HAMTRONICS® T306 UHF FSK DATA EXCITER: INSTALLATION, OPERATION, & MAINTENANCE

GENERAL INFORMATION.

The T306 is a single-channel uhf exciter designed to provide 2 to 2.5 Watts continuous duty output into a 50 ohm antenna system in the 420-450 MHz ham band or the adjacent commercial bands (special order for export or government use). Operating power is +13.6 Vdc ±10% at 550-650 mA.

There are several models, which have minor variations in parts and microcontroller programming, to provide coverage as shown in table 1. Channel frequency is controlled by a synthesizer with DIP switch channel setting.

The T306 Exciter employs a TCXO (temperature controlled xtal oscillator) to provide a temperature stability of ±2ppm over a temperature range of -30°C to +60°C.

The Exciters are designed for narrow band fsk data operation with ±3 to 4 kHz deviation. Optimum data rates are in the range of 1200 to 9600 baud. (Square waves do not go through the modulator symmetrically at frequencies below 50Hz, which limits the low end of the data rate range; and very high frequencies for data rates over 9600 baud cannot be sent over narrow band radio links.)

The exciter will accept TTL level (0 to 5Vdc) data signals. No external modem is required. The exciter is keyed (placed in transmit mode) by applying either a ground or a +5V signal to the /RTS or RTS input, respectively. With power applied to the module, it remains in standby mode until this RTS (request to send) signal is activated by the computer, microcontroller, or TNC providing the data.

At the receive end of the link, the R304HS Receiver may be used with the MO-96 modem. The R304HS is a specially modified version of our normal voice receiver, which has special filters for 9600 baud data operation. For operation at 1200 baud, the regular R304 can be used.

INSTALLATION.

Mounting.

The four mounting holes provided near the corners of the board can be used in conjunction with standoffs to mount the board in any cabinet arrangement. (See catalog for A26 PC Mounting Kits and A87-A88 series Cabinets.)

If a pa is used, keep the exciter shielded from the pa. Note that sometimes when the exciter is installed in a compact enclosure, rf from the output stage can be directed back into the vco and cause the synthesizer not to lock properly.

Electrical Connections.

Power and input data and RTS signals should be connected to the solder pads on the pc board with #22 solid hookup wire, which can be attached to the connector or feedthrough capacitors used on the cabinet in which it is installed. Be very careful not to route the wiring near the right hand side of the board, which contains sensitive loop filter and vco circuits which could pick up noise from the wiring. Also avoid routing wiring along the rf amplifier circuits on the top of the board. Keep all wiring at the left and bottom sides of the board.

Power.

The T306 Exciter operates on +13.6Vdc at about 550-650 mA. A well regulated power supply should be used. Positive and negative power leads should be connected to the exciter at E1 and E2. The negative power return can also be connected via mounting hardware to the chassis if it is grounded to the power supply. Be sure to observe polarity, since damage to the transistors will occur if polarity is reversed.

Antenna Connections.

The antenna connection should be made to the exciter with an RCA plug of the low-loss type made for rf. We have them available if you don't have any. (See A5 plugs on our website under Accessories.) The cheap audio type plugs sold in stores normally are difficult to work with and do not make a great connection for rf.

If you want to extend the antenna connection to a panel connector, we recommend using a short length of RG-174/u coax and a good RCA plug, such as mentioned. We do not recommend trying to use direct coax soldered to board or another type of connector. The method designed into the board results in lowest loss practical. When soldering the cable, keep the stripped ends as short as possible.

Data Connections.

The T306 Exciter is designed for use with TTL level (0 to +5V) data signals from a TNC or microcontroller; however, a gain adjustment allows the actual data signal peak to be anything from 3V to 12V. Connect the data signal to E5 on the board.

Note that this unit does not work well for data rates below 1200 baud because very low frequencies do not modulate well. Also note that if the exciter sits for a period without data level changing (i.e., parked at zero or one), the carrier will drift back to the center frequency; so when data is first sent, it is good to re-center the carrier by sending a string of alternating lo's and hi's before sending actual data.

Also, note that a lo data input results in high carrier output frequency and vice versa. This results in proper output from MO-96 at the receiver end of the link.

RTS (Keying) Connections.

There are two inputs provided to key the exciter into the transmit mode. The difference is polarity. E4 provides input for an RTS (request to send) signal of +3Vdc or greater. E3 provides a way to key the transmitter with a PTT or /RTS signal which is grounded to key the transmitter. Either one may be used.

When you key the exciter (activate the RTS line), it takes about 500-700 milliseconds for the synthesizer to come on. This delay normally is not a problem. You may be able to provide a delay in your software to allow the exciter to "come alive" before sending meaningful data. If you prefer, you can key the exciter manually and leave it on.

Table 1. Quick Specification Reference	
Model T306-1	410.000 - 420.235 MHz
Model T306-2	420.000 - 430.235 MHz
Model T306-3	430.000 - 440.235 MHz
Model T306-4	440.000 - 450.235 MHz
Model T306-5	450.000 - 460.235 MHz
Model T306-6	460.000 - 470.235 MHz
Operating Voltage:	+13.6Vdc
Operating Current:	550 mA @ 2W out
	650 mA @ 2½W out
Operating Current, Synth only:	35 mA
Audio Input:	40 mV p-p min. into 1KΩ
Size:	5 in. W x 3 in. D

ADJUSTMENTS.

