, amateur or no, has the legal option, perhaps right, to build appropriate gear and listen/look in. Provided interference and disturbance are not in any way caused the broadcast service and viewers/listeners, my view is that the eavesdropping experimenter (or illegal voyeur as the subscription entertainment services are contending) is legally within his rights, provided also that he does not record, distribute retransmit, or charge monies in any way concerning his private entertainment listening and viewing. Am I correct in thinking that the secrecy provisions of the regulations pertaining to Amateur Radio operators would technically have protected amateur experimenters' rights and those of the commercial entertainment service as well (had they not been deleted)? Those provisions would not, of course, apply to the non-amateur experimenter.

Clearly, rental of cable services is an extra fee paid for a special (optional) service not involving broadcasting as the final customer retail link; much the same as the telephone is still essentially a "line" service, even though through-the-air radio intra-service links are employed. Ths position of the potential commercial subscription through-the-air broadcast services seems, to me, to be that the pay TV link from station to a private telephone drop, or cable-TV connection, and so rentable. So far, all the opinion both technical and otherwise coming to my attention indicate this is not so: that through-the-air broadcasting of radio-frequency and electromagnetic emissions does not constitute a "line" in either a technical sense nor the sense of the Communications Act of 1934. Reception of radio waves has been free for a long time in this country: Paying or charging for direct through-the-air reception, special gear or no, jeopardizes something traditionally American to me.

It seems to me that 'the cable' offers best reception for most subscribers; that free broadcasting from satellites and ground stations via whatever wave bands are practical (including microwave) is a possible solution to crowding of TV channels, but that a radio-frequency link is not a customer 'line' and not rentable at the retail level (though employable as an intra-service program link); that except for encryption of electromagnetic emissions for reasons of national security and other experimental and scientific telemetry, the encoding and decoding of emissions are not appropriate to the field of commercial public entertainment boradcasting; and, lastly, that the halcyon days of the back-yard and basement experimenter are still very much with us, though greater precautions and cares are to be allowed so as to prevent interference in an increasingly crowded electromagnetic spectrum. Such precautions will require greater vigilance on the part of Amateur Radio operators and non-amateur experimenters alike, but courtesy and technical prowess on our part might go far in allaying the worries of other occupants and guardians of the ether while allowing us our accustomed privileges and liberties. - John David Weinland, N1ATB, 879 Whalley Ave, New Haven, CT 06515.

Packet Radio Requirements

[These comments are in reference to the article, "Packet Radio and Radio Communication Requirements," by Karl Meinzer, DJ4ZC in QEX 14 for March 1983.]

Four bytes of preframe sync is an entirely different thing from four bytes of sync vector. What Karl is advocating, in effect, is that the HDLC chip must receive four contiguous flags before it decides that a frame is truly arriving. I don't know of any way to make our HDLC chips go into start-of-frame mode on more than one flag.

If the data link is so bad that a lot of false syncing is expected, then I think we're going to have some serious problems getting any data through at all. If the receiver has started receiving a false packet at the very beginning of a transmission, only one properly received flag is required to scratch the false packet and start anew. There is no chance of missing a flag and its subsequent packet because you happen to be in the wrong byte-sync at the time the flag flew by.

Preframe sync of a zero pattern cat technically cause false packets to be detected. The pattern FLAG-ZERO FILL-ZERO FILL-... - FLAG will be interpreted as a frame with a bad FCS by most hardware. I know, as my repeater was tripping up on the packet stream being sent out by the VADCG (Vancouver Amateur Digital Communications Group) TNC (terminal node controller) in the early days of trying to make the two talk to each other. Filler FLAGS do not cause this problem (which is small but annoying).

HDLC inherently provides for sending transparent data, and fixed-block coding offers absolutely no advantage in that area. - Hank Magnuski, KA6M, 311 Stanford Ave, Menlo Park, CA 94025.

Diode Voltmeters

By Albert E. Weller, Jr.,* WD8KBW

Diode voltmeters have many applications: in SWR bridges, rf-output meters, rf "probes," etc. Fig. 1 illustrates the typical circuits. The circuit of Fig. 1A is used when the rf source has poor dc continuity, that of Fig. 1B when the rf source has a low dc resistance. Provided the rf source has a low dc resistance, the two circuits are equivalent.

