QEX

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The ARRL Experimenters' Exchange

QEX is Going Monthly

Surprise! Bet you weren't expecting QEX for another month. Starting with this issue, QEX will be published monthly, barring dire circumstances.

The every-other-month publication was done to ease the learning process. Before QEX first went to press, I was in the throes of bringing up a new Godbout CompuPro (tm) computer with MicroPro WordStar (tm) word-processing software and a cranky Diablo Hytype I printer. I think that the bugs are mostly out of the system. For those of you with word-processing capability, I'm all set up to receive ASCII text, either in the form of an 8-inch, CP/M floppy disk or via modem on the phone line. The telehpone setup uses a PMMI MM-103 modem (Bell 103 capable of speeds up to 600 baud) and Ward Christensen's MODEM7 communications software. In either case, please call me on 703-734-0878 before formatting.

Probably more important, we wanted to make sure that there would be an adequate flow of manuscripts coming to the editor. Quite a number arrived before issue 1 went to press. Presently, we have a backlog of 11 manuscripts, both short and long ones. That's a healthy number. Monthly publication should permit us to clear up this backlog within a few months. It should then be possible for many contributors to see their articles in print within a month or two.

Feedback

In this issue you will see some correspondence from the readers reacting to recent QEX issues. We hope that you will send in more letters which either add to subjects already mentioned in QEX or surfacing new ones. If you know something that may be of interest to the readers, send in an article or a short letter. On the other hand, if you need information that others might have, a letter would also be an appropriate vehicle. In order to keep topics alive, it is desirable to be able to publish replies in the following issue. So, please dash off your feedback within a day or so of receipt of a QEX issue.

If you do not have any comments for publication in QEX, you may still want to send a post card or brief letter to the authors of articles and columns. Authors appreciate this type of feedback as well as learning that their ideas are being applied elsewhere. If you would like a reply, it is good practice to include an s.a.s.e.

Missing Copies

Some readers informed us that their copies of issue 1 never arrived. We haven't figured out the precise cause, but it occured in the mail handling, not the League's processing of subscriptions and labels.

Here's how the system works. All QEX subscription applications go to Hq at Newington for processing. (If you send subscription applications, changes of address or notes concerning missed copies to the Editor, QEX, I simply mail them to Newington.) QEX is edited, printed and mailed in McLean, VA. The mailing labels which were generated in Newington are mailed to McLean just a day or so before the mailing is prepared by the printer. When the mailing is completed, the extra copies are shipped in bulk to Hq. Thus only Hq is able to replace mangled or lost copies. The editor keeps no stock of QEX back issues.

Technical Presentations at Meetings

Some experimenters or technically oriented hams feel like ducks out of water at local Amateur Radio club meetings and some conventions because there is nothing technical on the program. It is true that most Amateur Radio organizations combine social, operating and training activities and don't spend much time on the technical side of the hobby. If that's the way it is in your area, it doesn't need to be. It is a good idea to try to work with the existing ARRL-affiliated club serving your area. If you can give a technical presentation on one of your specialties or projects, ask the club activities chairman to book you for an upcoming meeting. That should get the ball rolling.

If you know someone in your area who can give a technical presentation by virtue of job or hobby experience, ask him or her to speak at a club meeting or special event such as a hamfest or convention. It helps to send a written invitation to the speaker, get the word out to members and others in the area, confirm by telephoning the speaker just before talk time, hosting the speaker during the meeting, and sending a written thank-you note afterwards. These small things help to make the speaker want to come back at a later time for another presentation.

If you don't have the technical speakers in your club and don't have the expertise locally, you might try the neighboring clubs. Your Section Communications Manager and/or Division Director should have a good idea of who's who and where in your area.

Maybe QEX can be used to locate a qualified speaker on a technical topic. If you think that it will smoke out someone, write a short item for QEX which includes the area of expertise desired, where the talk would be given and contact information.

If there's a convention, hamfest or computer festival being planned in your area, possibly you could work with the committee to line up technical speakers.

Data Communications

The "Data Communications" column is missing from this issue because Dave Borden, K8MMO is overseas. He should be back in time to carry on next month. - W4RI

Correspondence

Calibrating Frequency Counters

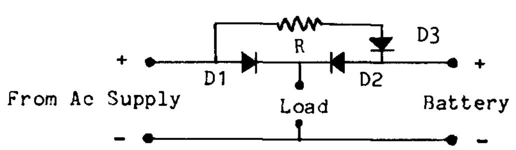
The April 82 issue on page 1 indicated interest in a method of calibrating frequency counters. A source of very accurate frequency at a power level easily readable by the average counter exists in nearly every home. The color subcarrier crystal of a TV set is phase locked and traceable to a cesium atomic clock at the major networks. The frequency is 3.579545 MHz, and the FCC tolerance is ±10 Hz. Working in TV broadcast for many years I never observed an error of more than 1 Hz with my counters referenced to WWV or 0.3 parts per million from the network signals.

The technique is simple. Be sure you are looking at a TV station carrying a direct network program, not a tape delayed broadcast. Be sure your set is in good color lock with the colors stable and normal on the screen. Couple your counter to the color crystal oscillator in the set. With tube type sets a "gimmic" capacitor of wire wrapped around the oscillator tube works fine. With solid-state sets the counter antenna held near the crystal usually works. Keep your equipment (and your body) away from the H.V. and sweep circuits. A handy probe jack can be easily mounted on the back cover of the set for repeated use. Be careful not to couple so heavily that it pulls the crystal oscillator out of lock as shown by rainbow colors on the screen.

If your counter doesn't read 3.579545 you better calibrate it so that it does, to all seven digits! - Rowland Medler, W4ANN, 1041 N.E. 20th Ave, Gainesville, FL 32601.

Uninterruptible Power Supply

Here is a circuit of an uninterruptible power supply for a repeater or home station.



The details can be worked out for one's own application. Diode switching is used. Both ac and dc supplies are essentially isolated from each other. D1 and D2 must be capable of carrying the load plus some for safety. D3 and R are set to give a trickle charge to the battery.

When ac power fails the load is picked up by the battery. Perhaps someone can use a system such as this. - Walter Z. Nagy, W2WLO, 4421 Mohican Trail, Valrico, FL 33594.

Improving Sensitivity of Collins 75S Receivers

This item is submitted more as a distribution of information than as a self-designed modification of the 75S series of Collins receivers. A couple of years ago I purchased a brand-spanking-new 75S3C. The radio was absolutely superb. It was audibly better than several older 75S3B receivers that I own. It took some considerable usage of the radio before I realized that something was fundamentally different. A review of the new Collins manual and any of the older manuals revealed a small but significant difference. This modification outlines the changes required to effect that difference.

In the plate of the second mixer, older model "S" lines utilized a 10-mH rf choke to shunt feed dc to the plate of V4A. In turn, two i-f cans (T4 and T5) are used in series when in the a-m mode. When in the sideband positions, the mechanical filters represent the coupled load to the second mixer plate. In the new "S" line, the 10-mH choke is removed, i-f can T4 permanently placed in the plate circuit V4A, providing proper termination for the mixer. The modification takes approximately 45 minutes to make. All parts are already contained in the radio. Somebody in Cedar Rapids still thinks of us!

