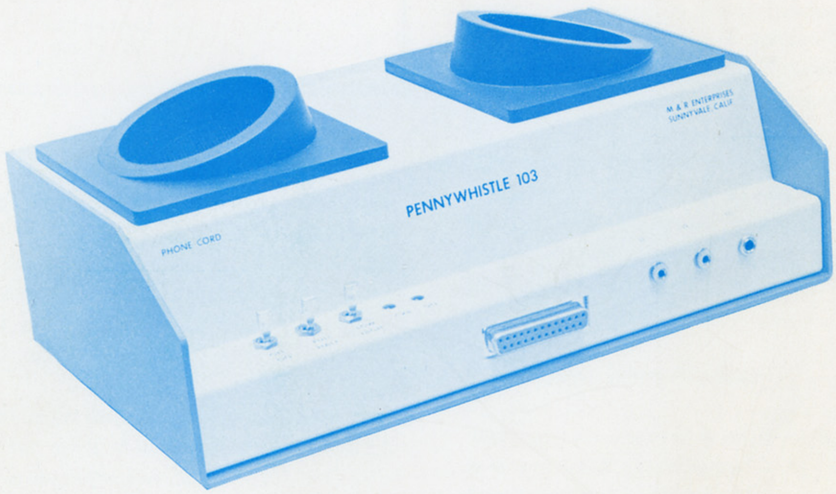
pennywhistle 103



originate modem manual

m&r enterprises
P.O. box 61011, sunnyvale, california 94088

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Introduction

Ask any digital enthusiast what he wants from Santa Claus and high on the list is a modem. With one of these "shoeboxes" and a terminal, you can get on line to numerous timesharing computer systems and gain considerable expertise with various high-level programming languages while your own system gets itself together.

But the true digital enthusiast doesn't stop here. His modem has to be capable of far more than the usual timesharing operation. Some of these requirements are:

- It must be capable of recording data to and from audio tape without critical speed requirements for the recorder.
- It must be able to communicate directly with another modem and terminal for telephone "hamming" and communications for the deaf.
- It must be free of critical adjustments and be built with non-precision parts which are readily available.

What Exactly Is A Modem?

Modem is a contraction of *modulator-demodulator* and is defined as a translator which allows communication of digital data signals over communications channels such as telephone, radio and other limited-bandwidth means. Modems can operate in a single direction only (*half duplex*) or in both directions simultaneously (*full duplex*). While modems can operate at up to 9600 Baud (bits per second) over telephone circuits, half duplex usually limits the maximum speed to 300 Baud or 30 characters per second.

Modems in this speed range usually operate using a *frequency-shift keying* (FSK) technique using four frequencies in two *bands*. The *low band* (1070 to 1270 Hz) is used for the *originate* transmission and the *high band* is for the *answer* transmission in the opposite direction. Modems which are built to transmit on the low band and receive on the high band are termed *originate mode devices*, since they are usually used at a terminal to enter data into a central computer.

In either band, data is translated from *marks* and *spaces* (digital 1s and 0s) to *high* and *low frequencies*. The receiving modem translates these frequencies back to digital data. Note that the high and low frequencies used in FSK are only 200 Hz apart – we are not refering to the difference between high and low *bands*.

Most originate modems use acoustical coupling to the telephone handset to transmit the data, although some are designed for *direct-wire* connection to the telephone line. Acoustical couplers avoid the necessity for the installation and rental charges for the special Data Access Arrangements (DAA) which the phone company insists upon when direction connection is made. Acoustic couplers do, however, cause an increase in distortion problems which may also increase the possibility of error. This is mainly due to the carbon microphone in the telephone handset which generates problematic harmonics of the transmitting frequencies.

One fact which is important to remember is that modems perform no processing of information. The modem only takes a serial bit stream in one end and outputs it from the other end with no format changes in the data stream. Modems *do not* contain UARTs – they connect to them.

Build Your Own Modem

Although the receiver is more complex than the transmitter, it is not hard to understand. At the heart is a *phase-locked loop* integrated circuit (A3), which contains a variable-frequency oscillator and a comparator. Internally, this chip is always trying to lock the frequency of its oscillator to match the incoming frequency. The correction voltage which the comparator feeds to the oscillator provides a measure of how far off the incoming frequency is from the preset *center frequency*.

A phase-locked loop looks like a neat solution to the problem of decoding FSK information, but it does have pitfalls. Primarily, it is inadequate in determining the difference between a signal of the proper frequency and one of its *harmonics* or *sub-harmonics*. Since the high band width frequencies are almost twice the low band frequencies, this becomes a real problem with modem designs. However, the **Pennywhistle 103** has a three-stage active filter ahead of the phase-locked loop which prevents most noise and harmonics from getting through. This filter is composed of both sections of A1 and one section of A2.

Potentiometer R10 sets the center frequency of the loop and a voltage appears between pins 6 and 7 of the chip which indicates how far off the incoming frequency is from a voltage divider network inside the chip. Pin 7 is the output.

Another problem of the phase-locked loop is that these voltages tend to drift with temperature changes and what was a space in winter might become a mark in summer! The **Pennywhistle 103** avoids this problem by means of a floating reference circuit (Q1 and A4) which takes advantage of a quirk in asynchronous data transmission. The fact is that between every character sent the serial data signal returns to the mark condition. The floating reference circuit looks for the mark and resets its reference voltage accordingly. If the data goes to the space and stays there, the circuit will slowly readjust itself and will claim that the new level is a mark in about two seconds. It readjusts much faster in the other direction, so it will correct such a mistake quite rapidly.

The floating reference voltage is fed to A5, a Schmitt trigger, and the data enters the other input. The output is the EIA DATA OUT and Q2 provides a 20 milliampere current data output for driving teleprinters.

The phase-locked loop is very persistent in trying to seek out signals when only noise is present at its inputs, so another circuit is needed to judge when an adequate signal level exists for reliable operation of the loop. A4 performs this function by providing a positive EIA-type *carrier present* signal to turn on external terminals and by holding the data output to the terminal at a mark when insufficient carrier is present.

Two light-emitting diode indicators are driven by a section of A5. The diodes are connected in parallel – but reversed – so that positive voltage will light one (amber) and negative voltage will illuminate the other (red). The output of A5 is normally negative when no carrier is present, goes positive when the carrier comes on and shifts back and forth when data is received. This means that the two LEDs will flicker in time with the data, providing a useful indication in case the terminal is not operating.

The carrier detect signal turns on the transmitting oscillator through R59. The high-low band switch has a section which simulates a received carrier to turn on the oscillator.

Data is *looped back* from the transmitter to the receiver output when the Half-Full Duplex Switch is in the *half* position. This provides an *echo* of the data orginated at the terminal without requiring that the data travel to the other end and come back. Some timesharing services require half-duplex operation and this feature provides a test capability for the terminal and the digital circuitry of the modem.

Circuit Description

The **Pennywhistle 103** has two sections which are almost completely separate: the *transmitter* and the *receiver*. The transmitter is designed around a 555 integrated solid-state timer circuit (A7) which produces a triangle wave and feeds it to the filter/driver (A8). This stage smoothes the waveform to reduce harmonics and provides enough power to drive a small speaker or the telephone line.

