UT400 TUNE-UP PROCEDURE

EQUIPMENT REQUIRED

Audio signal generator capable of producing signals of -60 dBV to +10 dBV into 600 ohms at frequencies of 10 Hz to 50 kHz. Used in development: Audio Precision ATS-1.

RF spectrum analyzer with sensitivity of -100 dBm or better, a frequency range of 10 MHz to 1.5 GHz or wider, a terminating impedance of 50 ohms, and capability of handling an input level of + 25 dBm without overload or significant distortion. Used in development: Hewlett Packard 8560E.

Frequency counter covering 10 MHz to 806 MHz with an accuracy of +/- 100 Hz and readout to the nearest 10 Hz or better. This function may be resident on many higher end spectrum analyzers.
Used in development: Boonton 8200 and Hewlett Packard 8560E.
Deviation meter capable of measuring frequency deviation from 0 to +/-100 kHz at 470 MHz to 806 MHz with an RF power level of +25 dBm or less in an FM system modulated by audio frequencies from 10 Hz to 50 kHz. The unit should also have a demodulated audio output. Used in development: Boonton Model 8200.

Digital multimeter capable of measuring current to at least 100 ma and voltage to 10 VDC with an accuracy of 3% or better. Used in development: Fluke Model 85.

Audio analyzer capable of measuring audio distortion to 0.05% or less over a frequency range of at least 10 Hz to 50 kHz. The unit should also have an output of residual distortion to an external measurement device. Used in development: Audio Precision ATS-1.

Oscilloscope with good audio response and sensitivity of at least 10 mv/cm with associated high impedance probe is also needed for evaluation of residual distortion. Used in development: Tektronix Model 224.

Power supply for bench top use capable of supplying 9 VDC at 100 ma of current is needed. Both current and voltage should be metered. The supply should also have a variable current limit adjustment. Used in development: Leader Model LPS-15SL.

RF power meter or 50 ohm RF probe and associated meter capable of measuring RF power to 806 MHz at power levels to +20 dBm to an accuracy of 5% is also required. Many higher-end spectrum analyzers have this capability available as part of the cursor functions. Used in development: Hewlett Packard 8560E and Hewlett Packard 437B.

AC RMS voltmeter with a range of at least +20 dBV to -60 dBV (10 Vrms to 1 mVrms) readable to within +/- 3% is needed. Used in development: Audio Precision ATS-1.

RECOMMENDED TEST FIXTURES

An audio cable with a 4-pin female .05” connector on one end. The other end should be appropriate to the audio signal generator. Note that DMMs may read inaccurately in RF fields. A cable that attaches to the spectrum analyzer and frequency counter plugs into the .1” spaced jacks on the unit under test.

GENERAL NOTES

The tuning capacitors are small and have a very small tuning socket. An alignment tool, which fits the tuning capacitors, is a must.

CHECKING THE POWER INDICATOR

Substitute the power supply for the battery. The supply should be current limited to 100 ma to protect the UT400 from shorts and over current due to misalignment. Set the supply for 9 VDC and connect it to the UT400. The current drain should 80 ma or less. When properly aligned this value should be nominally 72 ma with only the power LED illuminated. The green battery indicator LED located on the front panel should be brightly lit. Adjust the power supply voltage downward while watching the Power LED. The LED should change to red at 7.3 volts, and flashing red at 6.8 volts. This completes the power indicator checks.

PREPARATION

All alignment and adjustment is done with the power supply set to 9 VDC and current limited at 100 ma. All measurements are referenced to the RF-cold PC ground plane.
A 9-volt supply should be connected to the battery contact and ground.

PRESET ADJUSTMENTS

The frequency control switches are on the back of the audio/logic board. The COURSE switch is SW-1 and sets the frequency in 1.6 MHz steps. The FINE switch is SW-2 and sets the frequency in 100 kHz steps. The switch notation used here will be (# #) or (SW-1 SW-2) or steps of (1.6 MHz 100 kHz). For example (A 7) means set SW-1 at A and set SW-2 at 7.
Set the BCD switches, SW-1 and SW-2, to the highest frequency (F F). Chances are the loop will not be locked and the lock detector will inhibit the output of the transmitter. However, the oscillator will still free run at some frequency close to the set frequency (+- 15 MHz). The oscillator will be detectable at a low level by the analyzer.
Set the mic input level (R16 between SW-1 and SW-2) to mid position.

OSCILLATOR ALIGNMENT

Adjust C23 on the RF board to move the free running oscillator toward the desired frequency. Once the oscillator is close enough to the frequency set by the BCD switches, it will lock in. The RF output of the transmitter will now be enabled since the PLL (phase locked loop) is now locked. Continue to adjust C23 until the voltage at TP1 is 3 Volts. This is a temporary adjustment of C23 and is done so that the voltages on the modulation varactor D2 can be adjusted to a final setting without interacting with the tuning varactor D3.

VCO ALIGNMENT

Install the shield on the oscillator section. Set the BCD frequency switches to (F F), readjust C23 until the voltage at TP1 is 3.0 volts.