To modify: remove inductor L4 from between pins 3 and 6 of V4A. Remove the wiring on transformer T4 from all pins of T4. Couple the 3-pF capacitor formerly going to pin 3 of T4 to the switch wafer that formerly went to pin 1 of T4. Connect pin 1 of T4 to pin 6 of the mixer. Connect pin 2 of T4 to pin 3 of the mixer. Connect the plate side of C32 to pin 3 of T4 and reground pin 4 of T4. This completes the modification other than a modest retweaking of the i-f cans for max signal off the crystal calibrator.

I would have had great difficulty believing that such a modest change could have made such a drastic difference in the radio, but I have performed this modification on three 75S3Bs, two straight 75Ss and a 75S3C. The minimum discernable signal (MDS) remains unchanged at -143 dBm. A third-order intercept is improved from -23 dBm to -6 dBm. Absolutely unbelievable!

If you are running a big antenna or are in close proximity to other stations that still give you inter-mod problems, as long as you have the "S" line out of the case you might want to consider another modification. This one takes all of 30 seconds to effect. -143 dBm constitutes excess sensitivity on my radios.

A frequency-sensitive pad is installed in the front-end by removing C11, the input coupling capacitor, from pin 1 of the rf amplifier. In series with this open junction install a 10-pF capacitor. The loading on the input tuned circuit is reduced, permitting additional selectivity. Signal loss at 20 meters reduces the MDS to 133 dBm (still more than adequate), and on 10 meters with the reactance of the 10 pF going down, sensitivity is adequate for all but the weakest JAs. The third-order inter-mod on 20 meters becomes +7 to +9 dBm.

These two modifications have made the difference between considerable self-inflicted interference in multi-multi contest operation and the ability to work within 1 kHz of the harmonics of the station on the next lower band. - Harold E. Johnson, W4ZCB, 211 S. Ewing Ave, Clearwater, FL 33516.

1750-Meter Experiments

1981 has been a successful year for the 1750-meter band in Southern California. Thanks to Charles Falkner, W6FPV for many hours of solid-state circuit design and build-up of six ssb transceivers with noise blankers, which have made it possible to have daily 10 A.M. and evening 8 P.M. roundtable QSOs with a total of 86 logged hours of good copy at eight miles plus. Readable signals have been copied at 22 miles distance by Ed Phillips, W6IZJ. The one-watt power limitation on the band makes noise the center of attention, and the blanker works well on the light dimmer's raspy noise. However it is not as effective on static type noise. This challenge will no doubt bring about more effective ssb signal processing.

This year has more than proven the usefulness of this band, not only for the experimenter but for short-distance voice communications. The experience of building the transceiver, the help and friendship of the group have been a great pleasure. Those in the group are: Charles Faulkner, W6FPV; Jim Layne; Mike Benson; Dave Curry, WD4PLI; and the author. - Cliff Walker, WA6GGI, 12824 Cometa AVe, Sylmar, CA 91342.

Data and Clock Modem, DCM-1

By Paul Newland,* AD7I

Introduction

This is a description of Data and Clock Modem, Version One (DCM-1), a new type of terminal unit for amateur radio. The circuitry has been decomposed into two parts: the Data Module (DM-1) and the Clock Module (CM-1). DM-1 has been designed to provide hooks to CM-1; CM-1 will be described in a companion article soon to be released. The combination of these two units form the system. Those of you who have already looked ahead to the schematic may see that DM-1 alone does not differ much from other terminal units that have recently been appearing in the ham literature, and you are right! There isn't much difference between DM-1 and all the others. But before you cast this article aside, stay tuned at least until the features are presented.

Why Another New Terminal Unit?

Radio amateurs have used data communications for many decades, but only recently have they had access to high-speed data communications. In the past, amateur radio data communications consisted mostly of frequency shift keying (fsk) using 45-baud teleprinters. Today radio amateurs are constructing exciting new data communications systems such as packet radio. These systems require equipment more complicated than the average RTTY system. Thus, if maximum performance is to be obtained from these new systems, new components, such as terminal units, are required. DM-1 combined with CM-1 is such a component; it offers the following features as a radio modem:

1. Provides standard EIA RS-232 synchronous/asynchronous DCE interface.

2. Provides digital and analog self test for both near and far end testing.

3. Provides clock recovery within the modem. HDLC controllers in terminal equipment do not require built-in clock-recovery circuitry.

4. Provides NRZ - NRZI encoding/decoding via a strap option. It is compatible with HDLC controllers that do not have NRZI capabilities.

5. During RTS-CTS delay, demodulator transmits dotting data pattern to simplify far-end demodulator synchronization. Controllers do not need to send synchronization preamble before packet transmission.

6. Provides state indicator lamps for all important EIA leads.

7. Can use standard Bell 202, as well as Bell 113 or RTTY audio FSK tones.

8. Provides Single-Frequency (SF) tone detection for supervisory signaling.

Most amateur packet radio systems make use of the International Standards Organization (ISO) High-level Data Link Control (HDLC) frame structure. DCM-1 has features and capabilities that make it ideally suited for such systems. Additionally the DM-1 can be used alone, without the Clock Module, for 'normal' asynchronous RTTY communications by modifying the frequency-determining components to work with conventional radio data systems.

What follows is a description of one half of the DCM-1 system: the Data Modem, DM-1.

Circuit Description

Refer to Fig. 1, the schematic of the DM-1. There are some notations that I have used that may require some discussion. They are:

[] denotes a connection between this circuit board and another board or interface connector.

RSx denotes a low resistance strap (e.g., a wire or 2.7 ohm resistor) for selecting an option.

S-¦X¦-S denotes an analog switch (e.g., U8a or U8b). When the control lead is more than VDD - 0.5 volts the S to S resistance is less than 1k ohms. When the control lead is less than 0.5 + VSS volts, the S to S resistance is more than 1G ohms (the PC board will have more leakage resistance than the switch).

⎍ denotes CMOS schmidt-trigger input.

■ denotes an indicator lamp tap.

! denotes an active LOW signal.

The IRTS (Interface Request to Send) lead, when fed with an EIA RS-232-C ON signal (more positive than +3.0 volts), will cause will cause U4c to go LOW and the radio transmitter to transmit. With U4c LOW both D1 and D2 are OFF allowing the two timers, U7c and U7d, to begin timing. When normal RTTY operation is used, RS6 is installed. This defeats the watchdog timer and the transmitter will remain active as long as the IRTS is HIGH. To make the watchdog timer operational, remove RS6 from the circuit.

When BRTS and U7d are LOW, D3 is ON and [Y4], the !PTT, is low, turning the transmitter ON. After a delay determined by R2, R3, and C1, CTS will go HIGH, sending ICTS (Interface Clear to Send) HIGH (RS5 should be installed), informing the terminal that it is clear to send data. If RS6 is removed, the watchdog will timeout following a delay determined by R4 and C2. This delay should be longer than the maximum required transmit time. After U7d goes high the ICTS goes low and !PTT goes HIGH, disabling the transmitter.

The transmit data are sent from the terminal to the modem on the ITXD (Interface Transmit Data) lead. RS1 or RS2 is installed, as needed, to provide the modulator with either normal or inverted data (RS1 is normally installed).

The digital data are applied to the modulator, U101 pin 9. When LOW, the frequency generated is determined by R106, R107, and C102. When HIGH, the frequency generated is determined by R104, R105, and C102. The amplitude of the audio signal output is determined by the amount of current injected into pin 3. The output will be about 60 mV rms per kilo ohm of R103. The more resistance, the greater the output voltage. R110 reduces harmonic distortion in the output signal. Purists can use a pot.

