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ABOUT THE COVER

Those of you fortunate enough to have a limited-edition Wouff Hong should be aware of its utility as a floppy disk storage device. A bit of the old and the new in this year of ARRL's 75th Anniversary!

THE AMERICAN RADIO RELAY LEAGUE, INC

The American Radio Relay League, Inc, is a noncommercial association of radio amateurs, organized for the promotion of interest in Amateur Radio communication and experimentation, for the establishment of networks to provide communications in the event of disasters or other emergencies, for the advancement of the radio art and of the public welfare, for the representation of the radio amateur in legislative matters, and for the maintenance of fraternalism and a high standard of conduct.

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Purposes of *QEX*:

1) provide a medium for the exchange of ideas and information between Amateur Radio experimenters
2) document advanced technical work in the Amateur Radio field
3) support efforts to advance the state of the Amateur Radio art.

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

Both theoretical and practical technical articles are welcomed. Manuscripts should be typed and double spaced. Please use the standard ARRL abbreviations found in recent editions of *The ARRL Handbook*. Photos should be glossy, black-and-white positive prints of good definition and contrast, and should be the same size or larger than the size that is to appear in *QEX*.

Empirically Speaking. . .

Amateur Radio Education

There has been a lot said about growth recently. The supporters of an entry-level no-code license generally feel that removal of the first code hurdle will result in substantially increased numbers. In turn, that would convince the administration and those who would have our spectrum to leave Amateur Radio frequency allocations alone. The debate continues.

Leaving growth aside, let's talk about quality. Many who have addressed this aspect have talked in terms of the exam hurdle as a screening agent to let the good guys in and keep the riffraff out. Practically everyone who has ever taken an exam knows that testing is an imperfect tool to measure knowledge, much less as a prediction of human behavior. For the sake of this discussion, let's treat screening and growth questions as *givens*, and explore some aspects of quality.

However imperfect, any screening device discriminates between who is let in the door and who is not, and inevitably has some impact on quality. The hams interested in technology often advocate letting engineers in that door. Of course, there are many other professions and skills that we'd like to add to the considerable diversity we already have. It's hard to argue with the idea that Amateur Radio would be strengthened by attracting more people already possessing the qualities and abilities we need. Such newcomers would add to our capabilities not only in making important contributions to technology but also to public service in the broadest sense.

Yes, it would be nice to recruit the finest adult-born hams. But what about those with lots of potential (and not much kinetic at the moment)? To overlook them is to deny access to such people as youths and adults who haven't quite figured out what they want to do when they grow up.

It's clear that we need to give some attention to what happens to hams once they've passed their exams. Amateur Radio education has concentrated mainly on training new prospects to know what's needed to pass the Novice or Technician exams. Unfortunately, many of our training efforts stop when the exam is passed. Nevertheless, some groups prepare students for higher license classes, and there have been a number of conferences of appreciable educational value. The problem is: We need to do more to provide educational opportunities for hams to develop this rich, and potentially richer, human resource of ours.

An Amateur Radio educational program should have a number of components:

- educating the public about Amateur Radio (not just PR)
- training new prospects not only to get their tickets but to become active and productive hams
- upgrading to higher license classes
- continuing education.

Of these, the first three have received most of our attention. But the last one, continuing education, represents an opportunity for both maintenance of knowledge and skills, and enrichment. Over the years, forums and topical conferences (VHF/UHF/microwave, satellite, legal strategy and computer networking) have served the enrichment objective. We need more of these well-organized efforts to spread specialized knowledge and showcase the finest efforts of amateurs.

Tutorials are sometimes associated with professional society conferences and are designed to give attendees a crash course on a particular topic. *Workshops* are another format conducive to maintenance and enrichment, and provide an opportunity for an active dialog between workshop participants who have some knowledge of the subject matter. If they meet certain criteria, Continuing Education Units (CEUs) can be granted to participants in tutorials and workshops.

The bottom line is: We shouldn't worry only about who we let in the door, but what we would have them do once we get them. If you would like to discuss your proposed project for Amateur Radio continuing education maintenance and enrichment, please contact me at ARRL HQ. —*W4RI*

A Selective Calling Decoder for MF/HF Radio Systems

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I have been interested in selective calling (selcal) radio systems for many years. I am somewhat dismayed, in this era of good-quality data-communications systems like packet radio and AMTOR, that hams haven't yet done much work toward creating selcal systems for use on the MF/HF bands. Given that most modern Amateur Radio SSB transceivers now include a microcomputer for control of the radio, why couldn't an additional microcomputer be included for selective calling?

In modest quantities, microcomputer chips cost only a few dollars each. We all know how difficult it is to keep one ear glued to your radio's speaker, listening for someone to call you. Imagine how much simpler life would be if you could rely on a piece of hardware to do that listening for you.

This article represents a start toward correcting that problem. It outlines a simple and inexpensive decoder that can look for several selcal strings within an AMTOR FEC transmission. If it finds any of those selcals it flashes an LED and sounds an alarm. The decoder is small: It can be installed inside an SSB transceiver. It can do many other things in addition to just simple bell-ringing. For example, the received FEC text may also be outputted to a serial terminal or parallel printer. Because the unit is an AMTOR FEC decoder, I call it *FECDEC*

Several months ago, as an experiment, I thought I would see what it would take to make an inexpensive selcal decoder that worked with AMTOR FEC signals. I based my project on an old and inexpensive single-chip microcomputer, the 8749. This project has grown considerably in scope since I started it. Yet, by stripping out most of the hardware for the extra features, I can still achieve the minimal system that I was originally looking for, if that's necessary.

I have some further thoughts about a specific, but uncomplicated, transmission format based on AMTOR FEC that provides systematic selcal capabilities. I won't discuss it here, but I hope to do so in a future article.[1]

There are some system advantages to having a standardized transmission format, but FECDEC doesn't care about transmission format. It simply supplies the audible and visible warnings discussed above if it detects any of the selcal strings programmed into the device.

History of Selcal in the Marine Radio Service

The marine radio service has a lot in common with Amateur Radio. Both services are open systems where many stations, from many different nations, communicate. Unlike your local police or taxi communications systems, there is no *system controller* or *system operator* that ensures that all stations have totally compatible equipment, in either the marine or Amateur Radio services. Because of the similarities of the marine and Amateur Radio services, it is helpful to understand the histories of both, from the selcal perspective.

Some of the earliest uses of selcal systems have been in the marine radio service.[2,3] Such systems don't seem to have caught on in a significant way, however, even to this day. Probably the most common marine radio selcal system was that used by many of the Bell-operated companies on 2-MHz AM (later SSB) and VHF FM.[4] This system is called the 106A signaling system within the company. (From my days with an independent telephone company in the Pacific northwest, I knew it as the AFSK dial-pulse system.)

In the 106A system, a rotary dial was connected to an AFSK (600/1500 Hz) generator, but the AFSK generator did *not* follow the open/closed contacts dial. Instead, every dial pulse changed the frequency of the AFSK generator from one tone to the other, but not back again. It was as though the dial pulses were sent to a flip-flop that divided the number of pulses by two and the output of the flip-flop was driving the AFSK generator. Selcal numbers were usually 5 digits long, and if you added all the digits together (assuming that 0 counts as 10) they would usually add up to 23.[5]

To call an individual station, an operator would actually dial the selcal number with a 300-ms (or so) inter-digit delay (the pause between each digit). If the operator wanted to alert the whole fleet, a special circuit would send a continuous blast of 23 pulses. The mechanical decoders were constructed so that receiving 23 consecutive pulses would also trigger them.

With few exceptions, the 2-MHz systems of the telephone companies have been abandoned for VHF. Yet, the VHF systems often still include 106A signaling capability. Many of the service provider's operators don't even know they have the old AFSK dial-pulse system, although an old-time supervisor will sometimes know how to make it work. Too bad, because decoders for this format are simple to make from inexpensive CMOS chips.

So much for ancient history.

In the maritime service today, the sanctioned selcal system for MF/HF/VHF is Digital Selective Calling (DSC). DSC has been around for over a decade but it, too, hasn't caught on with equipment manufacturers or service providers. Again, too bad! As a recreational boater, I know that nothing is more useless on a Sunday afternoon than hearing one boat call another over and over again on the VHF marine-radio calling channel (156.8 MHz, channel 16). Perhaps it's only a New York phenomenon; maybe not. Recreational boaters often become so overwhelmed with the voice-call traffic on the distress and calling frequencies that they turn their radios down or even off. That doesn't help the skipper who strikes a submerged object—and needs assistance in the next 300 seconds or he is going to sink—to raise someone close to him via his radio; almost every radio is off!

The FCC has already started to get the DSC ball rolling by setting aside VHF marine channel 70 exclusively for DSC

[1]Notes appear on page 11.

communications. If all VHF marine radios were equipped with DSC selcal equipment, both user needs would be met: No voice-call monitoring would be needed, yet everyone would be capable of receiving calls addressed to their station or calls from any station in distress. Yet, as of this writing, I don't know of a single marine-radio equipment manufacturer that offers a DSC selcal unit (or a selcal unit using any other format) for its radios.

History of Selcal in the Amateur Radio Service

Hams have been pretty good about establishing group call systems on VHF for ARES, RACES, and so forth. Hams have been less quick to adopt group-call or selcal systems for MF/HF, for several reasons. The first reason was regulatory. In the ham phone bands, only voice or CW is permitted. How can we implement an effective automated selcal system in the HF phone bands using voice or CW? Remember, the key word here is *effective*.

