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JUNE 1990

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TABLE OF CONTENTS

COLUMNS

JUNE 1990 QEX ADVERTISING INDEX

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2) document advanced technical work in the Amateur Radio field
3) support efforts to advance the state of the Amateur Radio art.

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Empirically Speaking . . .

Coming Soon to a Sky Near You . . .

After some delays, STS-35 is presently scheduled to be launched at 0438 UTC on May 30. As with any Shuttle mission, however, this is subject to change up to the last few seconds of countdown. Listen to W1AW voice bulletins for details.

What's so special about STS-35? Amateur Radio is back on the Shuttle under the banner of SAREX—Shuttle Amateur Radio EXperiment—with mission specialist Dr Ron Parise, WA4SIR, as operator. The plan is for the Shuttle Columbia to use Amateur Radio to communicate with youths in the classroom, museums and space camp, with the following objectives:

- to encourage our youth to become excited about science and technology,

and

- to familiarize large numbers of the general public with manned space flight.

Thousands of volunteers—teachers, parents, AMSAT members, Johnson Space Center personnel, Amateur Radio industry people, local clubs, NASA and ARRL staff—are contributing countless hours to make everything come together for youth involvement. Over 800 schools, parents or science centers have contacted the ARRL Educational Activities Department for information. Ron selected a few locations for short voice QSOs. But the bulk of the communications will be via packet radio. The uplink frequency is 144.950 MHz, downlink 145.550 MHz. Modulation is ordinary 1200-bit/s AFSK with transmitter deviation set to no more than 3 kHz. Because the inclination of the shuttle orbit is only 28.5 degrees, the signals can be heard only between +43 and -43 degrees latitude. The packet QSO will be handled by a ROBOT, which replies every 2 minutes with something like this if you have met all the requirements of a two-way QSO:

WA4SIR>QSL <UI>:
NI3F/186 WB2TNL/185 W3IUI/179 etc.

If you are simply heard by the ROBOT, your call will appear in the QRZ beacon, per the following example:

WA4SIR>QRZ <UI>
#3405-NE3H NI3F K1LNJ etc.

Unlike the QSL "worked" list, the QRZ "heard" list will not be retained by the ROBOT or WA4SIR's laptop computer. In order to send SWL cards to those who were heard, hams around the world will need to help collect the list. You may send QRZ lists through the amateur packet network addressed like this:

SP SAREX @ W3IWI.MD.USA

or via the Internet addressed like:

sarex@tomcat.gsfc.nasa.gov

and make the Subject: field contain the date/time of the beacons like:

Jun 9 @ 03:42z

A schedule of packet operations, given in Mission Elapsed Time—day/hour elapsed since launch—follows:

0/2200-1/2020
1/2115-2/0835
2/2000-3/0755
3/1900-4/0640
4/1830-5/0545
5/1720-6/0550
6/1740-7/0535
7/1745-8/0445

W5RRR has supplied the following Keplerian elements based on an 0438Z launch:

Epoch time	90150.24513889
Element set	JSC-0011
Inclination	28.4690 deg
RA of node	148.3930 deg
Eccentricity	0.0005720
Arg of perigee	246.6067 deg
Mean anomaly	119.6564 deg
Mean motion	15.71792660 rev/day
Decay rate	3.1E-04 rev/day
Epoch rev	2

—W4RI

Design of a Multi-TNC Controller

By André Bakkers, PAØAPA, Erwin Hoogzaad, PE1CFJ, and Marcel Schwirtz, PE1NKB
ETGD Club Station PI8THT, University of Twente
PO Box 217
NL-7500 AE Enschede, Netherlands
indebted to DG9FU, DB8AS and PAØHWB

The realization of a node controller for packet radio nodes has been a weak point in the design of packet radio networks for a long time. Even though the NET/ROM software manual describes the well known diode matrix for this purpose, the four- port coupler is called "probably the maximum practical configuration." For a typical node, the N-E-S-W connections already take up four TNCs; addition of a Local Access Point and a Mailbox would require a six-port node, well beyond the capabilities of the diode matrix. PAØHWB has performed measurements on the RS-232 channel that indicate, at least in his system, that this channel exhibits a maximum efficiency of 20%. With a baud rate of 9600 on the RS-232, channel this results in an effective baud rate through the node of 9600 × 0.20 = 1920 baud. Division by the number of channels, in his case four, results in a throughput of 480 bauds per TNC!

On October 5 1988, DG9FU and DB8AS launched the idea to use RTS/CTS control in a system using TNCs equipped with NET/ROM software, to prevent packet collision on the RS-232 channel. These collisions occur when two TNCs transmit their packets on the RS-232 interconnection simultaneously. The idea of

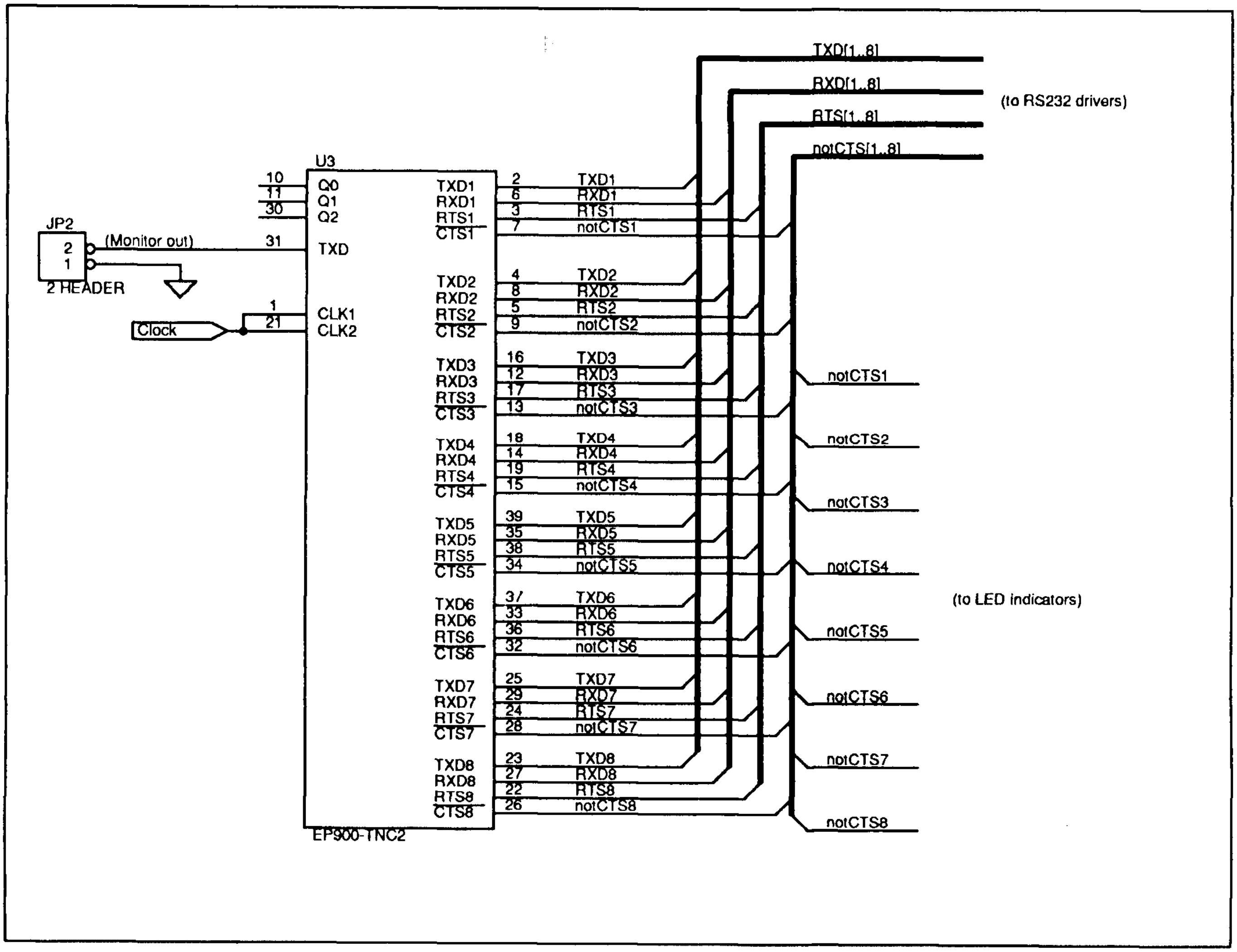


Fig 1—EPLD pin connections

DG9FU and DB8AS consists of a proposal to enable the CTS (pin 4 or 20) inputs of the TNCs one by one with the use of a counter. The counter will be stopped as long as the TNC replies with an active low RTS signal (pin 5), within approximately 3 ms. As a result this enabled TNC is the only one that may start transmitting on the RS-232 channel. As soon as the packet has been transmitted, this TNC will deactivate its RTS line which in turn allows the counter to resume counting.

The DG9FU and DB8AS design, consisting of a 4017 counter and a NE555 clock oscillator, excels in simplicity, but suffers still from the well-known problems of the diode matrix. Besides any TNC can halt the counter at any time by setting its RTS low. The TNC that is enabled by the counter will consequently be allowed to start transmitting. However, this need not be the same TNC that made its RTS low. As a result the system deadlocks.

At the club station PI8THT of the University of Twente this idea has been converted into logic formulas and has resulted in an EPLD and a printed circuit board design. The logic expressions are derived from the following design requirements:

- Only one TNC is allowed to transmit at a given time.
- The TNC that is allowed to transmit will transmit to all other TNCs but not to itself.
- The transmitted data of unauthorized TNCs is always masked off.
- If for some reason a TNC claims access to the RS-232 connection and its access time has expired in the mean time, the transmission of that TNC will be masked off.
- Each TNC is allowed to transmit one packet at a time. For transmission of consecutive packets, the TNC has to wait its next turn. This is important if Mailbox traffic is using the node as well.
- The multi-TNC controller should operate internally at TTL level and externally at RS-232 level.
- It should be possible to connect up to eight TNCs to the controller. Connection of less than eight TNCs should not influence the operation.

The newly designed multi-TNC controller has a theoretical throughput equal to maximum of all channels, that is equal to (1200 × n) where n is the number of 1200-baud channels. If the RS-232 baud rate is increased from the usual 9600 to 19200 bauds, the resulting delay of the network node becomes hardly noticeable. Furthermore all channels will be serviced evenly and one will not be bothered by the delay of Mailbox traffic as long as the Mailboxes use the maximum value of PACLEN = 236 and a value of MAXFRAME = 1 as the setting for their TNCs.

The multi-TNC controller is being used by a number of NET/ROM nodes in the packet radio network in the Netherlands.

Circuit Description

The main controller chip, EP900 Erasable Programmable Logic Device, called EPLD, is an integrated circuit manufactured by the ALTERA Corp. The EPLD

