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 400 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 1.5 VDC at 600 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 +25 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 5 pin Switchcraft plug on one end. The other end should be appropriate to the audio signal generator.

Note that DMMs may read inaccurately in RF fields.

A 50-Ohm coax cable (RG174) 2 to 3 feet long is necessary to connect the RF output of the-UM400 to the spectrum analyzer and/or frequency counter. One end should be terminated with an SMA. The other end of the coax should be terminated with a BNC male or appropriate connector.

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 UM400 from shorts and over current due to misalignment. Set the supply for 9 VDC and connect it to the UM400. The current drain should 70 ma or less. When properly aligned this value should be nominally 70 ma (for the combination of audio and RF boards) with only the power LED illuminated. The green battery indicator LED located on the top panel should be brightly lit. Adjust the power supply voltage downward while watching the Power LED. The LED should change to red at 6 volts(TBD). This completes the power indicator checks.

PREPARATION

Except as noted, all RF alignment adjustments are on PCB #17320. 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.

Separate the two PCBs. This is accomplished by removing the two screws on the RF board that attach it to the panel, and a small screw at the other end that attaches it to a spacer. Then carefully separate the two boards. Connect the boards together with a 7-pin right angle adapter and a short 4-conductor cable.

A 9-volt supply should be connected to the battery contacts.

Interconnect the UM400 RF board and the spectrum analyzer with a 2' to 3' length of reasonably good 50-ohm coaxial cable. The cable should be outfitted with a male BNC on one end and an SMA which mates with the SMA output jack on the top panel.

PRESET ADJUSTMENTS

There are two miniature trim pots on the RF board. Set these potentiometers at their midpoints. Set the mic level control, R16 on the audio board to maximum (CW).
The frequency control switches are on the audio board #17321. The left switch is SW1 and sets the frequency in 1.6 MHz steps. The right switch is SW2 and sets the frequency in 100 kHz steps. The switch notation used here will be (# #) or (SW1 SW2) or steps of (1.6 MHz 100 kHz). For example (A 7) means set SW1 at A and set SW2 at 7.

Set the BCD switches, SW1 and SW2, 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.

OSCILLATOR ALIGNMENT

Adjust C23 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 on 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.

AUDIO ADJUSTMENT

To set the audio level and distortion it is necessary to disable the DSP emulation. This is done by shorting Pin-1 to Pin-7 on test socket (J-7 on the audio board), adjusting the BCD switches to (D 0), and removing the short on the test socket. Then set the switches to (8 0) for the center of the operating range of the unit.
Set the audio signal generator to 400 Hz at 1.7 mVrms and connect it to UM400 using the audio cable. The RF output should be connected to the deviation meter and the audio output of the deviation meter should be connected to the distortion analyzer. Set the deviation pot R47 for about 60 kHz peak deviation. Check the distortion and set the varactor bias pot R19 for a maximum distortion of 0.1%. Some noise filtering will be necessary, since noise can over ride the distortion component of the deviation meter output. The bias will affect the deviation so it may be necessary to re-adjust the deviation pot to get the 0.1% reading. This is not the final setting of the deviation pot but it is final setting of the bias pot. Adjust the signal generator level to 10 mVrms, this is approximately 10 db into limiting, and adjust R47 for 70 kHz deviation. Adjust the mic level control to minimum (CCW), and the signal generator level to 560 mVrms. Adjust the limiter distortion pot (R42 on the audio board) for minimum distortion, typically .6%. This concludes the audio adjustments, and the audio cable can be disconnected.

VCO ALIGNMENT

Set the BCD frequency switches to (F F), readjust C23 until the voltage on TP1 is 3.0 Volts.
Set the BCD switches to (0 0) for the lowest frequency. The voltage on TP1 should be between .6 Volts and 1.0 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 of R19 does not need to be redone.

TRANSMITTER RF OUTPUT

CAUTION: A properly operating transmitter puts out nominally 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. Set the REFERENCE LEVEL to +20 dBm and other functions to AUTO.
Turn the transmitter on. Measure the output power of the transmitter. This may be most easily accomplished by using the cursor peak function if the analyzer has it. Otherwise use a power meter. The output power should be within +/- 1 dB of +20 dBm (100 mW). Don't forget to account for cable losses. 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 39 dB below the main output (-39 dBc assures a 6 dB margin to the FCC specifications)

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.

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 - .2 kHz). The pilot tone frequency will be between 25 kHz and 32 kHz for the UM400 (a different frequency for each switch setting), or 32.765 kHz for the UM200.

BATTERY MONITOR

To adjust the battery monitor, connect RF output of the unit to 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 1.0-volt. Short Pin-1 to Pin-7 on the test socket J-7, set BCD SW-1 to (A) and mark or record the frequency. Adjust SW-1 to (B) 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 (A) and (B) and measure the difference several times while making the adjustments.

This completes the alignment procedures of the UM400.