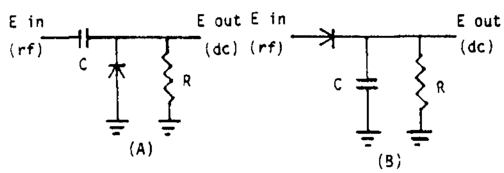


Figure 1. Diode voltmeters

The diode voltmeters of Fig. 1 nominally provide an indication proportional to the peak positive voltage of the rf source. In practice they always read less than the peak voltage. The dc components can be arranged to read e.g. 70.7 percent of the voltage on the capacitor, thus indicating the rms voltage of a sine-wave input, but the diode voltmeter is really a peak-reading meter. This results from the fact that the diode has a finite forward voltage drop, dependent on the diode current, and a small reverse current when reverse biased. The error is not constant but depends on the input voltage. The error - the difference between the peak input voltage and the voltage on the capacitor - increases as the input voltage is reduced. The face that the output voltage is not proportional to the input voltage - or even a linear function of the input voltage - greatly reduces the utility of the diode voltmeter when used to measure small voltages.

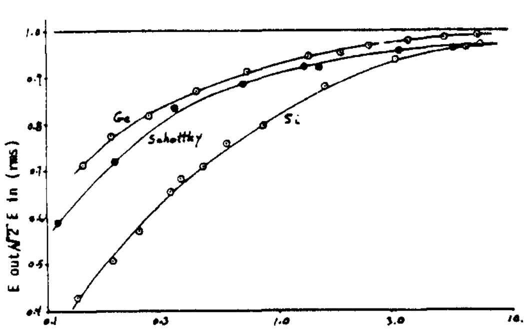


Figure 2. Calibrations of Diode Voltmeters Using Si, Ge and Schottky Diodes

Fig. 2 shows calibration curves for diode voltmeters using silicon (Si)(1N914), germanium (Ge) (1N34A) and Schottky (5082-2835) diodes. The measurements were made using a 22-megohm input resistance dc meter. The error increases as the meter resistance, the diode load resistance is reduced, and the diode current consequently increased. The error is larger than would be expected considering only the time average diode current. The forward current can flow only during that part of the input cycle when the input voltage exceeds the voltage on the capacitor - the output voltage. This cannot exceed 180 degrees and may be much less. The load current, however, flows continuously, and the diode reverse current flows whenever the diode is reverse biased - more than 180 degrees per cycle. As a result, the actual diode current is significantly larger than the load current.

It is curious that diodes with larger reverse saturation currents have smaller errors for finite loads and that the error is independent of the reverse saturation current for zero load current. The higher reverse satruation currents of the Ge and Schottky diodes are the reasons that these devices out perform the conventional Si diode.

The nonlinearity of the simple diode voltmeters of Fig. 1 is inherent in the characteristics of the diodes and cannot be eliminated by any adjustment of the load resistance. Is there any way that the situation can be improved without using active devices to compensate for the nonlinearity? One way is to use a dedicated dc indicator with a calibrated scale and do any range switching with an rf voltage divider ahead of the diode voltmeter. This is essentially the approach used by Bird in their well regarded rf wattmeters. A second way is shown in Fig. 3. The circuit shown can be regarded as a voltage divider. If the diodes were matched and the input dc, the meter would accurately read one half of the peak input voltage until the effect of the meter current became significant at low input voltages. However, as the upper diode has a conduction angle less than 180 degrees while the lower diode conducts continuously, the two diodes have different voltage drops, and the compensation is not perfect. Nevertheless, a significant improvement in performance can be obtained.

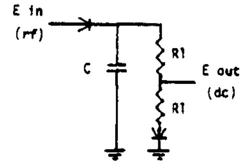


Figure 3. Compensated Diode Voltmeter

If the diodes have different characteristics, the compensation can be made perfect for one input
(continued on page 6)

*1325 Cambridge Blvd, Columbus, OH 43212.

Novation D-CAT Modem for Amateur Radio

By Robert Gervenack,* W7FEN
and Russell Faudree,** KA7HVA

The Novation D-CAT (tm) modem is interesting in that it uses isolation transformers for the input and output of the fsk signals. This feature makes it ideal to connect to Amateur Radio receivers and transmitters to have the capability of high-speed digital communications.

The output of the modem has a capacitor in series with the secondary of the output transformer. The diagram shows the connections required. The plug to the D-CAT phone jack should be wired as shown. The use of shielded wire is recommended to avoid any problems which may occur with noise or feedback. Additional switches may be installed to switch from telephone to different radios, i.e., vhf and uhf.

Modem Switch Setting

1. Set the modem siwtches to ANSWER, TEST, DATA IN and NORMAL.
2. Remove the plug from the HANDSET jack.

S1 and S2 Switch Settings

Receive Mode:

1. S1 to RECEIVE position.
2. S2 to OFF position.

*19701 320 Ave NE, Duvall, WA 98019
**3409 37th West, Seattle, WA 98199.

Transmit Mode:

1. S1 to TRANSMIT position.
2. S2 to ON position.

Switch Operation

Switch S1:

1. The OFF position opens the audio input to the modem so that garbage will not be put on the screen when there is no data present.