Frequency Readjustment.

All crystals age a little over a long period of time; so it is customary to tweak any transmitter back onto the precise channel frequency once a year during routine maintenance. Because modern solid state equipment doesn't require much routine maintenance, many transmitters don't get their oscillators tweaked as a matter of routine any more, but they should. This is especially important with data radios because the data pulses can get skewed if the center frequency has drifted off.

The adjustment should be done using an accurate service monitor. Of course, make sure the test equipment is exactly on frequency first by checking it against WWV or another frequency standard. During the adjustment, a data signal must be applied with a constant 500Hz square wave so that the service monitor reads the center frequency.

The channel frequency is trimmed precisely on frequency with a small variable capacitor accessible through a hole on top of the vctcxo (U3, which is housed in a small metal can). The proper tool is a plastic wand with a small metal or ceramic bit in the end. (See A2 Alignment Tool in our catalog.)

Data Adjustments.

There are three pots on the top of the board, which are normally adjusted as follows. *All adjustments are done with a 500 Hz square wave data signal applied to the data input and the RTS or /RTS line activated.*

FREQuency pot R39 is initially adjusted for 2.5Vdc center voltage with an oscilloscope connected to test point TP3 on top of the board. TP3 measures the signal applied to the vctcxo in the synthesizer. This pot normally is not adjusted to change the frequency; the variable capacitor on the vctcxo used for that purpose. However, should that variable capacitor not have sufficient adjustment range in the future after aging for many years, it is ok to adjust R39 to set the exciter on frequency.

BALANCE pot R46 is adjusted for a good looking square wave on the service monitor's modulation scope. What this pot does is to set the balance in gain for high frequency modulation components vs. low frequency components.

(Because of the way a synthesizer's phase lock loop works, very low frequencies are cancelled out. Therefore, in this design, we apply modulation to the vctcxo in addition to the loop filter in order to add back in the low frequency modulation. This pot balances the two modulation points.)

GAIN pot R34 should be adjusted for 3 to 4 kHz deviation, with 3.5kHz deviation being ideal for data over narrow band fm. This provides good data results while allowing for some frequency drift in the system without affecting performance. Never attempt to run 5kHz deviation as you would for voice.

Table 2. Frequency Settings

Device	Frequency Weight
Switch #1	5.120 MHz
Switch #2	2.560 MHz
Switch #3	1.280 MHz
Switch #4	640 kHz
Switch #5	320 kHz
Switch #6	160 kHz
Switch #7	80 kHz
Switch #8	40 kHz
Switch #9	20 kHz
Switch #10	10 kHz
Switch #11	5 kHz

Setting Channel Frequency DIP Switches.

The channel frequency is determined by frequency synthesizer circuits, which use a dip switch in conjunction with programming in a microcontroller to set the channel. The microcontroller reads the dip switch information and does mathematics, applying serial data to the synthesizer ic whenever power is applied. Following is a discussion of how to set the dip switch to the desired channel frequency.

☞ **NOTE:** *If the frequency is changed more than one MHz, a complete alignment of the Exciter should be performed, as described in later text. Optimum operation only occurs if the synthesizer is adjusted to match the frequency switch setting and all the tuned amplifier circuits are peaked for the desired frequency.*

To determine what channel frequency to use, the microcontroller adds the frequency information from the dip switch to a "base" frequency stored in eprom used for microcontroller programming. Each model of the T306 Exciter has a particular base frequency. For example, the T306-4 has a base frequency of 440.000 MHz, as shown in Table 1.

Dip switch settings are binary, which means each switch section has a different weighting, twice as great as the next lower section. Sections have weights such as 5 kHz, 10 kHz, etc., all the way up to 2.56 MHz. *(See Table 2 or the schematic diagram for switch values.)*

The system sounds cumbersome, but it really is fairly simple, and you don't need to do this frequently. A small calculator or a piece of paper is handy to aid in determining which sections of the switch to turn on. When done, you might want to record the switch settings in table 3 for future reference.

Begin by subtracting the base frequency, e.g., 440.000, from the desired frequency to determine the total value of all the switch sections required to be turned on.

If the difference is less than 5.120 MHz, turn off switch section 1. If the difference is greater than 2.560 MHz, turn on switch #1, and subtract 5.120 from the difference frequency to determine the remainder.

If the difference is greater than 2.560 MHz, turn on switch #2, and subtract 2.560 from the difference frequency to determine the remainder. Otherwise, skip switch #2.

Do the same for each of the other sections, from highest to lowest weighting, in sequence. Each time you consider the remainder, turn on the switch section with the highest weighting which will fit within the remainder without exceeding it. Each time it is found necessary to turn on a switch section, subtract the value of that section from the remainder to get the new remainder.