R9, R10, and C3 form an attenuator-buffer for interfacing to the transmitter's microphone circuit. In normal operation, TEST is LOW turning U8a OFF and U8b ON. The radio receiver audio is routed to the demodulator via R11, R12, and C5.

The demodulator is constructed around the EXAR XR-2211 phase-locked loop (PLL) FSK demodulator, U201. The audio is coupled from the source to U201 through C201, a dc isolation capacitor. R208 serves no purpose other than providing a mechanism for tuning the PLL. C204 and R204 are used to smooth the output from the quadrature detector. When an audio carrier is detected, the !LOCK output is a current sink to ground and LOCK is an open circuit. During no signal conditions, the outputs are in their complement state.

!LOCK, with U5b, informs the terminal when a

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data signal is being received. IDCD (Interface Data Carrier Detect) goes HIGH when receiving a data carrier from the radio.

R5 and U7c convert the 0-12 volt demodulator's data signal to 0-5 volts. When the CM is connected, neither RS3 or RS4 are included in the circuit. RS3 or RS4 are used to select either normal or inverted receive data (RS4 is installed normally). U5a converts the data to EIA voltage levels. U5d and U11a are used only when the CM is attached and will not be discussed further in this article. All the [Zx]s denote connections to the CM, if included; otherwise they are NO CONNECTIONs.

A 567 PLL single-tone decoder, U501, is used for the SF tone detector. C501, R501, D501, D502, and C502 process the radio audio going to the decoder. The diodes (which are GERMANIUM) limit the voltage to the chip to about 600 mV pk-pk. C504 and C503 are used for the PLL low pass filter and quadrature detector, respectively. R502, R503, and C505 set the PLL's free run frequency. R504 pulls up the open collector output of U501. When the decoder output is high, D6 is ON, and C12 is charged, U7f is LOW, U6d is HIGH, and U11b is LOW (inactive). When a tone is detected, the output of the chip goes LOW and D6 is OFF. C12 discharges though R13. If the output of the chip stays low and does not 'bounce', eventually C12 will discharge enough through R13 to cause U7f to go HIGH; the result of this will cause U11b to go high, indicating to the terminal equipment that a special condition has occurred. (This special condition might signal the terminal equipment to execute a 'hardware' reset.)

Construction

With low-frequency circuits, almost any construction technique will work well. The breadboard was constructed on phenolic perforated board using wire-wrap sockets for the ICs, and T44 pins for the discrete components. By the time this article is published a pc board should be available; see the appendix. Modulator and demodulator frequency and timing components should be selected from Tables 1 and 2. Only the 1200/2200 Hz at 1200 b/s values listed in the tables have been tested. None of the other values has been tested; they were determined by calculation.

Testing and Adjustments

CTS timer - Place a 1-Hz bipolar squarewave signal on the IRTS lead (use +- 5 volts). Watch the BCTS lead with a scope and adjust the LOW to HIGH delay via R2 as needed to provide enough time for the transmitter to come to full power and to synchronize any clocks in the system before CTS goes HIGH. Remove the 1-Hz signal from IRTS.

Watchdog timer - No adjustment should be required. If the watchdog times out too soon, increase the value of C2.

Modulator - With a counter, measure the frequency of the signal at MAUDIO. Set R103 such that the counter displays a stable indication. Apply either positive or negative 5 volts to ITXD to cause TXMDATA to go low. Adjust the modulator to the Mark frequency with either R105 or R107 (only one will have effect). Toggle the polarity of the voltage on ITXD and adjust the other pot for the Space frequency. Adjust R103 to provide about 2 volts peak to peak on MAUDIO. Remove the signal from ITXD.

Demodulator - This procedure assumes that the modulator has been tuned correctly. Connect a 600 Hz, 0 to +5 volt, squarewave signal to ITXD; connect Z11 to +5 volts; connect a scope to TP201 (U201 pin 10). Make sure to use a high impedance scope probe for these measurements. Set the scope to 2 volts per division dc and adjust the vertical position control such that the trace is at the baseline of the scope. Move the probe to TP202 (U201 pin 8) without upsetting the scope's vertical position control. Next, adjust R203 so that the signal at TP202 peaks just as much above the reference as it does below the reference voltage. R203 will have the effect of a "centering" control. Remove the signal on ITXD and the probe from the test points. With the voltage at TP202 centered, the demodulator is tuned up.

SF detector - Short out D502 and connect a frequency counter, via a high impedance probe, to TP501. Adjust R503 so the counter reads the same value as the SF tone required. (I use 697 Hz; that is easily generated from a DTMF tone generator.) Remove the probe and the short.

The values of R9, R10, R11, and R12 will vary from radio to radio. The values listed should work for most of the modern vhf fm transceivers on the market. If you need to juggle the values, leave R10 and R11 at their nominal values and adjust R9 and R12 to provide the proper amplitude signal.

The DM-1 is now tuned up and ready to go. No other adjustments should be needed.

Operation

Operation is straight-forward. Fig. 2 shows how to hook your EIA RS-232-C compatible terminal to the DM-1. Apply the power to the terminal and the DM-1. All lamps should be OFF. Have the terminal set RTS HIGH (if it isn't already); the RTS lamp should light, the transmitter should transmit, and the CTS lamp should light after a small delay. Keys typed on the terminal should modulate the transmitter and flash the TXD lamp. Drop the RTS and the transmitter should go off the air. When fsk tones are received by the radio, the DCD lamp should light; when the tones carry data, characters should print on the terminal as well as flash the RXD lamp.

Some Comments on Performance

As with most high-speed data modems, DCM-1 requires a quiet, flat audio spectrum bandwidth for good performance. Some amateurs who have used Bell 202 modems with radios have found it necessary to use an audio hi-fi equalizer in the audio circuits of their radios for the modems to work properly (ref.). This is not surprising.

Consider the audio processing that takes place from microphone to speaker in an amateur radio vhf set. The transmit audio is pre-emphasized via an R-C filter. Next, if the typical reactance modulator is used, the signal passes through a stage of integration before modulation. At the receiver, the signal is detected along with some not-so-white noise, then de-emphasized, and finally amplified to drive a speaker. The result of this audio processing is rarely perfect. The integrator reactance-modulator combination rarely yields perfect fm, and the pre-emphasis processing usually does not closely track de-emphasis processing. One result of these mismatches is that not all audio frequencies reaching the speaker are of the same amplitude, even though the tones sent to the transmitter were the same amplitude. Additionally, these amplitude variations as a function of frequency will vary whenever a different transmitter or receiver is used. All these factors make broadcast networks difficult to implement.

One test of this modem consisted of modulating a Kenwood TR-2400 with 1200-Hz and 2200-Hz tones of the same amplitude and detecting the signals with a Yaesu FT-227RA. The difference in speaker audio for these two different tones was greater than 6 dB, with 2200 Hz being the more poorly received signal. Again, all the above complications point to the requirement that good quality radios be used. (Good is a relative term. For example, I can't get 2200-Hz audio through my Motorola HT-220; the radio simply filters it out. Although not hi-fi, the HT-220 is considered to be a 'good' radio; however, it is not a 'good' radio for the purposes of data communications.)

The net result of these variations is that more experimentation using high speed fsk modems on radio channels must be done before any solid performance data can be reported. I am interested in hearing from others about their experiences using high-speed modems over radio.

