

SECTION 1. INTRODUCTION

1.1 DESCRIPTION

The Motorola Communications System Analyzer is a portable test instrument, designed specifically for servicing and monitoring communications equipment. Its functions supersede those of a Service Monitor, expanding the features and capabilities so that servicing involves only a single instrument, rather than a host of separate equipment.

The R2001D is the standard Communications System Analyzer. The R2002D has the added capability of an IEEE-488 Standard Interface control bus, and the R2008D has the added capability of "Cellular Radio" testing. The R2009D adds both of these capabilities to the basic unit. By improving a technician's efficiency and accuracy, the Analyzer reduces service time.

The Communications System Analyzer generates and monitors signals, performing the tests normally associated with the equipment listed below.

- Spectrum Analyzer
- Duplex Generator
- Modulation Oscilloscope
- Frequency Counter
- AC/DC Digital Voltmeter
- RF Wattmeter/Signal-Level Meter

- General Purpose Oscilloscope
- Multi-Mode Code Synthesizer
- Distortion/SINAD Meter
- Sweep Generator
- DTMF Encode/Decode
- Printer Port

The Analyzer meets the shock and vibration requirements of EIA test RS152B, the same specifications met by Motorola mobile radios. This minimizes failure when the instrument is used in a mobile service van, and means the Analyzer is as tough as the radios it services.

Tables 1-1, 1-2, and 1-3 list the physical, electrical, and input/output characteristics of the Communications System Analyzer.

Table 1-1. Physical Characteristics

| Characteristics | Description |
|-----------------|---|
| Length | 20.00 inches (50.8 cm) |
| Width | 15.50 inches (39.4 cm) |
| Height | 8.25 inches (21.0 cm) |
| Weight | 35.5 pounds (16.1 kg) (excluding battery pack and cover accessories) |

Table 1-2. Electrical Characteristics

| Characteristics | Description |
|------------------------------|--|
| MODES | |
| Signal Generator Mode | |
| Frequency | |
| Range: | 10 kHz to 999.9999 MHz |
| Resolution: | 100 Hz |
| Accuracy: | Equal to master oscillator time base |
| Output (into 50 ohms) | |
| Attenuator: | 16 dB variable plus 10 dB steps over 13 ranges |
| Range FM: | 0.1 μ V to 1 Vrms (-127 dBm to +13 dBm) |
| Range AM: | 0.1 μ V to 0.4 Vrms |
| Accuracy: | ± 2 dB maximum with step attenuator in 10 dB position. ± 4 dB maximum in any other state. |
| Spectral purity | |
| Spurious: | ≤ -40 dB |
| Harmonics: | ≤ -15 dB |

Table 1-2. Electrical Characteristics (Cont)