The frequency of the timer is determined by the voltage at the base of Q6. Transistors Q5, Q6 and Q7 form a symmetrical current source which keeps the on and off periods of the timer equal no matter what frequency at which it is operating. Potentiometers R77 and R75 set the normal (mark) frequency of the timer and the data input circuit switches potentiometers R78 and R76 in and out of this circuit. When they are switched in, the voltage at the base of Q6 changes depending on the setting of the pots and so the frequency also changes.

Transistors Q3 and Q4 form a *Schmitt trigger* which takes data in from one of two sources: (1) the EIA input (positive or negative voltage levels) through R80, or (2) the opto-isolator A6, which can be hooked up in series with a current loop such as the type used for teleprinter data.

Mark data is a *negative* voltage level at the EIA input or a current of 15 milliamperes or more at the current loop input. *Space* data is a *positive* voltage level at the EIA input or no current loop pins. With *nothing* connected to the inputs, the modem sees a *space* input.

The High-Low Band Switch selects which two potentiometers set the frequencies for the timer. This switch is normally kept in the *low* position, but must be set to the *high* position for tape recording or unit-to-unit transmission.

Assembly Instructions

1. Install the resistors. Bend the leads at right angles to the body and insert them into their designated holes. Bend the leads slightly outward underneath the printed circuit board and cut them to about ½ inch long.

2. Install the diodes in a similar manner. Note the end of the diode with the band (cathode). All diodes are oriented with the banded end to the left and this is indicated by a small triangle next to the lead hole for the cathode.

3. Install the capacitors. The capacitors which are mounted in the upright position have their lead holes intentionally spaced a bit wider than the lead spacing. This insures that a small amount of exposed wire is left above the board for test probes and clips. Therefore, spread the leads of the upright capacitors slightly and press them into the board until they stop, but use only moderate pressure. Spread the leads apart underneath the board and clip them to about ½ inch. When installing C17 & C18, leave ¾" between the bottom of the caps and the circuit board so they may be bent over later.

Care must be taken to mount the electrolytic caps with correct polarity. Each capacitor of this type is marked with a (+) to indicate the positive lead or with a (-) sign and an arrow to indicate the negative lead. Mount the electrolytic capacitors with the positive leads in the hole closest to the (+) sign on the PC board. Bend and cut the leads underneath the board in the manner described above.

4. Install the sockets for the integrated circuits. All are 16-pin except for A3 which is a 14-pin socket. Insert the sockets in their hole patterns and secure them by bending two pins

at opposite corners of each socket underneath the board. Note that no socket is used for A6, the opto-isolator.

5. Install the transistors. If the leads are not already pre-formed, hold the transistor with the flat face toward you and the leads pointing down. Bend the center lead out toward you slightly and bend the outer two leads backwards slightly.

Each transistor mounts in a triangular hole pattern having a etched "E" and a small adjacent line. This line is parallel to the flat face of the transistor when it is mounted correctly. The "E" denotes the emitter lead which is the left-hand lead when the transistor is held with the leads down and the flat face toward you. Get all three leads into their proper holes and gently press down until resistance is felt. The bottom of the transistor should be about ¼ inch off the board. Bend the leads outward beneath the board.

6. Install the opto-isolator. One end of the package has a small dot on the top face. This denotes pin 1 and the opto-isolator should be installed so that pin 1 is in the upper left hand corner of the mounting pattern. Position all the leads in their respective holes and gently press the opto-isolator down until it seats on the wide part of the leads. Bend two pins outward at opposite corners of the isolator underneath the board.

7. Mount the fuse in the hole provided. Make sure that the fuse rests close to the PC board and cannot move around. Bend the leads outward underneath and trim as described previously.

8. Mount the power transformer using 4–40 screws, flat washers and tapped spacers as nuts. Orient the transformer so the side with the two leads (black, primary) is closest to the fuse. Insert these leads into the holes marked "T" and secure them by bending underneath.

Insert the two red leads in the holes marked "24VCT" to the right of the transformer and secure them by bending. Insert the third center-tap lead in the hole marked "G" (CT) near the upright aluminum electrolytic capacitors.

9. Turn the board over and rest it on the transformer. Solder all leads and trim them close to the solder joint. Use a low-wattage iron (37 W or less) and rosin-cored solder. Be sparing with the solder to avoid "solder bridges". Make sure that the joint is strong and has a smooth, unfrosted appearance. Cold solder joints are the enemies of good electrical contact!

10. Install the 25-pin connector by pressing its terminals over the edge of the board. Make sure that the side with pins 1 through 13 is on the top side of the board. Align the connector with the traces brought out to the edge of the board and then firmly press the connector onto the board. Solder all pins to their pads only when you are sure the connector is properly oriented since it is impossible to adjust the connector once it has been soldered. Take care to avoid solder bridges.

11. With the board turned right side up, install the three switches and bend two of their pins *slightly* with pliers so they will stay in place when the board is turned over. Solder the switches one at a time. First, solder one of the pins and then apply pressure against the switch to force it all the way down against the board while remelting this joint. Then solder the remaining pins and proceed to the next switch.

12. Mount the LEDs, using the amber (or green) one for LED 2 and the red one for LED 1. Spread the leads slightly and insert the LED into its designated hole. The longer of the two leads mounts in the hole with the etched line on top of the board nearest it. ~~This should cause the flat edge of the LED's skirt to line up with the etched line.~~ Press the LEDs down until the crown extends just above the level of the switch bodies. The skirt should be just below the tops of the switch bodies. Solder the LEDs and trim the leads.

13. Solder the leads from the three-wire line cord in their proper holes. The black and white leads mount in holes marked L1 and L2. The green lead mounts in the hole marked G. All holes are to the right of the switches and the fuse. Be *absolutely sure* that the white or black lead is *not* mounted in the G hole or you will fry your modem.

14. Insert muffs in chassis with high ridge toward middle of chassis. Solder two wires to the speakers and feed the wires through the holes in the bottom of the rubber acoustical cups. Set the speaker face outward into the cup so it rests on the first rim. Using a thin screwdriver, pry the rubber of this rim up and over the rim of the speaker and slide the screwdriver point around the rim so the rubber is lifted over the speaker. *Do not* attempt to press the speaker into the cup as you will probably end up puncturing the delicate cone. Make sure that you are prying up only the top rim, so the speaker will settle into the groove separating the top and bottom rims. After the speakers are seated in the cups, place the round perforated-metal grilles over the speakers and pry the upper rim over them in a similar manner so they rest on top of the speakers.

15. Mount the PC board on the metal case baseplate using 4–40 screws, lockwashers and tapped spacers. Fasten the corners and the two spacers which mount the transformer to the baseplate.

16. Install and wire jacks using ribbon cable provided. See figure on right side of page 5 which shows the proper connections between jacks and the printed circuit board.