The second reason was the frequency drift of SSB radio equipment. Before synthesized rigs became so common, crystal control was almost a must for selcal systems to operate efficiently.

The third reason was that, until recently, station identification had to be made by voice or morse code. It didn't make sense to send a selcal message at 100 bit/s and then follow it with a station ID sent via CW at 17 bit/s (20 WPM). These problems made experimenting with selcal at MF/HF impractical.

Today things are different, thanks in part to the FCC. Station ID can now be done in baudot, ASCII, AMTOR, CW or voice. In § 97.131(a)(2)(iii) of General Docket 88-139, the FCC proposes to allow transmission of incidental, tone-modulated signals in the MF/HF phone bands. [The League's proposed revision of General Docket 88-139—known as Part 96—preserves this language in its Appendix 1.—Ed] This would make it legal to operate selcal systems based on FSK in the phone bands. Also, the cost of EPROM single-chip microcomputers—probably the most efficient means of implementing a selcal decoder—has dropped to an attractively low level.

Finally, many of today's radios have synthesized frequency control. Even those that use VFOs can be placed close to the desired channel using a modulated crystal calibrator.[6] All these changes make MF/HF selcal systems more attractive than ever for hams to implement.

Selcal Emission

I chose to use AMTOR FEC for the following reasons:

- It is already approved by the FCC for use on the ham bands
- FEC takes care of modest errors in transmission
- It permits free text to be included with the selcal transmission
- It allows the selcal transmission itself to include legal station identification.

Because these criteria are already in place, I chose to use AMTOR FEC as the selcal emission. Remaining issues are the choice of narrow shift (170 Hz) versus wide shift (850 Hz) and the absolute audio tone frequencies.

On the RTTY bands, I would suggest that narrow shift be used, in keeping with the narrow-band nature of the CW/RTTY subband. On the phone bands, I might suggest that wide-shift (850 Hz) FSK transmission be used and that demodulators be "broad-banded" so that frequency offsets between transmitter and receiver would be handled with less effort. For compatibility between the low and high ends of the bands, however, it's probably best to use narrow shift exclusively.

Next, we need to consider what set of audio tones to use. This isn't a big deal in the CW/RTTY sub-band, as RTTYers know, because only the shift is important. For operation in the phone bands, however, we would like to use the same carrier frequency for reception of the selcal message as we would to receive the following voice message. In this case, we do need to worry about the audio-tone frequencies.

If everyone doesn't use the same AFSK tone frequencies, there will be a frequency-offset problem when going from the AFSK selcal emission to the phone emission. For example, consider a transmitter using 2125/2295-Hz tones and a receiver set up for 1275/1445-Hz tones. The carrier frequency of each radio would be offset so that selcal messages sent by one will be received by the other. Following the selcal message, there is an 850-Hz offset when the selcal units are switched out and the microphones and speakers for voice communications are switched in. This clearly isn't desirable.

The way to avoid that problem is to have everyone use the same audio-tone frequencies for selcal operations. For those not familiar with RTTY I should point out that, for historical reasons, hams in North America started using high tones (between 2 and 3 kHz), but those in Europe used low tones (between 1 and 2 kHz). Intercommunication using RTTY was still possible, though, because both North Americans and Europeans used the same frequency shift.

Should those in North America change to the European tones, or should the Europeans change to the North American tones? Probably neither. The commercial people solve this problem by (usually) using tones that are centered at 1700 Hz, regardless of shift. I suggest that we do the same for this selcal system. For 170-Hz shift centered at 1700 Hz, the mark tone would be 1615 Hz, and the space tone would be 1785 Hz. That's what FECDEC has been designed for. Alternative values for the demodulator are provided for those that want to use 2125/2295-Hz tones.

Selcal Format

Transmission format can be almost anything that meets the user's needs. My selcal transmissions usually look something like:

K2DR K2DR K2DR DE AD7I <RETURN>

or

K2DR K2DR K2DR DE AD7I QSX 3950 <RETURN>

This provides several copies of the selcal string, provides legal station identification of my transmission and also forwards a text message, if the receiving station is set up to handle it.

Decoder Features

Now that some selcal history is out of the way and I've discussed why I chose to use AMTOR FEC as the emission, let's talk about what the FEC decoder can do for you.

First and foremost, FECDEC can respond to any one of three user-programmable selcal strings by lighting an LED, generating an audio signal, sounding an audible buzzer and closing relay contacts to actuate an external alarm circuit. Additionally, the decoder responds to the hard-coded strings SOS, XXX and TTT (the XXX and TTT responses can be inhibited by a user-programmable flag).

The decoder can print all received text on a serial 300-bit/s ASCII terminal or on a standard parallel printer (or both at the same time). Or, the user can specify that FECDEC only output text after a valid selcal string has been detected.

The user can command FECDEC to change the programmed strings it's looking for via the serial terminal. This information can also be stored in an inexpensive 8-pin DIP EEPROM[7] that retains the selcal strings after power is removed from FECDEC. Finally, several LED indicators show the status of the received data. These indicators—TRAFFIC, IDLE, VALID and ERROR—are useful to assure proper operation of the decoder.

If you don't need all features of the decoder, many of the components can be omitted from the board for cost savings. A minimal system is shown in Fig 1.

Operation

If you'd like to receive a detailed user's manual for FECDEC, please send me an

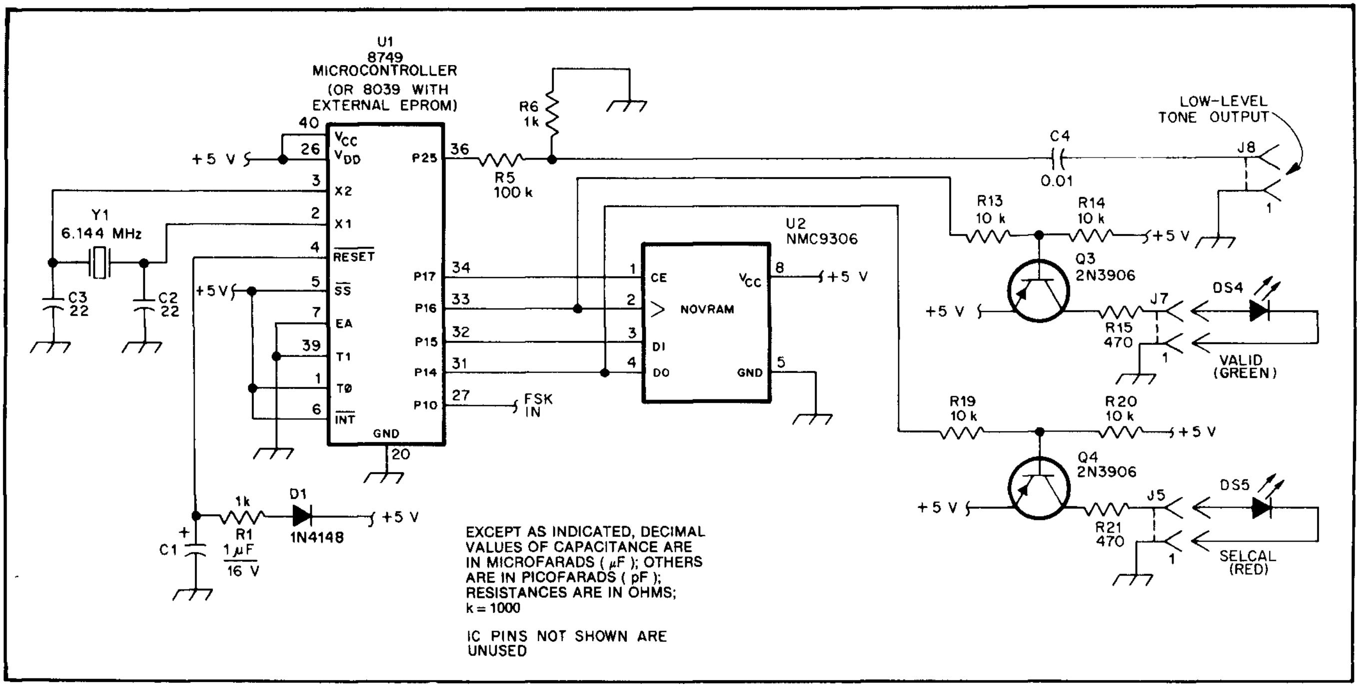


Fig 1—The AMTOR-FEC decoder, FECDEC, in its simplest form. This unit, intended for installation in an existing SSB receiver or transceiver, requires only a few connections, and has a basic selcal-warning system that can be connected into the rig's audio chain.

SASE at the address at the beginning of this article.

Internal v External Program ROM

I assume that most people who build FECDEC will opt for the 8749 with the on-board EPROM. By careful shopping, this part can be found for $10 to $12. Using an external EPROM, a latch and an 8039 (or an 8049 in external ROM mode) would save about $4, but takes more PC board space and eliminates the parallel printer port.

If you don't care about the parallel printer port and don't mind the PC board being a little bigger, feel free to get rid of the on-board EPROM and use an external one instead. To do so you only need to install the latch at U3, the programmed EPROM at U4, either an 8749, 8049 or 8039 at U1 and ensure that J1 *is not shorted*. If you want to use the EPROM internal to the 8749 (the usual case), install a shorting plug at J1. It doesn't matter if there are parts installed at U3 or U4 when J1 has the shorting plug installed.