As an example, let us consider how to set the Exciter for output on 449.150 MHz. The following discussion is broken down into steps so you can visualize the process easier.

a. 449.150 – 440.000 base freq. = 9.150 MHz remainder. So, turn on switch section 1.

b. 9.150 – 5.120 = 4.030 MHz remainder. Turn on switch #2, which represents the largest increment to fit remainder.

c. 4.030 – 2.560 value of switch #1 = 1.470 MHz. Turn on #3, which is 1.280 MHz, the largest increment to fit the remainder.

d. 1.470 – 1.280 = 0.190 MHz re-

Table 3. My Switch Settings

Frequency:____________________ MHz

Switch Sections Turned On: (circle)

1 2 3 4 5 6 7 8 9 10 11

mainder. Turn on #6, which is 0.160 MHz, the largest increment to fit the remainder.

e. 0.190 – 0.160 = 0.030 MHz remainder. Turn on switch #9 and switch #10, which have values of .020 and .010, respectively, which adds up to the remainder of .030 MHz. *Note that when the remainder gets down into the double digit range, it is very easy to visualize turning on multiple switch sections to satisfy the entire remainder, such as we just did.*

f. When we finished, we had turned on switch sections 1, 2, 3, 6, 9, and 10.

Shortcut ---

If you have access to the internet, our website has a long table of numbers which gives the equivalent binary number settings for every possible frequency. We couldn't print it here because it takes many printed pages of space. Surf to our website at www.hamtronics.com and look for Dip Switch Freq Programming for T306 under Reference Info near the bottom of the Table of Contents. Look up the frequency, and it will give you all the binary switch settings.

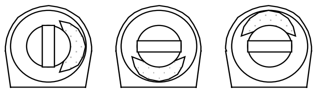
ALIGNMENT.

General Procedure.

A complete alignment is needed whenever the frequency is changed by more than about 1 MHz. Alignment ensures that the frequency synthesizer is optimized at the center of the vco range and that all rf amplifier stages are tuned to resonance.

Equipment needed for alignment is a dc voltmeter, a good uhf 50 ohm rf dummy load, an rf wattmeter accurate at uhf, and a regulated 13.6Vdc power supply with a 0-1000 mA meter internally or externally connected in the supply line.

The slug tuned coil should be adjusted with the proper .062" square tuning tool to avoid cracking the powdered iron slugs. Variable capacitors should be adjusted with a plastic tool having a small metal bit. (See A28 and A2 tools in catalog.)



Capacitor Adjustment

All variable capacitors should be preset to the center of their range unless the unit has been previously aligned. (Do not preset the TCXO, which is already set to frequency at the factory.)

☞ **NOTE:** *Following are some ground rules to help avoid trouble. Always adhere to these guidelines.*

1. Do not operate without a 50 ohm load. The output transistor could be damaged from overheating.

2. Do not exceed 2.5W output (about 650 mA total current) for continuous duty operation. You can operate up to 3W output for intermittent duty. If output exceeds this level, check to be sure your power supply is no higher than 13.6Vdc.

3. Class C amplifiers can become spurious if under-driven. Therefore, do not attempt to reduce power by detuning the drive. Better ways to reduce output are to set the power supply to as low as 10Vdc or to remove the output transistor and replace it with a blocking capacitor.

a. Connect 50 ohm dummy load to phono jack J1 through some form of uhf wattmeter suitable to measure about 5W.

b. Check output voltage of power supply, adjust it to 13.6 Vdc, and connect it to B+ terminal E1 and ground terminal E3 on the pc board. It is permissible to use the braid of the coax cable or the mounting hardware to the chassis as a ground if the power supply has a good low-impedance connection through this path to the ground on the board.

☹ ***CAUTION: Be sure to observe polarity to avoid damage to transistors!***

A 1000 mA meter or suitable equivalent should be connected in the B+ line to monitor current drawn by the exciter. This is important to indicate potential trouble before it can overheat transistors. Better yet, if using a lab supply for testing, set the current limiter on the power supply to limit at 700 mA.

☞***Note:*** *Meter indications used as references are typical but may vary widely due to many factors not related to performance, such as type of meter and circuit tolerances. Typical test point indications are for the 440 MHz band unit and may differ for other bands. The output power will be a little less at frequencies above 460 MHz, e.g., 2W max. instead of 2.5W which usually can be obtained at 440 MHz.*

c. Set dip switch for desired frequency.

d. Connect voltmeter probe to TP1 on top of the board. Activate RTS or /RTS line to key the exciter. Adjust vco coil L1 for +2.5Vdc. (Although the vco will operate over a wide range of tuning voltages from about 1V to 5V, operation is optimum if the vco is adjusted to 2.5V.)

e. Connect voltmeter probe to TP2 on top of board. Adjust doubler tank variable capacitor C20 and buffer tank variable capacitor C25 for a peak, which typically is only about +0.2Vdc.

f. Do the remaining adjustments for maximum rf output, as measured on the wattmeter. Alternately, peak C32, C35, C38, C39, C40, and C41 until any interactions are worked out. Sometimes one adjustment may affect another; so alternately adjusting two capacitors in a pair, such as C38 and C39 or C40 and C41 will "walk in" the two adjustments. Also, repeating the entire sequence of adjustments may improve the output a little. Sometimes if the drive on a stage is increased, slightly better efficiency can be obtained by repeaking the output.

g. At full drive, the total current drawn by the exciter should be 550-650 mA, and the RF output should be about 2 to 3 Watts. Note that full output may not be possible when operating on a power supply less than 13.6 Vdc. Power output falls rapidly as operating voltage is reduced.

This does not necessarily mean that the unit cannot be used on lower B+ voltage, however, since it is hard to distinguish even a 2:1 reduction in power on the air. And sometimes, you may wish to deliberately restrain the output level to be conservative. Reducing the power supply voltage is a good way to do it. Just don't operate below 10Vdc because the voltage regulators would fall out of regulation with too low an input.