2. The RECEIVE position connects the audio from the receiver to the modem input.

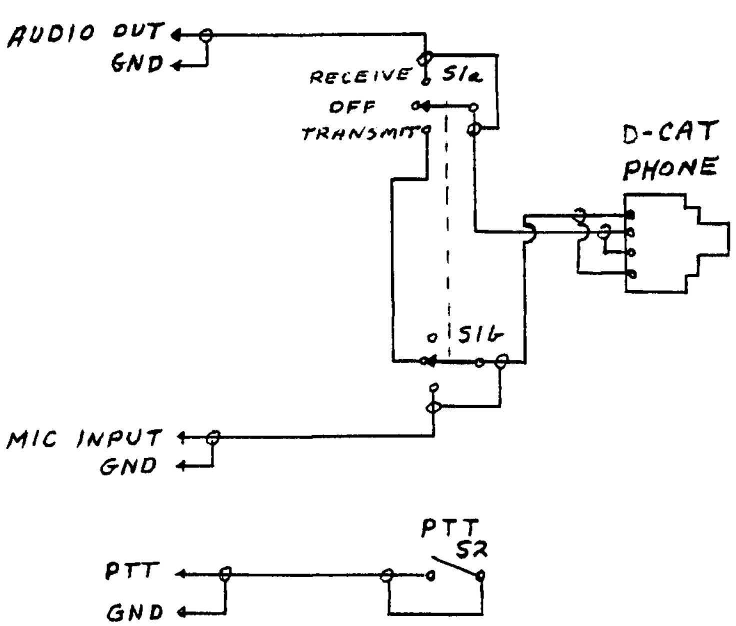
3. The TRANSMIT position connects the output of the modem to the MIC input. It also echos the audio output of the modem to the modem input. This is necessary to provide print on the screen of the information that is being transmitted. Many communication programs do not provide software echo. This also provides local loop (echo) when not transmitting via the radio.

Switch S2

This switch is the remote PTT switch to activate the transmitter.

The PHONE jack on the modem is the small (5/16-in. wide) type. To use a standard plug, such as obtainable from Radio Shack, it will be necessary to sand or grind the sides to fit the modem jack.

If the output level of the modem overmodulates the vhf or uhf transmitter, it may be necessary to install a 500-ohm pot in the line to the MIC.



Right on Channel - A Frequency Standard for Amateur HF RTTY

By Paul Newland,* AD7I

Introduction

Do you want to work some of the RTTY computer mailbox systems but don't have a radio that puts you exactly on channel? Here is a tuning aid that I call "Right On Channel" or ROC (pronounced ROCK). I have found it invaluable for putting my VFO controlled radios on channel for RTTY communications. Usually, RTTY communications do not present a problem because the operator can tune the rig while the transmitting station is on the air. What about those times when there is no station on the air to tune to? Say you want to work an AMTOR mailbox or copy a press or weather broadcast when you are away from the radio. How do you get your radio on channel? The tuning aid description that follows will allow you to get within several Hertz of your desired frequency, easily.

How It Works

Part of ROC operates the same as any normal frequency calibrator. Rf spurs are generated at constant increments of frequency throughout the hf spectrum. They provide frequency markers that your radio can detect. ROC allows rf spurs to be generated every 500 Hz, 1 kHz, 2 kHz, 4 kHz, or 8 kHz apart; this spacing is selected by a SP5T switch. That is nothing new. However, ROC also includes a synthesized audio oscillator; synthesized in 5-Hz steps. It is this oscillator that provides the tremendous utility of ROC over other calibrators.

With conventional calibrators, the radio is tuned until the audio beat note approaches 0 Hz. Most communications radios will not reproduce audio of less than 50 Hz. Thus, including both sides of zero beat, there is about 100 Hz of uncertainty in the frequency where zero beat actually occurs. For 170-Hz shift RTTY, that's way too much.

Instead of tuning the radio for an inaudible frequency of 0 Hz, why not tune it to an audible frequency? That allows precise frequency setting and is the approach that ROC uses.

How to use ROC

How can you use ROC to your advantage? Let's say you know that someone is going to broadcast a message that you want to copy, but you won't be in the shack during the broadcast. Let's say it is W1AW so you know when and where the broadcast will be. If you are going to pick up the 14095-kHz transmission, tune the radio to about 14095 kHz using the dial on the radio* and let it warm up until the VFO is stable. (If your radio is accurate to better than 1 kHz you can skip the coarse-tuning steps. Set ROC's SPUR SELECT to 1 kHz and go to step 4.) The frequency of ROC's rf spurs can be calculated as:

$$F(ROC) = 4096 \text{ kHz} \pm n(\text{SPUR SELECT}); \quad (\text{kHz})$$
$$n = 0, 1, 2, \ldots$$

*P.O. Box 205, Holmdel, NJ 07733, 201-741-1151 (H)

Thus, when SPUR SELECT is set to 8 kHz, the rf spur nearest to 14095 KHz is:

$$F(ROC) = 14096 = 4096 + 1250\ (8) \quad (\text{kHz})$$

To use ROC, just follow the step-by-step instructions below:

Step 1 Connect ROC to the radio and turn it on, set ROC's speaker volume to off, and SPUR SELECT to 8 kHz. Tune the radio until the received spur's audio from the radio is about 2 kHz.