If you want to use an external ROM at U4, be sure that J1 is open and that you have J4 strapped as described in Table 1. When using 2716 or 2732 EPROMs, be sure that pin 12 of the EPROM goes into pin 14 of the socket at U4.

Circuit Description

The circuit for FECDEC is pretty simple, although there are a few new twists for some readers. See Fig 2. An

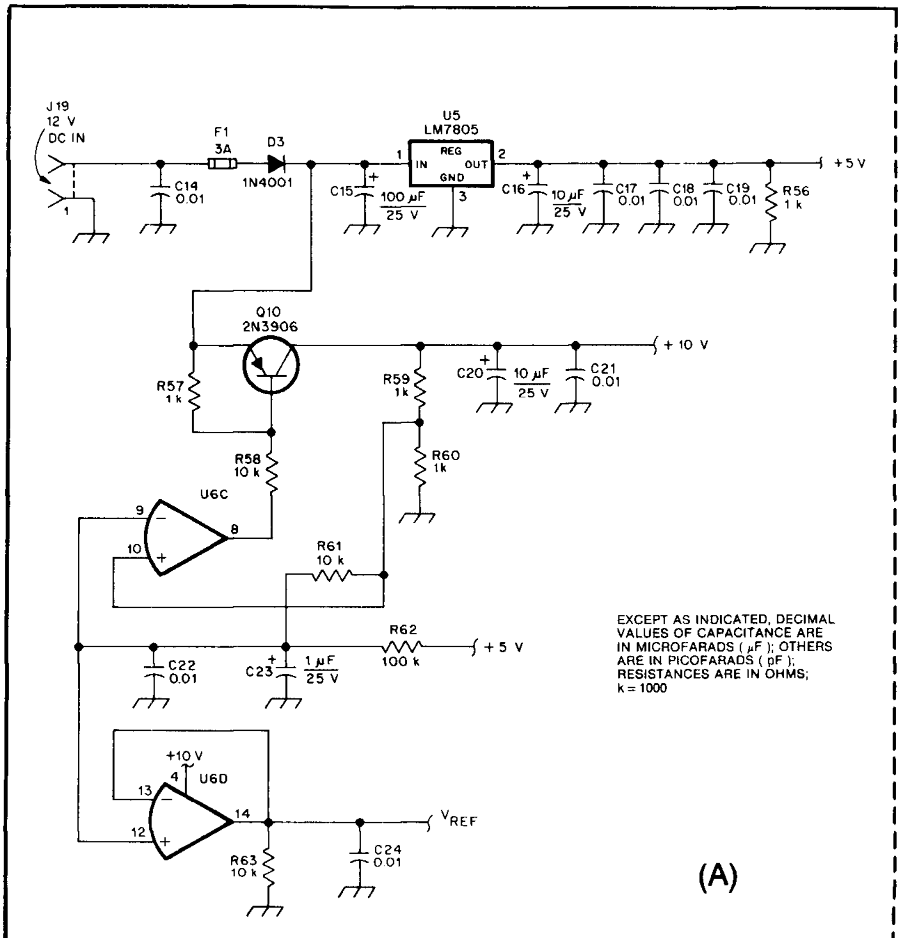


Fig 2 continued on next page.

Fig 2—A 12-V dc-powered supply for the FECDEC is shown at A. V_{REF}, developed at U6D, provides a reference voltage for the overload-detector circuit of Fig 3. Connections for a serial terminal are shown at B, and a serial-port interface at C. At D, a parallel-port interface scheme is shown.

(B)

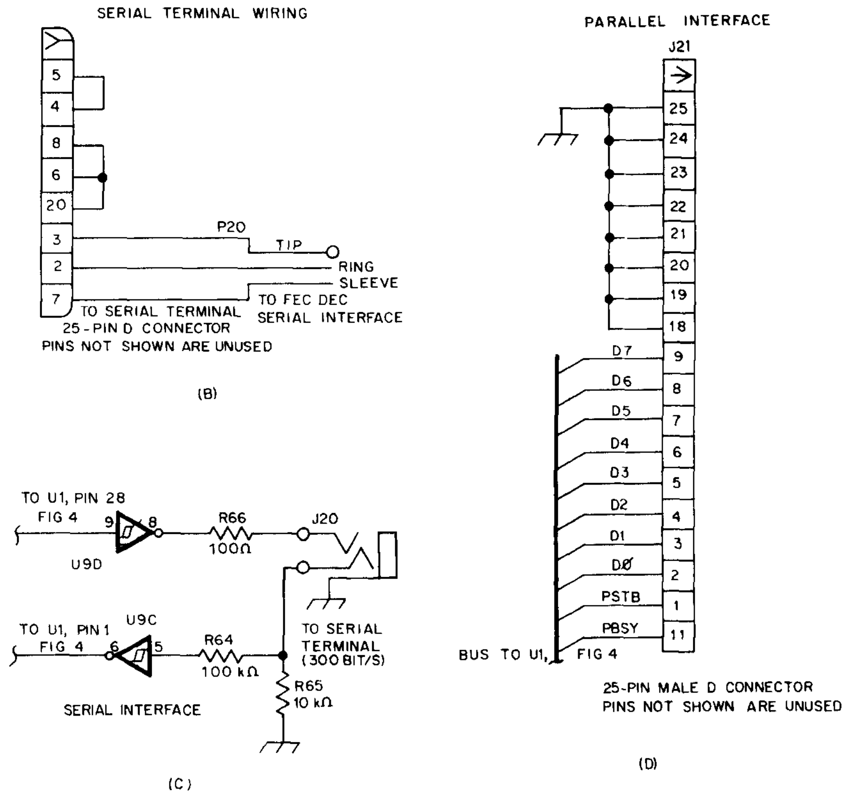


Table 1
EPROM at U4 v J4 Pin Strapping

ROM type	*J4, pin 1*	*J4, pin 2*	*J4, pin3*
2716	+5 V	N/C	+5 V
2732	+5 V	N/C	GND
2764	N/C	+5 V	GND
27128	GND	+5 V	GND
27256	GND	GND	GND

external supply of 9 to 15 V is applied to J19. F1 protects against over current, and D3 protects against reverse polarity. U5 provides a regulated +5-V output at up to 1 A. FECDEC draws 200 mA, so a heat sink should be used at U5. R56 provides a discharge path to ensure good reset characteristics for the microcomputer. R56 also provides a convenient place to get power for a logic probe if debugging is needed.

The +5-V signal is filtered by R62, C22 and C23 and is then buffered by U6D to generate the V_{REF} signal. This signal is also used as the reference to U6C and associated components that form the 10-V regulator. R61 increases the closed-loop gain of the regulator.

See Fig 3. As for the AFSK demodulator, feel free to bypass it with a better unit—I won't be offended! See the comments in the "Performance Issues" section for more information about the advantages and disadvantages of FECDEC's integral demodulator.

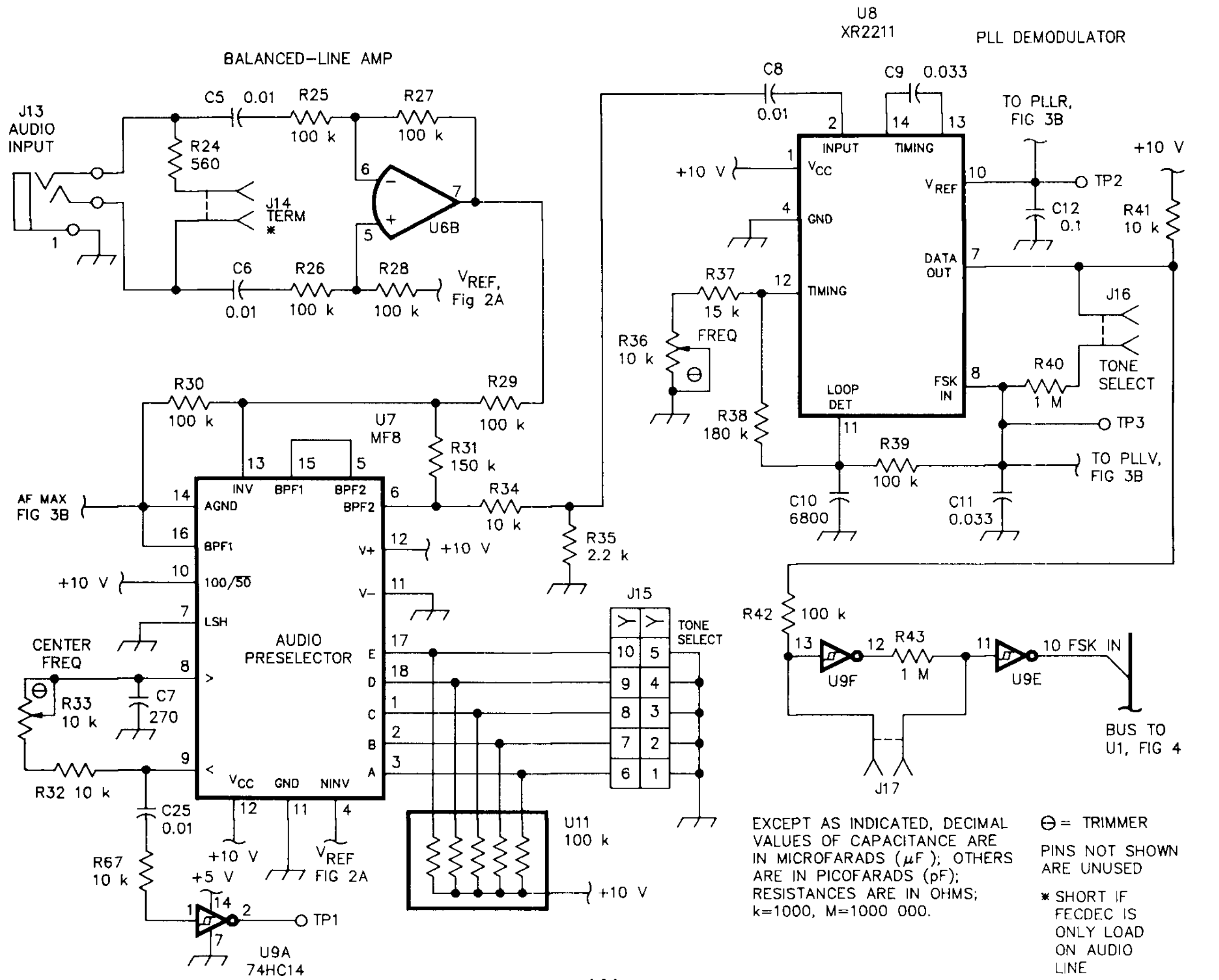
U6B and associated components form an amplifier with 0 dB gain that converts balanced signals (those without reference to ground) to unbalanced (those that are referenced to ground). If you use unbalanced signals (most people do), feed the input signal to pin 3 of J13, and ground pin 2 of J13. If you want the input to represent a 600-Ω load rather than a high impedance, install a shorting plug at J14.