After tuning the exciter into a known good 50 ohm dummy load, it should not be retuned when later connected to the antenna or power amplifier. Of course, the antenna or pa should present a good 50 ohm load to the exciter.

h. Perform the Carrier Frequency Readjustment and Data Adjustments given on pages 1&2 to complete the alignment of the exciter.

THEORY OF OPERATION.

Refer to the schematic diagram for the following discussion.

The carrier frequency is generated by voltage controlled oscillator Q1. The vco operates at half the desired frequency to allow the use of a circuit optimized for best phase noise. The vco output is doubled by Q2 and buffered by Q3 to minimize effects of loading and voltage variations of following stages from modulating the carrier frequency. The resultant signal is amplified in successive stages to provide 2 to 2.5 Watts output into a 50Ω load.

The frequency of the vco stage is controlled by phase locked loop synthesizer U2. A sample of the vco output is applied through the buffer stage and C3 to a prescaler in U2. The prescaler and other dividers in the synthesizer divide the sample down to 5kHz.

A reference frequency of 10.240 MHz is generated by a VCTCXO (voltage controlled temperature compensated crystal oscillator). The reference is divided down to 5 kHz.

The two 5kHz signals are compared to determine what error exists between them. The result is a slowly varying dc tuning voltage used to phase lock the vco precisely onto the desired channel frequency.

The tuning voltage is applied to carrier tune varactor diode D1, which varies its capacitance to tune the tank circuit formed by L1/C17/C18. C10 limits the tuning range of D1. The tuning voltage is applied to D1 through a second order low pass loop filter, which removes the 5kHz reference frequency from the tuning voltage to avoid whine.

Modulation is applied to the loop filter at R4, which is in series with the ground return of all the loop filter elements. Data signals are limited by U5a. Two pots set the gain and center voltage of the resulting output. U5b and U5c are low pass filters which have a cutoff of 5000 Hz to prevent splatter. The output of U5c is applied directly to the vctcxo to modulate the oscillator. It also is applied to R4 in the loop filter circuit through R46 and R47 which allows for balance adjustment between high and low frequency modulation components of the data waveform. The loop filter tends to cause the low frequency components of modulation applied to it to be cancelled. The opposite happens with the modulation applied to the vctcxo. Therefore, modulation is applied to both, and a balance adjustment allows the levels to be adjusted so the low and high frequency components cause the same frequency deviation. In practice, balance pot R46 is simply adjusted for a good looking square wave in the resulting modulation waveform viewed on a service monitor.

A lock detector in the synthesizer ic provides an indication of when the synthesizer is properly locked on frequency. In order for it to lock, the vco must be tuned to allow it to generate the proper frequency within the range of voltages the phase detector in the synthesizer can generate, roughly 0.5 to 4.5 Vdc. If the vco does not generate the proper frequency to allow the synthesizer to lock, the lock detector output turns off U5d, which provides operating bias to Q5 and Q6, thus preventing the exciter from putting out signals which are off frequency. Even if the vco is properly tuned, there is a short period when the synthesizer is first powered up in which the vco is not locked. This feature ensures that the signal will reach the antenna only after the carrier locks on frequency.

Serial data to indicate the desired channel frequency and other operational characteristics of the synthesizer are applied to synthesizer U2 by microcontroller U1. Everything the synthesizer needs to know about the band, division schemes, reference frequency, and other options is generated by the controller. Information about the base frequency of the band the T306 is to operate on and the channel within that band is calculated in the controller based on information programmed in the eprom on the controller and on channel settings done on dip switch S1. Whenever the microcontroller boots at power up, the microcontroller sends several bytes of serial data to the synthesizer, using the data, clock, and latch enable (LE) lines running between the two ic's.

+13.6Vdc power for the exciter is applied at E1. Higher level rf amplifier stages are powered directly by the +13.6Vdc. However, all the lower level stages are powered through voltage regulators for stability and to eliminate noise. U4 is an 8Vdc regulator to power the vco, buffer, and phase detector in the synthesizer. Additional filtering for the vco and buffer stages is provided by capacitance amplifier Q4, which uses the characteristics of an emitter follower to provide a very stiff supply, eliminating any possible noise on the power supply line. Q9 provides 5Vdc for the logic and synthesizer circuits.

The output of Q4 is inhibited at times when the unit is not supposed to transmit. This action is controlled by the RTS (request to send) signal or the inverted sense /RTS signal via Q11 and Q10.

TROUBLESHOOTING.

General.

Usual techniques of checking dc voltages and signal tracing with an RF voltmeter probe and oscilloscope will work well in troubleshooting the T306. A dc voltage chart is given to act as a guide to troubleshooting. Although voltages may vary widely from set to set and under various operating and measurement conditions, the indications may be helpful when used in a logical troubleshooting procedure.

The exciter draws about 35 on standby. When the exciter is generating an RF output, it draws a total of about 550-650 mA.

RF Amplifier Circuits.

You can use an RF probe with a dc voltmeter or scope to check the relative RF levels at the input and output of each stage. The output level should always be higher than the input level of a given stage. Also, check the dc operating and bias voltages for each stage. The pre-driver stage gets its bias only when the lock detector in the synthesizer is locked; so if that bias is missing, check the synthesizer and vco to see why it isn't locked.