Conclusion

DM-1 provides an interface between a data terminal and amateur radio. When combined with CM-1 it becomes a full-featured radio modem. Questions or problems concerning DM-1 are invited. Please include an s.a.s.e. if a reply is required.

Reference

Private conversation with Steve Robinson, W2FPY, December 3, 1981.

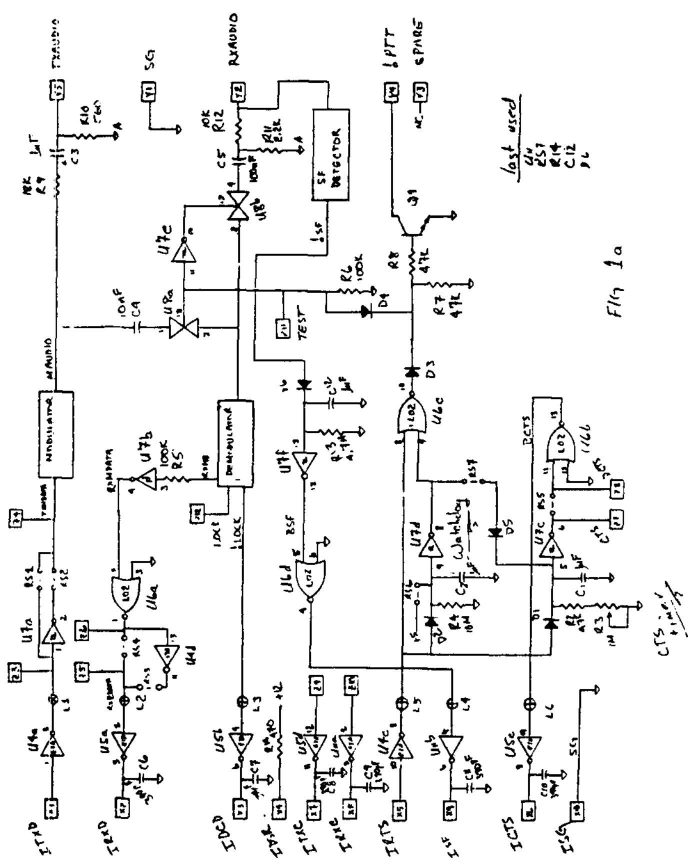


Fig 1a

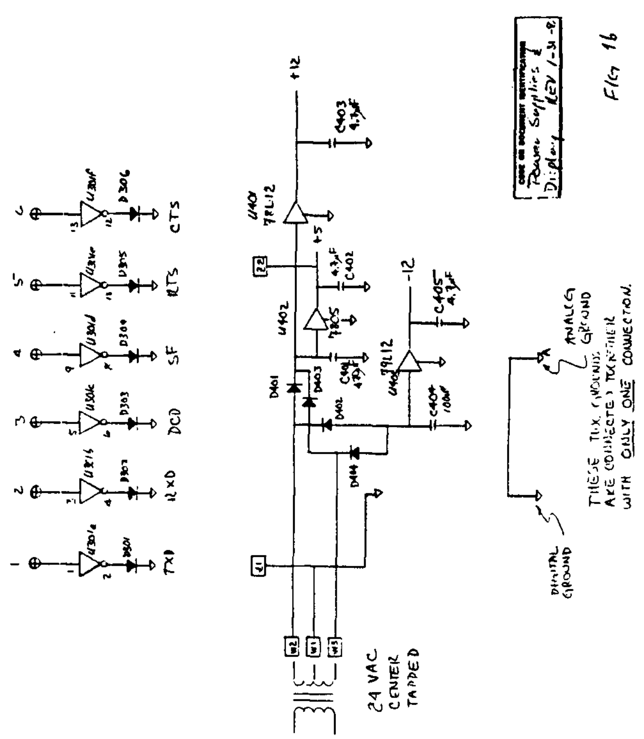
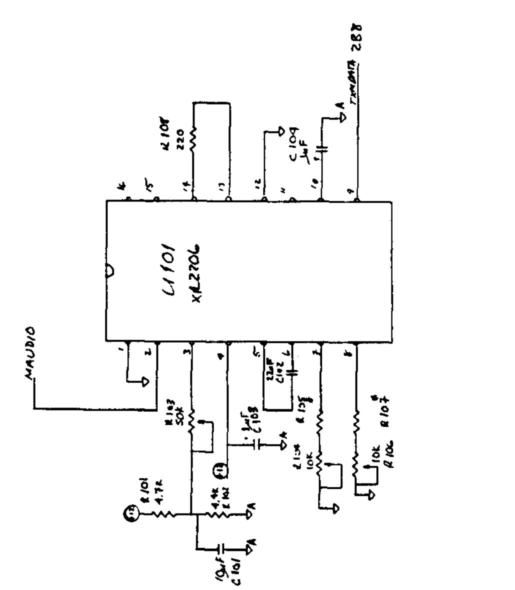
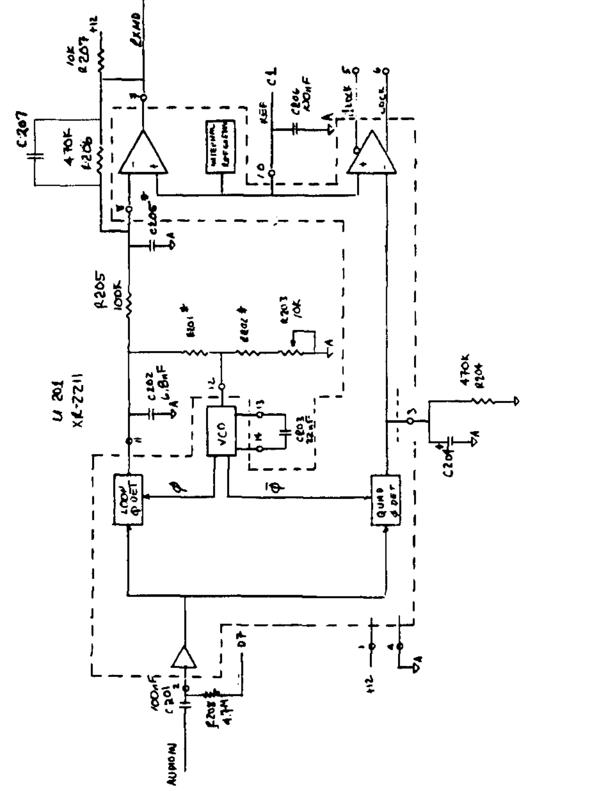


Fig 1b



* see table 1 for values

Fig 1c



* see table 1 for values

Fig 1d

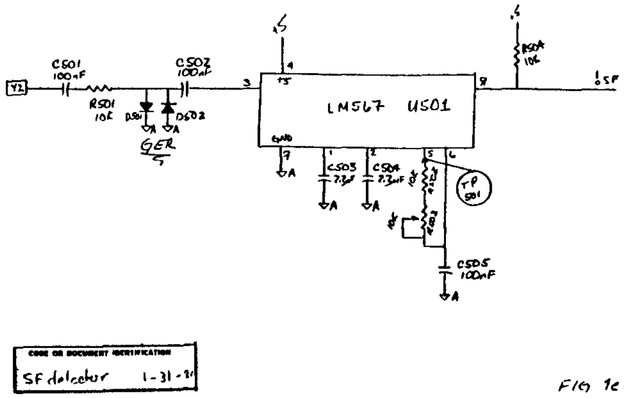


FIG 1e

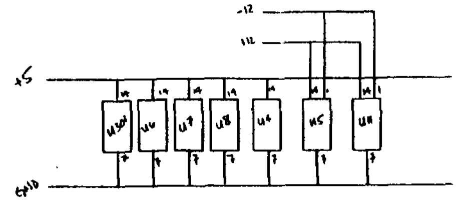


FIG 1f

Table 1: Modem Components vs Frequency					
Frequency Pair	Modulator R105	R107	Demodulator R201	R202	C204
1200/2200	33K	15K	47K	22K	100nF
1070/1270	39K	33K	150K	22K	470nF
2025/2225	18K	15K	220K	15K	470nF
2125/2295	15K	15K	270K	15K	470nF
2125/2975	15K	10K	56K	12K	100nF
1615/1785	22K	22K	270K	22K	470nF