| Characteristics | Description |
|---|--|
| MODES | |
| Signal Generator Mode | |
| Frequency modulation | |
| Range: | 0 to 75 kHz peak |
| Accuracy: | ± 5% of reading |
| Residual FM: | 20 Hz max. at 300 to 3 kHz from f_c |
| Residual AM: | 1.0% max. at 300 to 3 kHz from f_c |
| External/internal frequency range: | 5 Hz to 20 kHz (± 3 dB), 50 Hz to 20 KHz (± 1 dB) |
| External input: | Approximately 150 mV for 20 kHz deviation |
| Modes: | Internal, external, microphone or all simultaneously |
| Amplitude modulation | |
| Range: | 0 to 70% from 1 to 500 MHz |
| Accuracy: | ± 10% of full scale from 0% to 50% AM |
| External/internal frequency range: | 5 Hz to 10 kHz (± 3 dB), 5 Hz to 3 kHz (± 1 dB) |
| External input: | Approximately 150 mV for 80% |
| Modes: | Internal, external, microphone or all simultaneously |
| Double sideband suppressed carrier | |
| Carrier suppression: | -15 dB (1 MHz to 500 MHz) |
| Sweep Generator Mode | |
| Adjustable sweep width from 10 kHz to 10 MHz at a fixed sweep rate. Synchronized to internal scope display. | |
| Monitor Mode | |
| Frequency | |
| Range: | 1 MHz to 999.9999 MHz |
| Resolution: | 100 Hz |
| Accuracy: | Equal to that of master oscillator time base |
| Frequency error indicator | Autoranging CRT display. Resolution ± 10 Hz for frequency error measurements on 1.0 kHz, 10.0 kHz and 100.0 kHz full scale ranges. For frequency errors less than 100 Hz, 1 Hz resolution. Special function control will allow direct frequency read-out to 1 Hz resolution. |
| Input sensitivity (over 4 MHz to 1000 MHz) | 1.5 µV for 10 dB EIA SINAD (narrow band ± 6 kHz mod. acceptance). 7 µV for 10 dB EIA SINAD (wide band ± 100 kHz mod. acceptance). Useable to 1 MHz. |
| Spurious response | -40 dBc typical 0 dB image at ± 21.4 MHz -10 dB at L.O. harmonics ± 10.7 MHz |
| Deviation measurement | |
| Range: | 1, 10, 100 kHz full scale |
| Accuracy: | ± 5% of reading |
| Peak deviation limit alarm: | Set via keyboard to 100 Hz resolution (0 kHz to 99.9 kHz). Audible alarm indicates limit condition and will be active in all Monitor modes. |
| AM modulation measurement | |
| Range: | 0 to 100% |
| Accuracy: | ± 5% of full scale |
| Signal strength meter | |
| Range: | 1 MHz to 999.9999 MHz |
| Sensitivity: | -100 dBm to +52 dBm, combined specification of antenna and transceiver ports. |
| Selectivity: | 30 kHz maximum at 3 dB bandwidth. |
| RF Wattmeter (Autoranging display) | |
| Frequency range: | 1 MHz to 1000 MHz |
| Power range: | 0.1 watt to 125 watts |
| Accuracy: | ± 10%, 1 watt to 125 watts |
| Protection: | Over temp indicator |
| Scales: | 9.99, 99.9, 125 watts |

Table 1-2. Electrical Characteristics (Cont)

| Characteristics | Description |
|---|--|
| MODES GENERAL FUNCTIONS Spectrum Analyzer | |
| Dynamic range Frequency Range: Scan width: Sensitivity: | 75 dB minimum 1 MHz to 1 GHz 100 kHz per division to 1 MHz per division, continuously adjustable. -95 dBm minimum |
| Duplex Generator | |
| Frequency offset Frequency resolution Frequency accuracy Output level Deviation range Frequency response | Adjustable from 0 to ± 10 MHz in 5 kHz steps, plus fixed offset of ± 45 MHz 5 kHz $\pm 0.002\%$ -35 dBm minimum into 50 ohm load 0 to ± 20 kHz peak 5 Hz to 20 kHz, ± 3 dB |
| Enhanced Duplex Generator | |
| Frequency offset Frequency resolution Frequency accuracy Output level Deviation range Frequency response | Adjustable from 0 to ± 10 MHz in 5 kHz steps, plus fixed offsets of ± 39 MHz, ± 45 MHz, and ± 55 MHz 5 kHz $\pm 0.0005\%$ -40 dBm minimum into 50 ohm load 0 to ± 20 kHz peak 5 Hz to 20 kHz, ± 3 dB |
| Oscilloscope | |
| Size Frequency response External vertical input ranges Sweep rates Sync | 8 cm \times 10 cm DC to 0.5 MHz (3 dB point) 10 mV, 100 mV, 1V, 10V (per division) 1 μ s, 10 μ s, 0.1 ms, 1 ms, 0.01S, 0.1S (per division) Internal, normal, and automatic mode with adjustable trigger level. |
| Frequency Counter | |
| Normal Range: Readout: Input sensitivity: Period counting frequency determination Range: Display: Auto tune (SCAN LOCK) Range: Acquisition time: Resolution: | 10 Hz to 30 MHz 5 digit, autoranging 50 mV minimum 10 Hz to 100 kHz 4-digit autoranging to 3 kHz, 3-digit autoranging to 100 kHz In the monitor mode, the unit can automatically find and then tune to an input signal above -30 dBm. Operates from 1 MHz to 1 GHz 5 sec. typical to less than 1 sec, if a limited scan is used. ± 1 Hz |
| Digital Voltmeter | |
| Readout: DC accuracy: AC accuracy: AC bandwidth: | Autoranging 3-digit display, 1, 10, 100, 300 volts full scale. AC-dBm calibrated across 600 ohms. $\pm 1\%$ of full scale ± 1 least significant digit $\pm 5\%$ of full scale 50 Hz to 20 kHz |