U6B's output goes directly to the preselector filter, U7. This is a four-pole, switched-capacitor Chebyshev filter with 1 dB of passband ripple. The op-amp filter output (pin 14) is connected to the audio-input-overload detector (U6A). A 15-dB attenuator at the output of the filter ensures that the PLL demodulator, U8, can't be overloaded. Adjust R33 to set the center frequency of the filter. Install shorting plugs on the appropriate pins of J15 to select the filter Q. If you want to change the gain of the audio system, do so by adjusting the value of R29 (less resistance makes for more gain).

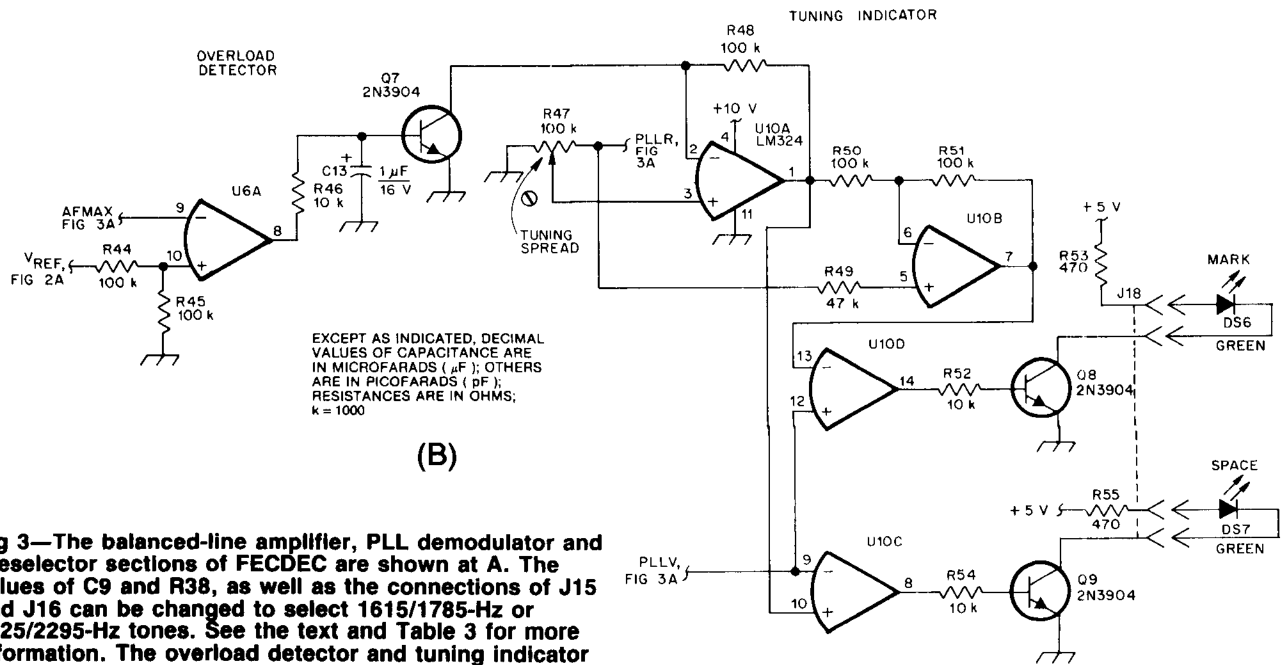
The PLL demodulator, U8, converts the frequency changes at its input to voltage changes at its output (TP3). R36 adjusts the center frequency of the PLL. An internal slicer converts the analog signal at TP3 to a digital signal for the microcomputer. Although the AFSK demodulator has been designed to demodulate AFSK tones of 1615/1785 Hz, other tones (such as 2125/2295 or 2125/2975 wide-shift AFSK) can also be demodulated with appropriate component-value changes. Table 2 gives component-value and jack-

Table 2
Tone-Dependent Values and Settings

Component	*1615/1785 Hz*	*2125/2295 Hz*
C9	0.033 μF	0.022 μF
R38	180 kΩ	270 kΩ
J15A	shorted	open
J15B	shorted	open
J15C	open	shorted
J15D	open	shorted
J15E	shorted	open



(A)



(B)

Fig 3—The balanced-line amplifier, PLL demodulator and preselector sections of FECDEC are shown at A. The values of C9 and R38, as well as the connections of J15 and J16 can be changed to select 1615/1785-Hz or 2125/2295-Hz tones. See the text and Table 3 for more information. The overload detector and tuning indicator sections of the FECDEC are shown at B.