Table 2: Modem Components vs Signaling Speed		
speed (bauds)	C205	C207
50	47nF	10nF
125	22nF	4.7nF
300	10nF	2.2nF
1200	2.2nF	470pF

Appendix

Parts may be obtained from the following sources:

Jameco Electronics	1355 Shoreway Road, Belmost, CA 94002 415-592-8097
Digi-Key Electronics	P.O. Box 677 Thief River Falls, MN 56701 800-346-5144
Jade Computer Products	4901 West Rosecrans Ave. Hawthorne, CA 90250 800-426-2668

Printed circuit boards are available from:

Jim Rhodes	1025 Ransome Lane Kingsport, TN 37660

DM-1 Parts List

Resistors (1/4-watt, carbon 10%)

R1	not used
R105, R107, R201, R202	as required
R108	220
R10	560
R11	2.2k
R101, R102	4.7k
R12, R207, R501, R502, R504	10k
R9	18k
R2, R7, R8	47k
R5, R5, R205	100k
R204, R206	470k
R13, R208	4.7M
R4	10M
R104, R106, R203, R503	10k pot
R103	50k pot
R3	1M pot

Capacitors (16 wVdc unless otherwise noted)

C204	as required
C6, C7, C8, C9, C10, C11	390pF disc
C202	6.8nF Mylar
C4	10nF disc
C102, C203	22nF Mylar
C5, C201, C206, C501, C502	100nF disc
C505	100nF Mylar
C1, C2, C3, C12, C103, C104	1uF tant or elec
C503, C504	2.2uF tant or elec
C402, C403, C405	4.7uF tant or elec
C101	10uF elec
C404	100uF elec, 25wVdc
C401	470uF elec, 25wVdc

Diodes

D501	1N34A
D1, D2, D3, D4, D5, D6	1N4148
D401, D402, D403, D404	1N4002
D301, D302, D303, D304, D305, D306	LED, gen. purpose

Integrated Circuits

U6	74L02
U301	74L04
U8	CD4016
U4	DS1489
U5, U11	DS1488
U401	LM78L12
U402	LM7805
U403	LM79L05
U7	MM74C14
U201	XR-2211
U101	XR-2206
U501	LM561

Transistors

Q1	2N6725 (darlington)

Connectors

X, Y, Z	16-pin DIP sockets or other

Pi-Network and Coil Design Made Easy with the TRS-80 Pocket Computer

by Malcolm Houghton,* W9MKY

Do you shy away from designing resonant rf circuits because of the complexity of the calculations? Would you like to extend the range of that faithful old linear amplifier to 160 meters but hate to depend on weeks of cut-and-try to find the proper coil size? Have you worn out your handbook by referring to the matching-network tables that never quite fit your application? If the answer to any of these questions is "yes," read on.

Here is a lazy man's approach to designing pi networks and air-core, solenoid-wound coils. If you have access to a TRS-80 (tm Tandy Corp.) type pocket computer you can load in this program and sit back while the computer does the work. In fact, if you can beg, borrow or steal the accessory hard-copy printer you won't even have to lift a pencil. The circuit components will be neatly printed out and labeled on paper tape.

As an example, suppose that you are building a new hf linear. Let's assume that you have determined tube plate voltage and power input and are ready to design the tank circuit. With this program in your computer simply enter RUN with the keyboard. The LCD display will first ask for power input, then plate voltage, desired output resistance (usually 50 ohms), the frequency, and finally the loaded Q (12 is a good number). Enter each of these inputs on the keyboard as it is requested. Then sit back while the computer prints out the pi network input and output capacitances and tank inductance. If you will then tell it what coil diameter you want to use and what length coil you can fit into the cabinet, it will also print out the correct number of turns of wire or tubing and the turns per inch. Or if you input the turns per inch that you plan to use, it will reply with the number of turns and the coil length. The only thing that it will not do is tell you what type or size conductor to use for the winding.

Typical Applications

This program interweaves several sub-programs to combine maximum versatility with minimum fuss and bother. This is achieved by starting your run with the RUN command best suited to your application. Six initial commands with typical applications follow:

(1) RUN: With the initial command RUN, the run starts by requesting input power and plate voltage for a tube-type amplifier. It yields the capacitance and inductance values for a pi-type output network. It also will calculate and print out the physical coil winding specifications.

(2) RUN 15: If you have completed a run as described in (1) above and need data for additional frequencies, entering RUN 15 will retain your initial input data while cranking out specs for each new frequency. This can be repeated as often as desired to achieve a continuous multi-band printout. Fig. 1A illustrates a printout resulting from an initial RUN command followed by RUN 15 after the first coil is completed.

*914 Criglas Rd, Wales, WI 53183.

(3) RUN 10: If you have need for a pi network which must match a given input resistance to a given output resistance, start with RUN 10. Electrical and physical specs will print out as in Fig. 1B. Here again RUN 15 was used for proceeding to the second frequency.

(4) RUN 100: If you already know what inductance a coil is to have but need the winding specs, make RUN 100 your initial command.

(5) RUN 200: When you have an existing coil and need to know its inductance, enter RUN 200 and then input the diameter, length and turns per inch. The computer will calculate and print out the inductance in microhenries.

(6) RUN 300: To replace an existing coil with one having new dimensions, start by entering RUN 300. The computer will calculate the inductance of the old coil and then compute the specs for a new one -- wound to your new dimensions but having the same inductance. A printout of this application is shown in Fig. 1C.

Important Note: There is no Greek alphabet on the pocket printer so the printout uses "MH" to designate "microhenries." Hence the values of inductance labeled MH are microhenry values.

This program demands one bit of input information in **exact** form. When the computer displays the prompt "LNTH or TPI?" you must enter either LNTH or TPI. Do **not** spell out length or turns per inch but respond with the exact abbreviated form used in the prompt.

Fig. 2 shows the complete program, ready to enter via your pocket computer keyboard.

Theory

There is really nothing in this program than cannot be found in various publications; though the information won't be in BASIC language for computer recognition. The pi-network calculations are based on relationships given in the twenty-first edition of "Radio Handbook" by William Orr. The component values derived from plate input power and voltage (initial command RUN) are not quite as accurate as those obtained using the plate load resistance determined from tube curves (together with the initial command RUN 10) -- but they are adequate for many purposes. The coil winding calculations depend on Wheeler's formula which is claimed to be accurate within one percent for any coil having a length-to-diameter ratio of 1/3 or greater. This covers most common applications with more-than-adequate accuracy.