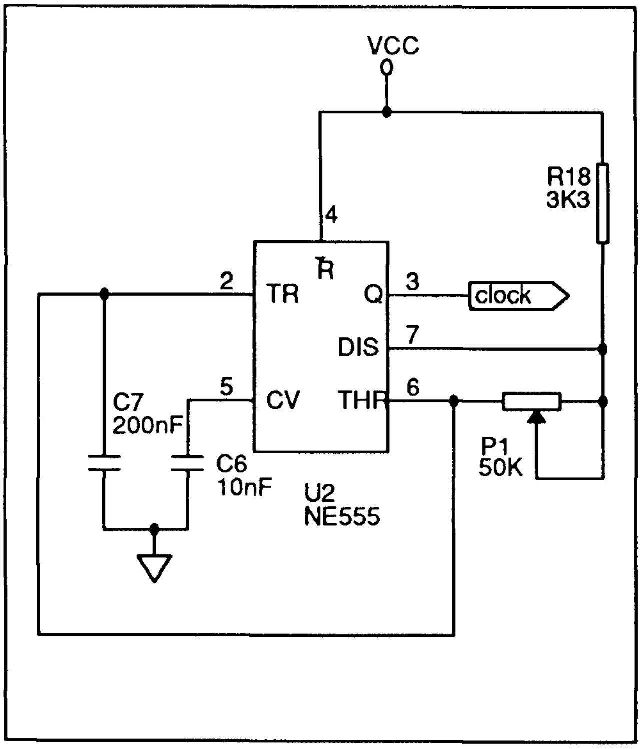


Fig 2—Clock oscillator

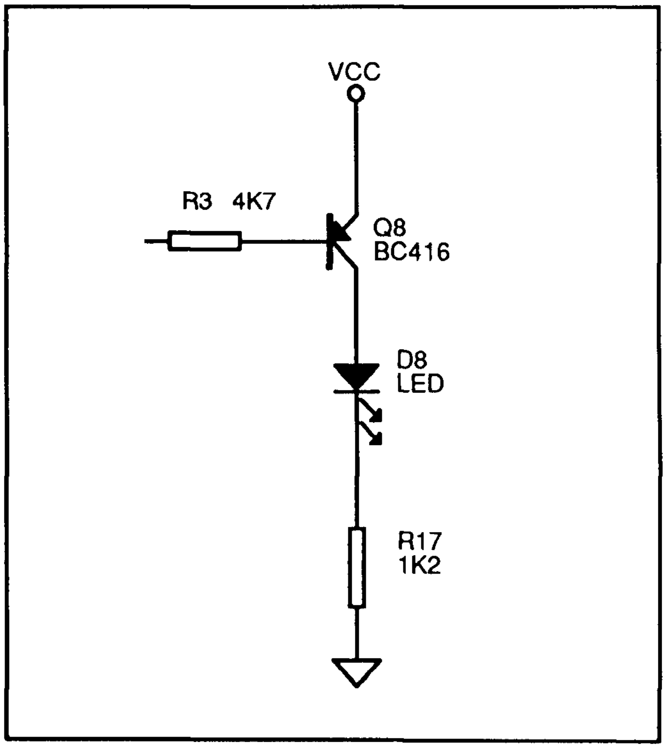


Fig 3—LED driver

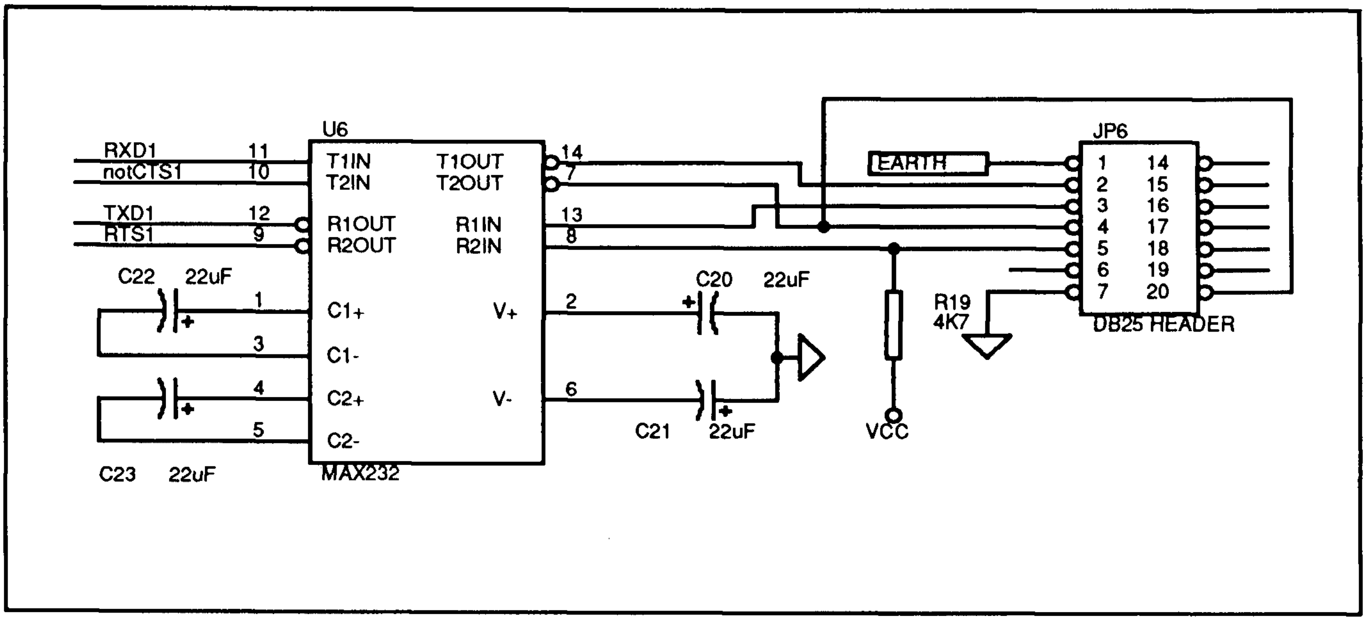


Fig 4—RS-232 to TTL converter

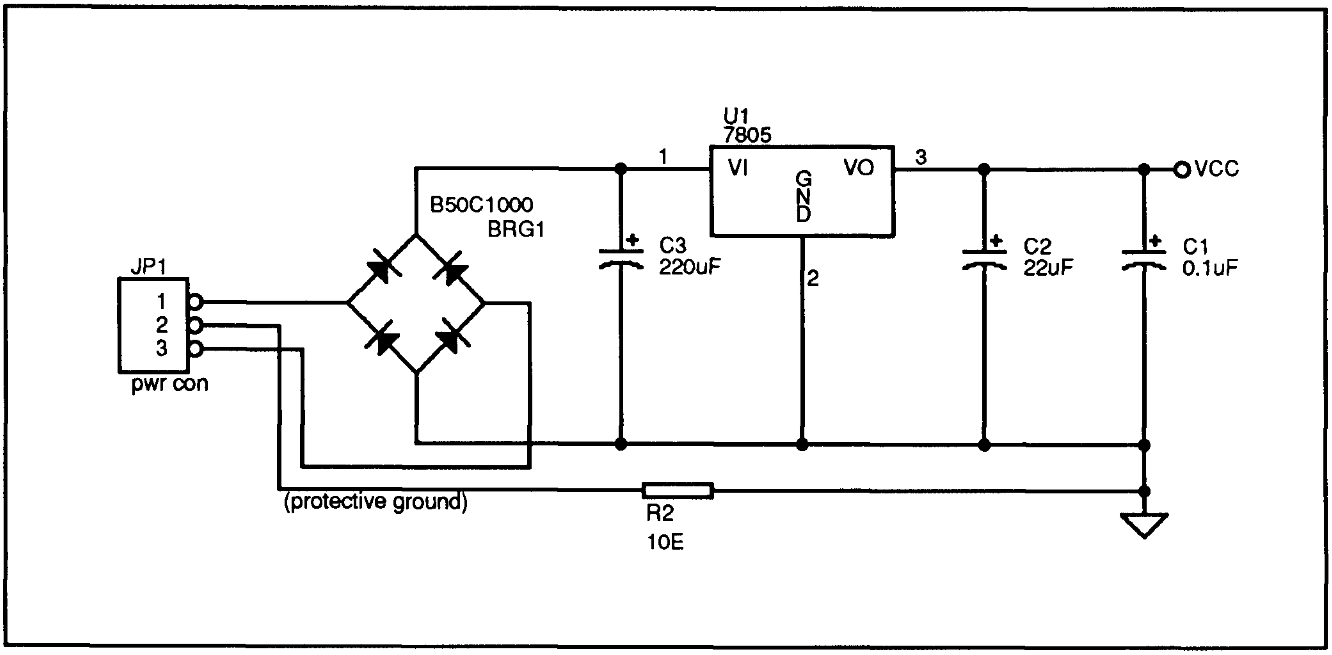


Fig 5—Five-volt power supply

may be used to implement over 900 equivalent logic gates. For the multi-TNC controller the programmed EPLD used 49% of its built-in logic gates. Because the EPLD provides 12 dedicated data inputs, 2 clock inputs and 24 I/O pins, the selection of the pins has to be done very carefully. The design uses every pin of the EPLD with eight channels; the layout of the EPLD is given in Fig 1. The EPLD comes in two versions, ie, an erasable version type number EP900-DC and a non-erasable version type number EP900-PC2. The EP910 is pin compatible with the EP900 but is more expensive. The EPLD should be programmed using a programming file that is available from the authors.

The clock signal required by the EPLD is generated by the NE555 clock circuit given in Fig 2.

Variable resistor P1 is used to adjust the clock frequency measured at pin 3 of U2. This clock frequency may be set to 450 Hz if 4.9 MHz TNCs are used with a data rate of 19200 bauds on the RS-232 line. The frequency of the clock is determined by C7 and P1. In order to obtain a setting of P1 somewhere in its mid-range, the value of C7 should not be increased. If the correct value can not be found, take the next lower value of say 180 nF instead. If possible look at the output signal on pin 3 of U2 to see if the signal is reasonably symmetric. It should be noted that the maximum clock frequency will not necessarily result in a maximum throughput. The clock switching will cause interrupts on the TNC resulting in additional overhead for the TNC. Therefore the maximum throughput may occur at a somewhat lower clock frequency. So far no measurements have been performed to substantiate this suspicion.

In order to check the operation of the controller, the CTS lines are connected to a LED display as shown in Fig 3. During normal operation the LEDs are illuminated at low intensity because of the switching frequency of 450 Hz. During actual operation a LED will be lit bright if its corresponding TNC transmits a packet through the controller. The transistor used in this circuit is an PNP-type BC416; it may be replaced with a 2N2905. Before soldering the transistors and LEDs, apply power after placing them. By touching the resistor in the base of the transistor one can see if the transistor and LED are properly inserted. Rotate the LED and/or transistor until the LED illuminates in this test. Only then may you solder these components in place!

The RS-232 to TTL conversion is done with a MAX232 integrated circuit, and is illustrated in Fig 4. It uses four 22 µF capacitors for the RS-232 level conversion. These capacitors may be low-cost aluminum electrolytic or tantalum if size is critical. The pull-up resistor on the RTS line is required to insure continued operation if not all RS-232 ports are connected to TNCs. The connection to the 14 pin DIL header have been laid out such that a flat cable connection may be used straight through to the 25-pin RS-232 connector at the TNC. One should realize that pins 4 and 20 of the header are tied together to accommodate both original TAPR TNCs and its clones. Before making the flat cables, select the proper layout and direction of the cables to ensure proper appearance.

The power supply circuit is given in Fig 5. It operates on 10 volts and higher. With higher voltages, the regulator U1 may become so hot that a heat sink may may required. The regulator should be mounted with its elevated body facing the EPLD. If the power supply is mounted first without soldering the regulator in place, the regulated voltage may be checked with a voltmeter to be 5 V on the MAX232 sockets between pins 16 (Vcc) and 15 (GND). If there is no voltage indication, the regulator may have been mounted in reverse!

The part layout of the multi-TNC controller is illustrated in Fig 6. Spacing for the LED is too tight for 5 mm LEDs. Orientation of the ICs is marked with a square pad on pin 1. Also the positive polarity of the electrolytic capacitors is given by a square pad. The complete schematics of the controller are given in Figs 7 and 8. The printed circuit board layouts are given in Figs 9 and 10.

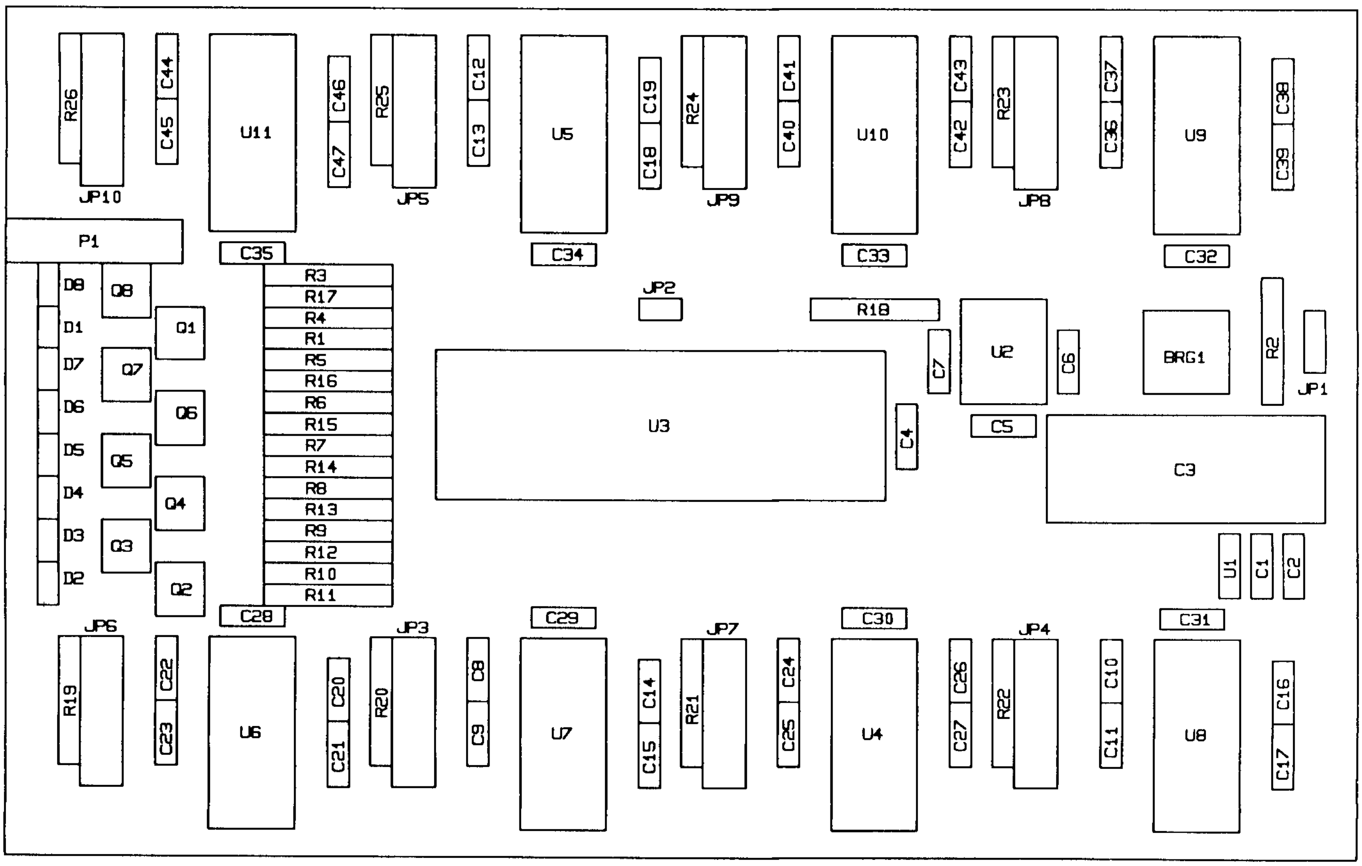


Fig 6—Parts layout for the multi-TNC controller

Table 1

Bill of Materials: Multi TNC controller, March 23, 1989
Revision: 2.0, Revised: May 26, 1989

Item	Qty	Reference	Part
1	8	D1,D2,D3,D4,D5,D6,D7,D8	LED
2	8	Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8	BC416 or 2N2905
3	8	R1,R11,R12,R13,R14,R15,R16,R17	1K2 (1.2 kΩ)
4	1	R2	10E (10 Ω)
5	16	R3,R4,R5,R6,R7,R8,R9,R10,R19,R20,R21,R22, R23,R24,R25,R26	4K7 (4.7 kΩ)
6	1	C1	0.1 μF
7	33	C2,C8,C9,C10,C11,C12,C13, C14,C15,C16,C17,C18,C19, C20,C21,C22,C23,C24,C25, C26,C27,C36,C37,C38,C39, C40,C41,C42,C43,C44,C45, C46,C47	22 μF
8	1	U1	7805
9	1	C3	220 μF
10	1	BRG1	B50C1000
11	1	JP1	Power connector
12	10	C4,C5,C28,C29,C30,C31,C32,C33,C34,C35	100 nF
13	1	P1	50 kΩ Bourns 3006-P-503
14	1	R18	3K3 (3.3 kΩ)
15	1	U2	NE555
16	1	C6	10 nF
17	1	C7	200 nF
18	1	U3	EP900-TNC2
19	1	JP2	2 header
20	8	U4,U5,U6,U7,U8,U9,U10,U11	MAX232
21	8	JP3,JP4,JP5,JP6,JP7,JP8,JP9,JP10	DB25 header (14 pins installed)

