APPENDIX A

Equipment and Parts

Kent Potter

To do the exercises, you need the NorCal 40A transceiver kit, available from Wilderness Radio, tel. 650.494.3806, http://www.fix.net/jparker/wild.html, P.O. Box 734, Los Altos, CA 94023-0734. The NorCal 40A has its own home page on the World Wide Web at http://www.fix.net/~jparker/norcal.html. The kit includes all the parts, a metal box with silk-screen lettering, and excellent instructions.

We have included a list of the equipment and parts that are used in each exercise and a vendor list. For reference, we include vendors for the components in the NorCal 40A, even though it is cheaper and more convenient to buy the kit. Vendors and parts change from time to time. There are additional considerations for a class. Extra components need to be purchased to allow for failures, and it is a good idea to talk to Bob Dyer at Wilderness Radio directly to plan. Power supplies and batteries *must* be short-circuit protected, both for safety and cost. For the batteries, we add fuses and switches and wrap everything in heat-shrink tubing.

A.1 EQUIPMENT

The measuring equipment that is required is similar to what would be available in a university electronics laboratory, or on the electronics bench of a radio amateur. Here is a list of the equipment we use:

Tektronix 2215A oscilloscope with a 10:1 probe. (Any 50-MHz scope should do.)
Hewlett-Packard 33120A synthesized 15-MHz function generator.
Hewlett-Packard 3478A multimeter. (The Fluke 87 is a good substitute.)
Tenma 72-860 sound-level meter (35–130 dB, available from Newark).
Tripp-Lite PR-3A power supply (3-A supply, available from Marvac).
Fluke 1900A counter. (Any 10-MHz counter with 10-Hz resolution would do.)
Kay 860 attenuator (a 120-dB attenuator).

A.2 VENDORS

Amidon Corporation
240 Briggs Avenue
Costa Mesa, CA 92626
tel. 714.850.4660

Hamilton/Hallmark
tel. 800.841.5197

Kay Elemetrics Corporation
2 Bridgewater Lane
Lincoln Park, NJ 07035
tel. 201.628.6200

Mouser Electronics
tel. 800.346.6873
http://www.mouser.com

Tronser, Incorporated
2763 Route 20 East
Cazenovia, NY 13035
tel. 800.379.2444

Digi-Key
701 Brooks Avenue, South,
P.O. Box 677
Thief River Falls, MN 56701-0677
tel. 800.344.4539
http://www.digikey.com

Jameco
1355 Shoreway Rd.
Belmont, CA 94002-4100
tel. 800.831.4242

Microcraft Corporation
Box 513Q
Thiensville, WI 53092
tel. 414.241.8144

Newark Electronics
tel. 800.463.9275

A.3 PARTS

Problem 2 – Sources

12 V, 0.8 amp-hour battery, Yuasa NP0.8-12, Newark 87F636
510 Ω Resistor (4), Digikey 510QBK-ND
24 AWG solid, tinned, insulated hook-up wire, red and black
3M #306 solderless breadboard, Newark 92F1460
banana patch cords, red and black
extra fuses for batteries

We add a 2.1 mm power jack to the breadboard for supply connections.

Problem 3 – Capacitors

10 nF, 25 V ceramic disk capacitor, Digikey P4300A-ND
300 kΩ resistor, Digikey 300KQBK-ND
BNC to mini-hook adapter (2)
BNC tee
30 inch BNC cable (2)
18 inch BNC cable (2)
10:1 oscilloscope probe

One short BNC cable should be used to connect the function generator trigger output to the external trigger (sync) input of the oscilloscope. With a BNC tee

at the channel 1 input, use the second short BNC cable and tee to connect the function generator first to the oscilloscope and then to the circuit.