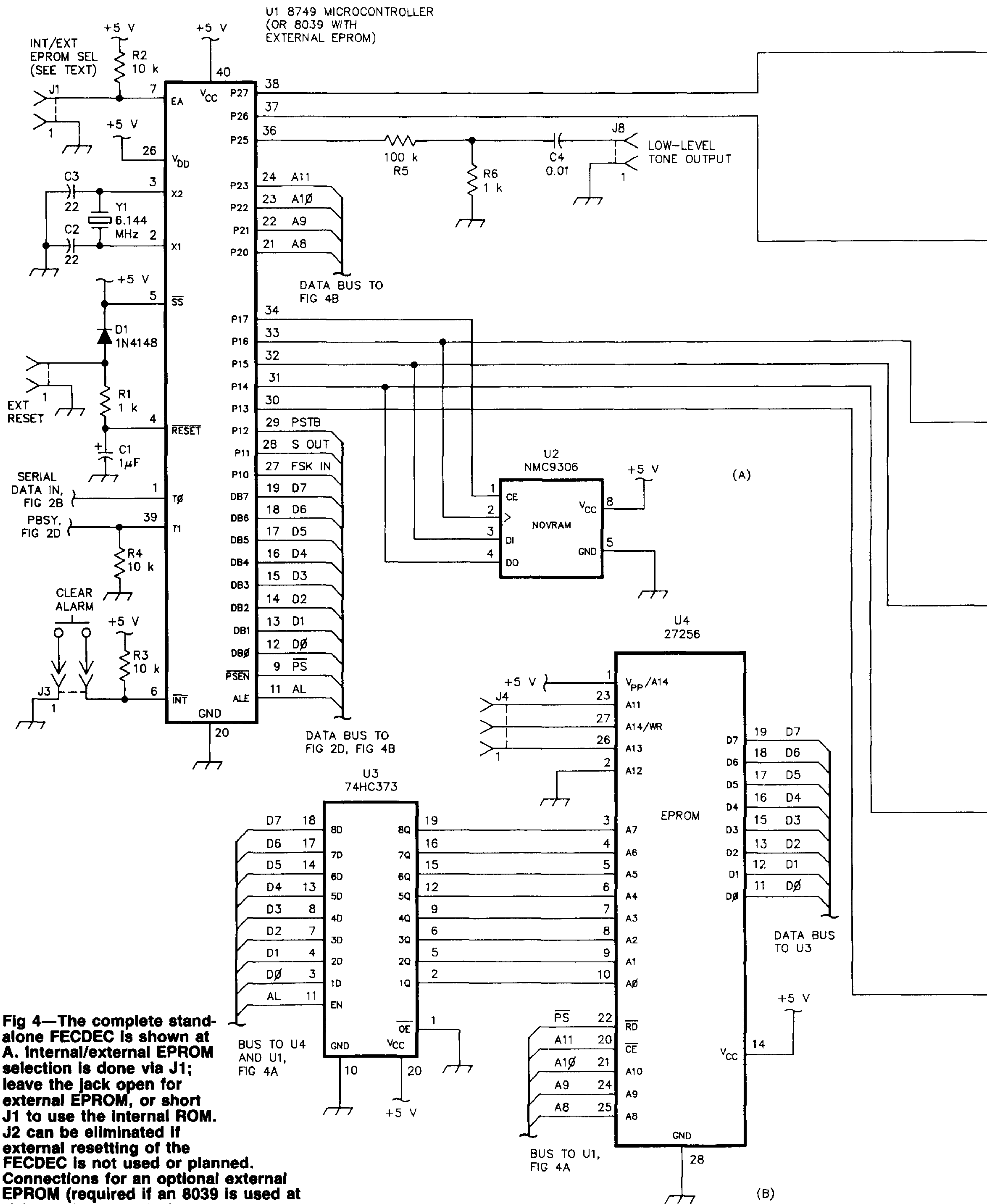
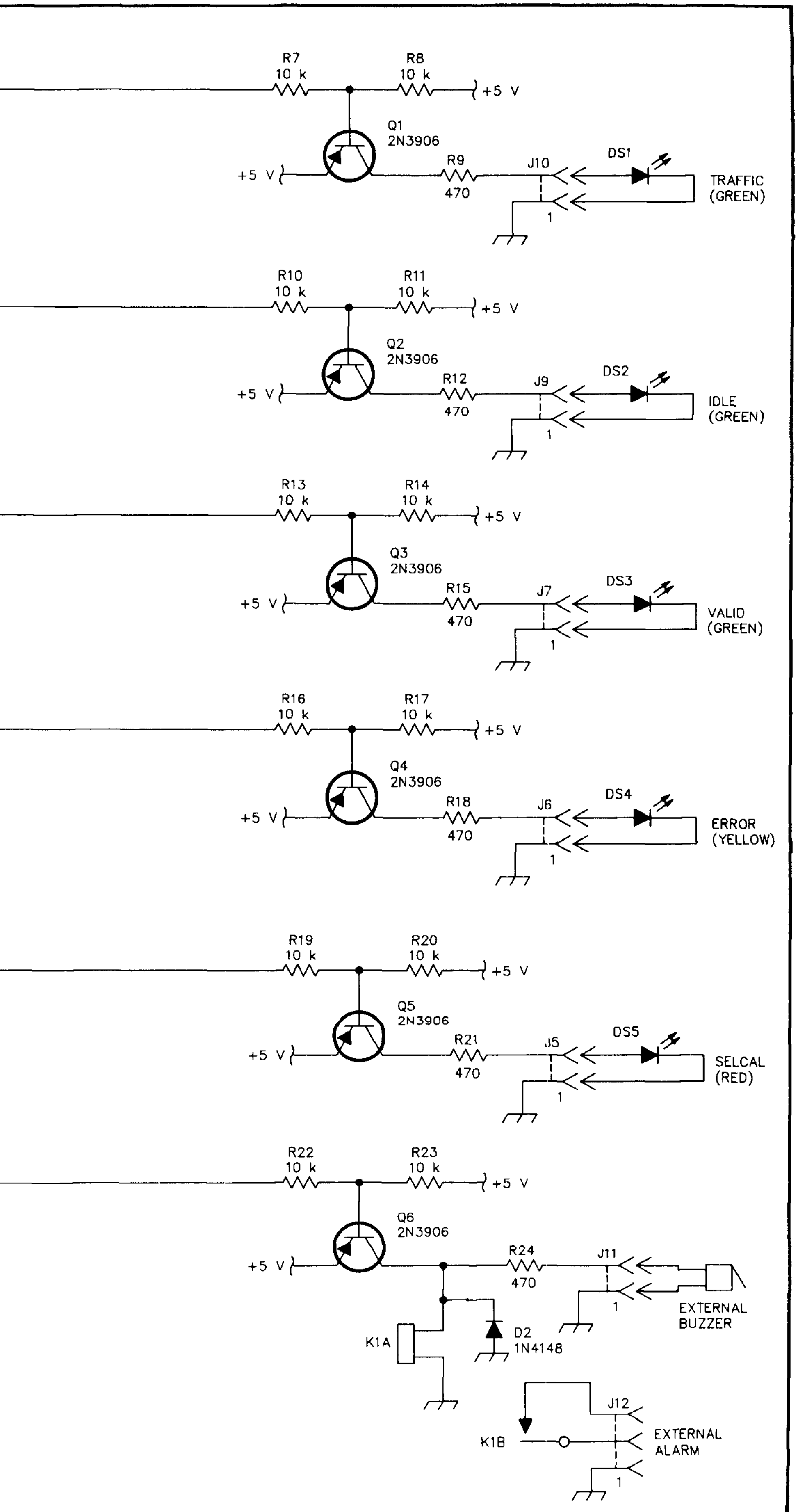


Fig 4—The complete stand-alone FECDEC is shown at A. Internal/external EPROM selection is done via J1; leave the jack open for external EPROM, or short J1 to use the internal ROM. J2 can be eliminated if external resetting of the FECDEC is not used or planned. Connections for an optional external EPROM (required if an 8039 is used at U1) are shown at B. J1 of Fig 4A must be open to use this option. A 27256 or smaller-capacity EPROM may be used at U4.



termination details for changing the tones. See the "Demodulator Adjustments" section for information on demodulator tuning.

U9F and U9E provide a level conversion and a logical inversion, when needed. J17 is usually left open.

The tuning indicator has two LEDs to show when valid mark/space signals are detected. R47 sets the level for the space input. This is buffered by U10A before passing to the space detector, U10C. The level from R47 is reflected around the PLL reference voltage (PLLV) and provides the level for the mark detector, U10D. When a radio is properly tuned to an FSK signal, both the mark and space LEDs flash with the incoming AFSK data.

An audio-input-level overload detector is provided by U6A. A threshold of 2.5 V is set on pin 10 of U6A. Whenever the audio input at U6A pin 9 (from the filter) goes below 2.5 V, the overload detector is triggered.[8]

When an overload condition is detected, the output of U6A goes high (to about 10 V), C13 charges through R46, and Q7 turns on. The time constant of C13 and R46 isn't critical; this network simply ensures that an audio-overload peak is caught. When Q7 saturates, the negative input of U10A is pulled low, causing the output of U10A to go high. This causes both the mark and space tuning LEDs to light at the same time, indicating an audio-input-overload condition.

See Fig 4. C1, R1 and D1 form the reset circuit for U1, the microcomputer. The microcomputer has an internal pull-up resistor on pin 4. R1 is to limit the discharge current that flows from C1 into the switch during a manual reset. D1 ensures that C1 is discharged quickly after power is removed.

Y1, C2 and C3 provide the timing for the on-board oscillator circuit of U1. Since FECDEC doesn't transmit AMTOR signals, there is no need to get the crystal to within the ±30 parts per million required by CCIR Recommendation 476/625. An accuracy of several hundred parts per million is just fine for receiving AMTOR FEC, which this circuit provides. If you have a choice of crystal parameters, get the crystal cut for parallel resonance at 20-pF loading.[9]

R2 pulls up the ROM control lead, EA. When this signal is high, the microcomputer (U1) gets its instructions from the external ROM located at U4. Operating in the external ROM mode this way can be cheaper, because the cost of an external EPROM, latch and a microcomputer without on-board EPROM is cheaper than a microcomputer with an on-board EPROM. If you want to have U1 get its instructions from its own program memory (the usual case) then *make sure J1 is shorted!* For more information about this option see the "Internal v External

Program ROM" section.

The EEPROM at U2 is used to retain the User Option String when the power is off. You don't need to have an EEPROM installed at U2 for FECDEC to work, but life is certainly easier if you do. There are several devices suitable for use here. You can use any that you like, but be sure it has at least 32 bytes of storage space. The microcomputer communicates with the EEPROM through a serial bit-transfer scheme.

R3 pulls up U1's interrupt lead, which FECDEC doesn't use as an interrupt. Instead, this input is programmed to be a general-purpose input port. A short across J3 from a momentary push-button switch clears FECDEC's selcal status memory.

R5, R6 and C4 form an attenuator and dc block for the low-level tone output. This signal is suitable for injecting into the audio system of a radio, after the volume control, to alert the operator that a valid selcal has been received.

R7, R8 and Q1 form a current amplifier to permit the microcomputer to drive modest current loads. The microcomputer can sink only a small amount of current (2 mA), and can source even less. Because of this, a dc amplifier is needed to drive LEDs. When the microcomputer's output at pin 38 is high, R8 pulls the base of Q1 up to the supply rail so that Q1 is cut off. If R8 wasn't there, the output of the microcomputer wouldn't go all the way to +5 V, and Q1 would be biased slightly on. When the output of pin 38 is low, base current for Q1 is drawn through R7, which limits the current to about 0.5 mA, thus saturating Q1 so that its collector is at 4.8 V. This voltage is applied to DS1, through current-limiting resistor R9. LED current is about 10 mA. All of the LED drivers operate this way.

The buzzer/relay driver operates the same way as the LED drivers. However, here there is no current-limiting resistor at the collector of Q6. D7 from the collector to ground is included to snub voltage spikes that can be generated when power is removed from the buzzer or the relay coil. The relay contacts are brought out for you to use as you choose. One caveat: Don't do something silly like using the relay contacts to control a 120-V ac lamp or some such device! If you want to control heavy-duty equipment, install another relay between FECDEC's relay and the controlled device. That's just good engineering practice.