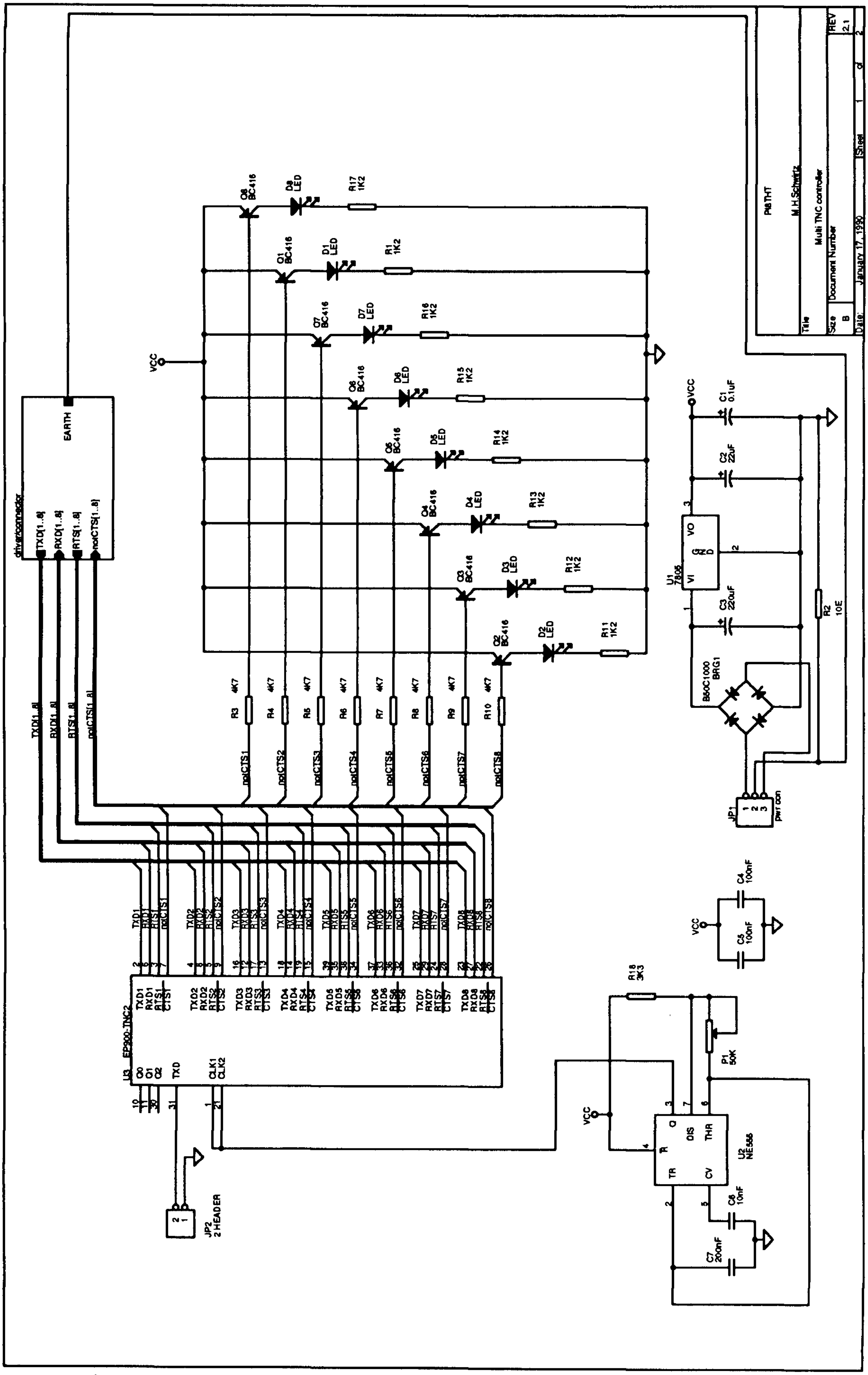


Fig 7—Multi-TNC controller schematic diagram

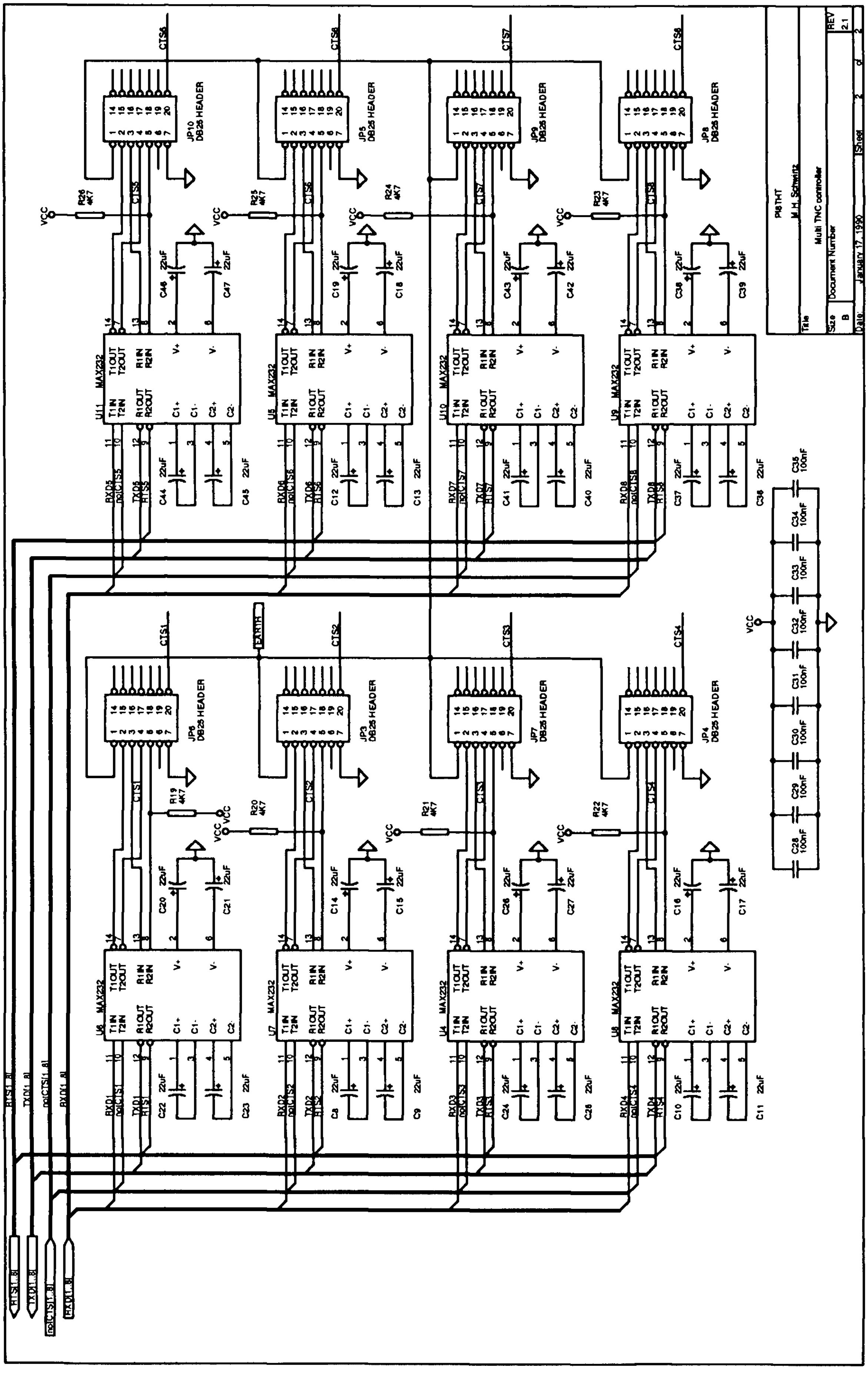


Fig 8—Multi-TNC controller schematic diagram

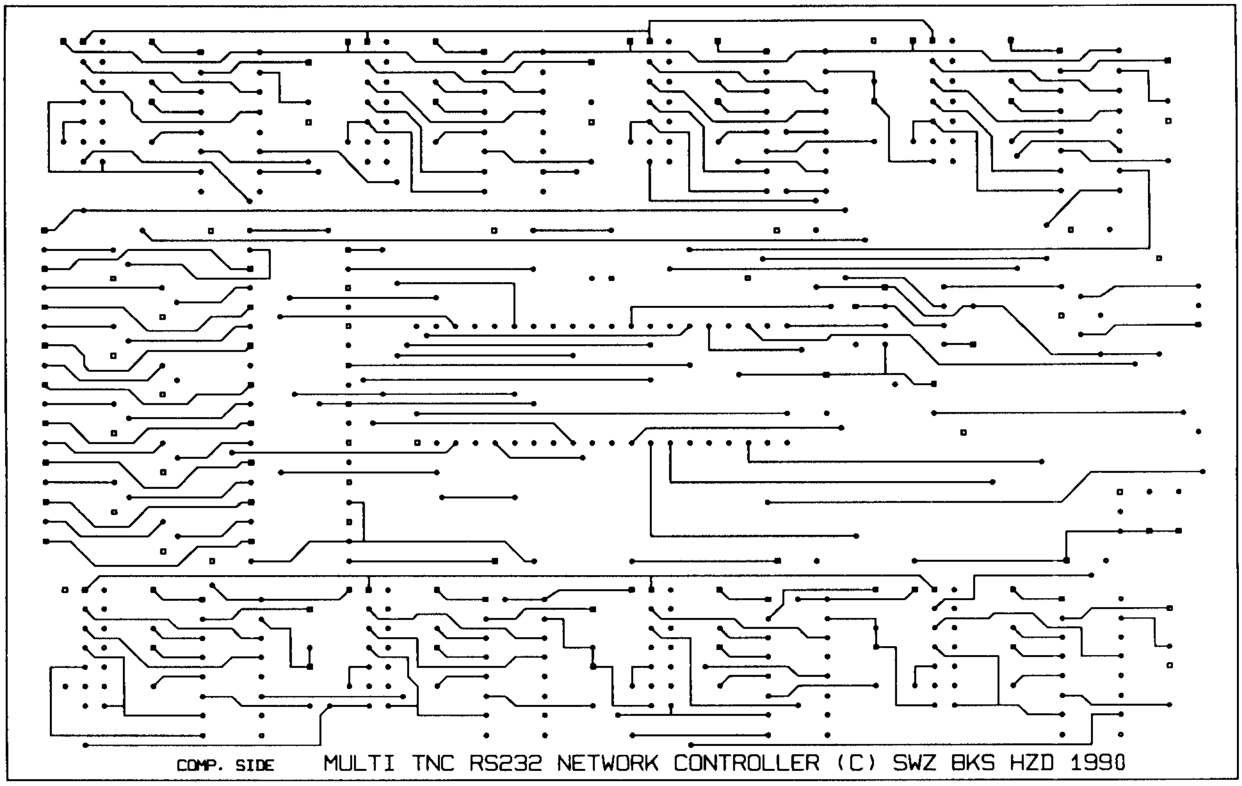


Fig 9—Multi-TNC controller PC board component side

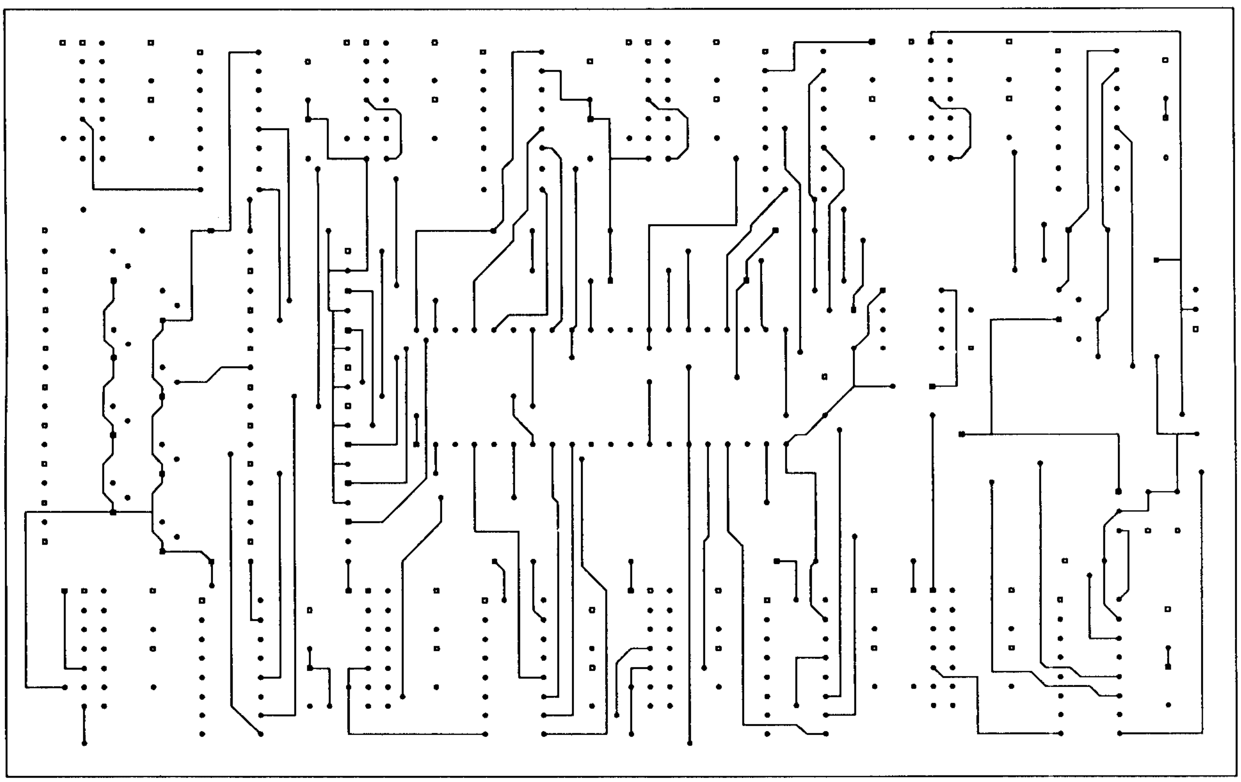


Fig 10—Multi-TNC controller PC board solder side

A Fifteen Channel Remote Controller for an OSCAR Array

By John White, VE7AAL
344 Oxford Drive
Port Moody, BC
Canada V3H 1T2

Introduction

The OSCAR antennas at VE7AAL consist of two Cushcraft 144-20T crossed Yagis, two Cushcraft 416-TB crossed Yagis and a quad of home-brew 20-turn helicies for 1269 MHz. These are all mounted on a single boom, on a 30-foot tower secured to the side of the house. The antenna array is low enough that the antennas are accessible when standing on the roof of the house, provided that they are turned and elevated in a suitable direction. Over a period of four years the antenna farm has grown from single Yagis to arrays, the 1269 has been added, feed lines have been changed out and general maintenance remains an ongoing task. To perform all these operations the antennas have to be rotated in azimuth and elevation to gain access to the part being worked on while standing on the roof.

The only way to gain access to various parts of the antennas had been to move them about while loosening the clamping hardware such that the array could be rotated by hand. This is workable except that nothing stays put and the array has to be mechanically realigned when the job is complete.