Problem 4 – Diode Detectors

1N4148 diode, Digikey 1N4148CT-ND
3 kΩ resistor, Digikey 3KQBK-ND
10 nF, 25 V ceramic disk capacitor, Digikey P4300A-ND
breadboard
BNC to mini-hook adapter (2)
BNC tee
30 inch BNC cable (2)
18 inch BNC cable (2, 1 sync)

Connect the function generator and oscilloscope as in Problem 3. Connect the function generator output and channel 1 input to the input of the detector. The detector output goes to channel 2.

Problem 5 – Inductors

1 mH inductor, Mouser 43LS103
1N4148 diode, Digikey 1N4148CT-ND
PN2222 npn transistor, Newark
2 kΩ resistor (2), Digikey 2KQBK-ND
breadboard
BNC to mini-hook adapter (2)
BNC tee (2)
BNC 50 Ω load
30 inch BNC cable (2)
18 inch BNC cable (2, 1 sync)
10:1 oscilloscope probe
power supply

The oscilloscope and function generator are connected as in Problem 3, excepting the addition of a tee and 50 Ω load at the channel 2 oscilloscope input.

Problem 6 – Diode Snubbers

As in Problem 5.

Problem 8 – Series Resonance

NorCal 40A printed circuit board
C1, 8–50 pF, 250 VDC ceramic trimmer capacitor, Mouser 24AA024
L1, 15 μH inductor, Mouser 43LS155
BNC to mini-hook adapter (2)

BNC tee
BNC 50 Ω load
30 inch BNC cable (2)
18 inch BNC cable (sync)

It is convenient to hold the circuit board in a vise when installing parts and making some measurements. A suitable unit is the Panavise Type 301, with the Type 308 base, both available from Newark.

Problem 9 – Parallel Resonance

C37, 5 pF, 50 VDC ceramic disk capacitor, Mouser 140-CD50S2-500J
C38, 100 pF, 100 VDC ceramic disk capacitor, Digikey 1313PH-ND
C39, 8–50 pF, 250 VDC ceramic trimmer capacitor, Mouser 24AA024
T37-2 powdered iron toroidal core, Amidon
#28 AWG enameled wire
lighters and sandpaper for stripping wire
BNC to mini-hook adapter
30 inch BNC cable
18 inch BNC cable (sync)
10:1 oscilloscope probe

The enamel should be removed from the ends of the inductor winding by burning and then sanding the wire. Tinning the wires and checking for a shiny, even coating of solder will help avoid poor connections.

Problem 10 – Coaxial Cable

box for measuring voltage and current
BNC tee
BNC union
BNC 50 Ω termination
10 meter BNC cable
18 inch BNC cable (2, 1 sync)
antenna

For the velocity measurement, use the short BNC cables to connect the function generator trigger and output to the oscilloscope, with a tee at the channel 1 input. For the antenna, we use a Lakeview 40-meter Hamstick antenna (tel. 864.226.6990, http://www.hamstick.com). It should be mounted outside the building. Though small, it provides plenty of noise and signal for the lab measurements. We use a ZFSC-10 10:1 power splitter/combiner to connect each bench to an antenna. It is available from the Mini-Circuits Corporation, P.O. Box 350166, Brooklyn, New York 11235-0003 (tel. 718.934.4500, http://www.minicircuits.com). The 10-way splitter allows simultaneous use of the antenna by ten students. BNC

cables are run from the splitter to each bench. BNC receptacles with 50 Ω resistors are mounted to each bench to terminate unused antenna lines. When measuring the antenna line length, remember the 10 dB of loss for each pass through the splitter. For the impedance measurement, an adapter is required to allow the oscilloscope to measure voltage and current. This box is described in Figure 4.16. A 1 Ω, quarter-watt resistor is connected across the channel 2 input, in series with the center conductor of the cable coming from the function generator. A transformer is used to avoid the common ground problem. It consists of seven turns of bifilar-wound #30 wire on a 73-mix ferrite bead. The #30 wires should be twisted together before they are wound on the bead. The voltage is measured at the output connector on channel 1.