Table 1-2. Electrical Characteristics (Cont)

| Characteristics | Description |
|--|--|
| MODES Signaling Sequence Encode/Decode | |
| <p>Code Synthesizer Frequency range: Resolution: Frequency accuracy: Distortion:</p> <p>Signaling Sequences General Sequence</p> <p>Two Tone A/B (Encode only; use General Sequence to decode)</p> <p>5/6 Tone</p> <p>Mobile Telephone IMTS MTS 2805 Select V ZVEI</p> <p>Modified ZVEI</p> <p>CCIR (100 ms)</p> <p>CCIR (70 ms)</p> <p>EEA</p> | <p>5 Hz to 19.9999 kHz sinewave encode. 50 Hz to 9999 Hz decode 0.1 Hz ± 0.01% ≤ 1%</p> <p>Encode up to ten tones with frequencies of 5.0 Hz to 19999.9 Hz and durations of 5 msec to 9999 msec. Decode ten tones with frequencies of 300 Hz to 9999 Hz and durations of 15 msec to 9999 msec.</p> <p>Tone-Only Sequence Tone and Voice Sequence Two-user programmable (See Figure 1-1 for sequence timing)</p> <p>Digit Frequencies (See Figure 1-2 for sequence timing) 0 - 600 Hz 6 - 1446 Hz 1 - 741 Hz 7 - 1587 Hz 2 - 882 Hz 8 - 1728 Hz 3 - 1023 Hz 9 - 1869 Hz 4 - 1164 Hz R - 459 Hz 5 - 1305 Hz X - 2010 Hz</p> <p>Complete IMTS base-station simulation. (See Figure 1-3 for sequence timing) (See Figure 1-4 for sequence timing) Tone length - 70 ms Digit Frequencies 1 - 1060 Hz 7 - 1830 Hz 2 - 1160 Hz 8 - 2000 Hz 3 - 1270 Hz 9 - 2200 Hz 4 - 1400 Hz 0 - 2400 Hz 5 - 1530 Hz R - 2600 Hz 6 - 1670 Hz</p> <p>Tone length - 70 ms Digit Frequencies 1 - 970 Hz 7 - 1670 Hz 2 - 1060 Hz 8 - 1830 Hz 3 - 1160 Hz 9 - 2000 Hz 4 - 1270 Hz 0 - 2200 Hz 5 - 1400 Hz R - 2400 Hz 6 - 1530 Hz</p> <p>Tone length - 100 ms Digit Frequencies 1 - 1124 Hz 7 - 1640 Hz 2 - 1197 Hz 8 - 1747 Hz 3 - 1275 Hz 9 - 1860 Hz 4 - 1358 Hz 0 - 1981 Hz 5 - 1446 Hz R - 2110 Hz 6 - 1540 Hz</p> <p>Tone length - 70 ms Digit Frequencies Same as CCIR (100 ms)</p> <p>Tone length - 40 ms Digit Frequencies Same as CCIR</p> |