Synthesizer Circuits.

Following is a checklist of things to look for if the synthesizer is suspected of not performing properly.

a. Check the output frequency of the vco with a frequency counter. It should be half the final frequency.

b. Check the lock detector at R22 (U5-12) with a dc voltmeter. (5Vdc locked, 0Vdc unlocked).

c. Check tuning voltage at TP1. It should be about +2.5Vdc. Actual range over which the unit will operate is about +0.5Vdc to just under +4.5Vdc. However, for optimum results, the vco should be tuned to allow operation at about +2.5Vdc center voltage.

d. Check the operating voltage and bias on the vco, doubler, and buffer stages.

e. Check the 10.240 MHz reference signal at pin 8 of the VCTCXO. A scope should show strong signal (near 3 V p-p) at 10.240 MHz.

f. Check the oscillator at pin 2 of microcontroller ic U1 with a scope. There should be a strong ac signal (several volts p-p) at the oscillator frequency of about 200kHz.

g. The data, clock, and latch enable lines between the microcontroller and synthesizer ic's should show very brief and fast activity, sending data to the synthesizer ic shortly after the power is first applied or a dip switch setting is changed. Because this happens very fast, it can be difficult to see on a scope. Use 100µSec/div, 5Vdc/div, and normal trigger on rising pulse.

h. Check the microcontroller to see that its /reset line is held low momentarily when the power is first applied. C1 works in conjunction with an internal resistor and diode in the ic to make C1 charge relatively slowly when the power is applied. It should take about a half second to charge up.

i. Check the dip switch settings to be sure you have the correct frequency information going to the microcontroller.

Synthesizer Locking Problems.

Note that sometimes when the exciter is installed in a compact enclosure, rf from the output stage can be directed back into the vco and cause the synthesizer not to lock properly.

The shields on the board should prevent this in all but severe cases of feedback. However, you need to be very careful to fully shield any power amplifier which the exciter may be driving and not put it in the same enclosure unless there is a full shield between them.

Also, check to be sure you don't have cabling laying near any rf circuits on the board which might couple rf from one area to another. Always lay cabling along the edge of the board and not under or over the board.

Table 4. Typical Test Point Voltages

TP1	Normally set at 2.5Vdc
TP2	approx. 0.2V
TP3	square wave ~1.5Vp-p centered at 2.5Vdc

Note: These can vary considerably without necessarily indicating a problem.

Table 5. Typical Xstr DC Voltages

STAGE	E	B	C
Q1 vco	1.5	2	7
Q2 doubler	0	0.7	5
Q3 buffer	0	0.7	5
Q4 dc filter	7	7.6	7.7
Q5 ampl	0.2	1	8
Q6 pre-driver	0	0.1	13.6
Q7 driver	0	0	13.6
Q8 pwr ampl	0	0	13.6

Figure 6. Typical IC DC Voltages

U1-1	4
U1-2	4 Vdc with 2.5Vp-p at 200kHz)
U2-1	3 Vp-p centered at 1.6Vdc
U2-5	normally set to 2.5Vdc
U2-7	4.7Vdc when locked
U2-8	1.7Vdc
U2-9, 10,11	ground at rest
U3-1	2Vp-p centered at 2.5Vdc
U5-1	2Vp-p centered at 2.5Vdc
U5-2	1.5Vdc
U5-3	1.5Vdc
U5-5,6,7,8,9,10	2Vp-p centered at 2.5V
MOD1 signal to loop filter	2Vp-p centered at 2Vdc (depends on adjustment)

Microphonics, Hum, and Noise.

The vco and loop filter are very sensitive to hum and noise pickup from magnetic and electrical sources. Some designs use a shielded compartment for vco's. We assume the whole board will be installed in a shielded enclosure; so we elected to keep the size small by not using a separate shield on the vco and simply use strip shields to prevent radiation between stages. However, this means that you must use care to keep wiring away from the vco circuit at the right side of the board. Having the board in a metal enclosure will shield these sensitive circuits from florescent lights and other strong sources of noise.

Because the frequency of a synthesizer basically results from a free running L-C oscillator, the tank circuit, especially L1, is very sensitive to microphonics from mechanical noise coupled to the coil. You should minimize any sources of vibration which might be coupled to the exciter, such as motors.

Excessive noise on the dc power supply which operates the exciter can cause noise to modulate the signal. Various regulators and filters in the exciter are designed to minimize sensitivity to wiring noise. However, in extreme cases, such as in mobile installations with alternator whine, you may need to add extra filtering in the power line to prevent the noise from reaching the exciter.

Other usual practices for mobile installations are recommended, such as tying the + power and ground return lines directly to the battery instead of using cigarette lighter sockets or dash board wiring.

To varying degrees, whine from the 5kHz reference frequency can be heard on the signal under various circumstances. If the tuning voltage required to tune the vco on frequency is very high or low, near one extreme, the whine may be heard. This can also happen even when the tuning voltage is properly near the 4Vdc center if there is dc loading on the loop filter. Any current loading, no matter how small, on the loop filter causes the phase detector to pump harder to maintain the tuning voltage. The result is whine on the signal. Such loading can be caused by connecting a voltmeter to TP1 for testing, and it can also be caused by moisture on the loop filter components.

Typical Dc Voltages.

