QEX 24 February 1984

The ARRL Experimenters' Exchange

QEX's Twenty-Fourth Issue

This edition of QEX includes the index for issues 13 through 24. In case you are missing any previous copies, Hq. will be happy to supply you with single copies of QEX back to issue no. 1 for $1 (U.S., Canada and Mexico) or $2 (elsewhere).

M²I² UC Grows 100% in One Month

Since the announcement in QEX no. 23, the Sony ICF-2002 Users' Cult has doubled its membership. Our second member is Harold Winard, KB2M who supplied the following information:

The service manual (with schematic and block diagrams) is available at $4 plus $0.75 handling (include your state's sales tax if there is a Sony office in your state) from:

Sony Consumer Service Company
Technical Publications Department
8281 N.W. 107th Terrace
P.O. Box 20407
Kansas City, MO 64195-0407

Handbook Construction Projects

Our call for people to develop several construction projects for the 1985 Radio Amateur's Handbook (QEX no. 22) has yielded some results. QEX subscriber Warren Dion, N1BBH, who presently lives in Connecticut, visited ARRL Hq. several times to discuss our requirement for a gelled-electrolyte battery system, with charger. Just the other day he brought in the nearly completed prototype, which looks great. We have a possible candidate to do the TV-receiver-to-monitor conversion. It looks like we may need to defer the deluxe phone patch until the 1986 Handbook, since our 1985 Handbook construction-project deadline of April 15 is fast approaching.

NF-105 Manuals

We would like to extend our appreciation to the donors of NF-105 manuals. We received three, all quite different.

Third ARRL Packet Conference (Trenton, NJ)

If you are interested in hearing the latest in amateur packet-radio developments, try to get to the Third ARRL Amateur Radio Computer Networking Conference at the Trenton State College on April 15, 1984, starting at 10:30 A.M. The conference will be inside the Trenton Computer Festival (TCF84) which runs April 14 and 15. No separate fee is required to attend the ARRL conference other than the TCF84 nominal registration. Proceedings containing papers presented will be on sale at the conference and at ARRL Hq. The price of the proceedings will be announced later.

The deadline for camera-ready papers for this conference has been extended from March 1 to March 15, 1984, at ARRL Headquarters. All papers should be mailed to Paul L. Rinaldo, W4RI, ARRL, 225 Main Street, Newington, CT 06111. For an author's kit call 203-666-1541 and ask for Marian Anderson, WB1FSB. Briefly, papers are to be typed on 11- x 14-inch white paper, in two 50-character columns, same as used for the second ARRL networking conference and same as IEEE papers. All drawings must be camera ready. Photographic positive black-and-white prints of good quality may be included. Use abbreviations listed on pages 53 and 54 of the January, 1984, issue of QST.

Florida Amateur Digital Communications Association

We just received Vol. 1, No. 1 of the FADCA Beacon, a well-written newsletter edited by W1BEL. FADCA was formed from the two Florida Beta Test groups for the Tucson Amateur Packet Radio (TAPR) terminal-node controller (TNC). The group is involved in VHF local-area network (LAN) operation on the statewide packet frequency 147.465 MHz and is interested in HF, meteor-scatter and HF packet experimentation.

FADCA's membership fee is $10 per year. Contact Gwyn Reedy, W1BEL, 812 Childers Loop, Brandon, FL 33511, 813-689-3355 after 8 P.M. Eastern Time. Gwyn requests that anyone wishing information should be sure to include a business-size s.a.s.e. with at least 37 cents postage. -- W4RI

Correspondence

Comments on METSCAT

The Central Iowa Technical Society was excited to learn of your METSCAT development efforts in the December 1983 QEX article (no. 22, p. 3), "'PACKET' METEOR SCATTER COMMUNICATIONS." It serves as an excellent introduction of this mode of digital communications to our technically minded Amateur Radio community.

Our organization has been researching METSCAT literature for several months and have arrived at a set of operating parameters which we are in the process of applying to a practical test. I bring the results of our research to your attention because it has caused us to go forward with significantly different plans than your article outlines. This leads us to believe more discussion of this mode is in order.