Table 1-2. Electrical Characteristics (Cont)

| Characteristics | Description |
|--|---|
| MODES | |
| Signaling Sequence Encode/Decode | |
| Tone remote access (Encode only; use General Sequence to decode) Digital private line (DPL) Fixed 1 kHz Accuracy: Distortion: External input Microphone: External Jack Frequency range: Level: Impedance: Code synthesizer external output level | Remote base access sequence as follows: Tone A for 150 msec Tone B for 40 msec 10 dB below Tone A Tone A continuously 30 dB below the first Tone A burst Codes 000 to 777 and inverted for encode. Decodes all valid DPL codes. Equal to master time base ≤1% Standard TMN-6013 microphone interface with IDC. 5 Hz to 19999.9 Hz 7 Vrms maximum 10K ohm minimum 0 to 3 Vrms into a 600 ohm load |
| Distortion/SINAD Meter | |
| Input frequency: Input level range: SINAD accuracy: Distortion range: Distortion accuracy: | 1 kHz ±1 Hz 0.1V to 10 Vrms ±1 dB at 12 dB SINAD 1% to 20% ±0.5% of Distortion for 1% <THD <10% ±2% of Distortion for 10% <THD <20% |
| Analog Synthesizer Tuning (AST) | |
| Step size: Calibration: | Variable steps from 3200 Hz to 3.2 GHz per 360° of rotation. 32 steps per 360° rotation |
| Time Base | |
| Standard TCXO Optional ovenized high stability | Aging: ±1 × 10 ⁻⁶ per year Temp: ±1 × 10 ⁻⁶ maximum error over the 0° to 55°C temp range Aging: ±1 × 10 ⁻⁶ per year Temp: ±0.05 × 10 ⁻⁶ maximum error over the 0° to 55°C temp range (warmup to ±5 × 10 ⁻⁷ of final frequency within 20 minutes) |
| Power and Environmental | |
| AC DC Optional battery Temperature range | 100 to 130 Vac or 200 to 260 Vac, switch-selectable; 47 to 400 Hz +11.0 to +16 Vdc external input 13.6V battery; 50 minutes typical 0° to 55°C operation; -40° to 85°C storage |

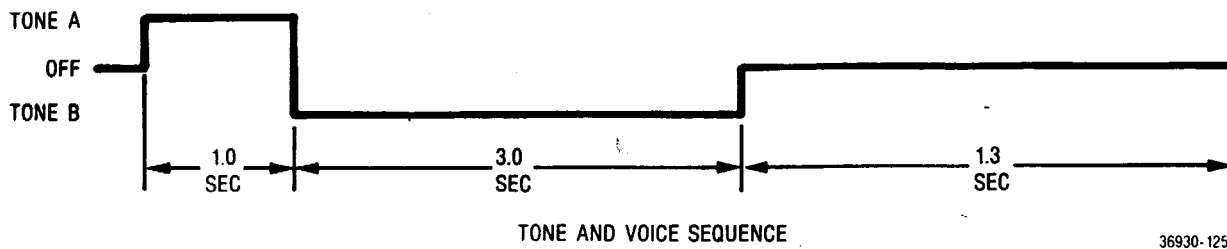
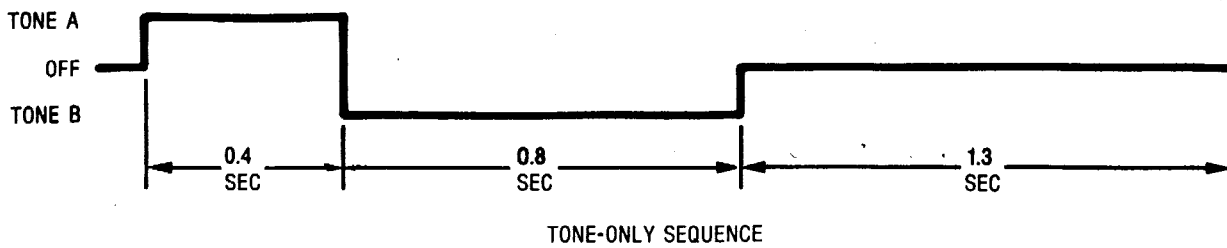