It should be noted that Wheeler's formula assumes radius or diameter measurements to the **center of the wire** making up the coil. While the diameter of the coil **form** is generally close enough to this, a small-diameter coil made of large tubing calls for the diameter measurement from tubing center to tubing center.

The various statements of this program are not necessarily in the best possible format for maximum speed of operation. The longest pause in operation, however, does not exceed a couple of seconds.

Some of the printout data is restricted to either three or five digits followed by one decimal. This was done to achieve a uniform printed format on the rather narrow paper tape. Six or more decimal places can be printed by removing the USING statements from the program. Or, you can query the computer for any of the variables and see the complete value on the LCD display. See Fig. 3 for the storage location of each variable. It might be noted that the decimal values shown on the printout are rounded down. That is, all subsequent decimals are simply dropped. It isn't too often, however, that coil specs accurate to even 1/10th turn are required.

Another point to note: This printout format allows enough digits for any capacitor values apt to be encountered in routine amateur applications. Very-high-Q or very-low-frequency circuits, however, might require capacitor printouts in excess of 99999.9 pF. In such a case some of the USING instructions of the program would have to be modified to avoid a hangup.

The units used in this program are watts, volts, amperes, ohms, picofarads, microhenries, megahertz, inches and turns per inch. This is true of both printout values and those that you enter in response to the prompting displays.

The program, as printed out by the accessory printer, appears in its entirety in Fig. 2. With the program loaded, the pocket computer still has roon for 207 additional program steps -- ample for a number of program additions or modifications. The existing program can be tightened up in numerous ways, though, to make more steps available should that be desired.

A number of runs using this program have been compared to the tables appearing in handbooks such as "The (ARRL) Radio Amateur's Handbook" and the "Radio Handbook," with acceptable correlation. Coil construction, followed by inductance measurement, has also verified the coil winding calculations of the program. If any reader sees fit to use (or improve upon) the program presented in this article I would be interested in their reaction, via either QSO or correspondence.

```
  1:REM *W9MKY-π
    NET-COIL-DES
    IGN-PROGRAM*
  5:CLEAR :USING
    :INPUT "P IN
    (WATTS) = ";
    V:PRINT "P I
    N = ";V;" W"
  6:INPUT "EB =
    ";S:PRINT "E
    B   = ";S;"
    V"
  7:T=V/S:USING
    "###.#":
    PRINT "IB
    = ";T;" A"
  8:B=S/(1.8*T):
    GOTO 14
 10:REM πNET-FRO
    M-RIN-AND-RO
    UT
 11:CLEAR :USING
    :INPUT "R IN
     = ";B:PRINT
    "R IN = ";B;
    " OHM"
 14:INPUT "R OUT
     ";A:PRINT "
    R OUT= ";A;"
     OHM":PRINT
    " "
 15:USING :INPUT
    "FREQ(MC) =
    ";C:PRINT "F
    REQ = ";C;"
    MHZ"
 16:INPUT "Q = "
    ;D:USING "##
    ###.#":PRINT
    "Q    =";D
 20:E=B/D
 25:F=A*(D*D+1)-
    B
 26:G=(-A)*√(B/F
    )
 30:H=A*A*G
 31:I=A*A+G*G
 35:J=(B/D)-(H/I
    )
 40:K=(1/(2*π*C*
    E))*1000000
 41:L=(-1/(2*π*C
    *G))*1000000
 42:M=(J/(2*π*C)
    )
 50:PRINT "C IN
    =";K;" PF"
 51:PRINT "C OUT
    =";L;" PF"
 52:PRINT "L
    =";M;" MH"
 53:GOTO 110
100:REM COIL-SPE
    CS-FROM-L,DI
    A,TPI,OR-LEN
    GTH
102:CLEAR :USING
    "####.#"
105:INPUT "INDUC
    T(MIC H)= ";
    M:PRINT "L
     =";M;" MH"
110:INPUT "COIL
    DIA = ";N:
    PRINT "COIL
    SPECS":PRINT
    "DIA  =";N;"
     IN"
120:INPUT "LNTH
    OR TPI ? ";U
    $
125:IF U$="LNTH"
    THEN 150
130:INPUT "TPI =
     ";R
135:X=5*M+√(25*M
    *M+(9/8)*N*N
    *N*R*R*M)
136:Y=.25*N*N*R*
    R:O=X/Y:GOTO
    160
150:INPUT "LENGT
    H = ";O
160:P=M*((18*N+4
    0*O)/(N*N)
165:Q=√P
170:PRINT "LNTH
    =";O;" IN"
180:PRINT "TURNS
    =";Q
182:IF U$="LNTH"
    LET R=Q/O
185:PRINT "TPI
    =";R
190:PRINT " ":
    END
200:REM L-FROM-C
    OIL-SPECS
201:CLEAR
205:USING "####.
    #"
210:INPUT "COIL
    DIA = ";N:
    PRINT "DIA
    =";N;" N"
220:INPUT "COIL
    LENGTH = ";O
    :PRINT "LNTH
     =";O;" IN"
230:INPUT "NO TU
    RNS = ";Q:
    PRINT "TURNS
    =";Q
240:M=(.25*(N*N*
    Q*Q)/(4.5*N+
    10*O)
250:PRINT "L
    =";M;" MH":
    PRINT " "
260:IF Z=1PRINT
    "NEW":N=0,O=
    0,Q=0:GOTO 1
    10
265:END
300:REM NEW COIL
    -FROM-OLD
301:Z=1:PRINT "O
    LD":GOTO 205
```

Fig. 2 - The complete program as printed out by the pocket computer.

A

```
P IN = 1500. W
EB   = 2500. V
IB   =    0.6 A
R OUT=  50.0 OHM

FREQ = 3.9 MHZ
Q    =    12.0
C IN =   211.5 PF
C OUT=  1191.7 PF
L    =     8.8 MH
COIL SPECS
DIA  =     2.0 IN
LNTH =     3.1 IN
TURNS=    18.9
TPI  =     6.0

FREQ = 7.2 MHZ
Q    =    12.0
C IN =   114.5 PF
C OUT=   645.5 PF
L    =     4.7 MH
COIL SPECS
DIA  =     2.0 IN
LNTH =     1.9 IN
TURNS=    11.6
TPI  =     6.0
```

B

```
R IN = 50. OHM
R OUT= 120. OHM

FREQ = 3.9 MHZ
Q    =     1.5
C IN =  1224.2 PF
C OUT=   886.8 PF
L    =     2.9 MH
COIL SPECS
DIA  =     0.7 IN
LNTH =     1.7 IN
TURNS=    21.1
TPI  =    12.0

FREQ = 7.2 MHZ
Q    =     1.5
C IN =   663.1 PF
C OUT=   480.3 PF
L    =     1.6 MH
COIL SPECS
DIA  =     0.7 IN
LNTH =     1.1 IN
TURNS=    14.0
TPI  =    12.0
```

C

```
OLD
DIA  =     1.7 IN
LNTH =     4.5 IN
TURNS=    31.0
L    =    13.1 MH

NEW
COIL SPECS
DIA  =     2.5 IN
LNTH =     3.1 IN
TURNS=    19.0
TPI  =     6.0
```

Fig. 1 - Typical printouts. 1A is for a linear-amplifier output network, 1B for a grounded-grid, tuned-input circuit. 1C is a conversion from an existing coil to a new coil having different dimensions. Note that MH designates microhenries.