Step 2 Set the SPUR SELECT to 1 kHz. The audio frequency of the spur detected by the radio should remain the same.

Step 3 Tune the radio down 1 kHz to the next spur.

Step 4 Turn ROC off, then on, to verify that the rf spur you hear is from ROC and not a birdie within your radio. Then, turn up the volume of ROC's audio, to about the same level as that of the radio's audio.

Step 5 Carefully, tune the radio so that the audio from the radio beats to *within* a couple Hz of the audio from ROC.

Step 6 Disconnect ROC and reconnect the antenna. Set your modem to AUTOSTART and you are in business. You are now Right On Channel!

What Audio Frequency to Use for ROC?

Commercial practice for RTTY is somewhat different from what most Amateurs use. Most things are the same: the shift is usually 170 Hz and the MARK signal transmitted by the radio is higher in frequency than the SPACE signal. However, there is one significant difference. The MARK signal (as discussed in ARRL and RSGB publications) is the channel frequency and the SPACE signal is below the MARK by an amount equal to the shift. For commercial stations, the MARK frequency is one half the shift frequency above the channel frequency and the SPACE frequency is one half the shift below the channel frequency. For systems using 170 Hz shift, that places amateurs 85 Hz below commercial stations. This difference, although small, makes the two systems incompatible. If you use one of the new synthesized radios with a smallest tuning step size of 50 or 100 Hz, then you can tune in one service but not the other. Additionally, you can tune in one service only if the modem tones are chosen correctly. This could pose a real problem for amateurs a few years down the road. I hope that, eventually, most amateur RTTY systems will migrate to the "commercial" method of frequency description.

ROC can accommodate either system. You only need to change the audio frequency generated by ROC's synthesizer. This involves adding or removing some diodes. Remember, ROC always generates rf spurs in integer multiples of 500 Hz. If you are using the current amateur's method of frequen-
(continued on next page)

Right on Channel

(continued from previous page)

cy description and listening to 14080 kHz, when ROC is activated you want to hear a 2125-Hz tone from the radio (since the channel frequency is the MARK frequency). Thus, you would want ROC to generate a 2125-Hz tone from its audio oscillator. For this, install diodes D4, D6, D8, and D9. If you are using the commercial method of frequency description and listening to 14080 kHz, when ROC is turned on you want to hear a 2210-Hz tone from the radio. (Because commercial systems have the channel frequency half way between the MARK and SPACE signals, the desired audio frequency from the radio with a spur exactly on the channel frequency will be half way between the audio MARK and SPACE tones, 2125 and 2295 Hz respectively.) This requires diodes D1, D4, D5, D6, D8, and D9. Some AMTOR operators use modems with tones of 1615 Hz and 1785 Hz. They want an audio tone half way between these values: 1700 Hz. This requires diodes D1, D2, D5, D7, and D9.

Circuit Description

The power supply for ROC is composed of F1, T1, D13, and filter capacitor C1. This provides about 9 volts of filtered dc to the voltage regulator, U10. The purpose of R17, the 68 ohm 2 watt resistor, is to provide a source of heat within the cabinet for ROC. That helps stabilize the temperature and thus the frequency of the crystal oscillator. Without it, the frequency stability suffers somewhat. The voltage regulator is composed of U10, C13, C2, and C3. This provides a well-filtered, well-regulated, low-impedance +5-volt supply for the remaining circuitry within ROC.

The crystal oscillator is made up of Y1, U1a, U1b, R1, R2, C6, and C4. U1a and U1b are biased for linear operation by R1 and R2, respectively, and C4 is used to net the oscillator to frequency. U1c buffers the oscillator and R3 pulls up the output of U1c for CMOS compatibility.

The 4.096-MHz clock provided by U1c is sent to U2 and U4a. At U2 it is divided down to provide reference frequencies of 500 Hz, 1 kHz, 2 kHz, 4 kHz, and 8 kHz. They appear on connectors X1 through X5. Also, the 4.096-MHz clock is sent to the on-off modulator, U4a. This gate is turned on and off by the 1 to 2 microsecond one-shot formed by U3. The outputs of U2 are brought to a SP5T switch which is used to select the rate that U3 is triggered. The increments, in frequency, that ROC's RF spurs occur are equal to the rate that U3 is triggered. If the input to U3 is a 500-Hz clock, the spurs from ROC will be every 500 Hz. If the input is a 4 kHz clock, the spurs from ROC will be every 4 kHz apart. These rf spurs are centered around the clock rate, 4.096 MHz, and extend up into the lower part of the vhf spectrum. U4b acts as a buffer and insures that the output of ROC has fast rise times. This insures good spectrum coverage. C8, R7, R8, and C9 couple and attenuate the rf spurs before being passed to the connector and on to the radio.