Initial Power-up

When your new **Pennywhistle 103** is wired up and ready to go, do a final check to see that all ICs are in their sockets correctly, that all electrolytic capacitors and diodes are installed in the proper direction and that both LEDs are installed. If you forgot to install both LEDs or only installed one, do not turn on the unit.

When you become brave enough to power-up, check for +18V to +20V at the positive terminal of C17 and −18V to

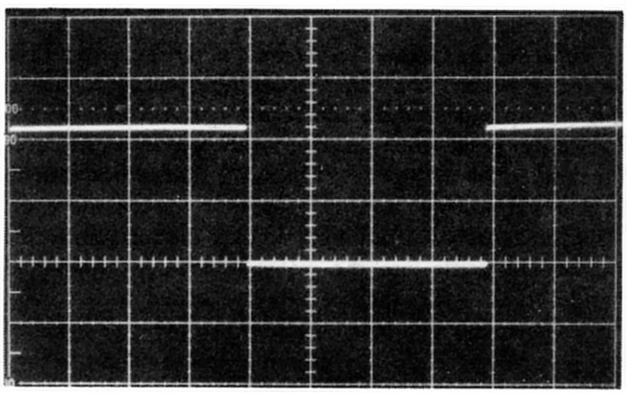
-20V at the negative terminal of C18 where both voltages are measured with respect to ground. If either voltage is below 15 volts, turn the unit off and check for shorts (if the fuse hasn't already done the job first). The +12V and -12V lines should be within ±1V. Shorts are less disatrous on these lines.

Transmitter Adjustment

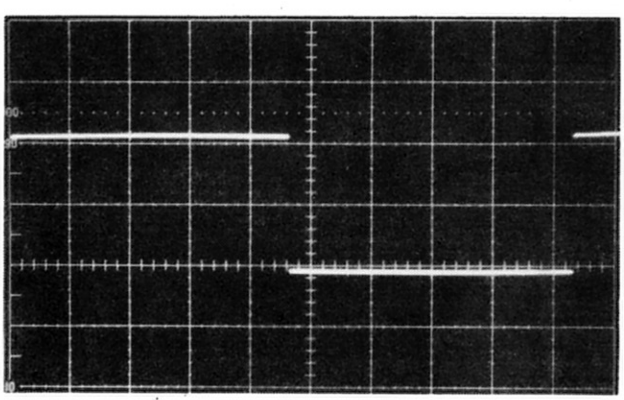
Adjustment of the **Pennywhistle 103** requires a frequency counter, an audio oscillator and VOM or VTVM. An oscilloscope is nice, but not absolutely necessary.

Set the High-Low Band Switch to *low* and the Half-Full Duplex Switch to *full*. Connect a jumper from pin 2 of the 25-pin connector to a negative voltage source (-12V is OK). Pin 3 of the connector will be negative if the carrier indicator (LED 2) is not on.

Connect the input to the frequency counter to test point 3 (TP3). Connect a clip lead across D16 which will turn the transmitter on. Adjust R77 for 1270 Hz ± 5 Hz. Remove the jumper connecting pin 2 of the 25-pin connector to the negative voltage source. Adjust R78 for 1070 Hz ± 5 Hz.

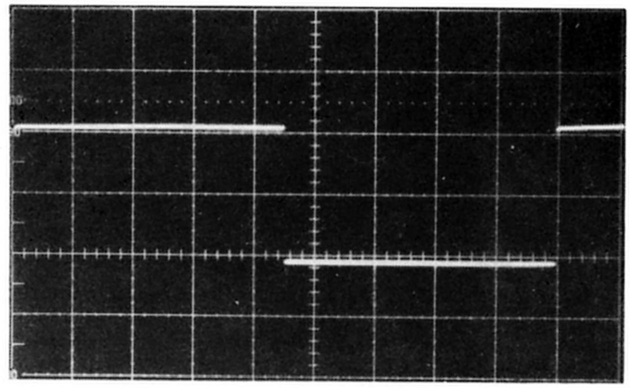


Low Mark 100 μ/div 5V/div
Frequency: 1270 Hz 555, Pin 3

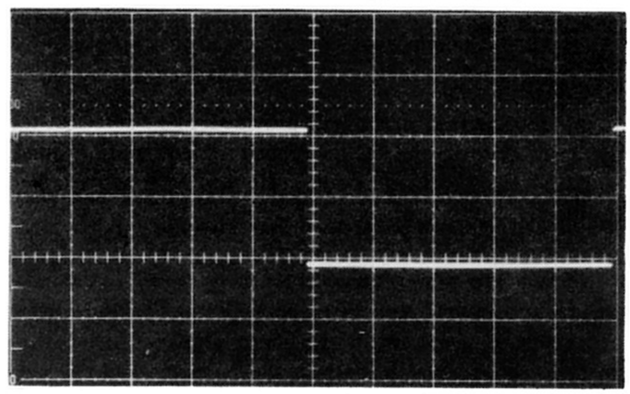


Low Space 100 μs/div 5V/div
Frequency: 1070 Hz 555, Pin 3

Throw the High-Low Band Switch to *high*. Replace the jumper from pin 2 of the 25-pin connector to the negative voltage source and adjust R75 for 2225 Hz ± 10 Hz. Remove the jumper and adjust R76 for 2025 Hz ± 10 Hz.



High Mark 50μs/div 5V/div
Frequency: 2225 Hz 555, Pin 3



High Space 50 μs/div 5V/div
Frequency: 2025 Hz 555, Pin 3

The output level (R79) must be adjusted for -15 dbm (0.14 volts RMS, 0.39 volts P-P) on the phone line when the phone is in position in the acoustic coupler. There is a standard modem test instrument made for this purpose which you might be able to get from someone you know who services modems. Otherwise, it will be necessary to measure voltage on your phone line. If so, observe the following precautions: (1) Make no adjustments until a connection has been established by calling a friend's phone. (2) Avoid shorting the phone terminals and make a measurement with an ungrounded meter. Use a 0.1μF capacitor in series with the meter if it does not have an output terminal.

Set the switches to *low* band and *full* duplex. Turn on the transmitter by shorting out diode D16. Place the telephone handset in the acoustical coupler and connect the meter to the terminals in the telephone connector block at the other end of the phone cord. Don't try to use a *key-set* type phone with lighted push buttons. Adjust R79 to the specified level.

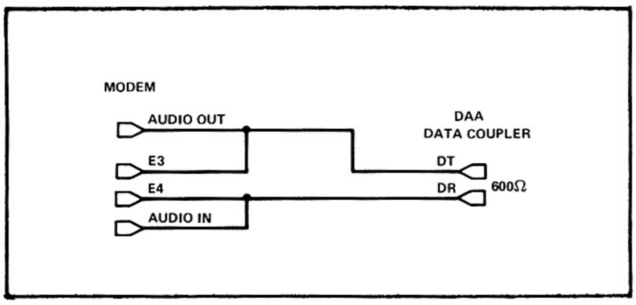
Receiver Adjustment

If a speaker is connected to the input terminals, connect the audio oscillator directly to the speaker terminals. If not make a voltage divider by connecting a 1K resistor between the input terminals and ground and by connecting a 100K resistor in series with the generator lead input terminal.