STORAGE LOCATION	VARIABLE
A	OUTPUT RESISTANCE, OHMS
B	INPUT RESISTANCE, OHMS
C	FREQUENCY, MEGACYCLES
D	LOADED CIRCUIT Q
E	✓
F	✓
G	✓
H	✓
I	✓
J	✓
K	INPUT CAPACITANCE, PICOFARADS
L	OUTPUT CAPACITANCE, PICOFARADS
M	INDUCTANCE, MICROHENRIES
N	COIL DIAMETER, INCHES
O	COIL LENGTH, INCHES
P	✓
Q	NUMBER OF TURNS
R	TURNS PER INCH
S	PLATE VOLTAGE EB, VOLTS
T	PLATE CURRENT IB, AMPERES
U$	TURNS PER INCH OR LENGTH SELECTION
V	POWER INPUT, WATTS
W	
X	✓
Y	✓
Z	✓

Fig. 3 - Variables used in the program listed by storage location.

Pc Board Standard Can Speed Experiments

By Eric J. Grabowski,* WA8HEB

The advent of MSI and LSI integrated circuits has certainly reduced the amount of real estate necessary to achieve complex hardware functions. Even so, there is still a need to support these devices with discrete components, i.e., capacitors, resistors, etc.

One popular way of doing this is with a printed-circuit (pc) board. Not only does this result in a neat and tidy method of interconnecting all the components, but it also assures that the circuit can be reproduced by others with excellent repeatability.

Unfortunately, many homebrew projects require a collection of irregularly shaped pc boards mounted as best they can be in an over-sized enclosure — not exactly a showpiece.

There is no reason why homebrew equipment cannot have the attractive appearance of their commercial counterparts. With this goal in mind, the rest of this article describes a standard, which I developed several years ago, to reduce the time required to design functional modules which can be interconnected to form a new piece of equipment that looks "commercial" both inside as well as outside.

By sharing my success with the readers of QEX, I hope that several of you will agree with my point of view and design your future projects to the defacto standard presented. Doing so would allow us hardware-oriented types to spend our valuable time designing avant-garde modular subassemblies which could be added to the family of ready-to-use functional modules.

I will take advantage of my literary license and proclaim that this be henceforth known as the Hardware Application Module Standard or more simply by the acronym HAM Standard. I think that you will agree that this is only fair considering that the software types have BASIC, etc.

Background

The need for a standard way of producing hardware surfaced in the early 1970s. For it was then that I wanted to evaluate many of the newly introduced linear integrated circuits.

It seemed obvious that the plan of attack should focus on designing functional subassemblies, i.e., receiver front-ends, intermediate-frequency amplifiers, detectors, audio-output modules, etc. Thus, a new detector, for example, could be evaluated by simply removing the previously designed one, inserting the new prototype and making a few connections. That seemed relatively straightforward, but it's also when the going got tough.

An untold number of lunchtimes, evenings and weekends were spent searching vendor catalogs for plug-in boards, connector sets, bus configurations and backplane wiring schemes. None appeared to be suitable either because of complexity or expense. In the tube era, the solution would have been easy -- the RETMA 19-inch relay rack.

It was then that inspiration struck. I recalled reading an article published in one of the amateur magazines describing the half-panel method (9.5- vs. 19-inch panel width). Unfortunately, I don't recall either the magazine or the author. The half-panel approach would yield a reasonably sized piece of equipment for a modern-day, solid-state transmitter or the like, but still seemed a bit large for the task at hand.

Inspiration struck again. What if the pc board were made a width equal to about one-quarter panel? The, two could be placed side by side and fit in a half panel, or four in a full panel.

In less than a weekend, a proposed standard was drafted. If one dimension of the pc board were held constant, the idea should work.

HAM Standard

Fig. 1 illustrates the principle and gives all pertinent dimensions. The width of each board is fixed at 3.6 inches. For mounting purposes, 0.3 inch is left copper free at the top and bottom (referred to as Zone A). Mounting holes which clear 4-40 machine screws are drilled in these areas on 0.5-inch centers.

Since some circuits require more real estate than others, the length of the board is a variable (labeled L). In practice, L can be any multiple of 0.5 inch from 0.5 to a maximum of 8.0 inches.

Zone B is the area available for the printed circuit. It has a constant width of 3.0 inches and may be as long as L. Experience has proven that it is wise to place a ground ring around the perimeter of Zone B for isolation. I use a 0.050-inch border in my projects.

No connectors are used for inter-board connections. After designing the first few projects, it became apparent that none was necessary and in fact were an added burden on pc artwork design. Instead, all board terminations are made at pc pads drilled to accommodate number 22-AWG hook-up wire. This greatly simplifies the artwork since the holes can be placed at a convenient location on the board rather than routing traces clear across the board to reach a connector.

Fig. 2 shows how the boards are mounted side by side. Any reasonable number can be positioned to complete the project at hand. Each board is mounted to the chassis or enclosure with threaded spacers. This is where the benefit of using a standard spacing for mounting holes becomes apparent. The order of boards can be switched, or new boards added between existing ones, without much reworking. In fact, boards can even be stacked if necessary by using additional threaded spacers.

Final Remarks

Perhaps the RETMA system of yesteryear has provided the basis for standardization in today's hardware development.

I have used the method just described over the past several years with great success. By dividing a large project into separate, functional subassemblies, development proceeds much faster. It usually takes less than a weekend to design a new subassembly.

I was able to evaluate nearly 100 different subassemblies and build quite a library of functional modules in just a few years. Many have been reproduced by others with instant success. Some have even been published in Amateur Radio magazines, for example:

"The Audiobox - An Amplifier with a Twist," QST, August 1978.

"Trouble-Free ID Timer," 73, February 1980.

*17020 Snyder Rd, Chagrin Falls, OH 44022, home phone 216-543-9313 after 1900 EST & weekends.

"A Versatile, Variable Active Filter," 73, December 1979.

If you happen to have one of these issues, you can see what actual boards look like.

Incidentally, throughout this development period, I also found that a standard for pc artwork cut down development time and reduced expense as well. Also, I came upon a way of making very inexpensive enclosures for complete projects at a fraction of the cost of commercial ones — need I mention that they look every bit as attractive too?

If you would like to explore some of my other techniques, I invite you to drop a line to the editor of QEX or myself and let your opinion be known. Every now and then I have a free weekend, so if you have an idea for a new subassembly send it along. I am always interested in fresh ideas.

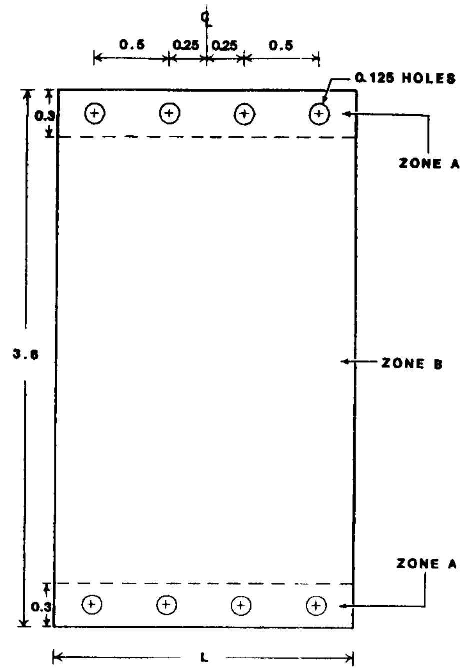


Fig. 1 - Specification drawing for HAM Standard pc boards. All dimensions are in inches. Zone A is a copper-free area for mounting holes. Zone B is available for printed wiring. See text for discussion regarding L.