The 500-Hz output of U2 provides a reference clock for the audio synthesizer. The synthesizer is formed by U5, U6, and U7a. U5 is the PLL that includes the low pass loop filter made up of R11, R12, and C10. The VCO is formed by U5b, R13, R14, and C11. The output of the VCO is fed back to U6 and the diode array as well as the terminal count detector, U7a. In composite, these components form a divide-by-N counter. By connecting subsets of the diodes D1-D12, different divisors can be selected yielding different frequency outputs from the synthesizer. Connections for the diodes are given in the schematic for common modem tones.

The output of the synthesizer is a clock signal at 100 times the frequency of the desired audio frequency. U8 and U9 form a divide-by-100 counter, and the output of these counters feed the speaker buffer, U1f. C12 couples audio from U1f to the speaker.

Not mentioned so far is R6. If you grind through all the math involved to describe ROC's operation you will find that theory predicts that there could be some rf spurs (maybe just the spur you are looking for) that have zero amplitude. Just which ones are zero depends on the length of the pulse generated by the one-shot, U3. R6 allows the operator to "peak" the spurs generated from ROC so that the one you are looking for has maximum amplitude. In practice, you will rarely have to use the "peaking" control. There appears to be enough jitter in the length of the pulses generated by the one-shot so that the amplitude nulls are not very deep.

Conclusion

This article describes a frequency calibrator for use by Radio Amateurs involved with hf RTTY. It is simple to construct and use. Despite its simplicity, it provides a powerful tool for frequency calibration of Amateur Radio RTTY receivers and transceivers.

Reader's comments and suggestions are always welcome. If you telephone, please understand that I may not be able to devote time, immediately, for discussion. Letters are also welcome but please include an s.a.s.e. if you wish a reply.

Diode Voltmeters

(continued from page 3)

voltage, or the meter can be compensated to achieve a specified maximum error over a certain range of inputs.

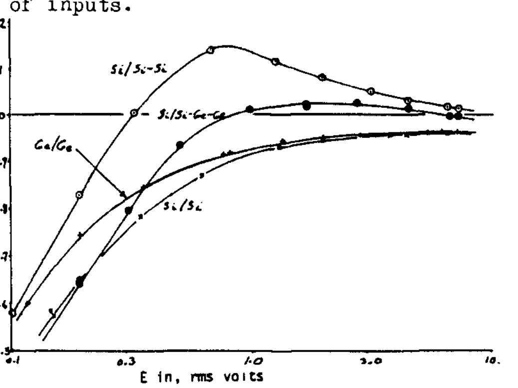
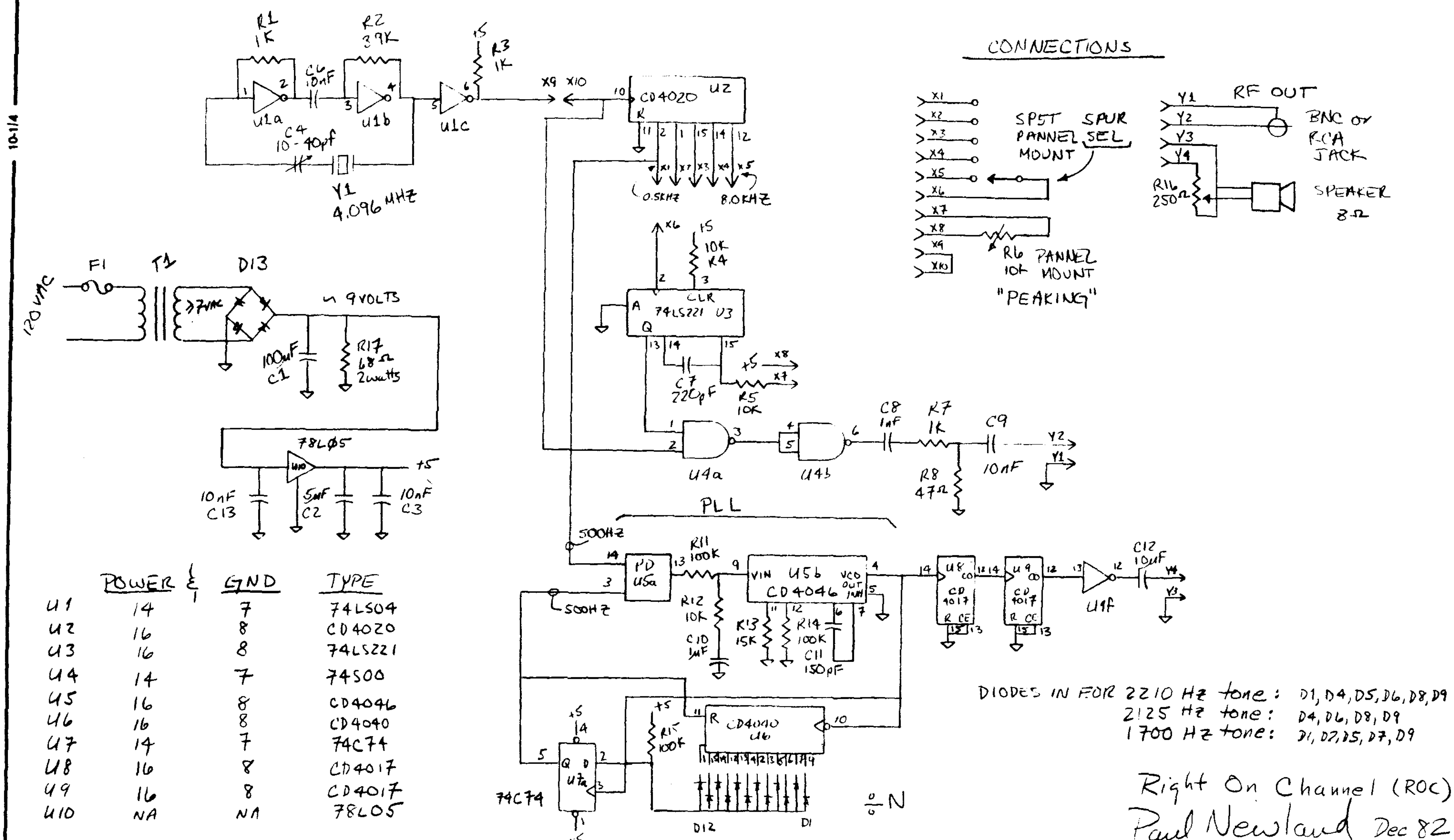