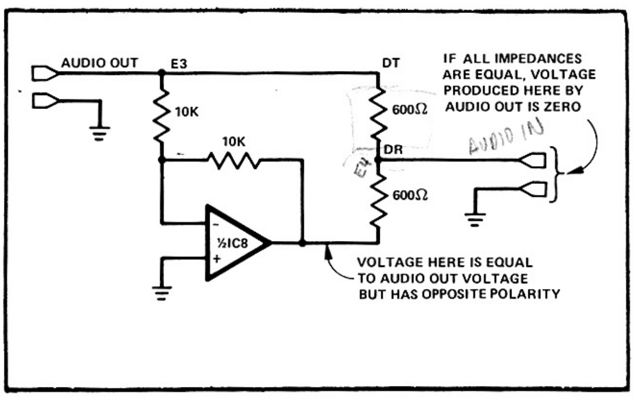
Connect the frequency counter to TP2 and adjust the generator for 2125 Hz. Connect the meter to TP1 and adjust R10 across its whole range to observe the region where the voltage varies smooothly from positive to negative as R10 is changed. This is the *lock range* of the phase-locked loop. Adjust R10 so the meter reads zero volts within the lock range. Make sure the adjustment is not outside the lock range since false zero indications are possible. This completes adjustment of the modem.

Direct Wire Connection

The telephone company requires the use of a DAA (Direct Access Arrangement) which isolates the telephone dial-up line from the data equipment. The cheapest available unit is the CDT or 1001A coupler. The CDT includes a switch in the phone which cuts the phone out and the coupler in when it is operated. Rental for the CDT is about two to five dollars a month, but could be more in some areas.



Integrated circuit A8 is wired as an *active hybrid* which can subtract the output of the transmitter from the input to the receiver. E3 is connected to the output terminal, which also connects to one side of the line. E4 is connected to the input terminal of the modem and to the other side of the line. R62 should ideally be of the same resistance as the line impedance, which the phone company specifies as 600Ω when a DAA is used. The value of this resistor can be changed if balancing out adjustments are required.

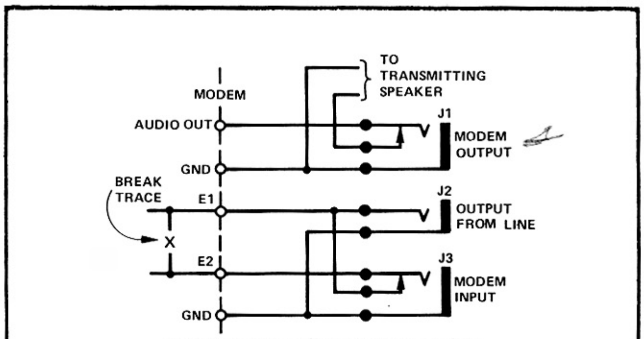


Unit To Unit Communications

To communicate between two of these modems, you must use the High-Low Band Switch as a *transmit* switch. Keep the Half-Full Duplex Switch on *full* and your receiver will come bombing back with what you are sending out. Communications can only go one direction at a time using this scheme. This capability designed into your **Pennywhistle 103** makes it useful for communications between the deaf.

Tape Recorder Connection

Two subminiature phone jacks are necessary for connection to cassette or other tape recorders. They should both be of the sort used for earphone jacks which break a circuit when the plug is inserted. One of these jacks should be connected just like an earphone jack to the transmitting speaker (see diagram). The microphone input to the tape recorder is plugged into this jack.

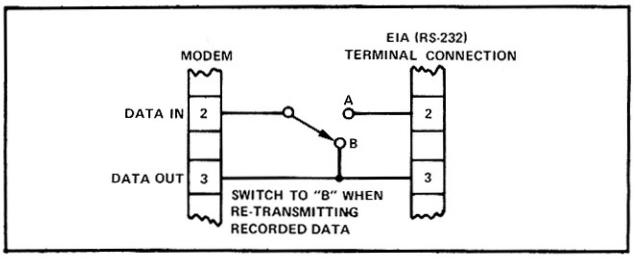


See Diagram of Engineering Update

The other jacks are connected between E1, E2 and ground as shown in the diagram. One of these jacks connects to E1, the output of the first filter stage. When plugged in, it will feed into the microphone input of the tape recorder also. The second jack breaks the connection between E1 and E2 and allows the output of the tape recorder to be connected into the second stage of the filter. The jacks are used as follows:

1. RECORDING DATA PRODUCED BY THE LOCAL TERMINAL: Insert a plug into J3 to break the modem's receive path. This plug need not be connected to anything. Plug the microphone input of the tape recorder into J1. Throw the High-Low Band Switch to *bigb*. Run the recorder and input data from the terminal.
2. RECORDING DATA RECEIVED FROM THE LINE: Plug the microphone input of the tape recorder into J2. Run the recorder for the duration of the desired output. Be sure to record a five second leader of no data carrier on the tape before the data.
3. PLAYING BACK TO A LOCAL TERMINAL: Plug the speaker output of the recorder into J3. Play the recorded tape. The modem will track with speed variations from the tape. The first point of failure for speed change will occur when the timing of the signal into the terminal goes beyond the limits of its serial receiver circuit.

4. PLAYING BACK DATA TO THE LINE: You will need to connect a switch to disconnect pin 2 of the 25-pin connector from the terminal and connect it to pin 3, which may remain connected to the terminal. Using the terminal, set up in the proper conditions on the system to receive data. Make sure the tap is in the leader area with the no-data carrier. Plug in the tape recorder end of the patch cord, then throw the switch connecting pin 2 to pin 3 and plug the patch cord into J3. If the modem loses the carrier, you have a problem. If it doesn't, you will be feeding data into the receiver of the modem and looping it right back to the transmitter section as well as seeing it on the terminal.



Long Distance Use

Long distance telephone circuits have *echo suppressors* stuck on them which hush the reverse direction when they detect audio. Since a full-duplex modem has to pass audio in *both* directions simultaneously, these echo suppressors can stop the whole process. Fortunately, the phone company has provided a way to disable the suppressors. All you need to do is to give them a brief spurt of 2100 Hz (2025 and 2225 Hz are also OK) and then go about your business. The answer modem is already transmitting at these frequencies, so its echo suppressors go away automatically.

To disable the echo suppressors which are listening to your **Pennywhistle 103**, you just flip the High-Low Transmit Switch to *high* for a second or so. Do this immediately after the hookup is made and before any data is transmitted.

Current Loop Connection

Teleprinters handle data on the *current loop* scheme wherein 20 milliamperes of current flowing in a circuit represents a *mark* or binary 1 and no current denotes a *space* or a binary 0. The **Pennywhistle 103** has a 20 mA current driver hooked to the data line which will provide the right signal to an electronic *selector magnet driver* present in recent teletypes. Pin 23 of the modem connects to pin 7 on the terminal block of the Model 33 and ground (pin 7 of the modem) is connected to pin 6 of the teletype.