First, we would like to offer a few corrections in the METSCAT basics you have provided. The maximum great-circle distance between stations is approximately 2000 km (1200 statute miles), with best communications performance achieved between 600 and 1000 statute miles. The long-term average throughput of a properly configured METSCAT system would be at least 100 WPM (30 kbytes per hour), although diurnal and seasonal variations in meteor bursts approach a ratio of 4:1.

It should be said that significant commercial METSCAT development has taken place in the past several years with commercial "packaged" systems available off-the-shelf. At least two major METSCAT systems are in operation. One is the Department of Agriculture's SNOTEL system that includes nearly 500 remote data terminals in eleven western states and is used for geophysical data acquisition. The other, AMBCS, is operated in Alaska by several government bureaus for weather and flight data acquisition and teletypewriter message communications with field survey teams.

Modern commercial METSCAT research has looked at an operating frequency range which includes our 10-, 6- and 2-meter amateur bands. Results of this research indicates that the range of best communications performance is 30 to 50 MHz with higher frequencies suffering from progressively lower efficiency (although improvement in privacy, security and performance in adverse environments such as a nuclear event -- all improvements not of our concern). Our CITS efforts will use the amateur 6-meter band and, with the advise of Bill Tynan, W3XO, we have crystaled-up on 50.505 MHz.

We feel that commercial research guides us in a very defined direction and it is our goal to "convert" the results of this research to practical (read "inexpensive") Amateur Radio application. Although your comments about the use of maximum legal transmitter power are certainly in line with research results, we do not believe Amateur Radio METSCAT will enjoy any significant use if 2-kW PEP amplifiers are necessary to make it work. Fortunately, commercial research and applied systems knowledge indicate that stations transmitting with only a few hundred watts can be successful (antenna gain discussed below). Hundreds of low-band VHF 1/4-kW FM base station transmitters have been taken out of service in the past few years and are available at a low cost. The final amplifiers in these "boat anchors" are usually 4-125's or HK-254's that surviving indefinitely with key-down at 250 to 300 W out. We intend to modify one or more of these beasts for METSCAT packet operation and publish our results.

Antenna gain is of equal importance to transmitter power although, as you point out, increased gain and reduced beamwidth will diminish the area of sky covered and therefore the number of usable bursts. Commercial research has studied antenna gains of up to 24 dBi, but good results have been achieved with five-element Yagi antennas and gain figures of 10 dBi. We are in the process of building a five-element NBS standard 6-meter Yagi and expect about a 9-dBd gain (see "Go for the Gain, NBS Style," QST, Aug. 1982).

METSCAT modulation methods have also been the subject of commercial research with consideration given to acquisition time, required bandwidth, environmental effects and complexity/cost. Research studies have included the use of non-coherent FSK (frequency shift keying), bi-phase coherent PSK (phase shift keying), quadri-phase shift keying (QPSK), minimum shift keying (MSK) and four nary non-coherent FSK. Research results indicate the superior performance characteristics of bi-phase coherent PSK over non-coherent FSK, however, we amateurs have given it little application save for OSCAR command station digital links.

We will be interested in your results using a 202-modem standard FSK as applied in the TAPR TNC. We have decided to use BPSK but must wait for the results of developmental work underway by AMSAT's engineering team for PACSAT ground station requirements. Phil Karn, KA9Q, AMSAT AVP-Engineering, is far enough along with this project to enable us to start modem construction. Briefly, the modulator/RF exciter will inexpensively develop BPSK modulated RF at the operating frequency ready for final amplification. The RF receiver/demodulator will produce synchronous data output as demodulated at the receiver IF without the need for AF circuitry. Phil has used available kits for a substantial portion of his work.

A typical receiver threshold for a system operating in the 6-meter band using BPSK modulation at 4800 BPS would be -114 dBm. This allows you to obtain a BERT (bit error rate) of 10-3.

Commercial research into data transmission

(continued on next page)

(Correspondence continued)
speeds point us toward much faster speeds than you will study. Fifty-MHz optimum bit rates are approximately 2 kBPS for short messages and 4 kBPS for more lengthy (>350 character) transfers that lead us to experiment with standard 2400 and 4800 BPS speeds.

