TUNE-UP PROCEDURE FOR 250 MW UNIT

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 960 MHz with an RF power level of +30 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 2 amps 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 960 MHz at power levels to +30 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.

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.

VOLTAGE CHECK & CPU PROGRAMMING

Substitute the power supply for the battery. The supply should be current limited to 900 ma to protect the SM from shorts and over current due to misalignment. Set the supply for 1.5 VDC and connect it to the SM. Check current draw, it should be about 100 ma. Check +3.3 volt, +6 volt, +1.8 volt and –3 volt supplies. If all voltages look good, connect programmer to J6 and program CPU.

CHECKING THE POWER INDICATOR

After programming, the current drain should 500 ma or less, nominally 250 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 1.25 volts. This completes the power indicator checks.

PREPARATION

Except as noted, all RF alignment adjustments are on PCB #17345. All alignment and adjustment is done with the power supply set to 1.5 VDC and current limited at 1.5 amps.

A 1.5-volt supply should be connected to the battery contacts.

Interconnect the SM RF board and the spectrum analyzer with a 2' to 3' length of reasonably good 50-ohm coaxial cable. The cable should be soldered to the isolator output terminals on the RF PCB.

SET BLOCK

Momentarily short J7 pin-7 to pin-1. This allows the unit to enter the setup mode. Press the AUDIO button twice, or until the display shows “b 20”. Press the UP ARROW until the display show the proper block number for the unit being aligned. Press the FREQ button and the unit should show a frequency in the selected block.

VCO ALIGNMENT

Press the FREQ button until the display shows “CH XX”, the “XX” represents a hex number from “00” to “FF”. Use the UP ARROW to adjust the frequency display to channel “FF”. With a DMM measure the voltage at TP1. Adjust C1 in the VCO for a reading of 2.9 to 3.0 VDC. The RF output of the transmitter will now be enabled since the PLL (phase locked loop) is now locked. Press the UP ARROW and the frequency display should go to “00”. Measure the voltage at TP1, it should be between .6 and 1.2 VDC.

FREQUENCY ADJUSTMENT

With the unit in the setup mode, press the AUDIO button until the display shows “F 00”. Measure the frequency with a frequency counter. Adjust the frequency using the UP or DOWN ARROW button until the frequency counter shows the correct frequency (+/- 2 KHz).

AUDIO ADJUSTMENT

To set the audio level and distortion it is necessary to disable the DSP emulation. This is done with the unit in the setup mode. Press the AUDIO button until the display shows “CP XXX”. The X’s represent the emulation mode. Press the DOWN ARROW until the display shows “CP ---“. This is the pass through mode. Press the FREQ button twice, the display should read “CH 80”. Use the UP or DOWN ARROW to set the frequency to “CH 80”. Press the AUDIO button and the display should read “Aud XX”, then use the UP or DOWN ARROW to adjust the audio level to “Aud 25”. Set the audio signal generator to 400 Hz at 6 mV rms and connect it to SM 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 R26 for minimum distortion. Some noise filtering will be necessary, since noise can over ride the distortion component of the deviation meter output. This is not the final setting of the deviation pot but it is final setting of the bias pot. Press the AUDIO button until the display shows “d80 “. Now the transmitter is transmitting a 1 KHz tone on channel “80”. Adjust R47 for a deviation of 100 KHz. Press the FREQ button and the display will show “d00 00”, now the unit is transmitting a 1 KHz tone on channel “00”. If necessary, use the UP or DOWN ARROW button to adjust the deviation to 100 KHz. Press the FREQ button again and the display shows “dFF 00”, now the unit is transmitting a 1 KHz tone on channel “FF”. If necessary, use the UP or DOWN ARROW button to adjust the deviation to 100 KHz.

LIMITER SETUP

Connect the audio output of the deviation meter to the audio analyzer and set the analyzer to measure dBV.
With the unit in the setup mode, press the AUDIO button until the display reads “Lr “. Apply a 60 mv, 400 Hz tone to the mic input and record the audio level. Press the FREQ button, the display will read “LS 00”. Use the UP and DOWN ARROW buttons to adjust the audio level to 5 dB (+/- 1 dB) below the previous reading. Press the FREQ button and the display will show “L 10 “. Adjust the audio input level until the –20 LED just turns RED, then increase the input level by 10 dB. Press the UP ARROW to store the –10 dB LED level.

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. Press the AUDIO button until the display shows “bS _ 00” and mark or record the frequency. Press the FREQ button and measure the difference in frequency. Use the FREQ button to switch between the high and low frequency shift positions, and use the UP and DOWN ARROW buttons to adjust the frequency shift until the frequency difference is 3.5 KHz.

Cycle the power to take the unit out of the setup mode.

TRANSMITTER RF OUTPUT

CAUTION: A properly operating transmitter puts out nominally 250 mW (+24 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).
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, 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 SM (a different frequency for each switch setting), or 32.765 kHz in the 200 emulation mode.

This completes the alignment procedures of the SM.