Electrical testing is also a problem. There has been need to check VSWR, power, and preamp operation at the antenna. This requires turning the transmitter on and

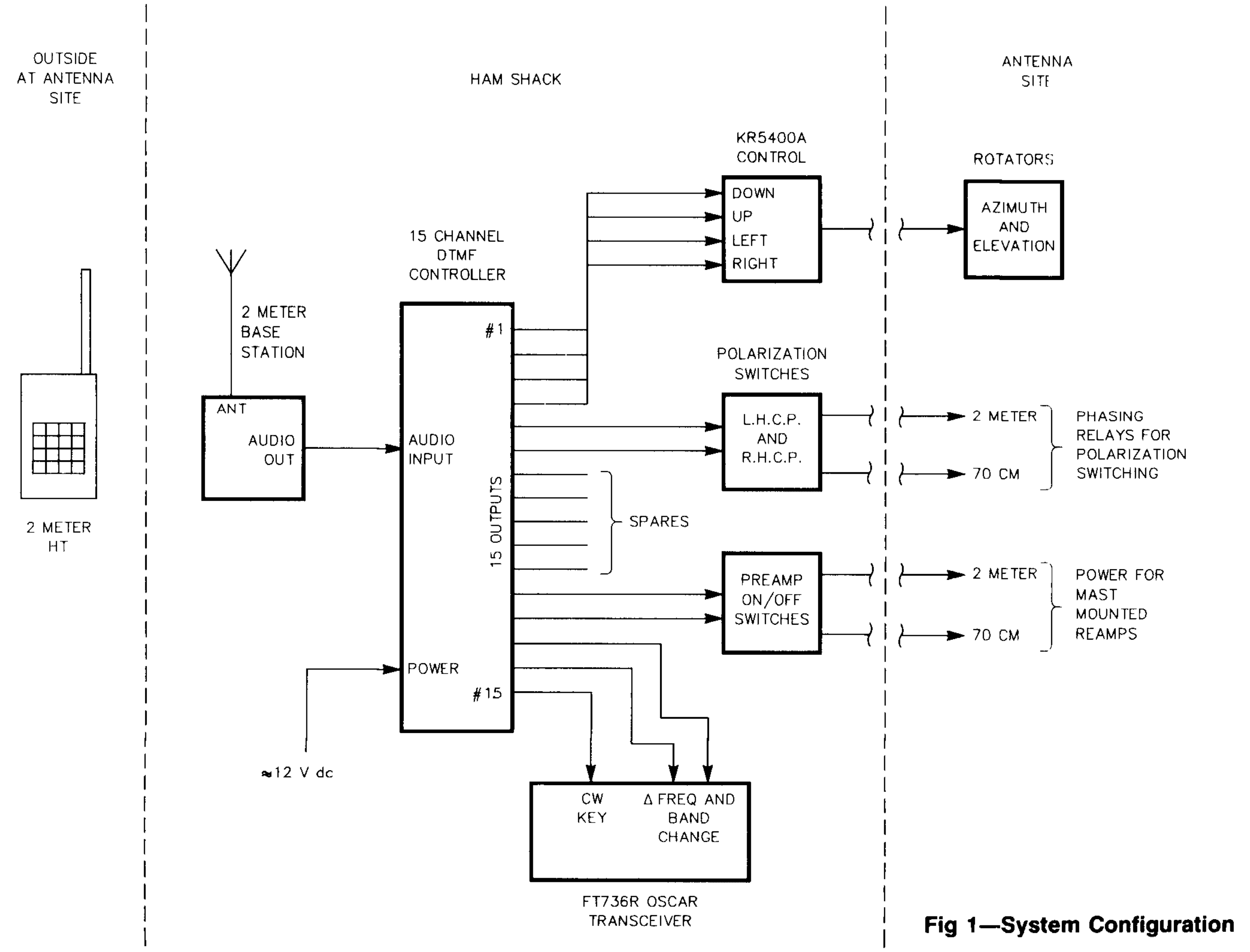


Fig 1—System Configuration

off as well as changing frequency and band. Running up and down ladders between the roof and the shack to turn things on and off may be good exercise, but it is most bothersome.

The ideal situation was visualized to be the control of these functions from the roof position, remotely. As such a wireless system has been built, which is described here, that allows control of azimuth, elevation, TX on/off, frequency change, band change, polarization activation and turning on and off of preamps from the roof.

Concept

The control is done through DTMF tones available on the HT (2 meters in my case). The tones are received by the base station in the shack, decoded and then directed to control a certain function. For instance, pressing the 1 digit turns on the UP function of the rotator; pressing the 1 again turns it off. Pressing the 2 turns on the DOWN, pressing again turns it off and so on. This is the "toggle" mode of operation. There is another mode which is a "momentary" action, that is, the action only occurs when the digit is pressed and ceases when the digit is released. This is used to change frequency and band on the transceiver. There is one last feature and that is an "all off" which terminates all operations.

System Design

Fig 1 shows a block diagram of the system. The HT is the control source and is in possession of the operator at the antenna array. It is shown with a keypad; there are 16 keys available to control 15 functions plus the "all off." These tones are radioed to the base station where the tones are recovered as audio. The tones are then fed directly into the DTMF controller unit from the audio output jack of the base receiver.

Table 1

Keypad Functions

Keypad	*Function*	*Type*	*U4 Output*	*U4 Pin*
1	Rotor Down	Toggle	Y1	9
4	Rotor Up	Toggle	Y4	7
7	Rotor Left	Toggle	Y7	4
*	Rotor Right	Toggle	Y11	19
2	Tx On & Off	Toggle	Y2	10
5	2-meter polarization	Toggle	Y5	6
8	70-cm polarization	Toggle	Y8	18
0	Preamps on & off	Toggle	Y10	20
3	Spare	Toggle	Y3	8
6	Spare	Toggle	Y6	5
9	Spare	Toggle	Y9	17
#	Spare	Toggle	Y12	14
A	Change freq up	Momentary	Y13	13
B	Change freq down	Momentary	Y14	16
C	Spare	Momentary	Y15	15
D	All Off	Momentary	Y0	11

The DTMF controller decodes the received tone and directs it to one of 15 outputs. Each output is connected to a unit which controls a station function. These are shown to be the Rotor Controller (KR5400A), the VHF/UHF transceiver (FT736R), the preamp power, and the antenna polarization unit.

Note that the DTMF controller has 15 outputs corresponding to each key on the HT pad; the 16th key is the "all off" which is internal to the controller. Table 1 summarizes the function (and the pin out of U4, a 4-bit-to-1-of-16 decoder which is discussed later).

Controller Functional Blocks

Fig 2 shows the functional blocks within the controller. The audio signal (DTMF tones) are coupled into the controller through an audio transformer which provides isolation between the radio receiver and the controller. The tone is fed into an industry standard DTMF decoder chip. This chip will take any of the 16 tone combinations and encode them as a 4-bit word (Q1/4). As well, the chip provides an output (STD) which is enabled only if the received tone is considered to be valid. Thus, a false word will not be used. This information is passed onto a 4-bit-to-1-of-16 decoder. This chip will activate one of its 16 outputs in response to a valid 4-bit word. If the received tone corresponds to a toggle function, the toggle circuits are activated. If the tone corresponds to a momentary function, the momentary circuits are activated and if the received tone is the "all off" function, all circuits will be forced to the off state (via D3).

The toggle circuit is described first. The enable bus will activate one input of all the enable AND gates if the data is valid. However, only one of these gates will have its other input enabled and that will be the one corresponding to the decoded output from the 1-of-16 decoder. With that particular gate enabled, the toggle flip-flop is latched into a state which drives its Q output high. This output is applied to a driver amplifier which in turn operates a relay and a front panel LED to provide verification of operation for that particular digit. The actual output is a set of relay contacts which provides isolation and the freedom to choose NO or NC contacts.

The F-F stays latched and the relay operated until the same tone is received again. When the next occurrence of the tone is recognized, the F-F is toggled into its complementary state and the relay and LED are held off.

The momentary function operates in much the same way except that there is no latching flip-flop; the output is only active in the presence of a tone. When the tone transmission is terminated, the 1-of-16 output is disabled and the relay/LED are deactivated.

In the case of the all off, the 16th output is enabled and is bussed to all latched flip-flops to reset them to their off state.

There are some peripheral functions as well. A power up reset is necessary to set all output to the off

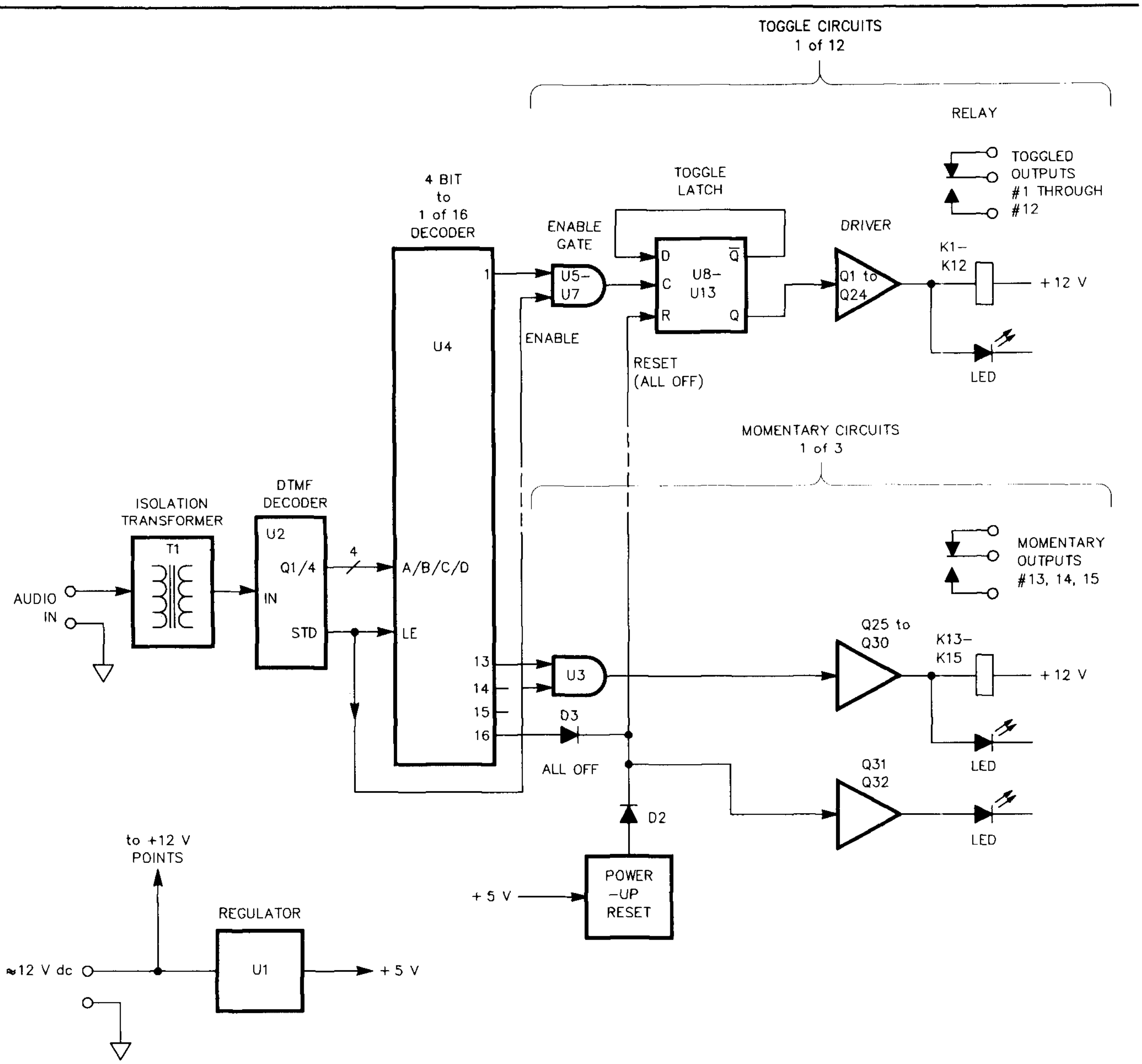


Fig 2—Functional Block Diagram

state when the controller is turned on. There is also a power supply which provides +5 V dc for the ICs; the relays are driven directly by the +12 V dc supply.

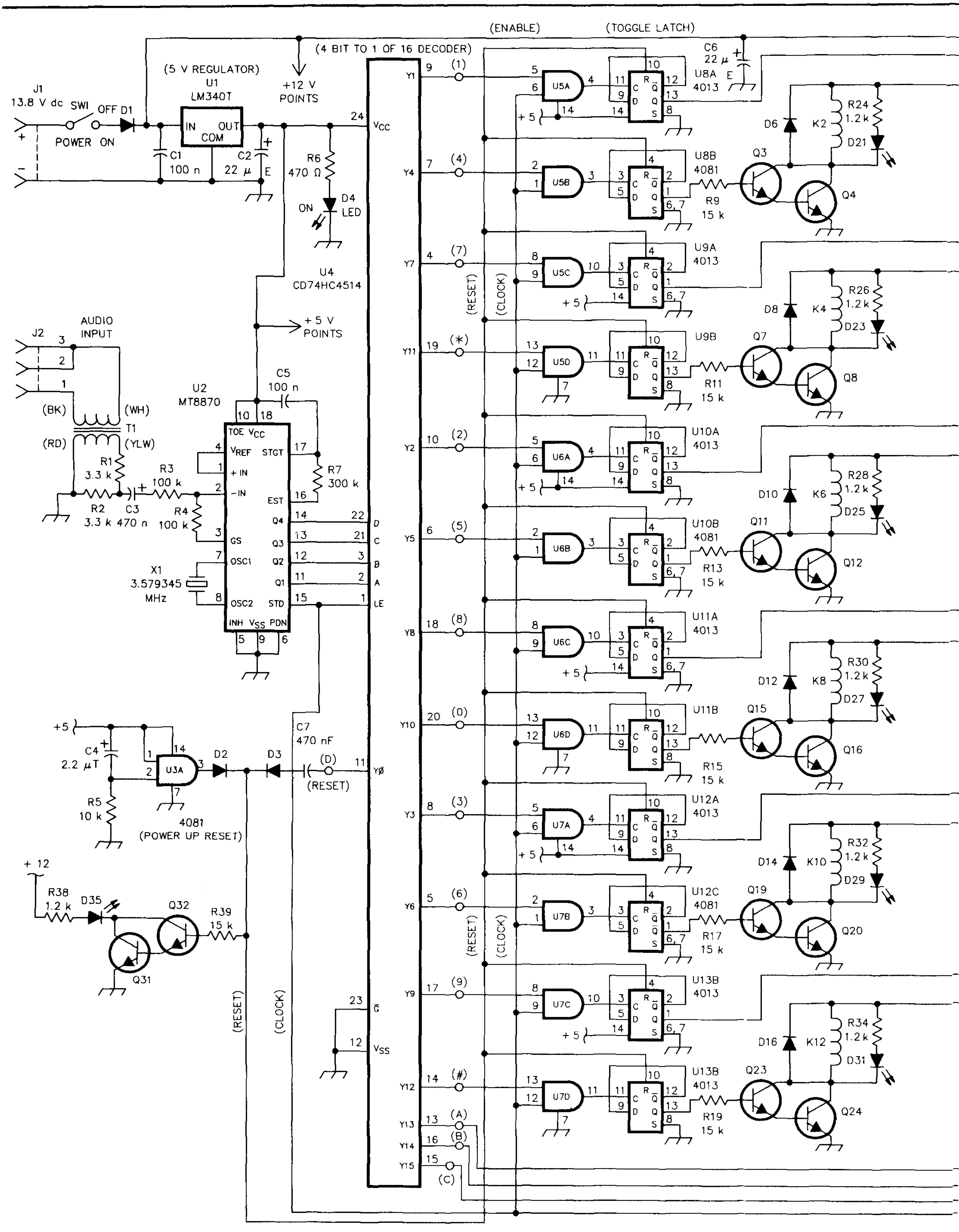
Electrical Implementation

A schematic is given in Fig 3 with an accompanying material list. The parts are generic, noncritical and mostly available at Radio Shack. A printed-circuit board has been made by the author; it is a double-sided through-hole board about 5 × 7 inches. Fig 4A is the component layout. Figs 4B and C are the printed-circuit pattern for both sides of the board. Should there be sufficient interest, a run of printed-circuit boards could be arranged; they would be about $30 each, though. Copies of the artworks are available for an SASE—note that US postage is not usable in Canada.

The controller uses +12 V dc as its primary power. This does not have to be well regulated. The current requirement would be about 1.5 amps if all relays and LEDs were on at the same time. Usually only two or three functions are enabled and so a 500-mA source such as a wall plug dc converter would likely be adequate.