Problem 12 – Resonance

BNC tee
10 meter BNC cable
18 inch BNC cable (2, 1 sync)
connections as for the first part of Problem 8

Problem 13 – Harmonic Filter

C45, C47, 330 pF, 50 VDC ceramic disk capacitor, Digikey P4030A
C46, 820 pF, 50 VDC ceramic disk capacitor, Digikey P4035A
J1, BNC pc-board-mount jack, Mouser 177-3138
T37-2 powdered-iron toroidal core, Amidon
#26 AWG enamelled wire
BNC to mini-hook adapter
BNC tee
BNC 50 Ω termination
30 inch BNC cable (2)
18 inch BNC cable (sync)

Problem 14 – IF Filter

C9-C13, 270 pF, 50 VDC ceramic disk capacitor, Digikey P4029A-ND
C14, 47 pF, 50 VDC ceramic disk capacitor, Digikey P4452A
L4, 18 μH inductor, Mouser 43LS185
X1-X4, 4.91520 MHz crystal, 20 pF, HC-49 case, Digikey CTX050-ND
plastic crystal spacer (4), Bivar BI-CI-192-028-SR, Electronic Hardware Ltd.
150 Ω resistor, Digikey 150QBK-ND
200 Ω resistor, Digikey 200QBK-ND
#22 AWG tinned wire
BNC to mini-hook adapter (2)
BNC tee

BNC barrel
18 inch BNC cable (2, 1 sync)

The function generator should be connected directly to the 150 Ω input resistor, and the output to channel 1 should use only the BNC mini-hook adapter and BNC barrel – no cable.

Problem 15 – Driver Transformer

R14, 100 Ω resistor, Digikey 100QBK-ND
FT37-43 ferrite toroidal core, Amidon
#26 AWG enamelled wire
200 Ω resistor, Digikey 200QBK-ND
1 kΩ resistor, Digikey 1KQBK-ND
BNC to mini-hook adapter (2)
BNC tee
BNC 50 Ω termination
30 inch BNC cable (2)
18 inch BNC cable (sync)

Problem 16 – Tuned Transformers

C2, 8–50 pF, 250 VDC ceramic trimmer capacitor, Mouser 24AA024
C4, 5 pF, 50 VDC ceramic disk capacitor, Mouser 140-CD50S2-500J
C6, 47 pF, 50 VDC ceramic disk capacitor, Digikey P4452A
FT37-61 ferrite toroidal core (2), Amidon
#22 AWG tinned wire
#26 AWG enamelled wire
#28 AWG enamelled wire
750 Ω resistor, Digikey 750QBK-ND
1.5 kΩ resistor (2), Digikey 1.5KQBK-ND
2.2 kΩ resistor, Digikey 2.2KQBK-ND
BNC to mini-hook adapter
30 inch BNC cable
18 inch BNC cable (sync)
10:1 oscilloscope probe

Problem 17 – Tuned Speaker

2.25 inch round speaker, Jameco 10840
2.5 inch (inside diameter) cardboard mailing tube, 16 cm long
#24 AWG 2-conductor speaker wire, 20 cm long
3.5 mm stereo phone plug, Mouser 17PP004

cork strip
foam blocks (2)
sound level meter
BNC to mini-hook adapter
BNC tee
BNC–banana adapter (to connect multimeter to BNC cable)
BNC-to-3.5 mm stereo phone jack adapter
30 inch BNC cable
18 inch BNC cable
glue gun

Use the short BNC cable to connect the function generator to a BNC tee at the multimeter and then the long cable to connect to the speaker. A BNC-to-3.5 mm stereo phone jack adapter can be fabricated to connect to the speaker. Alternatively, a BNC to mini-hook adapter can be used to clip to the speaker contacts. Hot-melt glue guns are available from craft and hardware stores – most any kind will work. A word of warning: Some do get hot enough to burn fingers, with the gun or the molten glue. Soft foam blocks, approximately 7 by 10 by 10 cm support the speaker and sound level meter. Foam is available from upholstery and craft shops, and they can often cut it to size. A band saw will work well for foam and cardboard tubes if the material is fed slowly. The cork strips are cut from eighth-inch Portuguese cork sheet, 1 cm wide and long enough to fit snugly inside the mailing tube with the ends butted together. A good source for the cork is ABC School Supply, 2990 E. Blue Star Anaheim, CA 92806, tel. 800.498.2990.