We appreciate your suggested METSCAT protocol although several others have been commercially used. Systems are operating with as few as four bytes and as many as 32 bytes in the data (text) field. We need to analyse and propose what length is best for Amateur Radio application as well as formats for beacon, probe, text and acknowledgement packets. We must select and publish a standard if METSCAT is to enjoy widespread application in Amateur Radio.

Your use of an existing packet radio TNC as a METSCAT controller seems efficient. As it happens, we have an accomplished Z80 MPU designer in our group who is undertaking the task of designing a dedicated controller for developmental purposes. We intend to accommodate both half- and full-duplex operation with ultimate intentions of interfacing with our Central Iowa packet radio CBBS.

We envision METSCAT as a potential inter-LAN trunking media along with 10-MHz 300-BPS links (now under test in the central states), OSCAR X special service channels, PACSAT - JAMSAT and the TAPR nationwide wideband amateur microwave backbone in the draft proposal state.

Along the way we have had contact with several individuals or groups who have indicated serious interest in METSCAT development. It may be productive to "connect" these folks together with a limited-lifetime newsletter so that we can become mutually knowledgeable about each other and encourage "pairing-off" into test groups.

Your continuing comments would be appreciated. - Ralph Wallio, WØRPK, Central Iowa Technical Society, RR 4, Indianola, IA 50125.

Support for TNC Lookup Tables

The letter from William Dillon in the December issue of QEX, (no. 22, p. 2), is interesting. I believe that for a lookup table to be more effective, it would require an increased amount of memory. In practice, a large number of packets contain short text (a few words) instead of 128 or 256 bytes. This follows normal speech in that exchanges are often short.

In this case, thruput is often limited by the header as much as by text. It is often better to eliminate the header on some packets when a connect is made. Another byte added to the control field could replace the addresses on several packets and indicate the number of consecutive packets that could be sent without a complete header. In effect, the TNC would "downshift" to a simpler protocol for a series of short packets within a QSO.

The unattended TNC is another problem cropping up from time to time. A board can appear to be hung up if the operator connects to it but fails to disconnect. That TNC will refuse a connect request from another board because it thinks it is still connected to the first station. I feel it would be useful to include another command in future versions of the software, namely RESET AFTER n. The argument "n" could specify a time interval the same as the BEACON command currently does and a default value of Ø would disable the RESET function unless the operator wanted it. This command would be especially useful on a TNC used as a digipeater at a remote location.

Packet radio is still new to the amateur service and I think it is a good idea to continue the dialog Mr. Dillon started. The experiences and thoughts of users will help advance this technique. - Tom Feeny, W8KOX, 1480 Meadow Drive, Walled Lake, MI 48088.

Adapter for the VIC 20 and Commodore 64

The VIC 20 and Commodore 64 can be used as a terminal for many applications with the adapter shown below. Although the output signal is not at the proper RS-232 level, many devices will accept it. I have used this arrangement and the accompanying 3-line terminal program on a Radio Shack telephone modem and a TAPR TNC.

While demonstrating Packet Radio at local radio clubs, this is all I use! I don't employ a tape recorder to load the terminal program -- I just enter it on the spot. The jumpers at each end eliminate bandshaking. This is called 3-wire RS-232 and is adequate for many purposes.

There is confusion at times about terminal configuration. How many stop bits and parity? A good rule is to configure "8-1-Ø." This means an 8-bit word, a 1-stop bit and no parity. This will talk to anything. - Tom Feeny, W8KOX, 1480 Meadow Drive, Walled Lake, MI 48088.