Mechanical Implementation

The controller is assembled into a standard Radio Shack (metal) enclosure. Fig 5 gives nominal placement and dimensioning of the front panel display and controls, and the rear panel connectorization arrangement. My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(4 BIT TO 1 OF 16 DECODER)
(5 V REGULATOR)
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COM
+12 V
POINTS
J1
13.8 V dc
SW1
OFF
D1
POWER ON
C1
100 n
C2
22 μ
R6
470 Ω
D4
LED
ON
U4
CD74HC4514
+5 V
POINTS
AUDIO
INPUT
J2
(BK)
(WH)
(RD)
(YLW)
T1
R1
3.3 k
R2
3.3 k
C3
470 n
R3
100 k
R4
100 k
U2
MT8870
C5
100 n
R7
300 k
X1
3.579345
MHz
TOE
VREF
STGT
+IN
-IN
EST
GS
OSC1
OSC2
STD
INH
VSS
PDN
Q4
Q3
Q2
Q1
VCC
C7
470 nF
(D)
(RESET)
(CLOCK)
+5
C4
2.2 μT
R5
10 k
U3A
D2
D3
4081
(POWER UP RESET)
+12
R38
1.2 k
D35
Q32
R39
15 k
Q31
C6
22 μ
E
U5A
U5B
U5C
U5D
U6A
U6B
U6C
U6D
U7A
U7B
U7C
U7D
U8A
4013
U8B
4081
U9A
4013
U9B
U10A
4013
U10B
4081
U11A
4013
U11B
U12A
4013
U12C
4081
U13B
4013
U13B
4013
R9
15 k
R11
15 k
R13
15 k
R15
15 k
R17
15 k
R19
15 k
R24
1.2 k
R26
1.2 k
R28
1.2 k
R30
1.2 k
R32
1.2 k
R34
1.2 k
K2
K4
K6
K8
K10
K12
D6
D8
D10
D12
D14
D16
D21
D23
D25
D27
D29
D31
Q3
Q4
Q7
Q8
Q11
Q12
Q15
Q16
Q19
Q20
Q23
Q24
Y1
Y4
Y7
Y11
Y2
Y5
Y8
Y10
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Y9
Y12
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YØ
(1)
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(*)
(2)
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(0)
(3)
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(A)
(B)
(C)

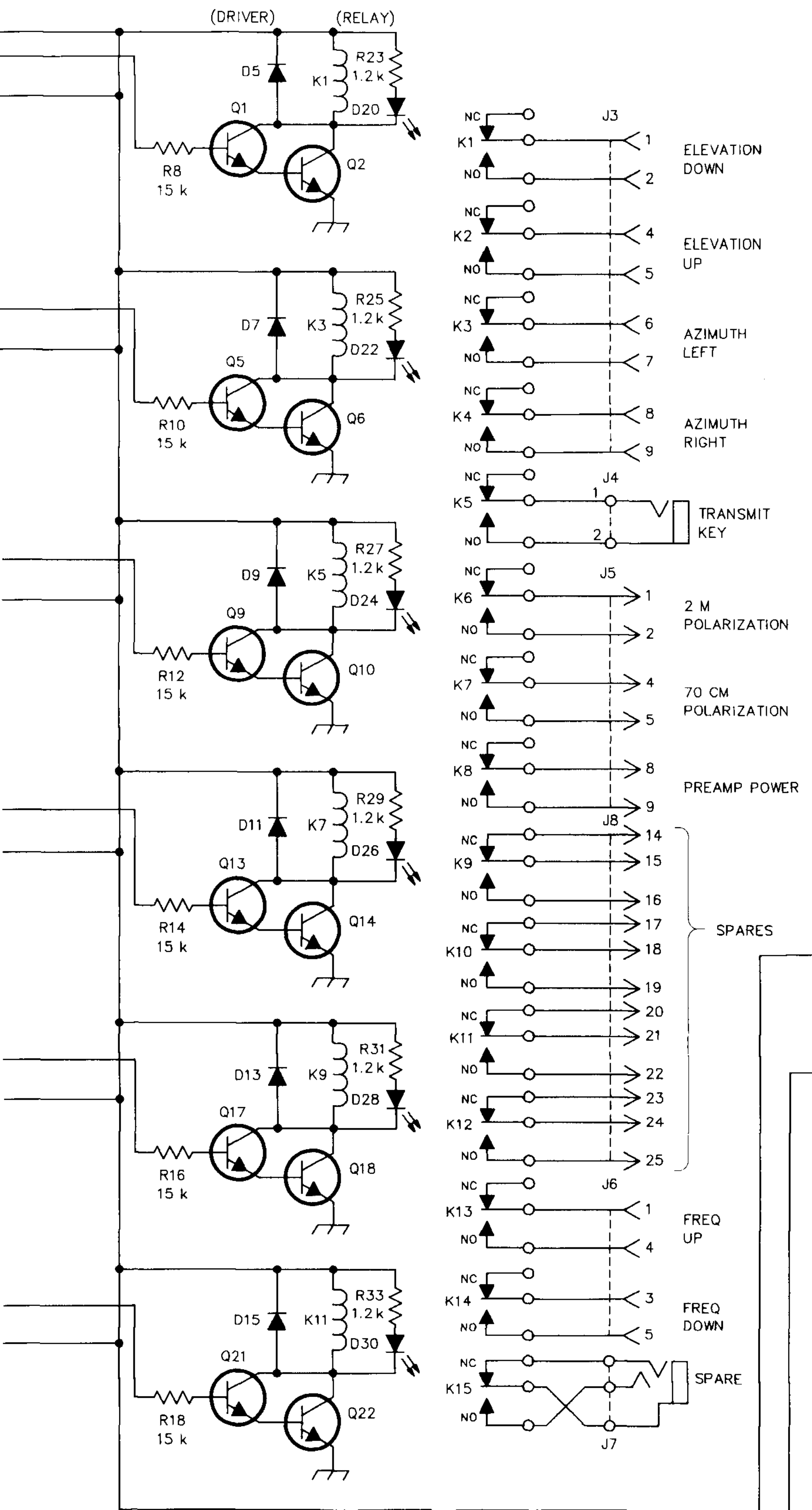
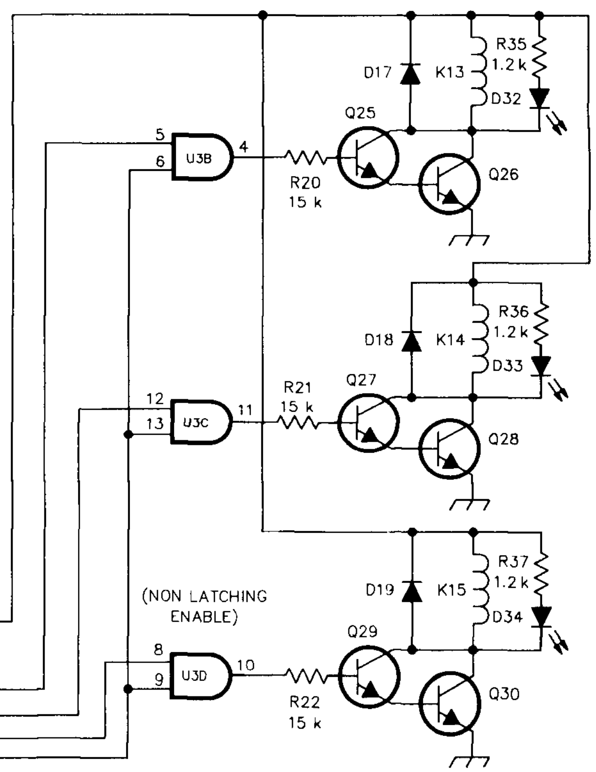


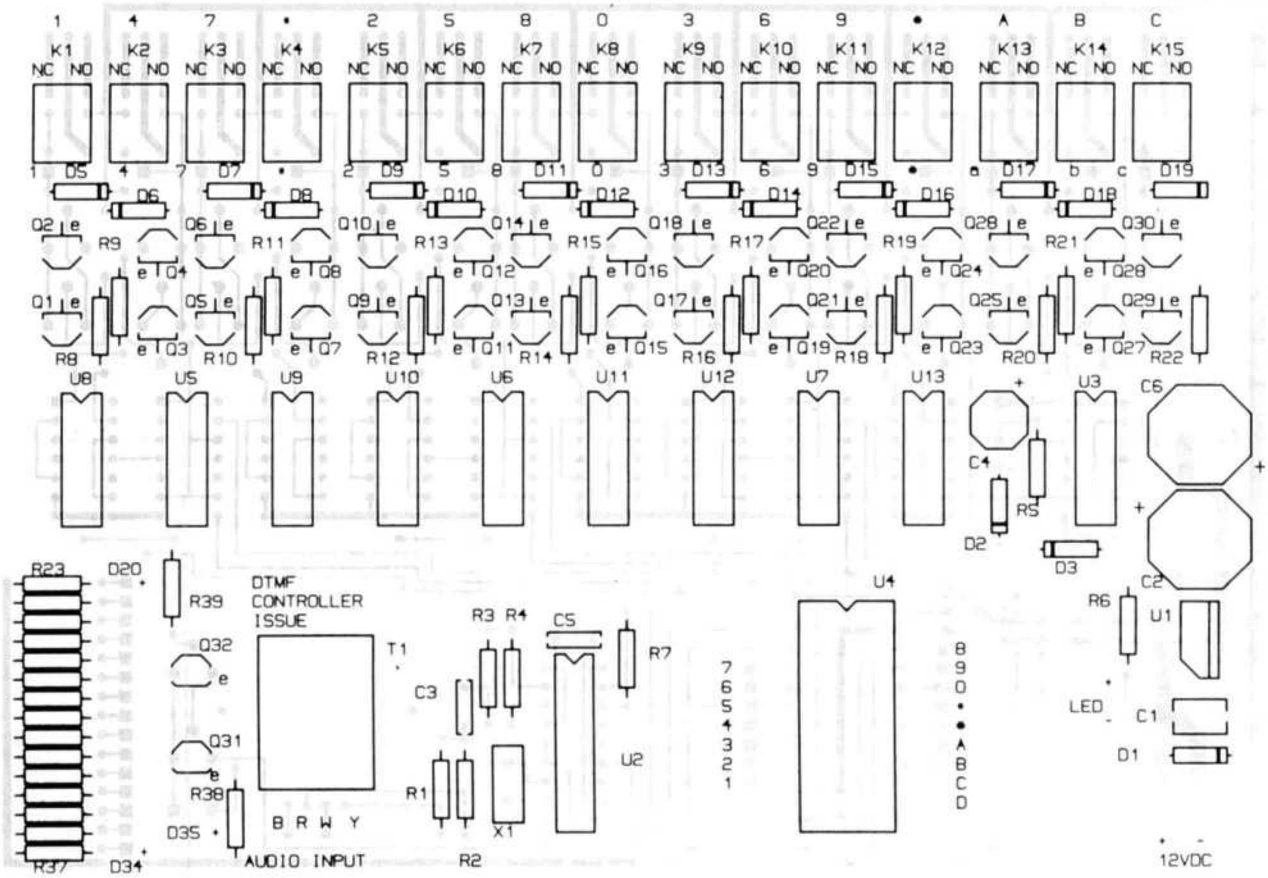
Fig 3—15 Channel DTMF Remote Controller

Parts List (closest Radio Shack part number) [quantity]

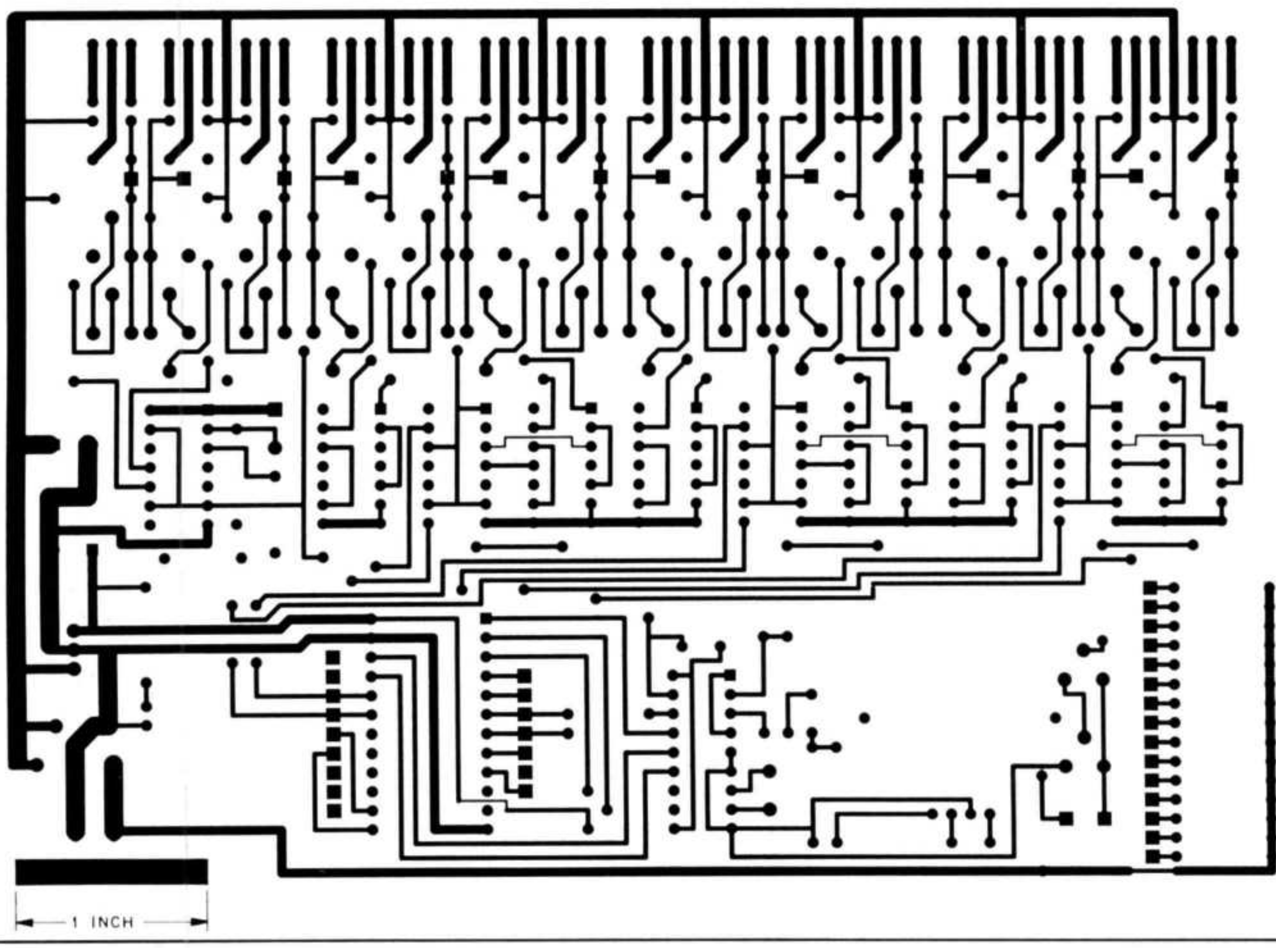
C1, C5—Capacitor, 100 nF, 50 V mono (272 109) [2]
C2, C6—Capacitor, 22 μF, 35 V radial (272 1026) [2]
C3—Capacitor, 470 nF, 35 V tant (272 1433) [1]
C4—Capacitor, 2.2 μF, 35 V tant (272 1435) [1]
C7—Capacitor, 470 nF, 50 V mono [1]
D1, D5-D19—Rectifier diode, 1N4001, 1 A/ 100 V (276 1101) [16]
D2, D3—Small signal diode, 1N4148 or equiv (276 1122) [2]
D4, D20-D35—LED, red, TLR-107 or equiv (276 033) [17]
J1—Jack, coaxial power panel mount (274 1565) [1]
J2—Jack, 4-pin microphone chassis mount (274 002) [1]
J3—Connector, submin D, 9-pin female chassis (276 1428) [1]
J4—Jack, ¼-inch phone chassis (274-255A) [1]
J5—Connector, submin D, 9-pin male chassis (274 1427) [1]
J6—Receptacle, 5-pin DIN socket, chassis (274 005B) [1]
J7—Jack, ¼-inch stereo chassis (274 312) [1]
J8—Jack, subminiature D, 25-pin male chassis [1]
K1-K15—Relay SPDT 1 A contact, 12 V coil (276 241) [15]
Q1-Q32—Transistor, 2N3904 NPN (276 2016 or 276 2017) [32]
R1, R2—Resistor, 3.3 k, ¼ W, 5% carbon (271 1328) [2]
R3, R4—Resistor, 100 k, ¼ W, 5% carbon (271 1347) [2]
R5—Resistor, 10 k, ¼ W, 5% carbon [1]
R6—Resistor, 470 Ω, ¼ W, 5% carbon [1]
R7—Resistor, 300 k, ¼ W, 5% carbon [1]
R8-R22, R39—Resistor, 15 k, ¼ W, 5% carbon [16]
R23-R38—Resistor, 1.2 k, ¼ W, 5% carbon [16]
SW1—Switch, SPDT panel mount (275 662) [1]
T1—Transformer, 1:1 audio 600 Ω (273 1374) [1]
U1—5-V regulator, TO220, LM340T (273 1770) [1]
U2—DTMF Decoder, MT8870BE (Mitel) [1]
U3, U5-U7—Quad, CMOS two input AND gate, 4081 [4]
U4—4-bit-to-1-of-16 decoder, CD74HC4514 (TI) [1]
U8-U13—Dual, CMOS type D flip-flops, 4013 [6]
X1—Crystal color burst, 3.579345 MHz (272-1310) [1]
14-pin DIP sockets, optional (276 1999) [10]
18-pin DIP socket, optional (276 1992) [1]
24-pin DIP socket, optional (276 1989) [1]
Housing > 3 × 5 × 7.5 inches (270 274) [1]
Heat Sink for U1 (276 1363) [1]