Figure 4. Comparison of Several Compensated Diode Voltmeters

Fig. 4 shows calibration curves for several diode voltmeters using the circuit of Fig. 3. The labels on the curves signify the diode arrangement: Si/Si indicating silicon diodes at both the upper and lower positions, etc. The multiple designations indicate series strings of diodes for the lower diode of Fig. 3. Each resistor was 106.4 kohm.

With two silicon diodes, Si/Si (1N914), the voltmeter characteristic is substantially improved compared to the simple voltmeters displayed in Fig. 2. Surprisingly, using two germanium diodes (1N34A) does not result in a large improvement ofer the simple voltmeter. The Si/Si-Si configuration overcompensates the meter, and a Ge/Si configuration (not shown) is severely overcompensated. The Si/Si-Ge-Ge configuration is quite attractive. The output is proportional to the input within ± two percent above about 0.7 volts and within ± five percent above about 0.45 volt. For lower input voltages, the Ge/Ge, or probably the Schottky/Schottky configurations would be better. But at best the errors become quite large at the lower voltages, and the diode voltmeters hardly can be used for quantitative measurements below 0.3 - 0.35 V rms unless calibrations are used.

A final thought: If the output tap on the voltage divider is set to read 70.7 percent of the input, rather than 50 percent, the overcompensation of the Si/Si-Si configuration would be reduced, and this arrangement might be attractive for a direct reading of the rms input voltage. Because the degree of compensation is dependent on the resistance used in the voltage divider - the degree of compensation decreasing as the total resistance increases - the Si/Si-Si or Ge/Si configurations might be usable with an increased total resistance and provide a higher input resistance voltmeter. Something for you to try!



POWER &	GND	TYPE
U1 14	7	74LS04
U2 16	8	CD4020
U3 16	8	74LS221
U4 14	7	74S00
U5 16	8	CD4046
U6 16	8	CD4040
U7 14	7	74C74
U8 16	8	CD4017
U9 16	8	CD4017
U10 NA	NA	78L05

DIODES IN FOR 2210 Hz tone: D1, D4, D5, D6, D8, D9
2125 Hz tone: D4, D6, D8, D9
1700 Hz tone: D1, D2, D5, D7, D9

Right On Channel (ROC)

Paul Newland Dec 82
ad7i

VHF+ Technology

Conducted by Geoff Krauss,* WA2GFP

Chip Capacitors Revisited

Thanks to the readers who have written to stress that chip capacitors should be soldered with a silver-bearing solder. Silver in the chip electrodes will be leached out if regular (lead-tin) solder is used, and the chip subsequently may fail. Not all chips have silver in their electrodes, but you usually cannot tell what the electrode material is; use of a 2-4% silver solder is always good practice. The main problem is finding silver solder and the flux to use with it. Most silver solders need an external flux. If any reader knows of a general source, I'd like to make everybody aware of it.

