# HAMTRONICS® DE-202 DATA DEMODULATOR: ASSEMBLY, INSTALLATION, & MAINTENANCE

## FUNCTIONAL DESCRIPTION.

The DE-202 is designed to provide interface between computer equipment and a vhf or uhf fm receiver to allow reception of "202" modem type digital fsk transmissions at rates up to 1200 baud. The '202" type modem scheme uses audio tones of 2200 Hz (mark) and 1200 Hz (space) to transmit digital information on simplex and half-duplex radio links. This is the type of transmission commonly used for packet radio and other computer based communications on the vhf and uhf bands.

The DE-202 is ideal for use with packet radio TNC's which have no internal modem, and it is also suitable for many other amateur and commercial applications, such as telemetry, wireless alarm systems, and teletype. In addition to receiving and demodulating the mark and space tones, the DE-202 also provides frequency compensation to counteract the de-emphasis circuits in the receiver, so that the two tones are applied to the detector at equal levels. This provides maximum sensitivity for clean reception of weak signals.

In addition to the DATA output from the DE-202, it also gives a receive carrier detect (ROD) handshake to the computer equipment when a valid data signal is being received. Outputs are available for use with either RS-232 or TTL computer interface. LED indicators on the board provide visual check of DATA and RCD status.

## CONSTRUCTION.

Assembly Is straight forward using the diagrams and parts list.

Following are some Items which should receive special attention.

a. Observe polarity of electrolytic capacitors, LED's, IC, and socket.

b. The LED's have a longer lead for the anode (positive side). Align them for polarity as shown in the diagram.

c. Resistor R16 has been added to the design after the pc board was made. it is installed in series with the base lead on Q1 as shown in the detail drawing. Install Q1 on the board with emitter and collector leads in the board and the base lead out of the board. After installing R16 in the hole previously provided for the base lead, splice and tack solder the free end to the Q1 base lead as shown.

d. Resistors mounted standing up are shown on the diagram with a circle indicating the position of the body and a line indicating the top lead going over to the other hole.

e. Terminal pins are supplied on a strip. Cut each one off the flashing metal, and install it in the board by pushing the pointed end through the board until the first set of dimples pops through the board to lock it in place. Be careful not to crush the barrel. The open end of the terminal will be up when properly installed. You can grip one wall of the open end with needle-nose pliers to press the terminal into the hole in the board.

f. In the original design of the ic, pin 9 was not used; so the pcb layout has a line running through that pad. We later found some ic's in which pin 9 is connected internally. Therefore, **it is necessary to remove the metal insert from pin 9 of the ic socket** before installing it.

## THEORY OF OPERATION.

The heart of the unit is UI, which is a phase-locked loop detector. The center frequency is set by C2 and R1/R3. The bandwidth is set by the resistors and capacitors between pins 7, 8, 11, and 12. The dc output at pin 7 is low for mark (2200 Hz) and hi for space (1200 Hz). Inverter Q1 provides the correct output sense for TTL loads, and inverter/switch Q2 provides output for RS-232 loads.

Pin 5 provides a lo when a valid carrier is received, either mark or space. Q3 inverts this RCD signal for RS-232 loads. Note that R12 and R15 provide -12V signal paths for RS-232 outputs when Q2 or Q3 is turned off, so that the RS-232 output signals are +12V instead of just +12V and ground. Such a symmetrical voltage swing above and below ground is better than using ground as one of the logic states to avoid problems with noise and hum on the ground leads between equipment.

The audio input for U1 is taken usually from the detector (discriminator) of the fm receiver. An fm receiver designed for voice operation has de-emphasis, which provides roll-off of high frequencies to be the reciprocal of a pre-emphasis curve in the transmitter. This is done to enhance voice communications with weak signals. It turns out not to be advantageous to do this for data signals transmitted in fsk modulation; so C1 is deliberately a small value in the DE202 in order to counteract the high frequency drop-off in the receiver. This avoids having to modify the receiver in order to optimize it for data reception.

**TABLE 1. DC SIGNALING LEVELS.**

| COMMAND | DATA/TONE | TTL | RS-232 |
|---|---|---|---|
| OFF | MARK 2200Hz | HI | -12V |
| ON | SPACE 1200Hz | LO | +12V |

**TABLE 2. RS-232 25-PIN CONNECTOR REFERENCE.**

| FUNCTION | CONN PIN | TO/FROM COMPUTER | MODULE*/ TERMINAL |
|---|---|---|---|
| Protective gnd | 1 | < | DE-202/E6 |
| Transmit data | 2 | > | MO-202/E1 |
| Receive data | 3 | < | DE-202/E1 |
| Req to send | 4 | > | MO-202/E5 |
| Clear to send | 5 | < | MO-202/E8 |
| Signal grounds | 7 | < > | DE-202/E6, MO-202/E4 |
| Rcv carrier detect | 8 | < | DE-202/E3 |

*MO-202 is the companion Data Modulator.