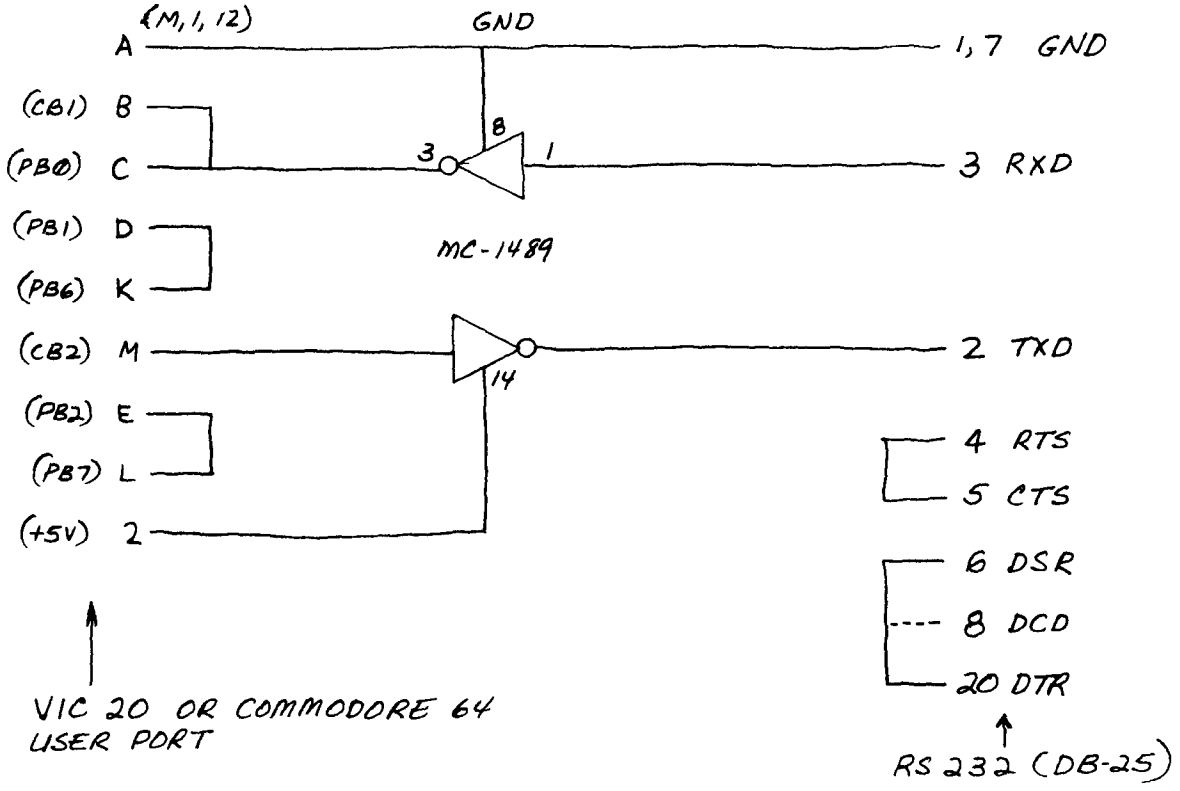
(Diagram for the adapter appears on page 4.)

New Surface Acoustic Wave Technology Newsletter

Sawtek Inc. announces the introduction of "SAW SCENE," a newsletter devoted to Surface Acoustic Wave (SAW) technology. It will cover new developments incorporating SAW technology, application notes, and other information useful to designers.

SAW SCENE will be published quarterly starting in early 1984 and distributed without charge to those interested in SAW devices and SAW subsystems. Subscription qualification forms are available upon request from SAWTEK Inc., Post Office 18000, Orlando, FL 32860, tel. (305) 886-8860, telex 529118.

SIMPLE RS-232 ADAPTER FOR THE VIC 20 OR COMMODORE 64



A VERY SIMPLE TERMINAL PROGRAM
FOR THE VIC OR C64

1. OPEN 2, 2, 2, CHR$(6) ①
2. GET A$: IF A$ < > "" THEN PRINT #2, A$;
3. GET #2, B$: PRINT B$; : GO TO 2

① CHR$(6) = 300 BAUD, CHR$(8) = 1200 BAUD

② ALWAYS CONFIGURE YOUR TERMINAL AS 8 BIT WORD, 1 STOP BIT, NO PARITY (THIS WILL TALK TO ANY CONFIGURATION) JUST REMEMBER "8-1-Ø".

An Improved RX Impedance Bridge

By Harry R. Hyder, * W7IV

Many simple RX Impedance Bridges have been described in Amateur Radio magazines. At least two inexpensive models are currently on the market. This article was written to help you modify a bridge and does not detail the construction of one. Publications like the ARRL Radio Amateur's Handbook are available for such purposes. You might want to refer to the 1981 edition of the Handbook while reading this article.