The serial-port receiver circuit of Fig 2 consists of a load resistor, R65, a current-limiting resistor, R64, and a buffer, U9C. U9C provides inversion and a measure of protection for the microcomputer. The output of the microcomputer is buffered by U9D to provide rail-to-rail swing (0 to 5 V dc) and plenty of current. Again, the buffer serves to provide some protection for the microcomputer. Be sure to connect the serial output of FECDEC to the tip (not the ring) of the miniature stereo jack.

The parallel-printer port data signals are driven from U1's data bus, and the output strobe (active low) is driven from U1, pin 29. The printer-busy input (active high) is given to U1 on pin 39, the T1 input. R4 pulls down this input when no printer is connected.

Demodulator Adjustments

The audio preselector filter should be tuned first. Ensure that shorting plugs are installed, as appropriate, at J15 for the desired tone set. Using a frequency counter with a high impedance probe (greater than 10 kΩ, less than 100 pF) measure the frequency at TP1. Adjust R33 so the frequency at TP1 is 170 kHz (221 kHz for standard high tones).

Apply an audio-input signal of about 100 mV rms to J13 at a frequency of 1700 Hz (2210 Hz for standard tones). Connect a high-impedance (greater than 1 MΩ volt meter to TP2 and TP3 (negative lead to TP2, positive lead to TP3). Remove the shorting plug (if there is one) from J13. Adjust R36 for less than 50 mV dc. Check that the ac voltage is below 50 mV rms as well. Change the frequency of the signal generator to 1615 Hz (2125 Hz for standard tones) and see that the voltmeter reads about +2.0 V, with less than 50 mV rms ripple. Change the frequency to 1785 Hz (2295 Hz for standard tones) and see that the voltmeter reads about −2.0 V with less than 50 mV rms ripple. Install a shorting plug at J16.

To calibrate the tuning indicator, apply an audio-input signal of about 100 mV rms to J13 at a frequency of 1795 Hz (2305 Hz for standard tones) and adjust R47 so that DS7 is off. Then slowly adjust R48 so that DS7 just comes on. That will calibrate the tuning indicator.

Performance Issues

In any system there are compromises, and FECDEC is no exception. FECDEC's shortcomings are in the demodulator. It's not a bad demodulator; it just isn't a great one. With a little more effort and a few more components, the demodulator could be improved. The demodulator, as described, is adequate for the intended function. Using a better external demodulator may or may not be important to some users. If you choose to use an external demodulator it's simple to bypass the internal one. Although FECDEC's demodulator is adequate, if you have an old ST-6 modem (or similar unit) that's sitting on the shelf not being used, this is the time to bring it out of mothballs.

If you plan on using FECDEC's internal demodulator in an environment where you expect significant temperature changes, consider using a different clocking circuit for the MF8 switched-capacitor filter (U7). The output of the internal clock generator in the MF8 varies quite a bit over the −20 to +50°C range, and with modestly varying supply voltages. An LM567 tone-decoder oscillator circuit can be used to provide a more stable clock for the MF8.

Even though the demodulator is an average performer, the microcomputer software is, by my own admission, pretty darn good. The synchronization process is quick, and the tracking, code-conversion and string-matching processes are carefully done.

Because the transmission method for AMTOR FEC is synchronous, probably the most important consideration for any device that decodes AMTOR signals is the speed at which it can synchronize to the signal. FECDEC uses an algorithm that provides quick synchronization. I recently discussed details of synchronization techniques for AMTOR systems in *QEX*,[10] so this discussion is not overly detailed.

General Operating Notes

FECDEC can be used as an AMTOR-to-ASCII receive converter as well as a selcal decoder. Keep in mind that the first character of the User Option String allows you to customize the operation of FECDEC to best meet your needs. Using these flags, you can invert the incoming FSK data if you are using the wrong sideband, or if you're using an external demodulator that requires inverted data. You can also command FECDEC to treat the strings $\overline{\text{XXX}}$ and $\overline{\text{TTT}}$ to be the same as the string $\overline{\text{SOS}}$. By the setting of these flag bits, you can tell FECDEC not to print any received data to the serial or parallel ports until a valid selcal string has been detected.

The tuning indicator, like the demodulator itself, is a modest circuit. The goal, when tuning in a RTTY signal, is to have both LEDs of the tuning indicator flash. You may find that stations that run slightly wider shifts (200 Hz) provide a larger tuning window, and those who run on the narrow side (say, 160-Hz shift) won't be able to light both LEDs at the same tuning position. For shifts that are too narrow, adjust the radio's tuning so that neither LED lights. For either slightly narrower or slightly wider shifts, you'll find that FECDEC's demodulator can still recover the data. It also does a pretty good job with slightly off-frequency signals: Up to 50 Hz of error can be tolerated on strong signals.

Parts and Programs

Most of the parts for FECDEC can be obtained from Jameco® Electronics. The difficult part to find is the EEPROM (it is available from Hamilton/Avnet). The transistors can be most any type; they aren't critical. U9 must be a 74HC14; A 74HCT14, 74LS14, 74C14 or similar part *should not* be used.[11]

Conclusion

I have had fun doing this project. FECDEC is a ham radio accessory that I have wanted for years. One thing I find interesting about this project is that all technology for FECDEC is about 10 years old. There's nothing new or fancy going on here; it's just an effort to glue together some old parts to do a new function.

I always enjoy discussing techniques for MF/HF selcal and low-speed RTTY systems (like AMTOR) with other amateurs. I can be reached at the address above.

Notes

[1]I plan to submit it for publication in the proceedings of the next ARRL Amateur Radio Computer Networking Conference.

[2]R. A. Heising, "Radio Extension Links to Telephone System," *Bell System Technical Journal*, Vol 19, No 4, Oct 1940, pp 611-646; also see pp 629-630.

[3]I am excluding the CW and phone auto-alarm systems used in the marine service because these are *all-call* rather than *selective-* or *individual-call* systems.

[4]The same system was used for years on the VHF land-mobile radiotelephone channels, but was superseded by the Improved Mobile Telephone System (IMTS).

[5]In some systems the digits summed to 25 or 27.

[6]Such calibrator systems don't require the user to adjust the receiver's tuning for a zero-frequency audio output, as is commonly (and inaccurately) done. Instead, the crystal marker is adjusted to be high in frequency (lower for LSB) by 1 kHz. The marker also emits its 1-kHz modulating tone through a speaker. The operator then adjusts the receiver's tuning so that the 1-kHz tone from the radio beats against the 1-kHz audio tone output of the marker. This system provides a simple means of tuning a radio to within 1 Hz of the modulated crystal marker's frequency.

[7]EEPROM stands for electrically (as opposed to ultra-violet-light) erasable programmable read only memory. EEPROM retains the data programmed into it even when power is removed from the chip. Despite the reference to "read only," EEPROM can also be written to.

[8]The audio from the filter has an average dc potential of +5 V. For an overload to occur, the audio signal would need a negative peak value of +2.5 V (2.5 V below the average value of +5 V) to meet, or go below, the threshold value of +2.5 V.

[9]This is true even though the circuit doesn't present a 20-pF load to the crystal.

[10]P. Newland, "Algorithms and Methods for SITOR/AMTOR Systems," *QEX*, Jul 1988, pp 9-12.

[11]Source code for FECDEC is available from me, or on CompuServe's® HAMNET in the Data Library. I can also program 8749s and EPROMS. Send me an SASE for details. (The ARRL and *QEX* in no way warrant this offer.)

Bits

Computer Power Interrupters

Electronic Specialists' line of ac Power Interrupters now includes automatic reset models with an integral reset delay. Should the ac line voltage be disrupted or exceed preset safety limits, the Power Interrupter disconnects the ac power from the equipment plugged into it. When ac line power is restored, a four-minute delay—followed by an automatic self reset cycle—helps protect the equipment from wide voltage fluctuations. Power Interrupters with an optional line-voltage monitor (see photo) are available.

Intended for use with computer installations operating unattended for long periods, the delayed, self-reset Power Interrupter provides safety and protection for equipment and personnel. The Power Interrupter connects to the ac line with a standard three-prong plug, and can accommodate a 15-A resistive, or 10-A inductive load (20-A options are available).

The model PI-SR-15 Self-Reset Interrupter is $269.95; the PI-SRV-15 Self-Reset and Voltage Monitor Interrupter is $329.95. These products are available from Electronic Specialists, Inc, 171 S Main St, PO Box 389, Natick, MA 01760, tel 800-225-4876.—*Paul K. Pagel, N1FB*

Beginners Guide to Packet Radio

The British Amateur Radio Teledata Group (formerly British Amateur Radio Teleprinter Group) has announced the release of a booklet entitled *Beginners Guide to Packet Radio*, by M.J. Martin, G4VRQ. For more information contact: Mr J. Beedie, GW6MOK, BARTG Components Manager, "Ffynnonlas", Salem, Llandeilo, Dyfed, SA19 7NP ENGLAND.

Battery-Powered Signal Intensifier

Electron Processing, Inc introduces the RFP-45, an inexpensive preamplifier that

covers MF to UHF frequencies. Powered by two 9-volt batteries (it's portable), the RFP-45 provides 15 dB gain from 1 MHz to 1300 MHz with a 2.8 dB noise figure. The RFP-45 is housed in a 2½" × 4½" × 1½" cast aluminum enclosure equipped with lightning/static protection, and is available with a choice of BNC, UHF (SO-239), or F connectors. Prices start at $99.95, quantity discounts available. Contact the Sales Department, Electron Processing, Inc, PO Box 708, Medford, NY 11763, tel 516-764-9798.