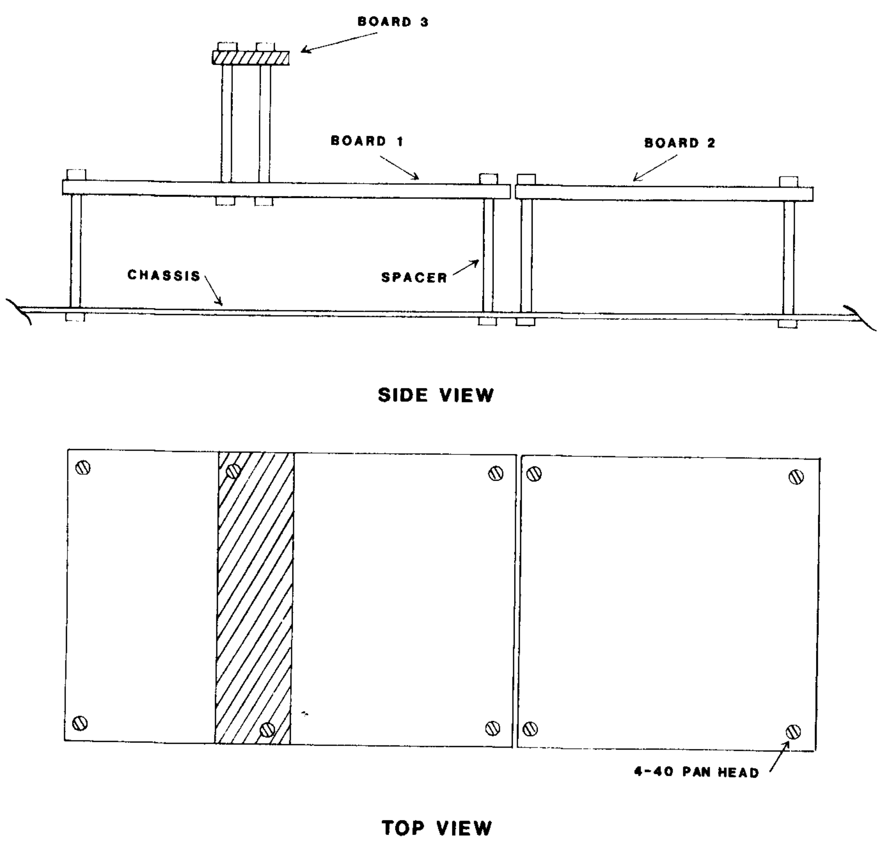


Fig. 2 - Boards comprising a project are placed side by side to minimize interconnecting- wire lengths. When necessary, boards may be stacked. Threaded spacers are used to support the boards above a chassis.

Components

Conducted by Mark Forbes, KC9C*

This month's column covers a variety of new components from nonvolatile memory to DTMF generators.

Xicor NOVRAM

A relatively new company in Milpitas, CA has introduced a very exciting line of nonvolatile random-access memories. The NOVRAM, as Xicor calls it has also been billed as a "Shadow RAM." The NOVRAM is actually a standard RAM with an EEPROM on the same chip. For normal operation only the RAM portion of the part is used which has access times of 300 ns. When desired, such as before a power failure, the entire contents of the RAM can be stored in the EEPROM. The storage of data is accomplished by a high-level signal on one pin and requires about 10 ms per kilobit of data. The data stored in EEPROM will now remain there, regardless of whether power is applied to the chip, until it is written over by another "STORE" pulse. To recover data from the EEPROM, an "ARRAY RECALL" pulse is applied to the chip. This action consumes about 1 to 1.5 ms and writes the entire contents of the EEPROM into the RAM. The NOVRAM is specified at typically 5000 store cycles and unlimited recall cycles.

Xicor currently markets three versions of the NOVRAM. The X2201 was the first product offered. The X2201 is organized in a 1024 x 1 architecture. The 2201 is housed in an 18-pin DIP and costs around $10.00 each. The X2210 is intended for small nonvolatile applications and is organized as 64 x 4 bits. It is also in an 18-pin DIP and is priced similarly. The final member of the NOVRAM family is the X2212. Also a 1k bit part, it is layed out in a 256 x 4 pattern. Again, it is in an 18-pin DIP cna comparably priced.

The Xicor parts have a second source in MEM Corp., Marin, Switzerland. This is the location where the founders of Xicor developed the NOVRAM and then brought it to the USA.

By the way, I have saved the best for last — the NOVRAM family is a 5-volt-ONLY part making it the easiest of any EEPROM or EAROM to use. For data sheets and parts write to: Xicor, Inc., 851 Buckeye Court, Milpitas, CA 95035.

Intersil CMOS Programmable Regulators

Intersil has recently introduced two micropower CMOS voltage regulators. The parts, ICL7663 and ICL7664, draw less than 4 uA, making them ideal for battery-powered circuits. The '63 is a positive, and the '64 is a negative regulator. The regulators can be programmed to obtain output voltages of 1.3 to 16 Vdc, with output currents up to 40 mA. The device also features very low input-output voltage differential and short-circuit protection. Data can be obtained from: Intersil, Inc., 10710 N. Tantau Avenue, Cupertino, CA 95041.

RCA CD22859 DTMF Generator

Many of the DTMF generators I have seen in use by hams use the Motorola MC14410 DTMF generator. In addition to being difficult to use (it requires external mixing of high and low tones) it is relatively expensive (list price is more than $10.00. RCA has introduced a COS/MOS (RCA's CMOS) DTMF generator. This part is very easy to use, inputs are the row and column address, and the output is a single pin referenced to ground which has both tones premixed. Like most telecommunications parts, the RCA CD22859 uses a 3.579545-MHz color-burst crystal as a frequency reference. The supply voltage for the part can be derived from the phone line or can be a regulated dc supply of 2.5 to 10 volts. The price of the CD22859, in single quantity, is only $3.95. For more information, contact: RCA Solid State Division, Box 3200, Somerville, NJ 08876.

AEG-Telefunken Vhf Front End

AEG-Telefunken has introduced what they claim is "the only commercially available monolithically integrated vhf front end IC that can operate to 250 MHz." Included in the IC is an rf amplifier, double mixer and voltage-regulating circuitry.

The on-board local oscillator can have a fixed- or mask-programmable gain. Typical buffer output is 150 mV. The operating voltage of the TDA10625 is 9 to 15 volts, and it draws about 30 mA. Typical power gain is 30 dB. The price of the 16-pin DIP is about $3.00. By the way, the literature in which I saw this chip listed the part number as TDA10625, but the photograph of the part showed TDA1062 printed on the package. You may want to ask for data on both parts to avoid confusion. Data is available at: AEG-Telefunken Corp., Rte 22 and Orr Drive, Sommerville, NJ 08876, 201-722-9800.

Distributors

I would like to mention that if anyone has difficulty finding parts or data listed in this column, please drop me a line (s.a.s.e. please). Several distributors in my area have agreed to sell single pieces to experimenters.

*1000 Shenandoah Dr, Lafayette, IN 47905, 317-447-4272, 2300-0230 UTC weekdays, until 0230 weekends.

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2) document advanced technical work in the Amateur Radio field, and

3) support efforts to advance the state of the Amateur Radio art.

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