DC levels were measured with a sensitive dc voltmeter on a sample unit with 13.6 Vdc B+ applied and /RTS terminal E3 grounded. All voltages may vary considerably without necessarily indicating trouble. The chart should be used with a logical troubleshooting plan. All voltages are positive with respect to ground except as indicated. Voltages are measured with the exciter operating and fully tuned. Note that meter probe must have a 1 megΩ or similar resistor in probe to isolate from RF signals. Even then, the type of meter and probe has an effect on the readings taken on points where RF is present.

Use caution when measuring voltages on the surface mount ic. The pins are close together, and it is easy to short pins together and damage the ic. We recommend trying to connect meter to a nearby component connected to the pin under question. Also, some pins are not used in this design, and you can generally not be concerned with making measurements on them.

REPAIRS.

If you need to unsolder and replace any components, be careful not to damage the plated through holes on the pc board. Do not drill out any holes. If you need to remove solder, use a solder sucker or solder wick. A toothpick or dental probe can be used with care to open up a hole.

If you need to replace a surface mount ic, first be very sure it is damaged. Then, carefully cut each lead off the case with fine nose cutters. Once the case is removed, individual leads can be unsoldered and the board can be cleaned up. Carefully position the new ic, and tack solder the two opposite corner leads before any other leads are soldered. This allows you to reposition the ic if necessary. Once it is aligned well, the remaining leads can be soldered. If you get a solder short between leads, use a solder sucker or solder wick to remove the excess solder.

If it becomes necessary to replace output transistor Q8, you must unsolder the three leads first from under the board. Then, carefully melt the solder holding the can to the top of the board. This requires a very hot iron, and care must be taken to avoid damaging the board. Once the transistor is removed, a vacuum solder sucker can be used to clean the excess solder off the ground plane. Install the new output transistor flat against the board, and solder the leads on the bottom of the board. Then, solder the bottom of the metal can to the pcb ground plane with a continuous bead of solder flowing around the can. (Soldering the can to the ground plane is necessary to provide a low impedance emitter ground; the transistor is designed to be installed this way.)

PARTS LIST FOR T306 EXCITER, REV. B.

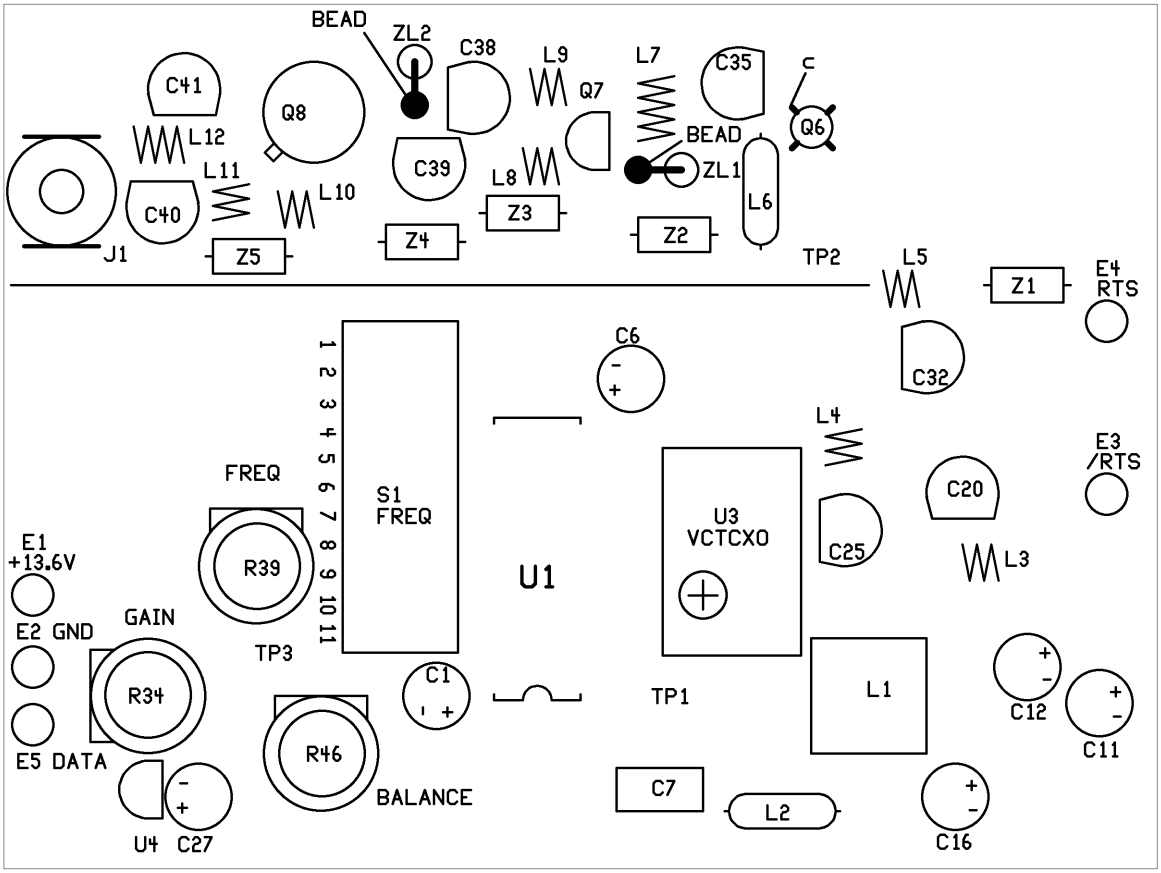
Ref Desig	Value (marking)
C1	1 µf electrolytic
C2	.047µf
C3	0.5pf
C4	100pf
C5	.047µf
C6	100µf electrolytic
C7	0.15µf mylar (red)
C8	.01µf
C9	.0047µf
C10	6pf
C11	10µf electrolytic
C12	100µf electrolytic
C13	.047µf
C14-C15	390pf
C16	10µf electrolytic
C17	12pf
C18	47pf
C19	2pf
C20	4.5pf variable (wht)
C21	390pf
C22	100pf
C23	2pf
C24	100pf
C25	4.5pf variable (wht)
C26	.047µf
C27	100µf electrolytic
C28	.01µf
C29	2pf
C30-C31	100pf
C32	4.5pf variable (wht)
C33	2pf
C34	100pf
C35	4.5pf variable (wht)
C36	100pf
C37	.001µf
C38	4.5pf variable (wht)
C39	20pf variable (red)
C40-C41	10pf variable (blue)
C42	7pf
C43-C44	100pf
C45	.001µf
C46	.047µf
C47-C52	.001µf
C53	100pf
D1	BB132 varactor diode
D2	MMBT3904
J1	RCA Jack
L1	1½t. slug tuned coil
L2	0.22µH RF choke (red-sil-red-red)
L3	2¾ t. air wound coil*
L4	1¾ t. air wound coil*
L5	2¾ t. air wound coil*
L6	0.33µH RF choke (red-sil-orn-orn)
L7	5¾ t. air wound coil*
L8	1¾ t. air wound coil*
L9-L11	2¾ t. air wound coil*
L12	3¾ t. air wound coil*