Land Mobile Communication Standards

The Electronic Industries Association has revised two of its standards on Land Mobile Communications to bring them in line with current industry practice.

EIA-152-C, *Minimum Standards for Land Mobile Communication FM or PM Transmitters, 25-866 MHz* (December 1988), promotes compatibility of these transmitters with the system in which they operate; details definitions and methods of measurement of the characteristics of FM or PM Land Mobile Transmitters in fixed or vehicular installations, and; includes the antenna changeover device (not the antenna system or audio input transducer). EIA-152-C applies to measurements of single-channel, voice-modulated transmitters. Cost $15.00 per copy.

EIA-220-B, *Minimum Standards for Land Mobile Communication Continuous Tone-Controlled Squelch Systems (CTCSS)* (December 1988), describes a continuous tone control system and establishes operational performance standards and environmental tests for both the transmitter and receiver. This revision accommodates equipment operating with a frequency deviation of 2.5 kHz. EIA-220-B applies to systems in either narrow or wide band deviation mode. Cost $13.00 per copy.

To order, please contact: EIA Standards Promotions, Attn: Lisa Grigg, PO Box 57258, Washington, DC 20036-0258, tel 202-457-8734.

Correspondence

The editing and preparation of my article "Characteristics of Some Common Power Tubes at 432 MHz," November 1988 *QEX*, pp 3-7, omitted some information and presented some incorrect information. This article will clarify those items in question. *—Steve Powlishen, K1FO, 816 Summer Hill Rd, Madison, CT 06443*

Editor's Note: Indeed, there were some problems in the editorial handling of the original article. We sincerely regret this and can assure authors of less-intrusive editing of future articles. In future editions of *QEX*, we will endeavor to keep rewriting to an absolute minimum, consistent with good English and style. In doing so, we may err on the side of too little editing, which still leaves the reader with the option of corresponding directly with the author to clear up any questions. After all, this is an *Experimenter's Exchange. —W4RI*

Table 1, Part 2: The 8283/3CX1000A7 is not obsolete; its current new cost is $1500.

Information for the 8792 is not correct. The correct data is: Cost new:$1800; Linear Pwr Out (W):1500; Linear Effic.: 55%; 3rd-order IMD (dBc): −37; Drive (W):75; Cost, Surplus:$300; Notes: Improved 7213.

Information on the 8938 was omitted. The 8938 data is: Cost new:$1500; Linear Pwr Out (W):1500; Linear Effic.:54%; 3rd order IMD (dBc): −44; Drive (W):85; Cost, Surplus:$600, Notes: rare coaxial.

Note: Surplus prices refer to typical street prices. They are not meant to infer that the author knows of, or that there is, a specific source for any of the tubes at the listed price.

Table 2: Some of the information for the 7213/7214 is incorrect. The corrected figures are: Anode, 3 kV; Anode mA (CCS), 1000; Frequency for maximum ratings (MHz), 1215 (specified at a maximum input power of 2.5 kW). Some manufactured 7213s may not be capable of the listed IVS plate current. The rated CCS single tone plate current on the 8792/V1 is 1000 mA.

Figure 1 & 2: The captions for these photographs (added by the handling editor) do not use consistent operating conditions between the two tubes nor conditions consistent with linear operation at 432 MHz.

Figure 4 & cover: The 8877 is not a recommended tube for 432 MHz.

In the first paragraph: The original K2RIW parallel 432 MHz kilowatt was designed under the old amateur power limits. It was intended for operation at an *input* power of 1 kilowatt.

References to CW power outputs in the article (paragraph 2) refer to power output in Morse code keyed CW operation. The specified output levels are for long term stable reliable operation in keyed CW service or SSB voice service. Except where references are made to continuous operation the tubes are not suitable for long term key down operation at the specified power levels.

Paragraph 5, the concept of "conservative CCS" ratings is extended to also include IVS ratings, which are not conservative, thus changing the thought process of the paragraph.

4X150A/7034

The specified plate dissipation of this tube is 250 watts. The specified frequency for continuous operation at maximum ratings is 150 MHz.

4CX250B/7203

The listed prices refer to a pair of tubes. The Eimac number system for the 8957 is the 4CX250BC.

4CX300A/8167

The 4CX300A has a specified frequency of 500 MHz for maximum ratings. The 4CX300Y/8561 has 110 MHz specified as the maximum ratings frequency although it is usable at 432 MHz with reduced ratings.

3CX800A7

A reference was added which listed a paper by N7ART, published in the 1986 *Central States VHF Conference Proceedings.* This paper described a *single* tube amplifier, not the two-tube amplifier which appeared in the *VHF/UHF and Above Information Exchange.*

4CX600J/8809

The information about the 432 MHz 4CX600J cavity is contained in reference 9, *An Eimac Family of 4CX600 Tetrodes.* Although the base of the 4CX600J is physically the same as the 4CX250 family, the pin connections are different. Most 4CX250 family sockets can be used with modification. Eimac does make a socket specifically for the 4CX600J (& 4CX600JA), the SK607.

Also available is the 4CX600JB which is a lower cost version of the 4CX600J. The 4CX600JB is not manufactured to as high tolerances as the "J" version, but it is quite suitable for amateur operation.

Electrically and in terms of physical size, the 4CX600B and 4CX600J are very similar to the RCA 7650, 7651 and 8791 tubes. Both manufacturers' tubes were designed for the same types of applications. A given circuit for one of the tubes could easily be adapted to any of the other tubes in this group.

7650

The RCA 7650 family also includes the pulse rated version, the 7651 and a more modern version the 8791/V1. Since the article was originally written, information describing DL7APV's parallel 7650 amplifier has been published in *432 and Above EME News* volume 16, #12, November 1988 and volume 17, #1, January 1989. *432 and Above EME News* is published By Allen Katz, K2UYH. These editions of *432 and Above EME News* are reprinted in *VHF/UHF and Above Information Exchange* in the December 1988 issue.

4CX1000A/4CX1000K

Wording was changed to say that it is my speculation that these tubes are not efficient at 432 MHz. Based upon testing by the manufacturer and attempts by several amateurs to build amplifiers, it has been found that they are in fact poor performers at 432 MHz due to low plate efficiency.

4CX1500A

The 4CX1500A should not be confused with the 4CX1500B. The "B" version is a linearized 4CX1000A. This improvement was made through the use of a segmented cathode and better grid alignment. The 4CX1500A is a very different tube which used a thoriated tungsten mesh hot filament/cathode, not the indirectly heated oxide coating cathode that the 4CX1000A and 4CX1500B use. Although the 4CX1500A's screen structure may make it more suitable for use at 432 MHz, I do not know of anyone who has attempted to use this tube at 432 MHz. It is however a good performer through 220 MHz.

8877/3CX1500A7

Text conveying the information that the 8877, 4CX1000A/K and 4CX1500B all have similar output characteristics and could be easily adapted to plate circuits designed for the 8938 was deleted.

Tube Recommendations

If money were no object, the Eimac 8938 would be my undisputed choice. It is completely stable and can run 1500 watts output at 432 MHz in continuous operation. If you are purchasing new tubes, the 3CX800A is recommended as a pair are less than half of the price of the 8938. A pair of 3CX800A7s will, however, reliably generate 1500 watts of power at 432 MHz only when operated in IVS or Morse code keyed CW service.

The 7213/7214/8792 are the watts per dollar champions considering their surplus cost and availability. They are not for the faint of heart as it will take a builder with considerable ability and knowledge to get them to work properly at 432 MHz. The experience of several builders indicates that a round or rectangular, sliding wall, cavity is the best approach with these tubes.

If one is interested in a challenge (although a lesser one than the 7213 provides) the 7650 or 4CX600 family tubes should not be passed up. With the publication of DL7APV's amplifier the task of building such an amplifier is now easier as they will work very well in a simple stripline circuit.

432 MHz POWER TUBE COMPARISON

PART 2

Tube(s)	*Cost New ($)*	*Linear Pwr Out (W)*	*Linear Effic. (%)*	*3rd IMD (dBc)*	*Drive (W)*	*Cost, Surplus ($)*	*Notes*
7650, 7651	1100	850	60	−30	22	100	IVS operation
4CX600B, 4CW800B	1200	900	63	−35	28	200	hard to stabilize
4CX1000A, K	800	1000	35	−23	25	150	Socket $800
4CX1500B/8660	800	1000	35	−40	25	150	Socket $800
4CX1500A	1000	1200	40	−32	40	150	"hot" cathode
8283/3CX1000A7	1500	1200	45	−31	200	450	IVS operation
8877/3CX1500A7	835	1300	40	−40	130	350	IVS operation
7213, 7214	1400	1500	55	−25	70	125	IVS operation
8792/V1	1800	1500	55	−37	75	300	Improved 7213
8938	1500	1500	54	−44	85	600	rare, coaxial
4628	2500	1500	50	−35	120	500	rare, coaxial

NOTE: Surplus prices refer to typical street prices. They are not meant to infer that the author knows of, or that there is, a specific source for any of the tubes at the listed prices.

Bits

1989 IEEE Sponsored and Cosponsored Conferences

April 28-May 3 — *1989 Vehicular Technology Conference*, San Francisco, CA. Contact: Wrex Beaman, c/o ETAK, Inc, 1455 Adams Drive, Menlo Park, CA 94025, Tel 415-328-3825.