Problem 18 – Acoustic Standing-Wave Ratio

Problem 17 equipment
speaker tube extender
phenolic tube with scale
foam block

The extender tube for the speaker is made of the same mailing tube, 30 cm long. Cork and a slightly larger tube can be used to fabricate a slip-on joint. The phenolic tube is sized to slip over the microphone of the sound level meter (one-half inch for the Tenma meter). It is 30 cm long with a paper centimeter scale attached. An additional foam block is needed to support the extension tube.

Problem 19 – Receiver Switch

C3, 47 nF, 25 VDC ceramic disk capacitor, Digikey P4307A-ND
Q1, 2N4124 npn transistor, Digikey 2N4124-ND
R1, 1.8 kΩ resistor, Digikey 1.8KQBK-ND
BNC to mini-hook adapter (2)

BNC 50 Ω termination
BNC tee
30 inch BNC cable (2)
18 inch BNC cable (sync)
banana to mini-hook test leads (2, to power supply)

Problem 20 – Transmitter Switch

C42, 10 μF, 25 VDC electrolytic capacitor, Mouser 140-XRL25V10
C43, C57, 47 nF, 25 VDC ceramic disk capacitor, Digikey P4307A-ND
D7, 1N5817 Schottky diode, Newark
D11, 1N4148/1N914A switching diode, Newark
J2, 2.1 mm coaxial power jack, Mouser 16PJ031
J3, 3.5 mm stereo phone jack, Mouser 161-3500
Q4, 2N3906 pnp transistor, Digikey 2N3906-ND
R9, 47 kΩ resistor, Digikey 47KQBK-ND
R24, 150 kΩ resistor, Digikey 150KQBK-ND
U5, 78L08 voltage regulator, 8 V, 150 mA, Mouser 333-ML78L08A
1 Ω resistor, Digikey 1QBK-ND
30 inch BNC cable
18 inch BNC cable (sync)
10:1 oscilloscope probe
keying relay cable

The relay is a Magnecraft W171DIP-7, Newark part number 47F1142. A BNC jack is connected to the coil, center conductor to pin 2 (note that this is polarity sensitive because of the included diode). The normally open contacts are connected to a mono 3.5 mm phone plug using #24 speaker wire or similar.

Problem 21 – Driver Amplifier

C56, 10 μF, 25 VDC electrolytic capacitor, Mouser 140-XRL25V10
D10, 1N5817 Schottky diode, Newark
Q6, PN2222A npn transistor, Newark
R11, 510 Ω resistor, Digikey 510QBK-ND
R12, 20 Ω resistor, Digikey 20QBK-ND
R13, 500 Ω trimmer potentiometer, Digikey 36C53-ND
BNC to mini-hook adapter (2)
BNC 50 Ω termination
BNC tee
30 inch BNC cable (2)
18 inch BNC cable (sync)
banana to mini-hook test leads (2, to multimeter)
shorting plug, mono 3.5 mm phone plug

Note that only one side of R11 is installed for this lab. The shorting plug is a 3.5 mm mono (two-contact) phone plug with the tabs soldered together. Adding a length of wire or tubing can make it easier to tell a shorting plug from an new plug.

Problem 22 – Emitter Degeneration

As in Problem 21.
10:1 oscilloscope probe

Problem 23 – Buffer Amplifier

C36, 47 nF, 25 VDC ceramic disk capacitor, Digikey P4307A-ND
Q5, J309 JFET, Newark
R10, 510 Ω resistor, Digikey 510QBK-ND
1.5 kΩ resistor, Digikey 1.5KQBK-ND
BNC to mini-hook adapter
30 inch BNC cable
18 inch BNC cable (sync)
10:1 oscilloscope probe
banana to mini-hook test leads (2, to multimeter)
shorting plug

The 1.5 kΩ resistor will be used again in Problem 25.