A standard made bridge has a highly unbalanced XC and XL range. The XC range is wider than the XL range, with the reactance range inversely proportional to the frequency.

The bridge appearing on p. 16-32 of the 1981 Handbook has a calculated range. For a 10% to 90% rotation of the balance control, the range at 1.8 MHz was -2800 to +343 ohms and -167 to +21 ohms at 30 MHz.

All of these RX bridges use the same circuit shown in Fig. 1. The resistive balance is independent of the frequency and a fixed capacitor is in series with an unknown. Its value is usually equal to the mid-scale capacitance of the variable balancing capacitor.

For unknown impedances containing capacitive reactance, the variable balances the sum of the unknown and fixed reactances. For inductive unknowns, the variable balances the difference of the reactances.

The easiest way to solve the diminishing range problem at the HF end of the spectrum is to build two bridge units, one for 1.8 to 10 MHz and the other for 10 to 30 MHz. The noise generator can be a separate assembly, arranged to plug into either bridge.

To equalize the XC and XL ranges, place a padding capacitor across the variable unit and use a variable capacitor having a non-linear capacitance vs. rotation characteristic. A single-gang called the "Straight Line Frequency" BCL unit is ideal for the 1.8- to 10-MHz bridge. The one I found in my junk box had a minimum capacitance measured at 10.3 pF; at 50% rotation it was 67 pF and 371 pF at maximum capacitance.

A little time spent with a calculator produced the values shown on the diagram. They may not be ideal, but are fairly close. With these values, the reactance range would be -796 to +756 ohms at 1.8 MHz. The zero reactance point falls slightly off of 50% rotation but this is immaterial as home-built bridges are hand calibrated.

Finding a suitable capacitor for the 10- to 30-MHz bridge is more difficult. It should have about 20% of the capacitance the LF unit has. Capacitors having offset plates, known as "Midline" capacitors, are usable if you can find one. Another possibility is to remove the plates from a BCL variable. I have tried this and it is a difficult operation because of the way they are constructed.

The capacitor in series with the unknown should be 18 pF for the HF bridge. If the variable's minimum is high enough, the parallel padding capacitor may not be necessary. A good idea is to use a small ceramic trimmer, about 12 pF maximum. This could then be set to obtain the desired range of reactance.

*1638 W. Inverness Dr., Tempe, AZ 85282

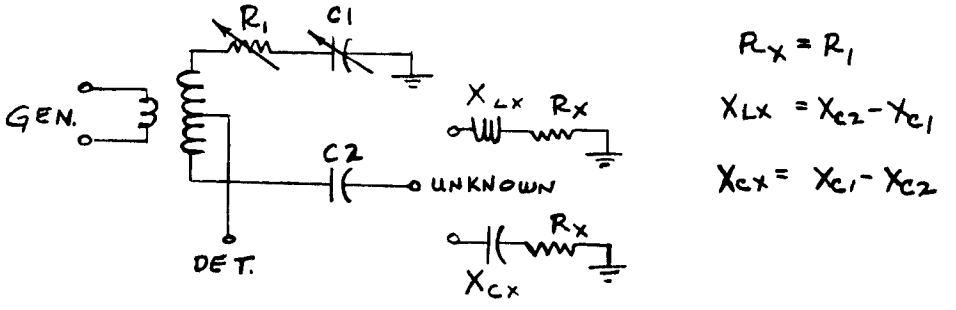


FIG. 1

(RX Impedance Bridge continued from previous page)

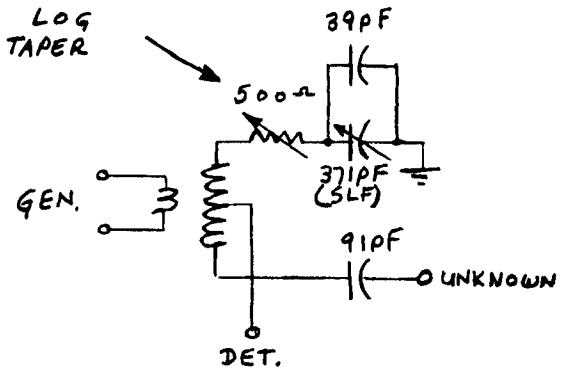


FIG. 2

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Commodore C64 Color-Code Program

By John A. Biggs, * K9MUJ

If you own a Commodore C64 and are having trouble mastering the Resistor Color Code, this program is for you. It will draw a resistor on the screen, insert color bands and ask for the correct value. Upon entering this information, the computer will tell you if you are right or wrong.