Figure 1-1. Two-Tone (A/B) Sequence Timing

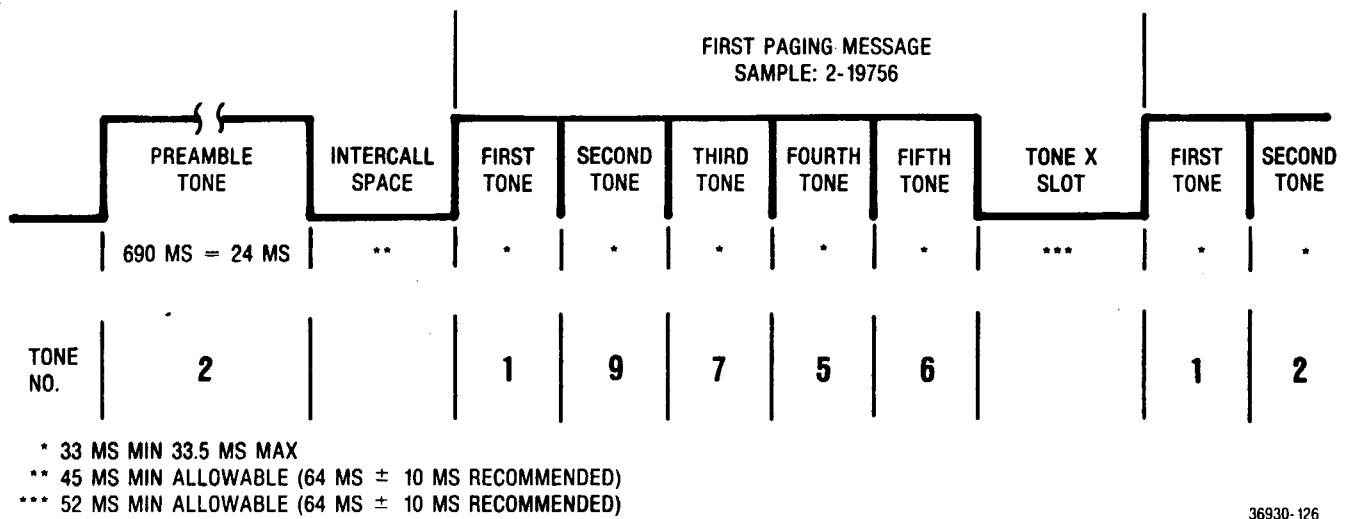


Figure 1-2. 5/6 Tone Sequence Timing

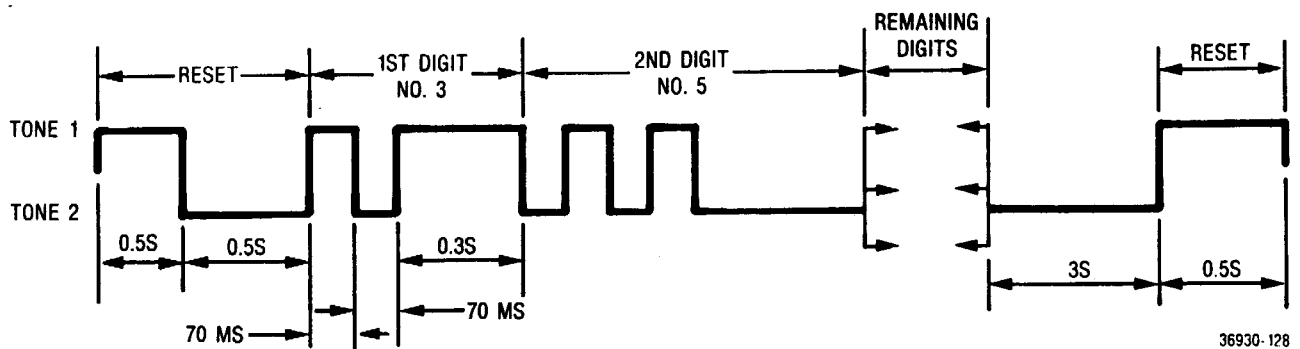


Figure 1-3. MTS Sequence Timing

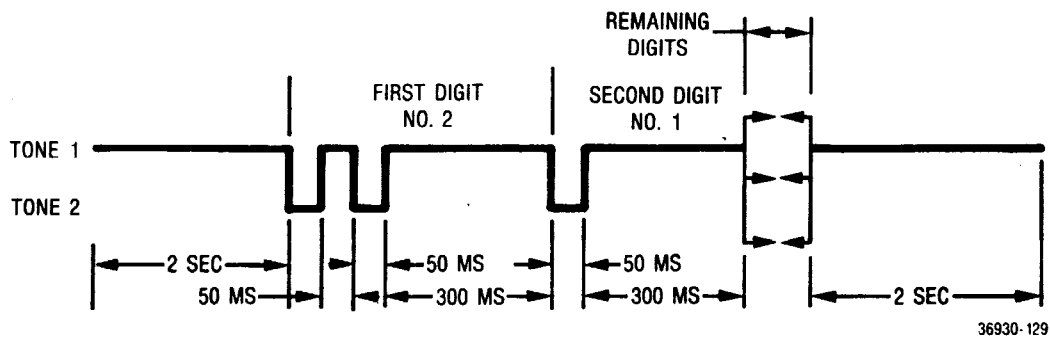


Figure 1-4. 2805 Sequence Timing

Table 1-3. Input/Output Characteristics

| Characteristic | Description |
|--|---|
| Input | |
| Ext Mod In Mic Ext Horiz Vert/SINAD/Dist/DVM/Counter In | 10K ohms nominal, 150 mV typical for 20 kHz dev. FM or 80% AM Mic input provides bias and IDC limiting suitable for Motorola TMN-6013 handset. PTT switches R2001 from monitor to generate. 1 volt minimum for full screen deflection. Maximum input 10 volts. 1 Meg ohm, 40 pf Nominal; ± 300 Vdc max, 300 Vrms max at frequencies below 500 Hz, 10 Vrms max up to 35 MHz <ul style="list-style-type: none"> • Scope Vert In: dc to 500 kHz or 50 Hz to 500 kHz ac mode (± 3 dB) • Distortion/SINAD In: 0.1 to 10 Vrms in at 1 kHz • DVM In: 1, 10, 100 and 300V