If an older model is used where bare coils are driven, use a reed relay driven by pin 23. Connect a diode between pin 23 and ground with the cathode of the diode connected to pin 23. This prevents burnout of the driving transistor Q2 from *inductive kickback* which builds up large voltages whenever the relay is turned off and the field collapses.

Teleprinter keyboards are switches which open and close in the proper pattern to control an externally supplied current. Pin 11 of the modem is a good source of current (18 mA maximum). Connect pin 11 to pin 12 of the modem and connect the teleprinter keyboard terminals from pin 13 to pin 7 of the modem. You don't have to worry about the direction of current flow from pin 12 to pin 13 since a diode bridge in the modem takes care of that.

EIA Interface

EIA stands for Electronic Industries Association which sets standards for data interconnections as well as other things. The standard which is relevant to this connection is known as RS-232-C and *any* terminal wired to meet this specification will plug right into the **Pennywhistle 103**.

EIA signals in this standard are always more than 3 volts and always less than 25 volts open circuit (15 volts when connected). They are positive or negative depending on the data. Negative data is a *mark* or binary 1 and positive data is a *space* or binary 0. Control lines are active with a positive signal. EIA signals do not have to drive a load if less than 3000Ω, but they must be short-circuit protected, not only to ground but also to each other.

About The Designer . . .

Lee Felsenstein holds a BSEE from the **University of California** at Berkeley, where he studied in the Co-operative Work-Study Program. Lee spent the next several years as a circuit designer for the **Special Products Division of Ampex, Inc.** where he was advanced to Associate Engineer prior to attaining his degree. As Chief Engineer for **Resource One, Inc.**, Lee supervised the installation, interface and maintenance of a large timesharing computer system and was instrumental in establishing the first experimental public-access information exchange program using that system. Lee has been self-employed as an electronic design consultant since mid-1974, doing business as **LGC Engineering**. He has authored two papers and several popularized columns on computer hardware which appear in **People's Computer Company**, the first newsletter for amateur computer users. Lee is co-holder of U. S. Patent 3,453,437.

Connector Pin Numbers And Functions

Pin	Function
1	Protective Ground
2	Transmitted Data
3	Received Data
6	Data Set Ready
7	Signal Ground Current Loop Data Out Return
8	Data Carrier Detector
11	20 mA Current Source
12	20 mA current Loop Data In
13	Current Loop Data In Return
23	Current Loop Data Out to TTY

SPECIFICATIONS

Data Transmission Method	Frequency-Shift Keying, full duplex (half duplex selectable).
Maximum Data Rate	300 Baud.
Data Format	Asynchronous Serial (return to mark level required between each character).
Receive Channel Frequencies	2025 Hz for space; 2225 Hz for mark.
Transmit Channel Frequencies	Switch selectable: Low (normal) = 1070 space, 1270 mark; High = 2025 space, 2225 mark.
Receive Sensitivity	-46 dbm acoustically coupled.
Transmit Level	-15 dbm nominal. Adjustable from -6 dbm to -20 dbm.
Receive Frequency Tolerance	Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz.
Digital Data Interface	EIA RS-232C or 20 mA current loop (receiver is opto-isolated and non-polar).
Indicators	Red LED indicates power without carrier. Amber LED lights and red LED goes out upon aquisition of carrier. Data received causes both LEDs to flicker.
Power Requirements	120 VAC, single phase, 10 Watts.
Physical	All components mount on a single 5" by 9" printed circuit board. All components included.

PARTS LIST

Integrated Circuits

A1, A2, A4, A5, A8	MC 1458 Dual 741-type op amp
A3	LM 565V Phase Locked Loop
A6	4N26, H11A4 (or equivalent), Optical Isolator
A7	LM 555 Timer

Transistors

Q1, Q2, Q4, Q5	2N 2907 PNP Switching Transistor
Q3, Q6, Q7	2N 2222 NPN Switching Transistor

Diodes

D1, D2, D3, D4, D9, D10, D15 D16, D17, D18, D19, D20, D21 D22, D23, D24, D25	1N4148 Silicon Hi-Speed diodes, low leakage
D5, D6, D7, D8, D11, D12, D13, D14	1N4001 Silicon Rectifiers, 1A, 50 PIV
Z1, Z2	1N4742 Zener Diode, 12V, 1W
LED1, LED 2	Light Emitting Diodes

Capacitors

C1	390 pF Silver Mica 5%
C2, C7, C10, C12, C21, C25	.1 μF Polyester Film 10% (104K)
C3, C4	.0047 μF Polyester Film 10% (472K)
C5, C14, C15, C22	.01 μF Polyester Film 10% (103K)
C6	.001 μF Polyester Film 10% (102K)
C8	.033 μF Polyester Film 10% (333K)
C9	620 pF Silver Mica 5%
C11	1800 pF Silver Mica 5% or .0018 μF Polyester Film 10%
C13	22 μF/25V axial aluminum electrolytic
C16, C19, C20	1 μF/25V axial aluminum electrolytic
C23, C24	270 pF Silver Mica 5%
C17, C18	470 μF/25V radial aluminum electrolytic

Resistors

R74	47 Ω	1/4W	5%
R62	620 Ω	"	"
R32	680 Ω	"	"
R15, R16, R22, R57, R64 R65, R66, R67, R68, R69	1K	"	"
R11, R70	2.2K	"	"
R27, R40, R46, R48, R58	3.3K	"	"
R36	4.3K	"	"
R12, R13, R53	4.7K	"	"
R20, R21	5.1K	"	"
R51, R80, R1	6.8K	"	"
R43	8.2K	"	"
R2, R3, R9, R17, R18, R45 R47, R54, R55, R59, R60, R61, R63	10K	"	"
R23, R24, R33	15K	"	"
R8, R14	18K	"	"
R7	20K	"	"
R52	22K	"	"
R38	24K	"	"
R19	39K	"	"
R34	68K	"	"
R44, R56	100K	"	"
R4, R5	150K	"	"
R39	180K	"	"
R35, R72, R73	220K	"	"
R6, R25, R26	330K	"	"
R71	470K	"	"
R37	1.5M	"	"
R49, R50	82 Ω	1/2W	"
R29, R30, R31	680 Ω	"	"
R28, R41, R42	1K	"	"
R10, R77	5K Single Turn Pot		
R79	5K Multi-Turn Pot		
R75	10K Multi-Turn Pot		
R76	100K Single Turn Pot		
R78	20K Single Turn Pot		