* Note: all air wound coils should be installed 1/16” above the board.

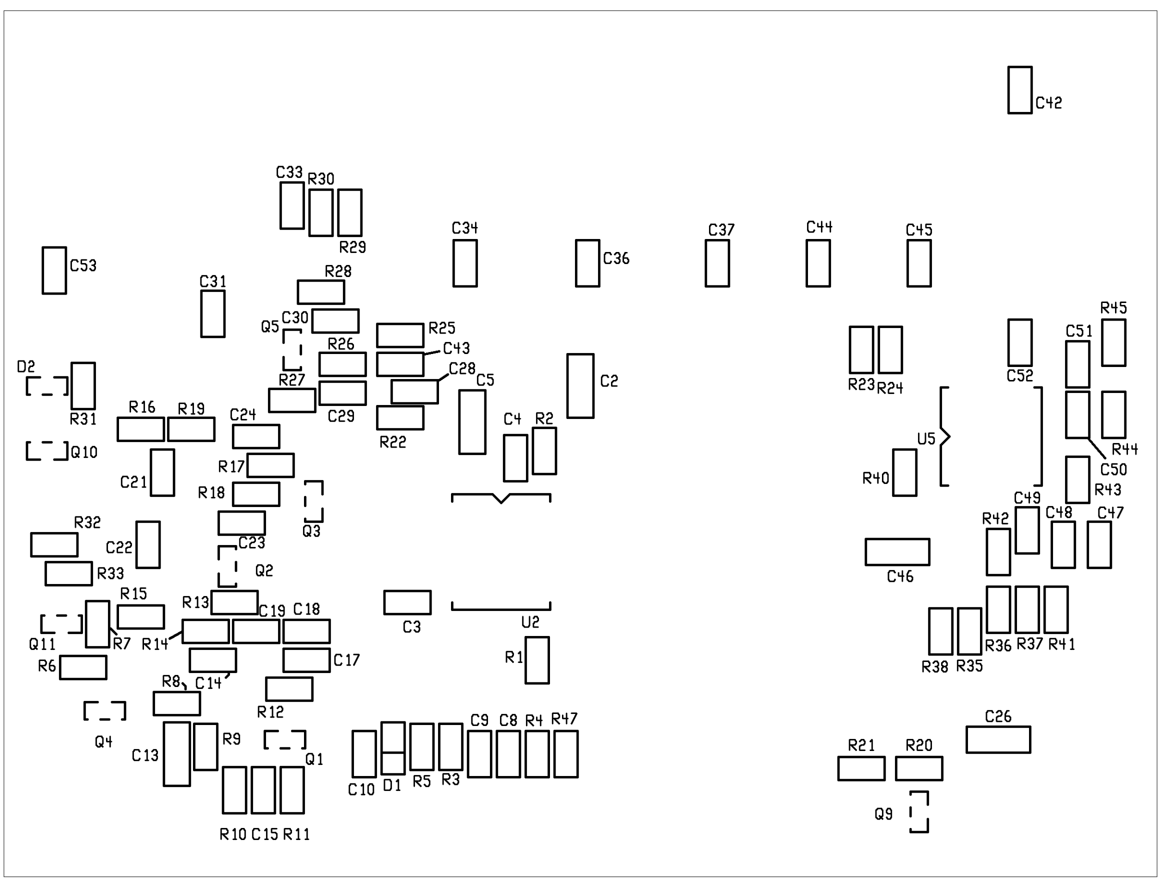
Q1-Q3	MSC3130
Q4	MMBT3904
Q5	MSC3130
Q6	2SC2369
Q7	Motorola MPS3866
Q8	Philips BFQ-43S
R1	2 meg
R2	27Ω
R3	15K
R4	100Ω
R5	10K
R6	2.2K
R7-R8	27Ω
R9	10K
R10	4.7K
R11	270Ω
R12	47Ω
R13	15K
R14	2.2K
R15	470Ω
R16	47Ω
R17	15K
R18	2.2K
R19	470Ω
R20	2.2K
R21	4.7K
R22	1 meg
R23-R24	22K
R25	270Ω
R26	15K
R27	2.2K
R28	100Ω
R29	15K
R30	1K
R31-R33	22K
R34	20K Pot
R35	22K
R36	15K
R37	10K
R38	4.7K
R39	2K Pot
R40-R45	10K
R46	20K Pot
R47	27K
S1	11 pos. DIP switch
U1 💣	MC68HC705J1A µP
U2 💣	LMX1501A synthesizer
U3 💣	10.240MHz VCTCXO