full scale ac (true rms) or dc. AC bandwidth 50 Hz to 20 kHz for $\pm 5\%$ F.S. accuracy (ac dBm calibrated across 600 ohms) • Frequency Counter In: 50 mV or greater required from 10 Hz to 35 MHz |
| RF In/Out ANTENNA | 50 ohms nominal, 125 watts max (1 to 1000 MHz) 50 ohms nominal, 50 mW max (1 to 1000 MHz). Fuse protected. |
| Ext Wattmeter 10 MHz STD In (rear panel) | Characteristics suitable for Motorola ST-1200 series Wattmeter Elements 70 to 350 mVrms input required at 10 MHz, impedance greater than 50 ohms. |
| Output | |
| Mod Out Demod Out Antenna Port Duplex Gen Out 10 MHz STD Out (rear panel) | Up to 11 Vp-p into 600 ohms 5 Hz to 20 kHz Typically 10 Vp-p into 600 ohms for ± 5 kHz deviation narrowband, 15 Vp-p for ± 75 kHz deviation wideband. DC to 20 kHz response 0.8 Vrms (+11 dBm) to 0.1 μ Vrms (-127 dBm) 50 ohm nominal source impedance. 10 kHz to 1 GHz. -40 dBm minimum, 50 ohm nominal source impedance 1 MHz to 1 GHz 250 mVrms nominal output into 50 ohms |