Set the BCD switches to (0 0) for the lowest frequency. The voltage at TP1 should be between .6 Volts and 1.2 Volts. If the voltage doesn't fall into these ranges it may be necessary to increase or decrease the coupling capacitor between the tuning varactor and the resonator. The modulation varactor bias adjustment does not need to be redone.

TRANSMITTER RF OUTPUT

CAUTION: A properly operating transmitter puts out approximately 100 mW (+20 dBm). Keep the input attenuator and, therefore, the reference level of the spectrum analyzer at a point where the analyzer will not suffer damage or produce significant distortion itself (seen especially in harmonic energy). A safe condition can be generally established by keeping the analyzer adjusted such that no discrete frequency trace hits the top, or reference line, on the analyzer display. Set the START FREQUENCY of the spectrum analyzer to 0 Hz and the STOP FREQUENCY to 2 GHz (200 MHz per division). This ensures that the fundamental and all required multiples of the oscillator frequency are simultaneously displayed on the screen.
Turn the transmitter on. Observe the spectrum analyzer display with the REFERENCE LEVEL set such that the main output is one box (10 dB) below the top of the display. ALL other signals should be at least 43 dB below the main output (-43 dBc assures a 6 dB margin to the FCC specifications).

FREQUENCY ADJUSTMENT

Set the transmitter on frequency. Connect the output of the RF PCB to a frequency counter if the spectrum analyzer does not have this capability. Short Pin-1 to Pin-7 on the test socket J-7, set BCD SW-1 to (F) and adjust SW-2 to set the frequency. Turn SW-2 clockwise to increase the frequency or counter clockwise to decrease the frequency until the unit is on the correct frequency (+ or – less than 1.5 kHz). Remove the jumper.
Insure that the lock detector is working by switching the transmitter to various frequencies and observing the spectrum. The carrier should be suppressed until the unit is on frequency. Turning the supply off and then on should give the same results.

AUDIO ADJUSTMENT

To set the audio distortion it is necessary to disable the DSP emulation and pilot tone. This is done by shorting Pin-1 to Pin-7 on test socket J-7 on the logic board, adjusting the BCD switches to (D 0), and removing the short on the test socket to disable the DSP emulation. Next, short Pin-1 to Pin-7 on J-7 and set the BCD switches to (D 1) and remove the jumper to disable the pilot tone. Then set the BCD switches to (8 0) for the center frequency of the unit.
Set the audio signal generator to 400 Hz at 3.5 mVrms and connect it to UT400 using the audio cable. The RF output should be coupled to the deviation meter with a cable and the audio output of the deviation meter should be connected to the distortion analyzer. Check the distortion and adjust the varactor bias (R19 on the RF board) for minimum distortion. Some noise filtering will be necessary since noise can over ride the distortion component of the deviation meter output.
The deviation level is adjusted by shorting P1n-1 to Pin-7 on J-7 and setting SW-1 to (5). This causes the DSP to produce a 1 KHz test tone at the highest level that it will be capable of producing. Adjust R47 to adjust the test tone deviation to 100 KHz. Set SW-1 to (4) to generate the 1 KHz test tone at the lowest frequency, and adjust SW-2 to set the deviation to 100 KHz deviation. Next, Change SW-1 to (6) to generate the test tone on the highest frequency, and adjust SW-2 for 100 KHz deviation. Then remove the jumper on J-7 to save the settings.

LIMITER ADJUSTMENT

With an audio signal from the signal generator applied to the audio input and the input level pot set to MID position, and the DSP emulation and pilot tone disabled. Be sure that the audio input level is low enough not to activate the limiter (D5 and D6 level LED's are both green). Install the jumper from pin-1 to pin-7 on J-7 and set SW-1 to (7). Measure the audio level for a reference. Switch SW-1 to (8), and measure the audio level difference from the reference. Adjust SW-2 to set the difference to -5 dbv +- 1.5 db. Then remove the jumper to save the setting. Cycling the power to reset the DSP to provide the 400 series emulation and the pilot tone.

PILOT TONE

With the unit connected to the modulation analyzer and the mic input pot R16 set to minimum, check the pilot tone deviation and frequency. Make sure there are no filters or roll off that will affect the measurement. The deviation should be 5 kHz (+ or - .5 kHz). The pilot tone frequency will be between 25 kHz and 32 kHz for the UT400 (a different frequency for each switch setting).

BATTERY MONITOR

To adjust the battery monitor, look at the RF output of the unit on a frequency counter, or a spectrum analyzer set to a narrow span and use the delta marker, to measure the frequency difference. Set the power supply output to 6.0-volt. Short Pin-1 to Pin-7 on the test socket J-7, set BCD SW-1 to (B) and mark or record the frequency. Adjust SW-1 to (C) and measure or calculate frequency difference. Adjust SW-2 clockwise to increase the frequency difference or counter clockwise to decrease the frequency difference until the frequency difference is close to 3.5 kHz. It will be necessary to adjust SW-1 between (B) and (C) and measure the difference several times while making the adjustments. When the difference is 3.5 KHz, remove the jumper on J-7 to save the setting.

This completes the alignment procedure.