May 23-25 — *1989 IEEE Electromagnetic Compatibility Symposium (EMC '89)*, Denver, CO. Contact: Mr John W. Adams, Chairman, 1435 Gillaspie Dr, Boulder, CO 80303, tel 303-497-3328.

June 1-2 — *1989 IEEE Pacific Rim Conference on Communications, Computers and Signal Processing*, Victoria, BC. Contact: Dr W.D. Little, Conference Chairman, Department of Electrical and Computer Engineering, University of Victoria, PO Box 1700, Victoria, BC, V8W 2Y2 Canada, tel 604-721-7211.

June 11-14 — *1989 IEEE International Conference on Communications (ICC '89)*, Boston, MA. Contact: Edmond N. Elowe, ELOCORP INTERNATIONAL, PO Box S, Brunswick, ME 04011, tel 207-833-5403.

June 26-30 — *1989 IEEE Antennas and Propagation Society International Symposium and National Radio Science Meeting*, San Jose, CA. Contact: Ray J. King, Chairman, Lawrence Livermore National Laboratory, L-156, Livermore, CA 94550, tel 415-423-2369, or Daniel H. Schaubert, Secretary/Treasurer, Antennas & Propagation Society, tel 413-545-2530.

September 6-8 — *1989 ASSP 6th Workshop on Multidimensional Signal Processing*, Monterey, CA. Contact: Professor Charles W. Therrien, Local Arrangements Chairman, Naval Postgraduate School, Department of ECE, Monterey, CA 93943, tel 408-646-3347.

September 10-14 — *ISDN '89*, Waikoloa, HI. Contact: Mr Russ DeWitt, Conference Chairman, Contel Service Corporation, 245 Perimeter Center Parkway, Atlanta, GA 30346, tel 404-551-4920.

October 15-17 — *1989 IEEE Frontiers in Education*, Binghamton, NY. Contact: Professor Richard S. Culver, General Chairman, Office of the Dean, State University of New York, Binghamton, NY 13901, tel 607-777-2871.

October 15-18 — *1989 IEEE Military Communications Conference-MILCOM '89*, Bedford, MA. Contact: Richard W. Coraine, 1001 Boston Post Road, Marlborough, MA 01752, tel 508-490-1287.

November 27-30 — *1989 Global Telecommunications Conference-Globecom '89*, Dallas, TX. Contact: Dr Harold Sobol, Associate Dean of Engineering, University of Texas, Arlington, Box 19019, Arlington, TX 76019, tel 817-794-5367.

Third Generation Wireless Access Information Networks Workshop

Rutgers Wireless Information Network Laboratory, in cooperation with the IEEE Vehicular Technology Society, will present a workshop on Third Generation Wireless Access Information Networks. This event will take place on June 15-16, 1989, in Piscataway, NJ. Topics are expected to include third generation services; network architectures; technologies, including switching, coding, signal processing, and transmitting; regulatory issues, and; standards. For further information contact: Dr David J. Goodman, Chair, Wireless Information Network Laboratory, Department of Electrical and Computer Engineering, Rutgers University, PO Box 909, Piscataway, NJ 08855-0909. Tel (201) 932-3262. Fax (201) 932-5313. Registration information can be obtained from Charles Rouse, Administrator, (address above). Tel (201) 932-5241.

New 10 Meter Net for OSCAR Satellite Beginners

AMSAT has set up a weekly Novice/Technician net to help introduce beginners to the world of OSCAR. Discussions are intended to be introductory in nature, and topics are expected to include transponder modes, satellite-tracking programs, antennas, equipment and simple orbital mechanics. The net will be in operation weekly, Sundays at 19:00 UTC on 28.460 MHz. Vinnie Banville, WB2YBA, is the Net Control Station (NCS). All are invited to check into this new AMSAT Novice/Technician Net.

Components

By Mark Forbes, KC9C
5240 Whitney Blvd
Rocklin, CA 95677

READER SURVEY

I've received a number of cards from you readers about the content of the column and your building preference. Interestingly, there is a very wide range of favorite projects; some were interested only in digital, and some were interested only in analog. Most enjoyed building a variety of different projects. If you haven't responded to my informal survey, drop me a card with your areas of interest, and tell me what the last project you built was.

One item appeared on most cards though, and that was about the difficulty in finding some parts, particularly microwave components and specialty capacitors (feedthroughs, polyester, etc). Beginning this month, I will try to highlight sources for components that sell in low quantity. I'll need help with this, so if you buy at a favorite source, send me the details so I can work them into the column.

Digi-Key

The first such source I'll list is Digi-Key. Digi-Key has been in business for many years. In the nearly ten years that I've been buying from them, they have expanded their line from mostly digital logic to a tremendous variety of components, enclosures, connectors, hardware, tools, and test equipment in low quantity at reasonable prices.

They have a very extensive catalog that they publish bimonthly, and can also provide technical data sheets on many of the components. They also delivery quickly.

To get a copy of their catalog, and get on their mailing list, write them at PO Box 677, Thief River Falls, MN 56701 or call 800-344-4539 (800-Digi-Key).

AMP Data Line Protector

Many of you no doubt have surge protectors installed in the ac line for your computer, and possibly HF rig as well. Another vulnerable point is at data input connectors. You can get spikes through these that can kill your computer system just as easily. The spikes can come from modems with unprotected power supplies, or even over the phone lines.

Now there is a surge suppressor for data lines available from AMP. They offer them for four different versions of the "D" connector (the DB-25, for example is the RS-232-C standard), with 9, 15, 25 and 37 pins.

All versions have identical specs of ± 25 V breakdown voltage, a response time of less than 5 nanoseconds, maximum surge power of 3 kW, and peak current of 75 amperes. The protectors are a bit longer than two back-to-back "D" connectors. If you're interested, you can learn more from AMP Incorporated, Harrisburg, PA 17105.

12-GHz MMIC Switches

Anadigics has recently introduced two monolithic microwave integrated circuits (MMIC). These two circuits act as SPDT switches. The ASW40010 operates from dc to 4 GHz, and the ASW12010 operates from dc to 12 GHz. Switching time for both is less than 2 nanoseconds.

Insertion loss on the ASW40010 is 0.8 dB at 500 MHz with 65 dB isolation; at 4 GHz, insertion loss is 1.0 dB and isolation is 45 dB. The ASW12010 provides 30 dB isolation with 2.0 dB insertion loss across its entire operating range. Anadigics does business at 35 Technology Dr, Warren, NJ 07060.

Chip Capacitor/Resistor Sample Kit

Communications Specialists, the folks who make the tiny PL encoders, have a Chip Capacitor Prototype Kit available. This is a good way to get a good assortment of chip capacitors on hand for future projects. The kit, called the CC-1, comprises 365 total capacitors. Most values have 5 pieces each, and 10 pieces each of the decade values (1 pF, 10 pF, ...1 μF).

The kit includes all standard values from 1 pF through 0.33 μF, and has two standard sizes: 1.25 mm × 2.0 mm, and 1.6 mm × 3.2 mm. The price is $49.95, and you can pay via check or call with your credit card number.

They also offer a similar kit for chip resistors. The CR-1 kit includes 1540 total chip resistors. All 5% values are included, including a 0-ohm jumper. This kit supplies 20 pieces of the decade values (10 ohms through 10 megohms), and 10 pieces of the other values.

The price is the same, $49.95. You can order or get more information from Communications Specialists, 426 West Taft Ave, Orange, CA 92665-4296. Their toll-free telephone number is 800-854-0547.

5-Volt Power Supply on an 8-Pin DIP!

This little part really caught my eye. Harris Semiconductor has just come out with a monolithic ac/dc converter called the HV-1205. This 8-pin minidip accepts ac input voltage from 30 to 264 V, and a frequency from 48 to 440 Hz. Output can be from 5 to 24 volts with regulation of less than 5%. The circuit delivers a minimum of 50 mA at 5 V dc.

The price for the standard part is less than $5.00. For more information on this highly useful part, contact Harris Semiconductor, PO Box 883, Melbourne, FL 32901, phone 407-724-7800.

Surface-Temperature Sensor

Airpax has a nice temperature sensor package in the convenient TO-220 "power-tab transistor" style case. This bimetallic thermostat is offered in two versions: normally open contacts and normally closed contacts. The contacts are rated at 1 A at 48 V dc.

The normally open version closes its contacts with rising temperature, while the normally closed version opens its contacts as temperatures increase. The sensing range is designed for sensing overtemperatures in electronic circuits, such as power supplies and amplifiers, with a range of 40 to 120° C in 5° C increments.

The thermostat can be mounted directly to the heat sink, thus providing accurate measurement of the temperature of critical components. The price for the thermostat is about $5.00, and is manufactured by Airpax, Box 868, Cheshire, CT 06510.

LED Clusters

Although this is April, this *is* a real product! Ledtronics has several models of "LED clusters." These clusters mount a set of LEDs in the "industry standard candelabra S6 screw-base lamp socket." For the rest of us, that's the size of those flame-like light bulbs that mount in many chandeliers, night lights, and older Christmas-tree sockets. The cluster contains rectifiers, limiting resistors, and LEDs. So you can screw them right in where an incandescent bulb has been removed.

These are available in 120 V ac styles, as well as six other dc voltages. The shock is the price: they cost over $10 in small quantities. For more information, contact Ledtronics, Inc, 4009 Pacific Coast Hwy, Torrance, CA 90505.