💣 Caution: Ic’s are static sensitive. Use appropriate handling precautions to avoid damage.

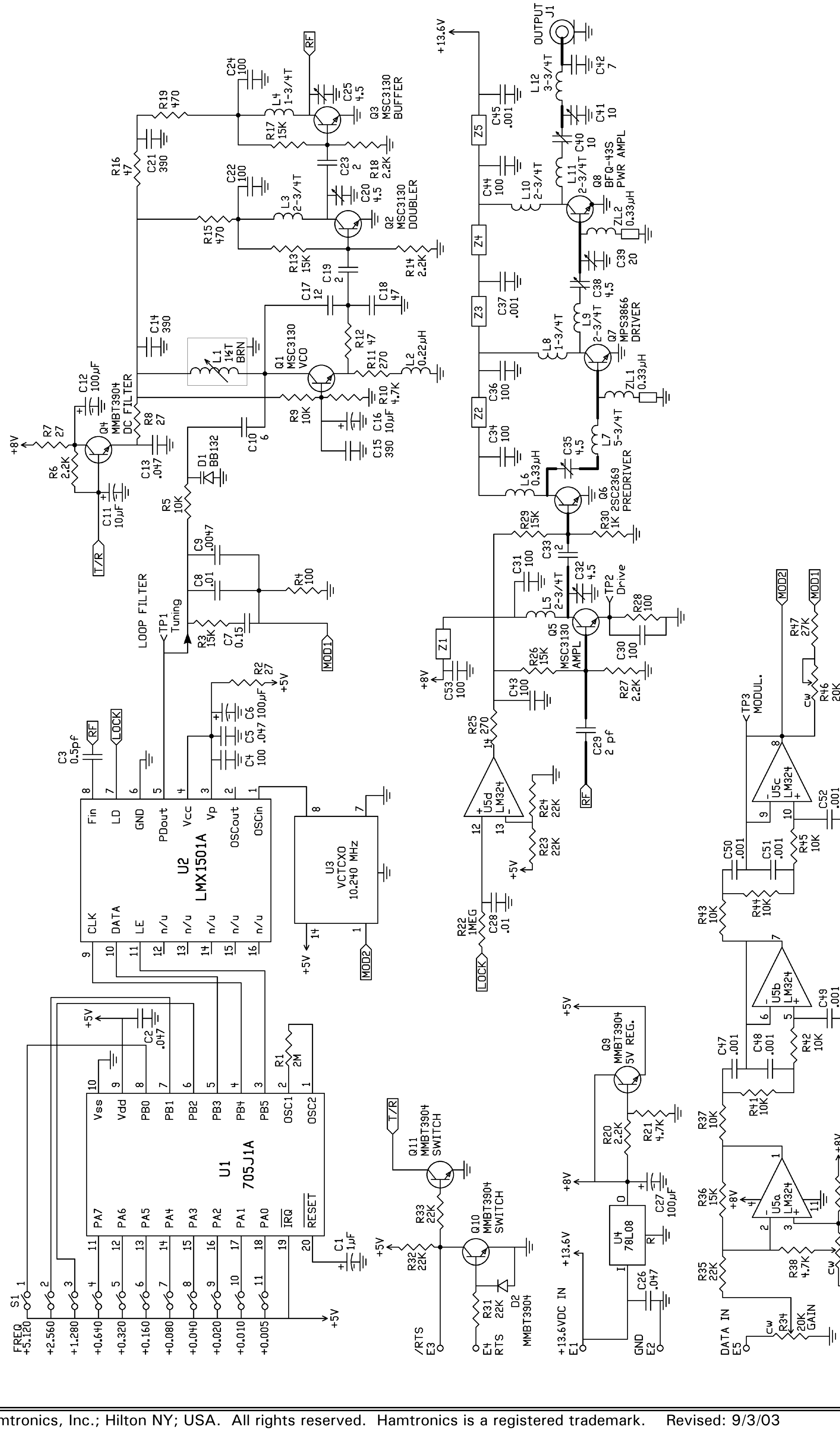
U4	78L08 regulator
U5	LM324 quad op amp
Z1-Z5	Ferrite bead, prestrung
ZL1-ZL2	0.33µH rf choke with ferrite bead on one lead



T306 Module Top View



T306 Module Bottom View



T306 UHF FSK Data Exciter, Schematic Diagram.

 Revised: 9/3/03