(A)


DTMF
CONTROLLER
ISSUE
AUDIO INPUT
B R W Y
12VDC
LED
K1 K2 K3 K4 K5 K6 K7 K8 K9 K10 K11 K12 K13 K14 K15
NC NO
U1 U2 U3 U4 U5 U6 U7 U8 U9 U10 U11 U12 U13
T1
X1
C1 C2 C3 C4 C5 C6

(B)


1 INCH

(C)

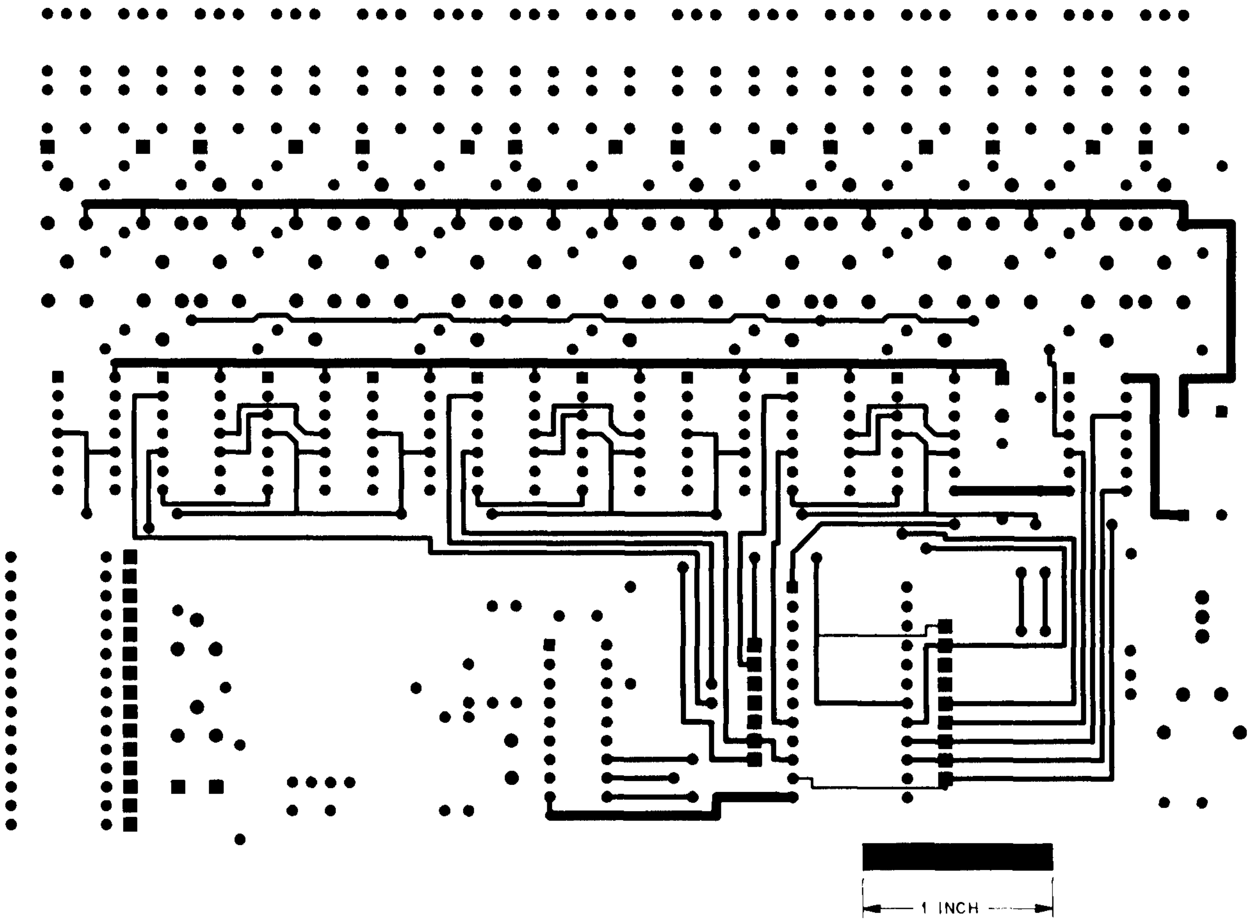


Fig 4A—Parts placement

Fig 4B—Component side

Fig 4C—Solder side

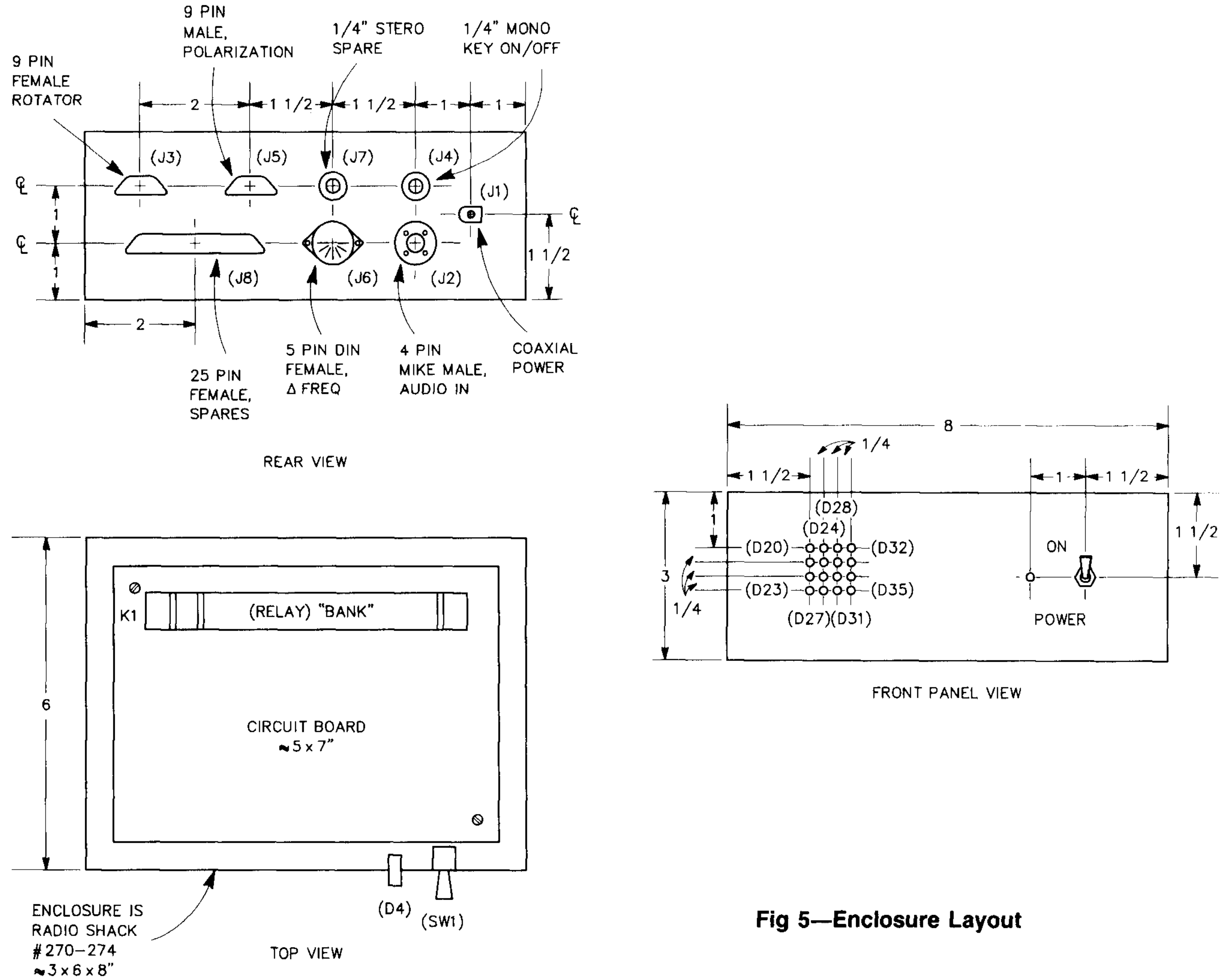


Fig 5—Enclosure Layout

controller is totally connectorized and cables are needed to connect all the station controls together since the controller is not permanently installed. Unique connectors were used for each functional group, ie the rotor controller has a DB9 connector, the audio output is a MIC jack, a MIC jack, the transmitter key is a ¼-inch phone jack and so on. In this way one cannot interconnect incorrectly. All connections are made to the rear of the enclosure.

The front panel has a power on/off switch and LED. More importantly, there is a 4 × 4 array of LEDs. These correspond to the 4 × 4 DTMF pad keys. When a particular key is operated, the corresponding LED will light up to confirm visually that the function is operational.

Summary

The controller has been in operation at the station for nearly a year and has proven to be of tremendous help. Although it is now winter and little outdoor activity is taking place, it will certainly be used for next spring's maintenance and enhancement plans "on the roof."

VHF + Technology

By Geoff Krauss, WA2GFP
16 Riviera Drive
Latham, NY 12110

New Book—I recently purchased a copy of the new (1989) RSGB *Microwave Handbook, Volume I—Components and Operating Techniques* which is to be followed by companion volumes on construction of rigs, test equipment and the like, and on equipment for specific bands (1.3, 2.3, 3.4, 5.6, 10, 24 GHz and above). The editor (M. Dixon, G3PFR) has assembled a most interesting first volume, with content of great depth and technical excellence; this volume, at least, is not for neophyte microwavers, but will make for very good follow-on work to the more basic material soon to be published in the *ARRL UHF/Microwave Experimenter's Manual, Volume 1*. North American microwavers who own one of the later editions of the RSGB's well-known Evans and Jessup *VHF/UHF Handbook* will find familiar much of the older material in this new RSGB Microwave book, although there is also a great amount of new material and even several computer programs written in relatively standard BASIC language.

In Spring, a young (radio) person's fancy turns to thoughts of. . . summer propagation and contests! In my home area, some of the grid-hopping group are building more of the duplex-type microwave equipment set which I have written about lately (see Fig 1). Oh, it is true that these rigs are not 1990s state-of-the-art (SOTA) equipment, but they are more transportable than the KK7B/WA8NLC-type rigs (and the companion 144-MHz transceiver) that are SOTA on the 33, 23, 13 and 9 cm bands; it is the ability to carry a station to a location off the beaten track that is a prime consideration for many of the several dozen rover people with whom I have discussed this activity in the last few years. Many of you may remember my comments on the origins of contest rovers (the multioperator contest groups pioneering large scale use of a "new" band generally must send out a rover team of their own people, just to have someone on the other end to talk to; then, to make it fairer for all, a contest rule was enacted allowing a single station on a grid-pedition to be counted **for both contact and grid credit** in each new grid it is used in). Well, it seems that some of the locations selected, being high up on mountains to afford best line-of-sight coverage, also have some nice scenic views, as do many of the trails and roads that the rover has to traverse to get to the contest QSO site. After a few contests, word apparently got around about both the enjoyment of rovering and the ease of operating the simple equipment. Many new rover candidates have appeared; some now even want to hike/climb/go to locations which were unthinkable several years ago, but which might be doable with some more powerful equipment and much perseverance. So, special (light-weight) versions of microwave exciters, converters and IF strips are being built, along with pack-mounted batteries and accessories for some of the younger hams who want to rover to new places this summer. Will they have equipment which can

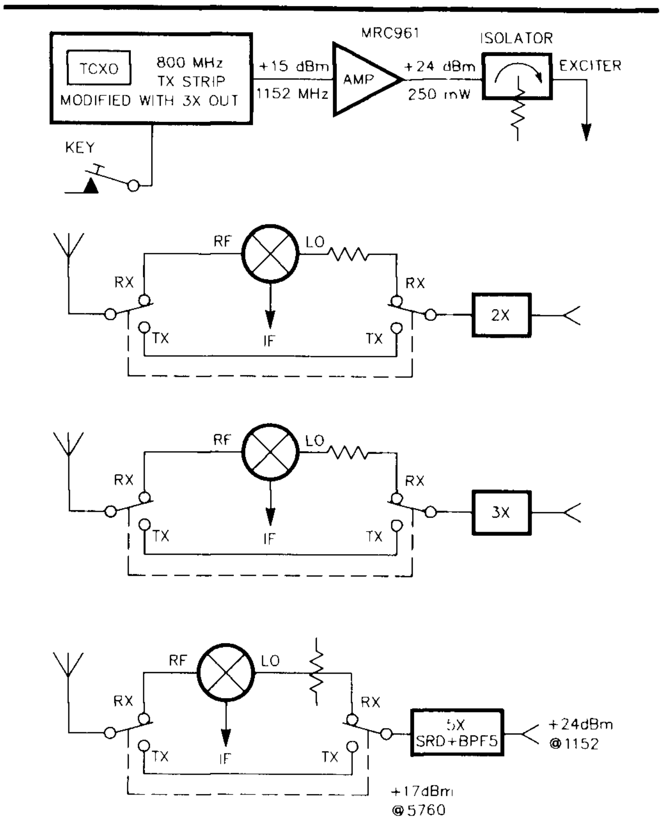


Fig 1

QSO *anyone* who wants to talk to them? No!! Only those stations who are equipped for the special duplex form of operation, with the right offset frequencies used, can even attempt contact,. . . *but* there are a growing number of such stations here in the northeast who are willing to use something less than SOTA equipment and techniques to try to have some fun. There will probably be those who feel that this is less-than-ideal, and I agree with them; I, too, would like to see every rover equipped with a FM/CW/SSB set up for all bands, 50-432 MHz, with transverters to 902, 1296, 2304, 3456, 5760 and 10368 MHz, at least. But the economics of most people's situation just doesn't make that feasible. The weight of the resulting package also dictates that simple CW duplex stations be used, especially if as many bands as possible are to be accommodated, in addition to the needed batteries and an obligatory 2-FM or 220-FM transceiver for liaison work. Each of the rover teams, themselves, picked what they wanted from a selection of what is available, and the CW duplex approach won so often that it was standardized (at least for us, here and now). Not every rover is happy with this choice; some are planning a multiband SSB station that can only be van-mounted, with a portable generator and multifeed dish on a short folding tower. But this will not be as easy to build as the simpler setups, nor will more than one such unit actually be built because of cost factors. When this unit finally is available, just about anyone in the area should be able to QSO the van at several of the planned locations.