Now that WARC-79 has been ratified in the USA, we can eventually look forward to a 902-MHz band. While I would not like to predict what kind of commercial equipment may become available, I will predict that most vhf+ers will encounter two problems in home-brewing equipment for this band: test instrumentation and circuit technology. The test instrumentation problem is always going to be with us and is only usually solved by perseverence. Uhf signal generators, frequency counters and even spectrum analyzers are available, even if many state-of-the-art units are not within the amateur price range. The best solution often is to team up with someone who has access to these goodies. Several of our better-known vhf clubs are founded on the premise that a few members have access to good test equipment and all members with sufficient interest **can** get to use the test equipment if they persevere! With respect to uhf frequency counters, the vhf+er may want to check out the RCA CA3179T, a DIP IC which is a divide by 256 up to 1300 MHz and a divide by 64 to about 300 MHz. Of course, anyone who has built a good, low-cost spectrum analyzer, operating up to at least 1300 MHz, should publish an article immediately. Many vhf+ers are waiting for that information.

The second problem is one of circuit-board processing, rather than a problem with selecting a circuit type. At frequencies 2 octaves (4X) below 902 MHz, lumped components are easily used in point-to-point wired stages. At frequencies 1 octave below 902 MHz (e.g., at 432 MHz) the size of distributed (mostly inductive and resonant) components start to become realistic and are as likely to be used as lumped components. At 1 or 2 octaves above 902 MHz (e.g., 2304 and 3456 MHz respectively), it becomes increasingly difficult to use lumped reactive components. Distributed components become very attractive and are almost mandatory above 3 GHz. Given the use of a reasonably low-loss dielectric, such as standard G-10 material, a quarter-wavelength 50-ohm section is about 1.75 inches long at 902 MHz. This is a reasonable length, and an entire stage of amplification can be fabricated on a 4-inch length of microstrip board (i.e., a printed-circuit board having a solid ground plane on one side and distributed components etched into a conductor material on the second side).

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Which technology should be used to fabricate microstrip circuit boards and mount components? The techniques used to prepare circuit boards can be divided into additive and subtractive technologies. Subtractive technology, using soldered-on parts, almost exclusively is used for amateur equipment. In both technologies, the starting point is a substrate to which a conductive foil, typically of copper, is bonded. In the subtractive process, the starting thickness of the copper foil is usually between 1 and 2 milli-inches. An etch-resist pattern is provided wherever conductors are desired. The board then is etched and the resist prevents etching away from the copper where conductors are desired. The resist is then removed. In the additive process, the initial copper foil is very thin, usually being about 0.2 milli-inches thick. A resist pattern is also used, but in this case the resist masks areas where conductors are **not** desired. Thus, the original thin copper layer is exposed only where conductors are desired. The board is then electroplated to add about 1 milli-inch of copper to those exposed area. The resist pattern is stripped away, and the copper is lightly etched until the thin, starting copper layer is removed. The additional, built-up copper is slightly reduced in thickness during the etching process but still has a 1 milli-inch thickness when the etch is completing.

In either process, the most crucial step is applying the resist pattern. As the relative dielectric constant e sub r increases (to provide a decreased velocity propagation factor and shorter quarter-wave line lengths at a given frequency) a decreasing line width is necessary for a line of given impedance, with the same dielectric layer thickness. The line width also decreases if the dielectric layer thickness is decreased. Therefore, as frequencies increase and/or smaller stage areas are attempted, the circuit elements must be of smaller dimensions making it increasingly difficult to lay down the more finely detailed resist pattern. Of course, if one has access to commercial facilities, this is usually not a problem. The rest of the vhf+ers need some system by which microstrip layouts can be easily and inexpensively transferred as a resist pattern to a printed-circuit board with a high degree of success. Anyone publishing such information will, I am sure, earn the gratitude of all vhf+ers.

While you are thinking about that problem, also consider whether some form of thick-film or thin-film construction technique can be utilized for amateur vhf+ construction. While chip capacitors and resistors are now being utilized, and surface-mounted analog components are beginning to become available at amateur prices, most of the techniques for building "hybrid"-type circuits still are not available to amateurs. While it would be nice if commercial manufacturers were to make available hybrids which can be utilized by vhf+ amateurs, some experimentation and publication on home-brew hybrid fabrication and surface-mounting techniques certainly would be welcome.

Data Communications

(continued from page 9)

8080-assembly-language version of the AX.25 link-level protocol. He is writing pluggable code, that is to say, we will try to stuff this code onto the VADCG board, changing only the drivers. We believe that original code written by Doug Lockhart, VE7APU, reworked by Hank Magnuski, KA6M, is in need of replacement. The code can then be "plugged" onto the packet assembler/disassembler (PAD) board designed by Terry Fox, WB4JFI.