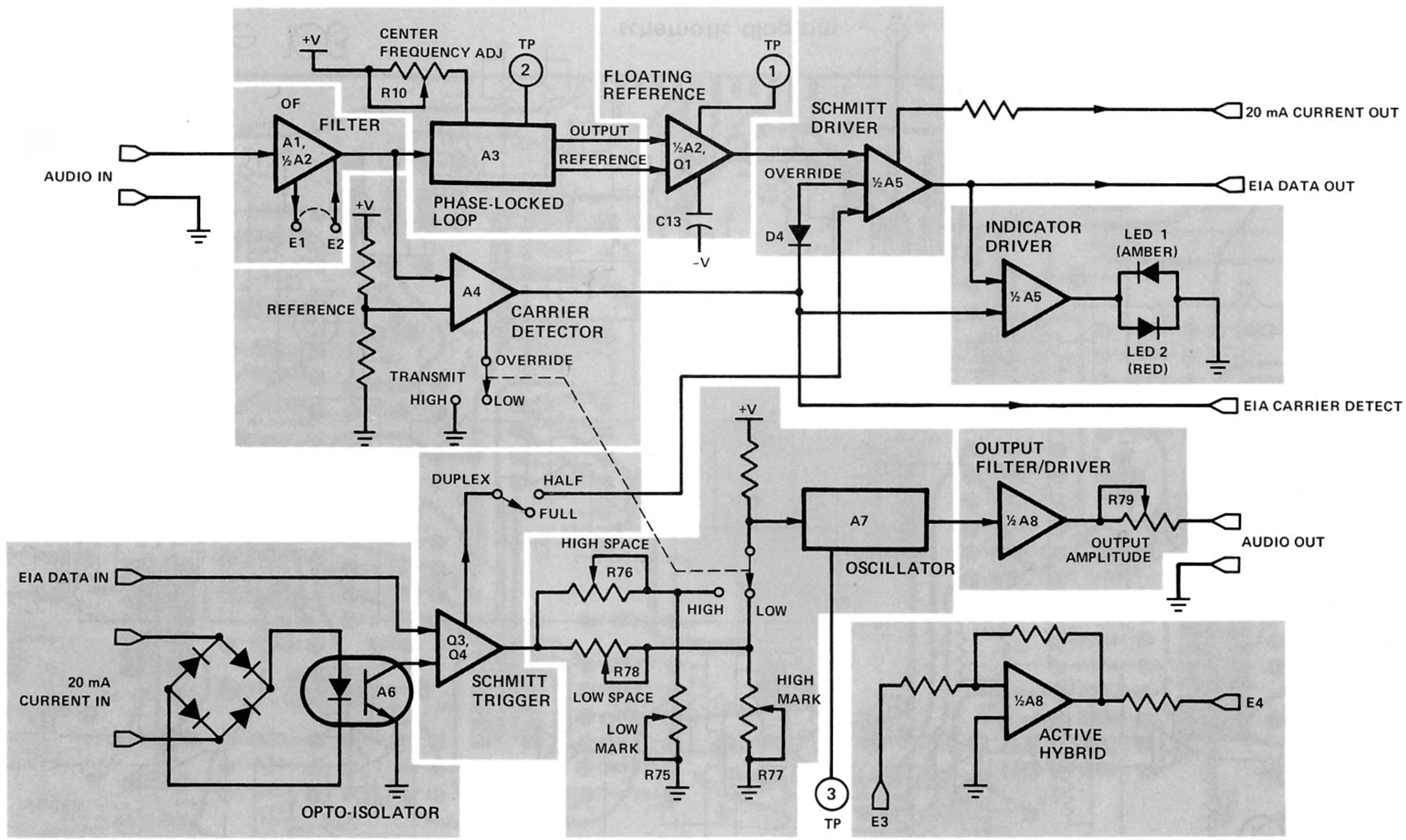
Hardware

T1	Power Transformer, 24VCT, 600MA
F1	Fuse, Pigtail 3AG, 1/2A Slo-Blo
P1	Connector, DB25S Type, Solder Cup Terminal
S1, S2, S3	Switches, Toggle, DPDT, PC Terminals