Problem 24 – Power Amplifier

C44, 47 nF, 25 VDC ceramic disk capacitor, Digikey P4307A-ND
D12, 1N4753A 36 V, 1 W zener diode, 583-1N4753A
Q7, 2N3553 npn transistor, Hamilton/Hallmark
heat sink, Mouser 532-578305B00
plastic transistor spacer, Bivar BI-515-020, Electronic Hardware Ltd.
RFC1, 18 μH inductor, Mouser 43LS185
BNC to mini-hook adapter
BNC 50 Ω termination
BNC tee
30 inch BNC cable (2)
18 inch BNC cable (sync)
10:1 oscilloscope probe
banana to mini-hook test leads (2, to multimeter)

Problem 25 – Thermal Modeling

C48, 10 nF, 25 V ceramic disk capacitor, Digikey P4300A-ND
BNC to mini-hook adapter
BNC 50 Ω termination

BNC tee
30 inch BNC cable (2)
18 inch BNC cable (sync)
banana to mini-hook test leads (2, to multimeter)
keying relay cable
shorting plug
thermometer
heat sink compound

The 1.5 kΩ resistor should remain from Problem 23. A −10 to 110°C thermometer is necessary. VWR Scientific (tel. 800.932.500) catalog number 61067-913 is suitable. Heat sink compound is available from Digikey, part number CT40-5-ND.

Problem 26 – VFO

D8, MVAM108 varactor diode, Hamilton/Hallmark
D9, 1N4148/1N914A switching diode, Newark
C7, 10 nF, 25 V ceramic disk capacitor, Digikey P4300A-ND
C32, 150 pF, 50 VDC ceramic disk capacitor, Digikey P4026A
C49, 47 pF, 50 VDC ceramic disk capacitor, Digikey P4452A
C50, 2–25 pF air-variable capacitor, Tronser 10-1108-25023-000
C51, 390 pF, 50 VDC polystyrene capacitor, Mouser 23PS139
C52, C53, 1200 pF, 50 VDC polystyrene capacitor, Mouser 23PS212
C54, 47 nF, 25 VDC ceramic disk capacitor, Digikey P4307A-ND
Q8, J309 JFET, Newark
R15, 510 Ω resistor, Digikey 510QBK-ND
R17, 10 kΩ potentiometer, Mouser 314-1410-10K
R19, R21, 47 kΩ resistor, Digikey 47KQBK-ND
R20, 4.7 kΩ resistor, Digikey 4.7KQBK-ND
R23, 1.8 kΩ resistor, Digikey 1.8KQBK-ND
RFC2, 1 mH inductor, Mouser 43LS103
T68-7 powdered iron toroidal core (L9), Amidon
#28 AWG enamelled wire (L9)
nylon 0.5 inch, 6-32 round-head screw (L9)
nylon 6-32 nut (L9)
nylon #6 shoulder washer (L9)
BNC to mini-hook adapter (to counter)
30 inch BNC cable (to counter)
10:1 oscilloscope probe
banana to mini-hook test leads (2, to multimeter)

Problem 27 – Gain Limiting

R16, 1 kΩ potentiometer, Mouser 31CW301
U6, LM393N comparator, Digikey LM393N-ND
1.5 kΩ resistor, Digikey 1.5KQBK-ND

BNC to mini-hook adapter
30 inch BNC cable
10:1 oscilloscope probe
banana to mini-hook test leads (2, to multimeter)
shorting plug
thermometer
blow drier
plastic box

A hand-held blow (hair) drier is an effective heat source. For even heating and cooling of the VFO circuit, the board can be placed in a plastic box. The type used for food storage is suitable. Holes may drilled or cut in the box to allow hot air from the blow drier to flow in over one side of the board and exit over the other side. A hole should be drilled to allow proper thermometer placement.