## MOUNTING THE MODULE.

Once construction is completed and the board has been checked for wiring errors and bad solder joints, the module may be mounted to the chassis. The preferrable location is close to the receiver to provide short hook-up wire connection the the detector in the receiver. The unit was designed for easy mounting at the right-hand side of Hamtronlcs receiver modules, adjacent to the detector circuitry. The module may be mounted with 4-40 screws in the four 1/8-inch mounting holes in the corners of the board. Although the length of leads to the computer equipment and power supply are not critical, it is good practice to keep the audio lead from the detector circuits as short as possible to avoid getting noise and hum into the receiver audio output stage; so it would be good to keep the DE-202 next to the receiver. In selecting the location, be sure to allow for access to the trim pot used to adjust the frequency of the phase-locked loop, R3. When the unit is to be mounted in an rf tight box, the DE-202 is designed for mounting at the right-hand side of the receiver with room behind the DE-202 for potentiometer adjustment.

## POWER CONNECTIONS.

Power connections depend on whether the unit will be used with TTL or RS-232 computer interface. For TTL interface, only a positive supply voltage and ground must be connected. For RS-232 interface, it will also be necessary to have a negative supply to the board unless the computer equipment is modified.

Connect the power supply return (common lead) to E6 on the DE-202 unless you can rely on a chassis ground through the mounting hardware and have the chassis connected to the power supply return line. The positive supply lead should be connected to DE-202 terminal E8. This should be +13.6 or +12Vdc capable of a current drain of 40mA maximum. The unit will work perfectly well on supply voltages of +10 to +15Vdc, but the rest of the receiver system probably has a preference for + 13.6Vdc, so that is a convenient voltage to use.

If the computer interface is RS-232, then a negative 12V supply needs to be connected to E2. This is so because RS232 interconnections use ±3 to ±12 Vdc for signalling levels instead of having one logic state ground. This, of course, requires a more complicated power supply arrangement than normally is used for radio equipment. One way around this extra power supply problem for most hams is to put the negative power pull-down resistor in the computer (TNC) equipment instead, since the computer already has a -l2Vdc supply by definition if it requires an RS-232 interface. If you elect to do this, remove R12 and R15 from the DE-202 and wire them in the computer equipment from the DATA and ROD lines to -12V bus. They will perform the same function; just the location will be different.

## DATA AND HANDSHAKE CONNECTIONS.

The DATA and RCD signals are usually connected to the computer through a 25-pin connector according to Table 2 for RS232 interface. If TTL interface is used, then the connections would be made to different terminals on the DE-202: E4 and E5. Table 1 gives the relative signal levels for either type of interface. It is helpful to refer to Table 1, since the levels for mark/space and on/off can be confusing, especially if you try to relate them to 0's and l's. It is best to forget 0's and 1's, and just refer to Table 1 and to the relative signal pulse symbols in the schematic. Those indicators show the positive or negative-going nature of the signals at each point in the circuit with regard to the active state, which is defined as the RCD circuit turned on (valid carrier detected), and with regard to "space", which is the active state on the DATA line. (Remember that the data rests normally at "mark" when no data is being sent.) Don't forget to connect a ground line from E6 on the board to the signal ground in the computer equipment; otherwise, there may be noise on the signals or the reference level may be floating.

The TTL outputs will sink up to 20 mA of current. The RS-232 outputs are designed to drive the specified RS-232 line, which is 3000Ω to 7000Ω load at the computer.

## AUDIO CONNECTIONS TO RECEIVER.

Terminal E7 on the DE-202 should be connected to the output of the detector in the receiver after the rf filter-ing/deemphasis network, which is usually a simple R/C network with a resistor in series and a capacitor to ground. The top of the volume control usually is a good place to make the connection. In most receivers, like the Hamtronics receivers, the audio signal from the detector passes through the de-emphasis network and then through a dc blocking capacitor to the top (hot terminal) of the volume control. C1 in the DE-202 makes it unnecessary to avoid connecting to the de-emphasis network. If you tried to connect directly to the output of the detector, you usually would encounter problems with rf floating on the audio signal; so avoid doing so. The DE-202 requires a minimum audio level of 80 mV p-p, which is easy to find at most discriminators. Be sure to have a good ground return from the DE-202 to the receiver as a reference for the audio. If the two modules are mounted to the same chassis, that usually is sufficient to get a good signal ground.