Resistors appearing on the screen are selected at random with values between 10 ohm and 99 meg ohms. At the end of the program, the computer will show the number of correct and incorrect resistors you have named. After several hours of utilizing this program, you will have adequate knowledge of reading the color code.

I will explain various sections of the program as it will enable the user to fully employ it.

Lines 10 and 11 serve as copyright protection. The copyright protection is waived if the program is not to be sold, but will be used by you or members of your Amateur Radio club or class.

H1 and C1 are assigned screen and color locations in line 12. They are used for proper color band location on the resistor. Line 12 also sets the screen color to light grey. It is the only color that will allow all 10 colors to appear true to life on the monitor.

If you already know the color code and have no need for the instructions, delete "gosub 2000" from line 15. It is not necessary to enter lines 2000 to 4950 as it includes instruction information for beginners. This deletion will not effect the program, however, the print statement sets the color of the drawing on the screen and the poke statement (POKE 53272,21) sets the screen for capital letters.

Lines 20 through 70 contain information for drawing the resistor body on your screen. The color bands are poked in at a later time, taking their proper position. The "B" shown in the printout on the resistor is a shifted B on the keyboard and is a vertical line.

To color the resistor body brown, poke in the numeral used by the computer (9) in lines 71 and 75. The reversed cursor (160) will be assigned brown and poked into the resistor at the proper body positions to color it.

Three random numbers between Ø and 9 are selected in line 77. These numbers are assigned colors to match in the following lines.

If the first and last bands or the first and second bands on the resistor appear black (Ø), lines 78 and 80 will return the program to line 77 so other colors can be chosen. This prevents invalid color codes from appearing on the screen.

Because the numeric code for the computer colors does not correspond to the color code, lines 81 through 128 reassign these numbers. In all the "if" statements, these numbers are made to match the computer and resistor color.

Lines 170, 180 and 190 poke the selected and corrected colors on the resistor body, and prints an abbreviation of the color below it. On some computer monitors, it is difficult to tell red from brown from orange. This allows you to be sure of the color on the screen and allows you to use a black and white monitor though a color one is better.

The remainder of the program (lines 510-910) converts the resistor value to common terminology and prints the answer on the screen with prompts. Lines 5000-5010 prints your final score.

Copies of this tape may be purchased from Lemco Corp. Software Division, 608 Joliet St., LaSalle, IL 61301 for $5.95. Other programs available for both the VIC 20 and Commodore 64 include BEAM ANTENNA, SATELLITE, LOGIC OPERATION and much more. Write Lemco Corp. for further program and price information.

(Program appears on next page)