Problem 28 – RF Mixer

C5, 10 nF, 25 V ceramic disk capacitor, Digikey P4300A-ND
C8, 47 nF, 25 VDC ceramic disk capacitor, Digikey P4307A-ND
C15, 2.2 μF, 25 VDC electrolytic capacitor, Mouser 140-XRL25V2.2
R2, 1 kΩ potentiometer, Mouser 31CW301
U1, U2, SA602AN mixer IC, Newark
30 inch BNC cable
10:1 oscilloscope probe

Problem 29 – Product Detector

C17, 8–50 pF, 250 VDC ceramic trimmer capacitor, Mouser 24AA024
C18, 270 pF, 50 VDC ceramic disk capacitor, Digikey P4029A-ND
X5, 4.91520 MHz crystal, 20 pF, HC-49 case, Digikey CTX050-ND
plastic crystal spacer, Bivar BI-CI-192-028-SR, Electronic Hardware Ltd.
3 kΩ resistor, Digikey 3KQBK-ND
BNC to mini-hook adapter
BNC barrel adapter
10:1 oscilloscope probe
banana to mini-hook test leads (2, to multimeter)
thermometer
blow drier
plastic box

Problem 30 – Transmit Mixer

C31, 5 pF, 50 VDC ceramic disk capacitor, Mouser 140-CD50S2-500J
C33, 47 nF, 25 VDC ceramic disk capacitor, Digikey P4307A-ND
C34, 8–50 pF, 250 VDC ceramic trimmer capacitor, Mouser 24AA024
C35, 270 pF, 50 VDC ceramic disk capacitor, Digikey P4029A-ND

L5, 18 μH inductor, Mouser 43LS185
U4, SA602AN mixer IC, Newark
X6, 4.91520 MHz crystal, 20 pF, HC-49 case, Digikey CTX050-ND
plastic crystal spacer, Bivar BI-CI-192-028-SR, Electronic Hardware Ltd.
BNC to mini-hook adapter
BNC 50 Ω termination
BNC tee
BNC barrel
30 inch BNC cable (2)
18 inch BNC cable (sync)
10:1 oscilloscope probe
keying relay cable
shorting plug

Problem 31 – Audio Amplifier

C20, C21, 100 nF, 100 VDC mylar capacitor, Mouser 140-PM2A104K
C22, C55, 10 nF, 25 V ceramic disk capacitor, Digikey P4300A-ND
C23, 2.2 μF, 25 VDC electrolytic capacitor, Mouser 140-XRL25V2.2
C27, C41, 100 μF, 25 VDC electrolytic capacitor
R7, 47 kΩ resistor, Digikey 47KQBK-ND
R22, 1.8 kΩ resistor, Digikey 1.8KQBK-ND
U3, LM386N-1 audio amplifier IC, Digikey LM386N-1-ND
5.6 Ω resistor, Digikey 5.6QBK-ND
8 Ω resistor, Digikey 8QBK-ND
1.5 kΩ resistor (2), Digikey 1.5KQBK-ND
BNC to mini-hook adapter (2)
30 inch BNC cable (2)
18 inch BNC cable (sync)
banana to mini-hook test leads (2, to multimeter)

Problem 32 – Automatic Gain Control

C29, 10 μF, 25 VDC electrolytic capacitor, Mouser 140-XRL25V10
C30, 2.2 μF, 25 VDC electrolytic capacitor, Mouser 140-XRL25V2.2
D5, D6, 1N5817 Schottky diode, Newark
Q2, Q3, J309 JFET, Newark
R5, 2.2 MΩ resistor network, Bourns 4608X-102-225, Newark
R6, 10 kΩ trimmer potentiometer, Mouser 36C14-ND
300 kΩ resistor, Digikey 300KQBK-ND
BNC to mini-hook adapter (2)
30 inch BNC cable (2)
18 inch BNC cable (sync)
banana to mini-hook test leads (2, to multimeter)