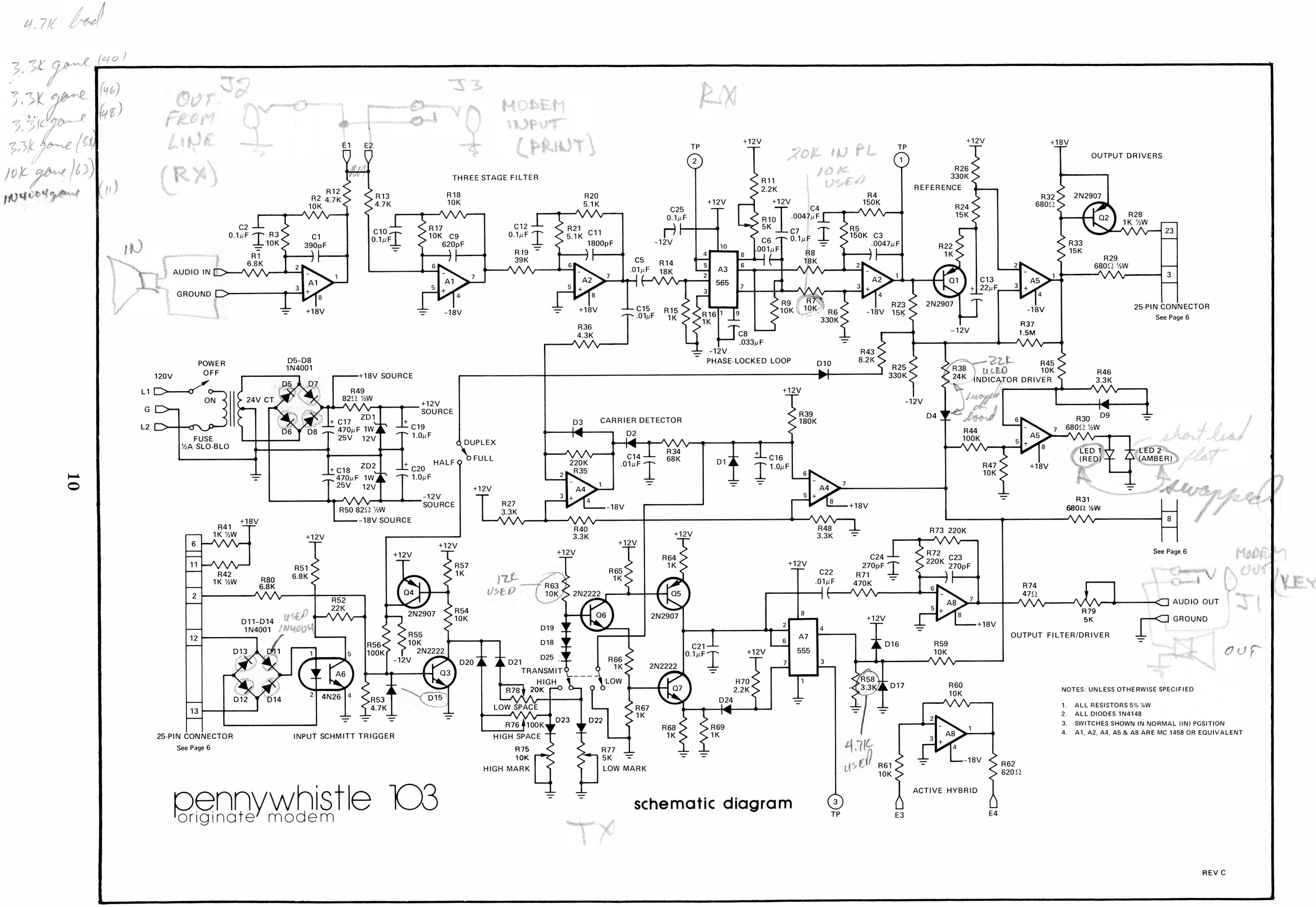
Miscellaneous

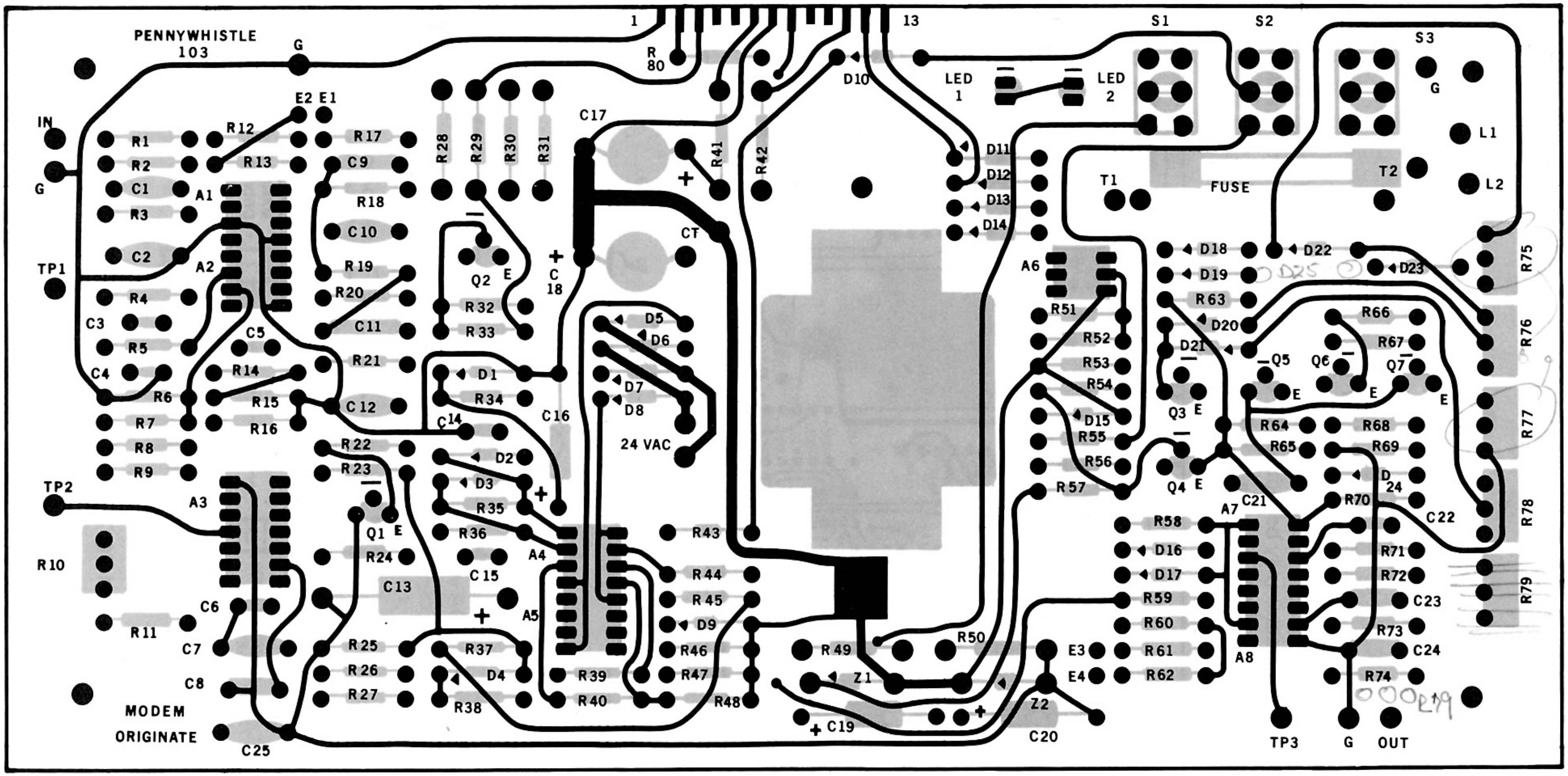
Line Cord, strain relief, printed circuit board, chassis, spacers, muffs, speakers, speaker screens and jacks.

This manual prepared for M&R Enterprises by **Laurel Publications**



pennywhistle 103 originate modem block diagram


THREE STAGE FILTER
PHASE-LOCKED LOOP
REFERENCE
OUTPUT DRIVERS
25-PIN CONNECTOR
See Page 6
INDICATOR DRIVER
CARRIER DETECTOR
POWER
OFF
ON
120V
FUSE
½A SLO-BLO
24V CT
+18V SOURCE
+12V SOURCE
-12V SOURCE
-18V SOURCE
DUPLEX
HALF
FULL
AUDIO IN
GROUND
AUDIO OUT
INPUT SCHMITT TRIGGER
OUTPUT FILTER/DRIVER
ACTIVE HYBRID
TRANSMIT
HIGH
LOW
LOW SPACE
HIGH SPACE
HIGH MARK
LOW MARK
LED 1 (RED)
LED 2 (AMBER)
NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS 5% ¼W
2. ALL DIODES 1N4148
3. SWITCHES SHOWN IN NORMAL (IN) POSITION
4. A1, A2, A4, A5 & A8 ARE MC 1458 OR EQUIVALENT
pennywhistle 103
originate modem
schematic diagram
REV C