## REQUIREMENTS OF A GOOD DATA RECEIVER.

There are two requirements imposed on a receiver for good data reception: low distortion and fast squelch operation.

For low distortion, it is necessary to have the receiver aligned well. The if section must be set up properly with the discriminator properly centered on the if frequency and the crystal filter trimmed properly for low distortion according to instructions packed with the receiver. There usually is a little distortion in speaker amplifiers. That is why it is recommended to connect the FSK Demodulator directly to the detector. The receiver must also be on-frequency.

The response time of the squelch circuit can adversely affect the turn-around time on packet radio transmissions. If the squelch circuit is slow, which most are for good voice reception, then the transmitter must allow a longer period of time between RTS and CTS or the first part of the message will not be received. There are two ways of avoiding unnecessary delays in transmission. The preferred way is to leave the squelch control open and turn the speaker volume down. Ther there is no delay due to the squelch response time. When you want to use the radio for voice operation, then you can turn up the volume and close the squelch control. The second method, for those who want to listen to the speaker during data operation, is to modify the squelch circuit for minimum response time.

The squelch response time is usually determined by an electrolytic capacitor which integrates the rectified output of the noise detector in the squelch circuit. Values of 0.47 or 1µF are common in the Hamtronics receivers. This capacitor can be reduced to as low as 0.1µF for squelch response time as low as about 15 mSec. The setting of the squelch threshold also affects response time. If the squelch threshold is set at about 0.7µV on one of our receivers, for example, the response time is 15 mSec. If the threshold is loosened to only 0.5µV, the response time increases to 25 mSec, and if the threshold is reduced to 0.2µV, the response time increases to 50 mSec or more. This is because setting the threshold higher provides more amplified noise to the noise detector in the squelch circuit and therefore it takes less time to integrate sufficient signal to operate the squelch. Still, with all this said about modifications, it is better to simply not use the squelch when operating in the data mode. The DE202 does not require squelch operation to operate. It determines on its own whether or not a valid data signal is present based on the presence of a 1200 or 2200 Hz tone, not based on noise. The RCD signal from the DE-202 will not false, regardless of the amount of noise coming from the receiver, as long as there are no tones in the range of 900 to 2800 Hz, which is the approximate passband of the phase-locked ioop detector.

The squelch capacitor to be changed in Hamtronics receivers is C43 in the R144 or R220 Receiver, and C39 in the R451 Receiver. If you do reduce the value of the capacitor, you may expect that squelch popping may occur occasionally with squelch settings at low signal levels due to the shorter integration period of the noise detector filter capacitor.

## TESTING AND ADJUSTMENTS.

The first thing to do following installation is to verify the proper audio input levels. Connect an oscilloscope to pin 2 of the ic, and verify (a) that the audio level is at least 80mV p-p and (b) that the two tones are at about equal levels. C1 is a low value capacitor deliberately to equalize the tone levels counteracting the de-emphasis in the receiver. If it provides too much compensation for your particular receiver, then the high frequency tone (mark) will be at a higher level than the space tone. This can be remedied easily by replacing C1 with a higher value capacitor. It is only necessary to have tone balance within about 20%, and then it is necessary only if you wish to optimize the receiver for reliable reception on weak signals.

The following procedure is used to set the center frequency of the phase-locked loop.

a. Temporarily remove the jumper between E6 and E9 during alignment.

b. Temporarily jumper between pins E10 and E11.

c. Connect a frequency counter, via a high impedance 10:1 scope probe to reduce noise triggering, to E9.

d. Adjust R3 for a reading of 1700 Hz within a few Hz.

e. Remove test connections and jumper from E10 to E11.

f. Connect a permanent jumper between E6 and E9. (This jumper is removed only during alignment.)

To test the unit, simply run it with and without data input. Check to be sure that the LED's indicate when data is received and distinguishes between mark and space.

## TROUBLESHOOTING.

Finding problems should be relatively easy, since the only circuits other than the phase-locked loop detector are dc switches. The testing procedure at the left describes how to check the detector center frec1uency. The bandwidth is preset with fixed resistors. You can check for a minimum of 30 mV p-p audio at E11 to be sure that sufficient tone level is applied.

Following is a voltage chart indicating proper dc voltages at various points and under various conditions. The tests were done with +13.6 Vdc power supply, because +13.6 Vdc is ideal for operation of the companion receiver. If you use +12 Vdc or some other supply voltage, be sure to make allowances in analyzing your test results.

