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.

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 J3 and program CPU.

CHECKING THE POWER INDICATOR

After programming, the current drain should 75 ma or less, nominally 65 ma 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 6.2 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 200 ma.

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

Interconnect the RF output to the spectrum analyzer with a 2' to 3' length of reasonably good 50-ohm coaxial cable. The cable should be plugged into P1 and TP11 (GND).

SET BLOCK

Use a jumper to short J2 pin-7 to pin-1. This puts the unit in the setup mode. Use the frequency switches to select the “Block” the unit is to operate on. Set S3 (MSB) to “2”, and S2 (LSB) “1 thru 9” for Block 21 thru 29. Remove the jumper to save the setting.

OSCILLATOR ALIGNMENT

Change the FREQ switches (S3 and S2) to “FF”. With a DMM measure the voltage at TP5. Adjust C102 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. Change the FREQ switches to “00”. Measure the voltage at TP5, it should be between .6 and 1.2 VDC.

FREQUENCY ADJUSTMENT

Use a jumper to short J2 pin-7 to pin-1. Set S3 to “F”, and adjust S2 until the frequency counter shows the correct frequency (+/- 2 KHz). Remove the jumper to save the setting.

AUDIO ADJUSTMENT

Connect the audio output of the deviation meter to the audio analyzer and set the analyzer to measure distortion.

To set the audio level and distortion it is necessary to disable the DSP emulation and pilot tone. To do this, install the jumper to short J2 pin-7 to pin-1. Set SW3 to “D” and SW2 to “0”, then remove the jumper. That disables the DSP emulation. Now install the jumper, change SW2 to “1”, and remove the jumper. This removes the pilot tone.

Set the FREQ switches to “80”, this sets the frequency of the unit in the center of the block. Apply an audio signal to the mic input connector. Use a 250 Hz tone and adjust the level until the two audio level indicator LEDs (D5, D6) are green. Use the audio analyzer to monitor the audio out of the modulation meter. Adjust R7 for minimum distortion of the audio signal.

Use the jumper to short J2 pin-7 to pin-1. Set SW3 to “5”, this will cause the DSP to generate a 1KHz tone at frequency “80”. Adjust SW2 to set the deviation to 100 KHz. Set SW3 to “4”, This will generate a 1KHz tone on frequency “00”. Adjust SW2 for a deviation of 100 KHz. Set SW3 to “6” to generate a 1KHz tone on frequency “FF”. Adjust SW2 for 100 KHz deviation. Now remove the jumper to save the settings.

LIMITER SETUP

Connect the audio output of the deviation meter to the audio analyzer and set the analyzer to measure dBV.

Use the jumper to short J2 pin-7 to pin-1. Set SW3 to “7”, record the audio level on the audio analyzer. Change SW3 to “8”, and adjust SW2 for an audio level 5dBv below the level recorded before. Remove the jumper to save the setting.

Adjust the audio input level until the –20 LED (D6) just turns RED, then increase the input level by 10 dB. Install the jumper from J2 pin-7 to pin-1, set SW3 to “D” and SW2 to “3”. Then remove the jumper to save the setting.

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 6.0-volt. Install the jumper from J2 pin-7 to pin-1, and set SW3 to “B”. Record the carrier frequency. Change SW3 to “C” and measure the frequency difference. Use SW2 to adjust the frequency difference, and switch back and forth between “B” and “C” on SW3 until the frequency difference is 3.5 KHz.

TRANSMITTER RF OUTPUT

CAUTION: A properly operating transmitter puts out between 17 dBm and 19 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 +18 dBm. 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

Cycle the power to the unit off and back on. This will enable the DSP emulation and the 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 LMa.