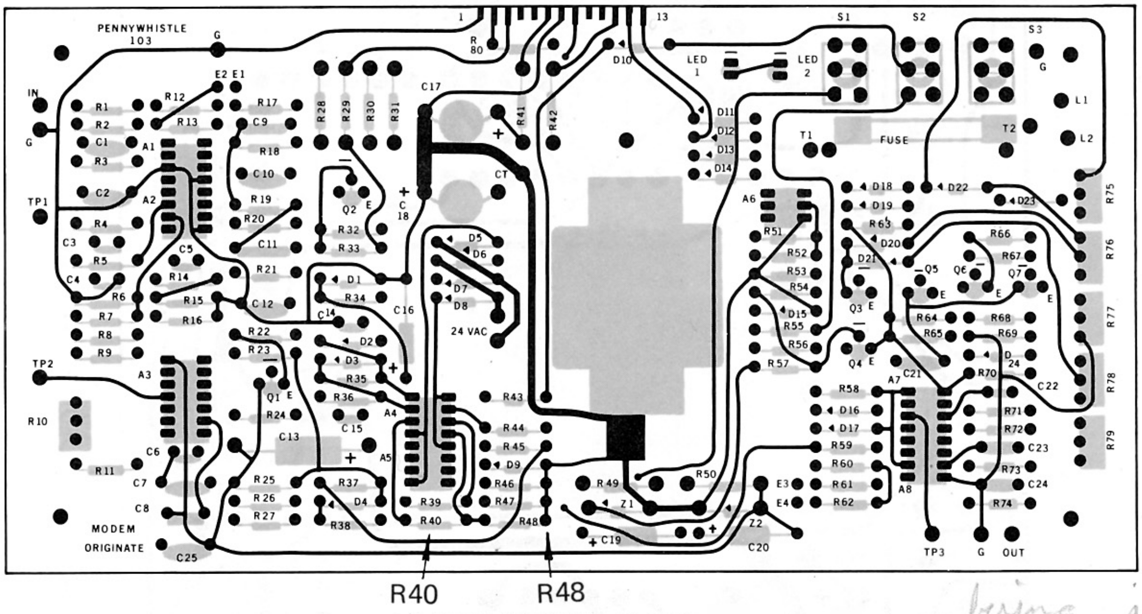
pennywhistle 103 originate modem

stuffing diagram

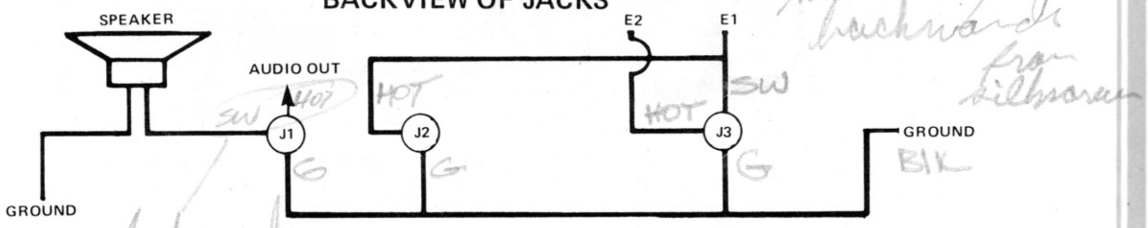
engineering update

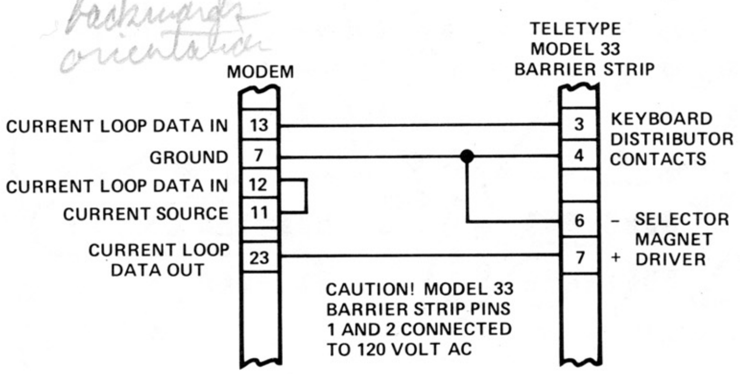
LOW SENSITIVITY MODIFICATION

Should pickup of background room noise trigger false turn-on of carrier, the sensitivity of the carrier detector may be reduced by changing the following two resistor values:
R40 – change to 4.7K; R48 – change to 1.0K.



BACKVIEW OF JACKS





MODEM TO TELETYPE MODEL 33 CONNECTION

BARRIER STRIP IS LOCATED AT REAR OF ELECTRICAL SERVICE UNIT BELOW CONNECTOR PANEL.

M & R ENTERPRISES
P. O. BOX 1011
SUNNYVALE, CALIF. 94088

CHANGE THE FOLLOWING ON PARTS LIST:

R77 change to 5K Multi-turn pot
R79 change to 5K Single turn pot

CIRCUIT BOARD ASSEMBLY:

R79 is moved to a position just below R74. Adjustment slot should face the board edge.
R75 and R77 positions are changed to accomodate multi-turn units. Adjustment slots should face bottom edge of board.
R76 and R78 are moved slightly. Their adjustment slots should face away from the board edge.
D25 is inserted to the right of D19.

SCHEMATIC:

Connection between E1 and E2 is removed.

ASSEMBLY INSTRUCTIONS:

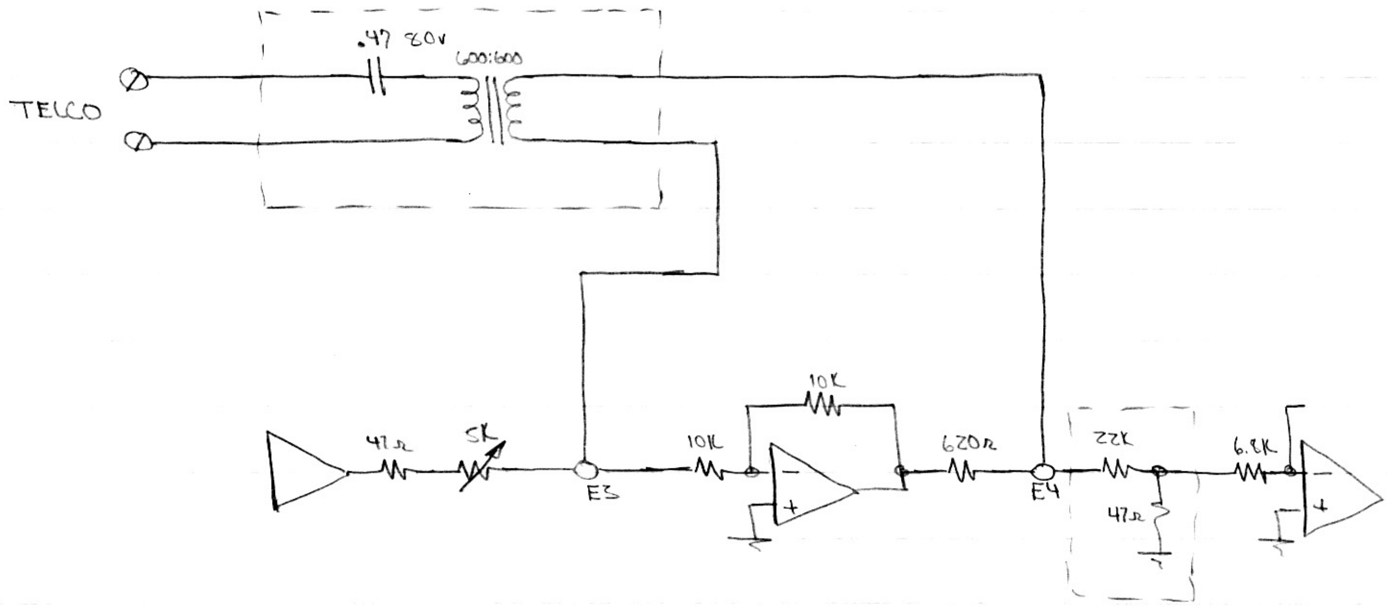
All IC's and the opto-isolator are inserted with their pin 1 end (with a notch or small indented dot) facing toward the top side of the board(the edge with the 25-pin connector.)

Page 3, Item 13. Place line cord through hole in top chassis, then solder the leads from the three-wire line cord in their proper holes.

Page 2, Item 3. Leave only 1/3" for C17 and C18.

IMPORTANT: The Red and Yellow (or amber) LED's supplied with the kit have one long and one short lead. THE SHORT LEAD IS THE CATHODE.

DIRECT MODEM CONN:



(A mod by S. Lafferty, circa 1979.)