Most problems with new kits are due to construction errors; so be sure to check all parts and connections if you have any problem. Seldom is the problem due to a bad part.

The LEDs can be helpful in checking major functions. DS1 is lit on space, and DS2 is lit when valid data (or any tones within the 900 to 2800 approx. bandwidth) are received.

Current drain of the module is 40 mA maximum and depends on data conditions and load resistance of the computer equipment.

## PARTS LIST.

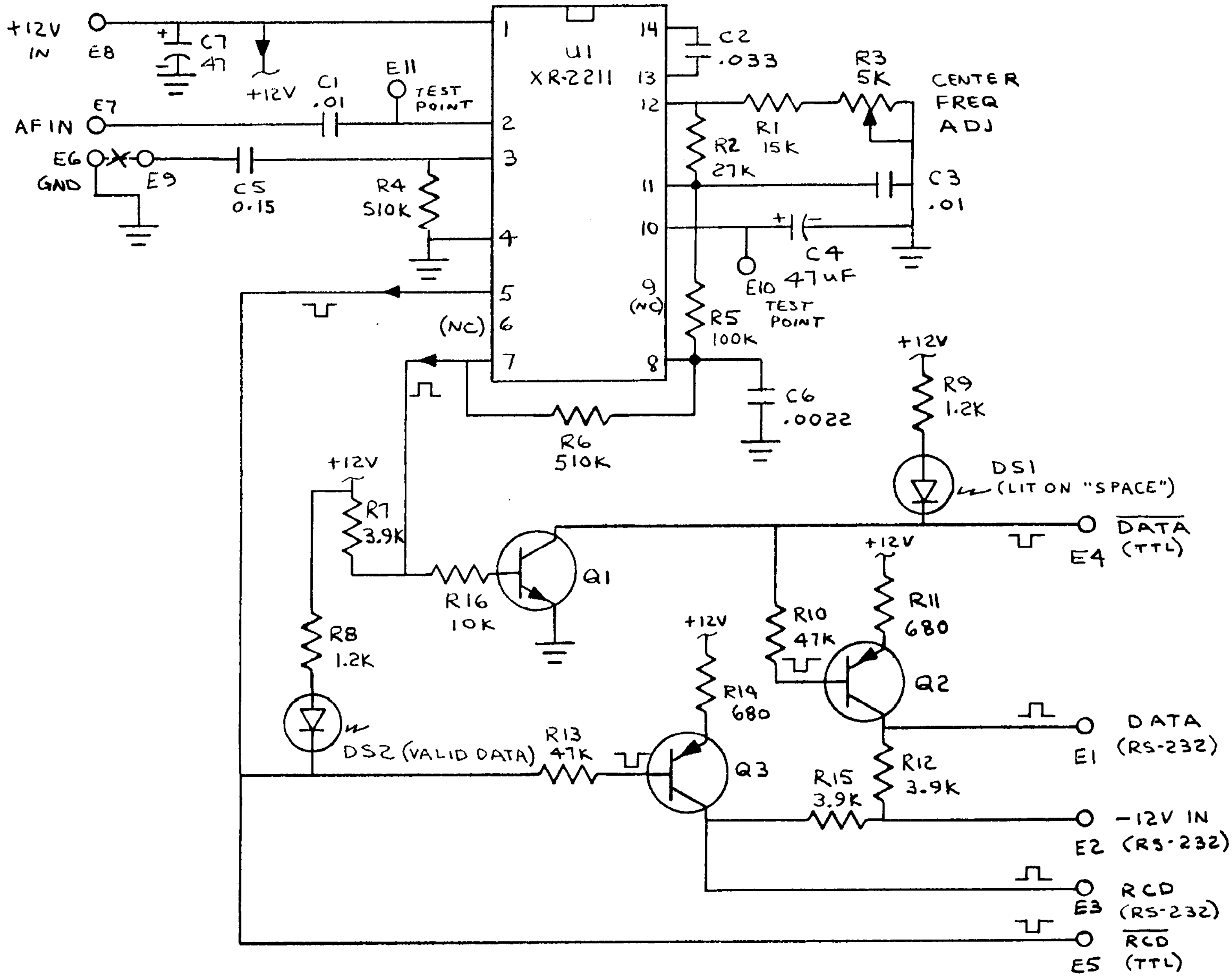
| Ref Desig | Value (marking) |
|---|---|
| C1 | .01µf disc (103) |
| C2 | .033µf mylar (333) |
| C3 | .01µf disc (103) |
| C4 | 47µf electrolytic |
| C5 | 0.15 µf mylar |
| C6 | .0022µf disc (2n2K or 2.2nK) |
| C7 | 47µf electrolytic |
| DS1, DS2 | Mini red LED |
| E1-E11 | Solder Terminal |
| Q1 | 2N3904 |
| Q2-Q3 | 2N3906 |
| R1 | 15K |
| R2 | 27K |
| R3 | 5K, 20-turn pot. |
| R4 | 510K |
| R5 | 100K |
| R6 | 510K |
| R7 | 3.9K |
| R8-R9 | 1.2K |
| R10 | 47K |
| R11 | 680Ω |
| R12 | 3.9K |
| R13 | 47K |
| R14 | 680Ω |
| R15 | 3.9K |
| R16 | 10K |
| U1 | XR-2211 PLL detector |