*Lemco Corp., 608 Joliet St., LaSalle, IL 61301

```
10 rem--copyright 1983, john a. biggs,    lasalle illinois
11 rem--all rights reserved--do not      copy!!!!!
12 h1=55790:h4=h1+9:c1=1518:c4=c1+9:cr=0:cw=0:poke53280,15:poke53281,15
15 print"■■":gosub2000:poke53272,21
20 forx=oto08:print:next
30 print"■"
40 print"              ____________________
50 print"                  B   B   B       |       "
55 print"         ______   B   B   B       |______
60 print"                  B   B   B       |
70 print"              ____________________  ■
71 ford3=h4toh4+80step40:forx=d3tod3+5:pokex,9:nextx:poked3-10,9:nextd3
75 forc=c4toc4+80step40:forx=ctoc+5:pokex,160:nextx:pokec-10,160:nextc
77 q1=int(rnd(0)*10):q2=int(rnd(0)*10):q3=int(rnd(0)*10)
78 ifq1=0andq2=0then77
80 ifq1=0andq3>0then77
81 ifq1=0thenr1=0:r1$="bk"
82 ifq2=0thenr2=0:r2$="bk"
83 ifq3=0thenr3=0:r3$="bk"
84 ifq1=1thenr1=9:r1$="wh"
85 ifq2=1thenr2=9:r2$="wh"
86 ifq3=1thenq3=7:r3=4:r3$="ye"
87 ifq1=2thenr1=2:r1$="rd"
88 ifq2=2thenr2=2:r2$="rd"
89 ifq3=2thenr3=2:r3$="rd"
90 ifq1=3thenq1=12:r1=8:r1$="gr"
91 ifq2=3thenq2=12:r2=8:r2$="gr"
92 ifq3=3thenq3=08:r3=3:r3$="or"
93 ifq1=4thenr1=7:r1$="vi"
94 ifq2=4thenr2=7:r2$="vi"
95 ifq3=4thenq3=5:r3=5:r3$="gn"
96 ifq1=5thenr1=5:r1$="gn"
97 ifq2=5thenr2=5:r2$="gn"
98 ifq3=5thenr3=5:r3$="gn"
117 ifq1=6thenr1=6:r1$="bl"
118 ifq2=6thenr2=6:r2$="bl"
119 ifq3=6thenr3=6:r3$="bl"
120 ifq1=7thenr1=4:r1$="ye"
121 ifq2=7thenr2=4:r2$="ye"
122 ifq3=7thenr3=4:r3$="ye"
123 ifq1=8thenr1=3:r1$="or"
124 ifq2=8thenr2=3:r2$="or"
125 ifq3=8thenr3=3:r3$="or"
126 ifq1=9thenr1=1:r1$="bn"
127 ifq2=9thenr2=1:r2$="bn"
128 ifq3=9thenr3=1:r3$="bn"
170 ford=h1toh1+80step40:poked,q1:poked+1,q1:poked+3,q2:poked+4,q2
180 poked+6,q3:poked+7,q3:next
200 forx=c1toc1+080step40:pokex,160:pokex+1,160:pokex+3,160:pokex+4,160
220 pokex+6,160:pokex+7,160:next
510 print"                 "r1$" "r2$" "r3$
520 r4=r1*10+r2:r5=r4*10↑r3:w3$=""
570 ifr3=0thenw3$=""
580 ifr3=1thenr4=r4*10
590 ifr3=2thenw3$="k ":r4=r4/10
600 ifr3=3thenw3$="k "
610 ifr3=4thenw3$="k ":r4=r4*10
620 ifr3=5thenw3$="meg":r4=r4/10
630 ifr3=6thenw3$="meg"
640 print:print"enter the resistor value";
650 inputr9:r5=int(r5)
660 ifr5=r9thencr=cr+1:print"excellent!!!";
670 ifr5<>r9thencw=cw+1:print"not so good!!";
680 print"the value is"r4;w3$"ohms"
690 print:print"hit any key to continue--e ends program
700 geta$:ifa$=""then700
710 ifa$="e"then5000
910 print"■":goto20
2000 poke53272,23:print"■":printtab(240)"Small resistors are usually marked in
2010 print"bands of color to tell the value of the
```