If anyone is interested in the schematic of the state machine and the the contents of the PROM, I can supply it for $5 copying/mailing cost, but I do not recommend trying to duplicate this method unless you own one of the Ma Bell blue computers or already have an SIO board. Wait for the 8530 schematics to appear. That chip is an SIO upgrade which will do the jobs required.

I asked Jon what is next after the box talks AX.25 link-level protocol fluently. He has two of these boxes and is going to put the software in both and then connect them up directly. The speed will then be cranked up and testing conducted to see how fast it will go (we hope 56 kilobauds).

Data Communications

Conducted by
David W. Borden,* K8MMO

The Synchronous Line Analyzer

It became obvious when the Tuscon Amateur Packet Radio (TAPR) terminal-node-controller (TNC) boards hit the Capitol area, that they were not communicating with the existing Vancouver Amateur Digital Communications Group (VADCG) boards that were here already, in theory running the new AX.25 link-level protocol. Upon connecting to the new TAPR boards, the VADCG board would receive a new type of frame not programmed for (REJ for instance) and disconnect. Just exactly what was happening was diagnosed by having an independent observer put his TAPR board in TRACE mode which gives a hex and ASCII dump of what is going on the channel. A VADCG user and a TAPR user then connected up (or attempted to). The condition was then that TAPR could talk to TAPR and VADCG could talk to VADCG, but no mixing. This condition is unsatisfactory. What we have here is a protocol, which both sets of software should be coded to and conform to. Back to the PROM burner!

This first exercise in serious testing of the two pieces of hardware revealed the need for an impartial observer, in this case a third-party TAPR board with TRACE capability. However, it occurred to me that the impartial observer should be running neither TAPR hardware nor VADCG hardware, in order to be truly impartial. Probably this is an overzealous testing requirement since the local TAPR Beta-Test Coordinator, Tom Clark, W3IWI, was glad to act as an observer and could see what was happening on the channel and record it using his IMSAI microcomputer/disk drive and printer. I figured that we needed an X.25 analyzer like the one I saw in the industry magazine for $20,000. Being a normal frugal ham however, it had to cost $70 at most.

Off the shelf came a computer that our club had obtained in a surplus buy about a year ago. This wonderous machine used the PROLOG STD Bus, a 56-pin bus normally employed in industrial control environments. It used a Z80 CPU card with onboard RAM and ROM and a serial input/output (SIO) card to deal with serial data. The best part of this little beauty was that we obtained them for $60 each from Ma Bell. Do not write concerning these units, they are all sold, and mine will not leave my shack, ever. I saw one at a hamfest for $250, and that still was a good price. Could this gem be used to receive packets? The answer is, of course, yes. It needed the addition of a little hardware and software to become the Capitol Area Packet Radio Logging Node. I was not smart enough to accomplish this, so I called on our local smart guy, Jon Bloom, KE3Z who had always thought these boxes could packet.

My initial approach to using the STD bus was a plan to build the Hank Magnuski, KA6M, STD board (with Western Digital 1933 packet controller chip) which he uses in his packet repeater. That approach will work, but Jon pointed out that we owned an SIO board, and Zilog SIOs can HDLC with no problem. "Fine," I replied, but how do we do the preframe sync, digital phase-locked loop (DPLL) and cw i-d? Jon provided a schematic which is a mystery to me.

This mystery that he reveals is a "state machine." I recognized the parts, serial line receivers/transmitters, a PROM and a latch, but could not see what they were doing. Jon explains that what is happening here is non-return to zero, inverted (NRZI) decoding and clock recovery. The input to this device is received NRZI-encoded data from the modem receive line, and the outputs are decoded receive data and clock which is recovered from the data. We provide the latch with a 16 times clock (from the SIO board, TSET) and recover clock from data sending it to the receive SIO channel (RSET). The real secret of this lashup is the PROM. It contains data which is accessed by what appears on its address lines (A0-A10). I rushed home with the schematic like the kid on Mr. Wizard used to do every Saturday morning after Don Hurbert gave him the word. Quick wire wrapping and plugging in the PROM containing the magic data produced a device which received NRZI-encoded packets and sent data and clock to the SIO board which accepted the data, breaking out the packets just like the Intel 8273 controller chip on our VADCG TNC boards. I now have this independent synchronous line analyzer, just like the industry guys, and I have expended $70.

After considerable study of this machine, it should be pointed out that the transmit side is now finished and works also. It probably is not worth duplicating by other experimenters. The Zilog SIO is a $10 chip. The PROMs and latches required are inexpensive, but Zilog makes a chip that does it all - the 8530. Future effort should center on that chip.

Jon is now using this machine to finish an
(continued on page 8)

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