Why is it so hard to build a multiband VHF+ rover? Because, given the desire to have a new grid put on-the-air on one or more bands not normally workable from that grid, even if commercial equipment is available for most of the bands, there is one band for which no commercial rig, or easily built and reproducible amateur design for the majority of needed subassemblies, has ever been available. This, of course, has to do with. . .

The State-of-the-Art in the 5650-5925 MHz (6-cm) Band

My first move in determination of amateur SOTA was to check my box of articles for 5760 (the weak-signal frequency on this, and for which mode I would expect most work to normally be done): a whopping total of **four** whole articles in 33 years of collecting! One was the now-famous early-60s write-up by members of the Santa Barbara Microwave Society, on FM work using klystron-equipped Polarplexers (use of klystons is *not* a viable technique today). A second article was the Al Ward, WB5LUA, article on microwave preamplifiers from the May, 1989 issue of *QST* (for which unit kits, parts and complete amps are available from Down East Microwave); these units could also be used for transmit amplifiers, to a power output of perhaps +17 dBm (50 mW) after a SSB/CW up-conversion mixer, if one were available. The other two articles were, it is true, about techniques for building these types of mixers, but use European parts, dimensions, etc. The specific microstrip line patterns are not useful (because the specific type of PC board is usually not available here) even though the design problems and solutions are, of course, useful anywhere; the basic information is available in many other books (even if not normally for hams) but not having some specific design already done and tested means that one would have to do a complete development program. It's not easy at almost 6 GHz!

Are there hams on 5760 MHz? Yes. Is the 5760 population growing? Yes, but not nearly as fast as the growth on 2304 or 3456 MHz. Why is this so? Remember that the recent rapid increase in use of 2304, and especially 3456 MHz, has been due to the availability of the WA8NLC transverters, which make use of printed microstrip filters and silicon monolithic microwave integrated circuits (MMICs). It is true that the no-tune filters can be used at 5760, although, because the wavelength is only about ⅔ of that at 3456, the 5760 filters will be smaller, and holding of required dimensional tolerances will be that much harder. Still, it can be done, even on a semi-production basis. The real problem is that the commonly available silicon MMICs are already falling off in gain and output power by 3.5 GHz, and are basically useless at 5.7 GHz. Sure, use of GaAs MMICs would probably correct this problem, except that GaAs MMICs are few and far between and, even then, are not to be found at ham-affordable cost. Without a reproducible transmit-receive converter being readily available for this band, what *is* state-of-the-art?

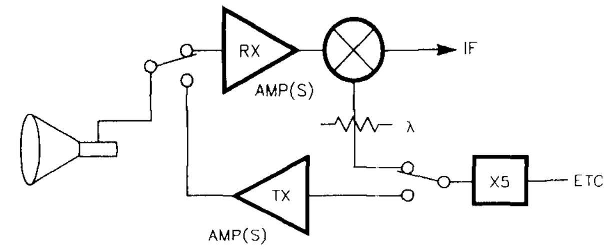


Fig 2

The area in which the SOTA should be easily found by anyone is 6-cm antennas: There are no practical Yagis (loop or otherwise) at this short a wavelength; a horn is almost universally used, either alone, with gains up to 20 dB for short-range work (to 50 miles), or with a parabolic reflector for much increased gain (up to about 46 dB for a 16-foot diameter dish with 50% efficiency). Of course, high gain equates to narrow beam width (a 12-foot dish will have a beam of about 1° width, which is hard to aim at a terrestrial target, but is still wider than the angle subtended by the moon for EME work). The circular cylindrical feedhorn, whether used alone or at the focus of a dish, should have a diameter of more than 0.59 wavelength; a practical value is about 0.68×6 cm $\approx$ 1.6 inch. Horn length should be at least 2 wavelengths, or about 12 cm $\approx$ 4.7 inch. I have used a tomato sauce can to good advantage (just like my standard 23-cm horn is a pair of 3-pound coffee cans soldered end-to-end, a 1-pound coffee can is great on 13 cm, as is a racquetball can on 9 cm). The probe is placed about 1 inch in front of the closed can end and the probe is formed of no. 18 wire, or about ½-inch length (if you can get access to a return-loss measurement setup, vary the probe length for maximum return loss); I typically get 26+ dB RL, which is a VSWR less than 1.1:1. As suggested in Fig 2, a properly sized brass funnel can make a very good 5760 antenna, as can a proper length of waveguide WG-112 or WG-137. Waveguide is heavy (important if backpacking) but may also have to be considered for transmission line since the attenuation of usable coaxial cables is very high at 6 cm.

Receiving converters are superheterodyne mixers, preferably with an image-rejection filter after the 'LUA preamp. Surplus filters, mixers, couplers and the like, are still the main source of subassemblies here. Unlike 2304, and perhaps 3456 MHz, one would like to avoid use of poor mixers because losses are sufficiently hard to overcome at 5760 MHz. Luckily, there is rather a lot of now-outmoded 6-GHz commercial equipment which can be made to function at 5.7 GHz (it's only 5% lower!). Thus, a decent 6-cm receiving converter might use a surplus cavity for an input filter, followed by a two-stage 'LUA preamp, a surplus bandpass filter, and a surplus microstrip-type mixer with low-side LO injection. If you have access to engineering equipment and techniques, a lower noise LNA could probably be put together and tweak-tuned (remember that the 'LUA

(continued on page 25)

Conducted by: Stan Horzepa, WA1LOU
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Wolcott, CT 06716-2702

PACKET RADIO STARS AT DAYTON HAMVENTION

New Packet-Radio Wares on Display

The 1990 edition of the Dayton HamVention® provided a platform for the introduction of a bevy of new packet-radio products. So much so that it took most of the weekend to see it all and so much so that I can only mention each new item briefly to make sure I get them all in. Here they are in alphabetical order.

The forthcoming (autumn 1990) AEA DSP-1232 and DSP-2232 multimode controllers were showcased at the AEA booth. The DSP-1232 ($789) and DSP-2232 ($999) use digital signal processing (DSP) to provide compatibility with nearly every modem standard you are likely to encounter in Amateur Radio today and tomorrow. The DSP-1232 has two switchable active radio ports, whereas the DSP-2232 has two simultaneously active radio ports. AEA also announced the availability of a 2400-baud PSK modem for their PK-232/MBX multimode controller.

The new *ARRL 1990-1991 Repeater Directory* ($6) containing listings of major packet-radio operations was available at the ARRL booth. The Second Edition of *Your Gateway to Packet Radio* ($12) was sold-out on Friday. A new shipment was delivered on Saturday and, by the end of the day, that was sold out, too.

Bartech (4110 Emerson Av NE, Cedar Rapids, IA 52402) introduced its Station Control Node system ($250) that uses packet radio to control and monitor remote equipment. Current applications include a telemetry system for a solar-powered car, a multifunction ATV repeater controller and a remote equipment controller/monitor.

DRSI has the DSP*Packet Adapter ($750), which is a DSP version of their TNC-on-a-PC-plug-in-board product line, scheduled for mid- to late-summer release. This one radio port board uses the Motorola 56001 DSP chip and an optional daughter board to provide a second radio port. A new *PC*Packet Adapter User's Manual* is now available to all owners of the PC*Packet Adapter. Contact DRSI for your copy.

Grace Communications (623 Palace St, Aurora, IL 60506) showed its PackeTen Communication System, a high-speed multiport packet switch that supports bit rates up to 4 Mbit/s. It can be configured as a stand alone or as a high-speed communications co-processor for a PC/XT/AT computer. When fully configured, the switch supports six full-duplex, high-speed channels (up to 4 Mbit/s) and four lower-speed channels (up to 19.2 kbit/s).

HamPute (PO Box 6797, Auburn, CA 95604-6797) displayed the first issue of *HamPute*, a bimonthly periodical devoted to DSP and other high tech modes of Amateur Radio.

Kantronics' booth featured its Data Engine platform ($370), a high-speed (56 kbaud) dual port TNC and the $79 DE1200 1200-baud modem for installation in the Data Engine. Also on display was their DVR 2-2 fast-switching 2-meter data/voice radio for $219 (a 70-cm version, the DVR 4-2, will be available in late 1990) and the Kantronics Telemetry Unit (KTU) with Weathernode EPROM ($299), a DTE that interconnects weather sensors to any TNC.

The MFJ-1278T Turbo ($360), an MFJ-1278 with a new 2400-baud modem (the $80 MFJ-2400), was on display at the MFJ booth.

The PacComm booth featured their new $220 Handi-Packet TNC, a 1.28 × 2.55 × 4.15 inch unit in an all-metal RF containing case that includes a built-in 500-mA/h battery pack, personal BBS (supporting message-forwarding and reverse-forwarding), open squelch DCD and belt clip. Another highlight of the booth was the PSK-1 modem ($220) that is compatible with the new MICROSAT packet satellites (OSCARs 16, 19 and 20), as well as OSCARs 10 and 13. In the software arena was AC4X's Node Manager, a PC terminal program that front-ends the G8BPQ software switch in conjunction with PacComm's PC-100 TNC-on-a-PC-plug-in-board series (the software is bundled with the PC-100 series).

Pavillion Software (PO Box 803, Hudson, MA 01749) had the new version of its PacketCluster software (version 4.0) for $200 at *The DX Bulletin* and *The W6GO/K6HHD QSL Manager List* booth.

At the busy TAPR booth, the latest release of TNC 2 firmware (version 1.1.7) and its brand new manual were available ($12).

Technical Excellence Award Presented to N4HY

For the second year in a row, a packet-radio mover and shaker came away with one of the three awards presented at the Dayton HamVention banquet. This year, Bob McGwier, N4HY, a name and call sign that have graced the pages of *Gateway* innumerable times in the past, walked away with the Dayton Amateur Radio Association's (DARA) Technical Excellence Award. (Last year, Phil Karn, KA9Q, the father of packet-radio TCP/IP, received the DARA Special Achievement Award.)

Bob's achievements were listed briefly in the Dayton HamVention program: "Bob is a member of the original team who pioneered the MICROSAT series of OSCAR satellites in late 1987. His specific contributions include writing command, telemetry and control flight software for all of the MICROSATs, designing the Digital Orbiting Voice Encoder (DOVE) and managing software and computer hardware design for the MICROSATs.

"N4HY is the author of the well-known satellite tracking software known as Qwiktrak. For seven years, this software has been the single largest source of revenue for AMSAT.

"Bob has co-authored several articles for *QST*, and has written several papers that appeared in the proceedings of the ARRL Computer Networking Conferences. He is currently Assistant Vice-President of Engineering for AMSAT and is a former member of the TAPR Board of Directors."

In his free time, Bob and Tom Clark, W3IWI, have championed the cause of digital signal processing (DSP) in Amateur Radio applications.

Packed Packet-Radio Forum Emphasizes Improvements

Improvements in packet radio was the main topic of the packet-radio forum at the Dayton HamVention this year as a bevy of speakers kept a full house of listeners riveted to their seats for the entire Friday afternoon session. The forum was organized and moderated by Bob Neben, K9BL, and featured the following talks.

Lyle Johnson, WA7GXD, told us what to expect in the way of hardware and software improvements as packet radio matures in the 1990s.

Harold Price, NK6K, narrated 35-mm slides of the MICROSATs' pre-launch preparation and discussed the broadcast protocol which will soon replace the Pacsat's digipeater function.

Bob McGwier, N4HY, answered the question "Why DSP?" To do modems in software (instead of hardware) was his answer.

"Improvements in Digital Packet Hardware" was presented by Bdale Garbee, N3EUA, and Dom Lemley, N4PCR, who discussed their extensive experiments at 10 Mbit/s.

Phil Anderson, WØXI, described the Kantronics Data Engine and was joined by John Wiseman, G8BPQ, who explained why he plans to use the Data Engine as a platform for his future software design efforts.

Jim Hendershot, WA6VQP, told us how to save channel space in crowded areas by using ACSSB with modified 2-meter SSB transceivers operating at 4800 bauds.

Greg Jones, WD5IVD, discussed the state of TexNet and revealed some new projects coming out of the Lone Star State including TexLink, which is TexNet on an EPROM for installation in a TNC 2, and Project Cardinal, which is an effort to put a TexNet network control processor (NCP) on a PC XT plug-in card. A dual port daughter board for a TexLinked TNC 2 is also under development.

Jay Nugent, WB8TKL, and Brian Straup, NQ9Q, closed the forum with their description of the The Great Lakes Net, which is the implementation of TexNet in Michigan and Indiana.

AMSAT-ITALY MICROSAT PROGRESS

Alberto Zagni, I2KBD, reports that AMSAT-IT achieved a major milestone in the construction and assembly of their MICROSAT when they successfully tested their new on-board computer (OBC) design. This OBC is based on the design found in the current flock of MICROSATs. The biggest difference is that the AMSAT-IT OBC consists of three printed circuit boards instead of two. With the help of Lyle Johnson, WA7GXD, Harold Price, NK6K, and Bob McGwier, N4HY, the OBC worked the first time running the software they had developed. During the same testing, I2KBD also reported that the computer was sending telemetry.

from AMSAT

DIGITAL CONTROL PETITION WITHDRAWN

On April 19, the ARRL formally withdrew petition RM-7248, concerning automatic control of HF digital communications, from consideration.

The petition, filed Dec 12,1989, sought FCC rule-making from interested parties in the matter of automatic control of HF packet stations. When it became apparent that the proposal was controversial, ARRL requested that FCC extend the deadline for reply comments by 45 days, to April 23.