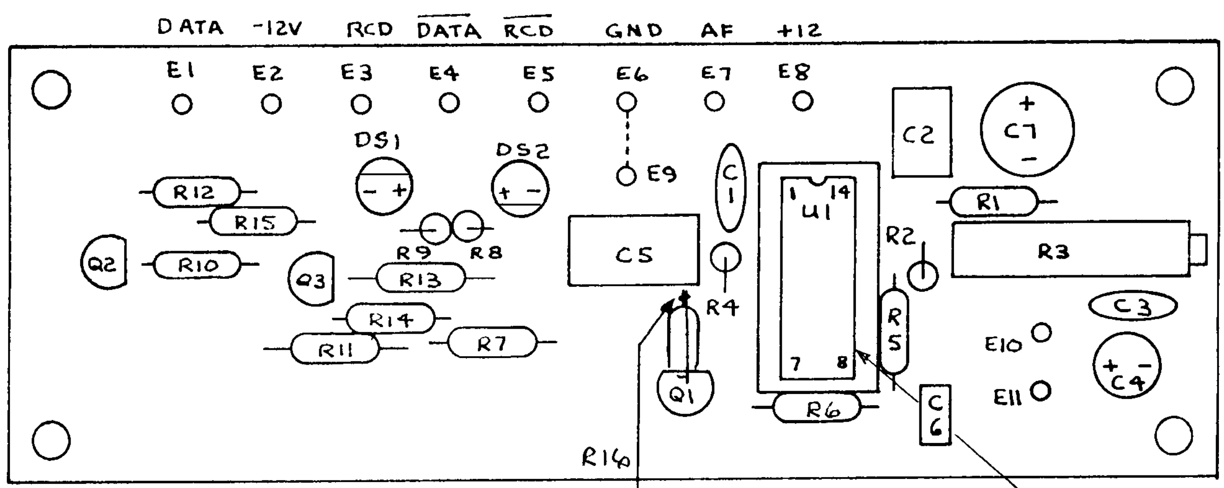
**TABLE 3. DC TEST VOLTAGES WITH 13.6 VDC POWER.**

| U1 PIN | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Mark | 13.6 | 6.8 | 0.2 | 0 | 1.5 | 0 | 0.15 | 2.5 |
| Space | 13.6 | 6.8 | 0.2 | 0 | 1.5 | 0 | 0.88 | 7.4 |
| No Sig | 13.6 | 6.8 | 0.2 | 0 | 13.6 | 0 | * | * |
| **U1Cont** | **9** | **10** | **11** | **12** | **13** | **14** | | |
| Mark | 6.8 | 6.0 | 3.0 | 6.0 | 11.2 | 11.2 | | |
| Space | 6.8 | 6.0 | 8.8 | 6.0 | 11.2 | 11.2 | | |
| No Sig | 6.8 | 6.0 | * | 6.0 | 11.2 | 11.2 | | |
| * Undetermined | | | | | | | | |
| **Xstr Lead** | **Q1-B** | **Q1-C** | **Q2-E** | **Q2-B** | **Q2-C** | | | |
| Mark | 0.15 | 13.6 | 13.6 | 12.9 | -13.6** | | | |
| Space | 0.88 | 1.6 | 13.6** | 12.8 | +13.6*<br>* | | | |
| **Xstr Lead** | **Q3-E** | **Q3-B** | **Q3-C** | | | | | |
| Valid Data | 13.6** | 12.8 | +13.6** | | | | | |
| No Tones | 13.6** | 13.6 | -13.6** | | | | | |

** No load voltage; can be much less, depending on load resistance presented by computer interface unit.




Note: Some LED's have flat on one side, and others have a longer positive lead than negative.

Note: Some led's have flat on one side, others have longer positive lead than negative.

BASE LEAD SPLICED

**Be sure to remove pin 9 of ic socket!**