Problem 33 – Alignment

C19, 10 nF, 25 V ceramic disk capacitor, Digikey P4300A-ND
C26, 10 μF, 25 VDC electrolytic capacitor, Mouser 140-XRL25V10
C28, 100 nF, 100 VDC mylar capacitor, Mouser 140-PM2A104K
D1, D2, D3, D4, 1N4148/1N914A switching diode, Newark
J4, 3.5 mm stereo phone jack, Mouser 161-3500
R3, 150 kΩ resistor, Digikey 150KQBK-ND
R4, 8.2 MΩ resistor, Digikey 8.2MQBK-ND
R8, 500 Ω trimmer potentiometer, Digikey 36C53-ND
attenuator
BNC to mini-hook adapter (2)
BNC 50 Ω termination
BNC tee
30 inch BNC cable (3)
18 inch BNC cable (attenuator)
banana to mini-hook test leads (2, to multimeter)
keying switch

The keying switch can be any SPST switch wired to a 3.5 mm phone plug. A miniature toggle switch (Mouser 1055-TA1120 is suitable) is convenient and can be attached to a short section of wire with heat-shrink tubing.

Problem 34 – Receiver Response

attenuator
BNC to mini-hook adapter
BNC 50 Ω termination
BNC tee
BNC barrel
BNC to banana plug adapter
30 inch BNC cable (2)
18 inch BNC cable (2)
banana to mini-hook test leads (2, to multimeter)
keying switch
battery
antenna

For the Part A, the BNC to mini-hook adapter can be clipped to the speaker contacts, with a cable to a BNC tee at the multimeter (with BNC to banana plug adapter) and another cable running from the tee to the counter. Test leads can also be used for the multimeter. Substituting a BNC barrel for the short BNC cable between the source transceiver and attenuator may help reduce leakage. See Problem 10 for a description of the antenna.

Problem 35 – Intermodulation

attenuator
BNC 50 Ω termination
BNC tee
BNC barrel
30 inch BNC cable
18 inch BNC cable (2)
combiner
battery (2)

We use a ZFSC-2-4 2:1 power splitter/combiner for the intermodulation measurements. It is available from the Mini-Circuits Corporation, P.O. Box 350166, Brooklyn, New York 11235-0003, tel. 718.934.4500, http://www.minicircuits.com.

Problem 36 – Demonstration

Equipment for the demonstration requires some thought. Because of leakage around attenuators, it is difficult to provide a signal small enough for a reasonable MDS test, but large enough to measure on a counter. Using a completed transceiver as a source provides the proper range of frequencies. If the transmitter power is reduced until just measurable on a counter, a following attenuator should provide a reasonable test signal. To measure the frequency of the transceiver being demonstrated, the attenuation can be reduced until the counter reading is stable. An oscilloscope can be used for power measurement, or a power meter can be added at the output of the tested transceiver. The Diamond SX-200 power meter is quite suitable; it is available from Ham Radio Outlet, tel. 800.854.6046, http://www.hamradio.com.

Problem 39 – Listening

antenna
Microcraft Code Scanner for decoding Morse Code and radio teletype

It may be useful to provide cassette tape recorders to provide samples of Morse Code and to record received messages. The Code Scanner is designed to receive at 800 Hz and must be modified to operate at the frequency we use in our measurements, 620 Hz. The following resistor changes shift the frequency of the active filters.

Change R14 and R18 from 150 kΩ to 200 kΩ.
Change R15, R19, and R24 from 6.8 kΩ to 8.2 kΩ.
Change R16, R20, and R25 from 1.3 MΩ to 2 MΩ.
Change R17, R21, and R26 from 4.7 MΩ to 6.8 MΩ.
Change R23 from 100 kΩ to 150 kΩ.