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2020 Print"resistors.":Print
2030 Print"Knowing this color code, and having
2040 Print"the ability to instantly read resistors
2060 Print"is one of the characteristics of a well
2070 Print"trained technician or engineer."
2080 Print:Print"If you need to see the color code--
2090 Print"enter 1 on your keyboard!"
2100 Print"If you already know the color code,
2110 Print"enter 2 on your  keyboard!
2120 Getq$:ifq$=""then2120
2130 ifq$="1"then3000
2140 ifq$="2"thenPrint"■":return
2150 Goto2120
3000 Print"■":Printtab(94)"Color code":Print
3010 Printtab(15)"BlacK--0
3020 Printtab(15)"BrowN--1
3030 Printtab(15)"REd----2
3040 Printtab(15)"ORange-3
3050 Printtab(15)"YEllow-4
3060 Printtab(15)"GreeN--5
3070 Printtab(15)"BLue---6
3080 Printtab(15)"VIolet-7
3090 Printtab(15)"GRey---8
3100 Printtab(15)"WHite--9
3110 Print:Print"It is necessary for you to memorize
3120 Print"this color code!!!"
3130 Print"When you think you have done so,
3140 Print"hit any key to continue"
3150 Getu$:ifu$=""then3150
3160 Print"■":Printtab(080)"Now that you know the color code, it is
3170 Print"necessary that you know how it is used.
3180 Print:Print"There are three Pertinent bands on the
3190 Print"resistors.--If there are four, that
3200 Print"band is used to tell the tolerance of
3210 Print"the resistors, and need not concern you
3220 Print"at the Present time":Print
3230 Print"The first band is the first one read,
3240 Print"the second band is the second one read
3250 Print"and the third band is the number of
3260 Print"zeros following the first two.
3270 Print:Print"As an example, if the three bands were
3280 Print"red red red--the value would be 2 2 00,
3290 Print"or in other words--2200 ohms resistance,
3300 Print:Print"Hit any key to continue
3310 Getu$:ifu$=""then3310:Print"■"
3320 Print"■":Printtab(80)"It is common Practice when reading
3330 Print"resistors, to use abbreviations of the
3340 Print"values.  If the resistor is between
3350 Print"one thousand and 999 thousand ohms, it
3360 Print"is usually called 'K-ohms'
3370 Print:Print"If the third color is red (2 zeros)
3380 Print"the first two numbers are divided by 10
3390 Print"and the value then read as--using
3400 Print"red-red-red as an example, 2.2k ohms.
3410 Print:Print"If the third color was orange,(3 zeros)
3420 Print"and the resistor was red,red,orange,
3430 Print"the value of 22000 ohms would be read
3440 Print"as 22k ohms.
3450 Print:Print"Hit any key to continue"
3460 Getu$:ifu$=""then3460
3470 Print"■"
4380 Printtab(80)"If the third band is yellow-that is
4390 Print"between 100000 and 999000 ohms, it is
4400 Print"common Practice to read the resistor
4410 Print"as if the first two numbers were multi-
4420 Print"Plied by 10 and then adding 'K ohms'.
4430 Print"A red red yellow resistor would be read
4440 Print"as 220k ohms.
4450 Print:Print"On a Green third band, the same Princi-
4460 Print"Ple aPPlies. The first two numbers are
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4470 Print"divided by ten, and the name 'me9ohm
4480 Print"is used.  A red red 9reen resistor
4490 Print"(value 2200000 ohms) would be read as
4500 Print"2.2 me9ohms
4510 Print:Print"If the third band is blue, then the
4520 Print"resistor would be 22 me9ohms"
4530 Print:Print"Hit any key to continue"
4540 9etk$:ifk$=""then4540
4550 Print"■":Print:Print"  THIRD BAND      Add zeros  Pronounced
4560 Print      "-------------------------------------------------"
4565 Print"     ■B■lac■K■              none         ----"
4570 Print"     ■B■row■N■              0             100
4580 Print"     ■R■e■D■                00           .10 k
4590 Print"     ■OR■an9e              000           k
4600 Print"     ■YE■llow              0000          100k
4610 Print"     ■G■ree■N■               00000        .10 me9
4620 Print"     ■BL■ue                000000       me9
4630 Print:Print"These are the common resistor values."
4640 Print"There are others above and below this
4650 Print"ran9e, but are not normally used."
4670 Print:Print:Print
4930 Print:Print"Hit any key to 9et some Problems"
4940 9etu$:ifu$=""then4940
4950 Print"■":return
5000 Print"■":Printtab(240)"you have scored"cr"resistors r19ht"
5010 Print:Print"you have scored"cw"resistors wron9":end

ready.
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Carl L. Smith, WØBWJ
President

David Sumner, K1ZZ
General Manager

Paul L. Rinaldo, W4RI
Editor

David W. Borden, K8MMO (Data Communications)
Geoffrey H. Krauss, WA2GFP (VHF+ Technology)
Associate Editors

Maureen Thompson, KA1DYZ
Assistant Editor

Debbie Chapor
QEX Circulation Manager

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