"The petition," ARRL General Counsel Christopher Imlay, N3AKD, wrote to FCC Private Radio Bureau chief Ralph Haller, "was the result of experience gathered pursuant to a Special Temporary Authorization (STA) granted by the Private Radio Bureau, and twice renewed. A number of amateurs, operating pursuant to the STA, have established a message traffic system which has worked well over the past several years and has given the amateur community some insight into the proper regulatory framework for such operations."

The League's short-lived petition accomplished two things. It encouraged discussion, resulting in a number of constructive alternatives. The generally thoughtful response to the petition also demonstrated that additional time would be needed to arrive at a workable plan, thus making it more likely that the STA will be renewed.

Prior to the filing of RM-7248, there was reason to believe the FCC might allow the STA to expire unrenewed; the petition addressed that possibility.

Criticism of the petition came in part from other users of the CW subbands; some offered alternative proposals for automatic control of HF digital communications on some limited basis while protecting those other users from interference and still allowing the much-needed development of a more efficient packet network to proceed.

"The League is no longer convinced," Imlay's letter to the FCC continued, "that the rules proposed in its petition necessarily represent the most efficient plan for permitting automatically controlled HF RTTY and data communications in the Amateur Radio service.

"The petition incorporated previously concluded international band planning efforts of IARU Region II, though other approaches could be consistent with such planning as well."

ARRL/CRRL NETWORKING CONFERENCE: CALL FOR PAPERS

The deadline for receipt of camera-ready papers for the joint ARRL/CRRL Computer Networking Conference is August 6. Those wishing to submit paper(s) for this 9th conference are urged to obtain an author's package from Lori Weinberg at the ARRL, 225 Main St, Newington, CT 06111. Topics may include, but are not limited to, HF packet investigations, packet satellites, network development, hardware, protocols, software, packet services and future systems.

London, Ontario, Canada will be the site of this year's joint ARRL/CRRL Computer Networking Conference, which will be held on Saturday, September 22.

PC TNC EMULATION SOFTWARE IN THE WORKS

Coming soon: TNC emulation software for the IBM® PC and compatible computers. Flori Radlherr, DL8MBT, the author of DIGICOM, the very popular TNC emulator for the Commodore C-64, is presently testing BAYCOM for the PC. BAYCOM will include all of the features of DIGICOM (remote commands, screen editor, etc) and more.

Besides the software and a PC, all that is required is a serial port on the PC and a simple one-chip (TCM 3105) modem that can be built for approximately $30. Note that BAYCOM is still being tested as this is written. An official announcement concerning its actual release will be forthcoming.

By the way, BAYCOM is named after Bayern, Bavaria.

A MEDIUM SPEED MODEM FOR AX.25 PACKET RADIO LINKS

This paper describes experiments and development work on a 3000-bit/s modem for use over amateur packet radio data links by Mike Tubby, G8TIC, and Robin Downs, G8VPQ.

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Introduction

At present, the majority of the UK's packet-radio links operate at 1200 bit/s, the same speed as the user access and user channels. James Miller, G3RUH, described a 9600-baud modem for high speed links.[1] Many of the G3RUH boards have been sold, but, as yet, only a few are in active service.

The main reason for the small number of links using this design may appear to be the difficulty in implementing reliable links. Some people have suggested that the signal strengths required to make the link work are some 20 dB or so stronger than those originally required by Miller.

In addition, the modem's transmitter side needs configuration for the inadequacies in the distant receiver (ie, the programming of the transversal filter EPROM) making multidropped (multiuser channel) systems difficult to implement unless the same radio equipment is used at all stations.

The 1200-baud modulation standard we use is based on simple FSK with tones of 1200 and 2200 Hz. This, not surprisingly, is the American Bell 212 telephone modem standard and is implemented by both the AM7910 and TCM3105 integrated circuits.

Since late 1982, data systems over PMR radio have been available. PMR systems operate on channel spacings of AF bandwidth requirements, which are tighter than those used by amateurs. This led to modems being developed specifically for PMR systems.

FX439 Modem IC

One device now available is the FX439 from CML.[2] This is a single chip modem for data transmission/ telemetry over PMR type radios at 1200 bit/s. The FX439 uses tones/modulation compatible with the DTI's specifications MPT1317/MPT1327 FFSK (Fast Frequency Shift Keying).

FFSK is better described as coherent FSK, that is, the two tones used are generated from the same reference source and are phase continuous. The tones used are 1200 Hz and 1800 Hz and, as the device is synchronous only (unlike the AM7910 and TCM3105), it provides both transmit clock and receive clock to the serial controller IC.

On transmit, the FX439 always generates either (a) one cycle of 1200-Hz tone or (b) one and one-half cycles of 1800-Hz tone. The cycle always starts and ends at the zero crossing point and is, hence, phase continuous (ie, phase coherent).

At 1200 bit/s operation, the total audio bandwidth required (tones plus modulation) is 900 Hz to 2100 Hz. This is significantly better than the AM7910 and TCM3105, which have significant sideband energy at 3400 Hz when being modulated by 1200-bit/s data.

The advantages of the FX439 are:

- Near optimum bandwidth usage
- Easy to set up and use — only input and output levels need adjustment
- Fast carrier lock up/data detect; typically 16-bit periods, ie, TXDELAY = 3 is usable with radios with PIN diode switching
- Good BER (bit error rate); typically 1 in 1OE5 with only 20 dB SNR and 1 in 1OE4 at 12 dB SNR
- Inexpensive
- Low power consumption CMOS

NRZ vs NRZI Operation

The FX439 can be used in data transmission systems employing NRZ or NRZI encoding. The AM7910 and TCM3105 devices must be used in the NRZI mode because they are asynchronous-only modems. The use of NRZI encoding adds clock edges from the transmitter to the data in order to allow the receiving modem/demodulator to recover the original transmitter's clock (or an approximation of it). This is usually done with a state-machine (eg, TAPR TNC 2), edge detector/shift register (eg, TINY-2) or digital phased-locked loop (eg, PK88/IBM PC cards: DRSI/ PC120, etc). NRZI encoding is not required when the FX439 is used because it recovers the synchronous clock from the data tones themselves (this can only be done because phase coherent tones are used).

NRZ coding, while simpler to implement for people building new/homebrew TNCs, loses the high-low/low-high tone independence which is inherent in NRZI. This independence is useful on HF because it allows either sideband to be used to receive the data.

The implementations in this paper assume that NRZI operation will be retained.

Connecting the FX439 to Existing TNCs

Whether the FX439 is used at 1200 bit/s or 3000 bit/s, modifications to the TNC are necessary because the FX439 always provides the synchronous clock signals (TX SYNC and RX SYNC). As the FX439's synchronous clock signals are at 1 x data rate, connection cannot be made through the modem disconnect header. Instead the appropriate pins of the SIO have to be connected to directly after isolating unwanted parts of the TNC's original modem.

DCD on the FX439 is active high rather than active low as it is with the AM7910, therefore, an inverter is required when DCD is used. DCD is detected by an internal integrator which is part of the signal-to-noise comparitor. An external capacitor is used to alter this timing.

Connection to TNC 2-type TNCs

Most TNCs use a 74HC107 or equivalent JK flip-flop and an inverter to encode the NRZ data from the SIO into NRZI. The local HDLC baud rate clock (at 16 × data rate) is divided down to 1 × data rate and fed into the 74HC107 (the divider is typically half of a 74HC393). This 1 × clock must now be provided by the FX439 so that the SIO generates the data bits to be transmitted at zero crossings in the tones.

On receive, the FX439 provides both clock and data outputs. If the TNC uses a shift register and edge detector (eg, TINY-2) for NRZI/NRZ conversion on receive, then this needs to be replaced.

If the TNC has a "finite state machine" type decoder (eg, MFJ-1270/1274, BSX-2, RLC-200, etc), this can be reprogrammed to operate with the 1 x receive clock from the FX439. (Robin, G8VPQ, can provide the necessary details on reprogramming of the state machine EPROM.)

Connection to Zilog SCC-based TNCs

TNCs like the PK88 and plug-in cards for the IBM PC (DRSI, PC120, RLC-100, etc) are based on the Zilog SCC. This device is newer than the SIO and is able to handle NRZI encoding/decoding internally.

Note that normally in the NRZI mode, the SCC will have an otherwise spare pin programmed to output 32 × clock (the internal DPLL RX clock) which is divided externally by 32 and fed back in as the transmit clock. With the FX439, the divide by 32 is not required. The SCC is still programmed by software for the baud rate in use (on receive), but generates transmitted packets at the rate defined by the clock output from the FX439. Also note that the FX439's RX SYNC pin is not used.

Operation at 3000 Bauds

CML claim that all their devices are 100% functional at a clock rate of twice the normal specification. This lead us to believe that the FX439 would function at 2400 bit/s or possibly higher.

Experiments were carried out to find the highest clock rates into the FX439 that resulted in reliable operation. The lock rate select pin (19) was held low to select operation with a 1.008-MHz crystal and various TTL level clocks were injected into the device under test. The device was operated in local loopback and carrier detect and receive data were monitored.

The highest data rate that was found to work reliably was 2926 bit/s, which was obtained by using a 2.4576-MHz clock. This frequency is commonly found in TNCs as it is used by the AM7910. The data rate is equal to 1200 × 2.4576 / 1.008 or 2926 bit/s (we refer to this as 3000 bit/s) and yields transmit tones of 2926 Hz and 4389 Hz, which are phase coherent. The overall bandwidth requirements are increased by the same amount and the channel bandwidth is now 2000-5100 Hz.

When used at 3000 bit/s, the DCD signal does not always appear to work correctly. The TNC requires a DCD signal to enable CSMA to operate and may not receive packets if DCD is not present at the serial controller. We recommend that the squelch signal from the radio be used as the input to the TNC.

Using the 3000-bit/s Modem and Radio Considerations

In order for the FX439 to be used successful, the following practical considerations should be borne in mind.

a. The device is designed to perform best with 250-mV RMS signal at the receiver input.

b. The receive input should be AC coupled through say O.1 μ and there should not be a resistor to ground at the device's input as this alters the bias conditions on the substrate.

c. The transmit audio output pin is high impedance (around 10 k) and becomes distorted if loaded by a low impedance. So, use a buffer op amp into the radio's transmit modulator.

d. Pick-up of HF noise and clock signals in the TNC on the receive input pin (due to stray capacitance, etc) can degrade operation at high baud rates. So, fit the 1000-pF decoupling capacitor.

e. The transmitter/receiver used to make a 3000-bit/s link needs a flat response with minimum group delay/phase distortion.

The transmit/receive tones should not be subjected to HF pre-emphasis/deemphasis in the radio, ie, tones should be sent at equal deviation levels on the radio channel.

Most radios will work well using this modem design with little or no modification providing they have 25-kHz channel spacing filters. Radios used/modified for the G3RUH 9600-baud modem are ideal.

Inject the transmit tones into the transmitter after the microphone amplifier/limiter, ideally at the "set deviation" pot.

Take the receive audio directly from the discriminator output prior to any deemphasis circuitry using an op amp, if necessary, to buffer/amplify the level.

f. Keep the transmitter's deviation down to around 2.5-kHz peak so that the signal comes through the receiver's IF filter.

Using the 3000-bit/s Modem with G8BPQ Systems

If the FX439 is used at 3000 bit/s with a G8BPQ-type system, then the following notes will be of interest.

KISS-mode TNCs connected via a serial (COM:) port: No changes are needed to the configuration file since all timing, etc, is local to the TNC. It is, however, worth having the serial port communications to the KISS-mode TNC at a higher speed than used on the radio channel. A data rate 4800 baud is recommended between the PC and the KISS-mode TNC.

Internal HDLC cards (RLC-100, DRSI, PC120, etc): The configuration file must show the exact data rate being used by the SCC for receive because the SCC's programmable divider is used to operate internal DPLL. For operation at 3000 bit/s, the entry in the PORT definition must include "SPEED = 2926."

Conclusions

The 3000-bit/s modem is currently "working but experimental." Robin, G8VPQ, has a dedicated link between the NEC and VPQ network nodes operating at 3000 bit/s with Pye R414/T414 UHF link radios. Observations of this equipment show that it is highly reliable with error rates and retries significantly lower than the previous 1200-bit/s link.

The modem is still being developed and tested. We plan to implement several more dedicated point-to-point links using this technique in the FourPak (SW Midlands) area. A small adaptor printed circuit board, called "FX/AM," will soon be available from Mike Tubby to allow the FX439 to be plugged into the socket of an AM7910.

When development of this project is complete, we will issue full circuit diagrams, parts lists, etc. Anyone interested in building the 3000-bit/s modem can contact the authors for further details as needed.

References

[1]A 9600 baud high speed modem, J. Miller, 1987.

[2]FX439 Data Sheet, Consumer Microcircuits Ltd, Nov. 1988.

from *Connect International*

GATEWAY CONTRIBUTIONS

Submissions for publication in *Gateway* are welcome. You may submit material via the US mail or or electronically, via CompuServe to user ID *70645,247* or via Internet to *70645.247*@compuserve.com. Via telephone, your editor can be reached on evenings and weekends at 203-879-1348 and he can switch a modem on line to receive text at 300, 1200 or 2400 bit/s. (Personal messages may be sent to your *Gateway* editor via packet radio to WA1LOU @ N1DCS or IP address 44.88.0.14.)

The deadline for each installment of *Gateway* is the tenth day of the month preceding the issue date of *QEX*.

VHF +Technology

(continued from page 20)

preamps are fixed tuned to average device parameter values). Beware of any tube-type items for reception use on this band; small-signal TWT amps may be labeled "Low Noise" but that's relative to other TWTs—the noise figure can still be higher than a bare mixer, as a number of buyers learned some years ago.

The biggest problem is the generation of a signal at 5+ GHz; generating a highly stable signal is truly difficult whether for a local oscillator or for a transmitter. Again, most solutions center around the use of surplus parts or entire oscillator multiplier chains. There are many "brick" sources to which one applies power, and possibly an external frequency-controlling signal (if the brick source does not have an internal crystal/oscillator), and can obtain appreciable 5-6 GHz power output; changing frequency becomes only a matter of changing the crystal to one at a new frequency and can be ordered from any one of the several suppliers advertising in the usual ham magazines. There is a good article on "Surplus Microwave Local Oscillators —Evaluating and Modifying Them," by Charles Osborne, WD4MBK, in the *Proceedings of Microwave Update '88*, available from ARRL. The same mixers that are used for reception can be used to up-convert a VHF-SSB signal (preferably from 432, rather than 144 MHz, to give more spacing between desired and image frequencies and thus makes the filtering job easier) if 6-cm SSB is desired. The same LO chain and mixer can be used on transmit and on receive. In fact, if up-conversion is used, the resulting 5760 signal is likely to be so weak that amplification, as with the 'LUA preamp used for receive, may be required. There are several ways to get some transmit power: Amplification by tubes, such as TWTs, or amplification by solid-state devices, such as power-GaAsFETs. Either way requires some specialized knowledge, which few have. As on the 9-cm band, may VHF+ers seek a surplus commercial TWT amplifier, complete with power supply and all the needed goodies, to make the task possible: There are not that many such units around, which indicates that there will not be all that many SOTA stations on 6 cm in the immediate future. Much more experimentation and publication is needed on this band.