

SECTION 1. INTRODUCTION

1.1 GENERAL

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

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

Table 1-2. Electrical Characteristics (Cont)

Characteristics	Description
MODES Signal Generator Mode	
<p>Frequency modulation Range: Accuracy: Residual FM: Residual AM: External/internal frequency range: External input: Modes:</p> <p>Amplitude modulation Range: Accuracy: External/internal frequency range: External input: Modes:</p> <p>Double sideband suppressed carrier Carrier suppression:</p>	<p>0 to 75 kHz peak ± 5% of reading 20 Hz max. at 300 to 3 kHz from f_c 1.0% max. at 300 to 3 kHz from f_c 5 Hz to 20 kHz (± 3 dB), 50 Hz to 20 KHz (± 1 dB) Approximately 150 mV for 20 kHz deviation Internal, external, microphone or all simultaneously</p> <p>0 to 80% from 1 to 500 MHz ± 10% of full scale from 0% to 50% AM 5 Hz to 10 kHz (± 3 dB), 5 Hz to 3 kHz (± 1 dB) Approximately 150 mV for 80% Internal, external, microphone or all simultaneously</p> <p>– 15 dB (1 MHz to 500 MHz)</p>
Sweep Generator Mode	
Adjustable sweep width from 10 kHz to 10 MHz at a fixed sweep rate. Synchronized to internal scope display.	
Monitor Mode	
<p>Frequency Range: Resolution: Accuracy:</p> <p>Frequency error indicator</p> <p>Input sensitivity (over 4 MHz to 1000 MHz)</p> <p>Spurious response</p> <p>Deviation measurement Range: Accuracy: Peak deviation limit alarm:</p> <p>AM modulation measurement Range: Accuracy:</p> <p>Signal strength meter Range: Sensitivity:</p> <p>Selectivity:</p> <p>RF Wattmeter (Autoranging display) Frequency range: Power range: Accuracy: Protection: Scales:</p>	<p>1 MHz to 999.9999 MHz 100 Hz Equal to that of master oscillator time base</p> <p>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.</p> <p>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.</p> <p>– 40 dBc typical 0 dB image at ± 21.4 MHz – 10 dB at L.O. harmonics ± 10.7 MHz</p> <p>1, 10, 100 kHz full scale ± 5% of reading 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.</p> <p>0 to 100% ± 5% of full scale</p> <p>1 MHz to 999.9999 MHz – 100 dBm to + 52 dBm, combined specification of antenna and transceiver ports. 30 kHz maximum at 3 dB bandwidth.</p> <p>1 MHz to 1000 MHz 0.1 watt to 125 watts ± 10%, 1 watt to 125 watts Over temp indicator 9.99, 99.9, 125 watts</p>

Table 1-2. Electrical Characteristics (Cont)

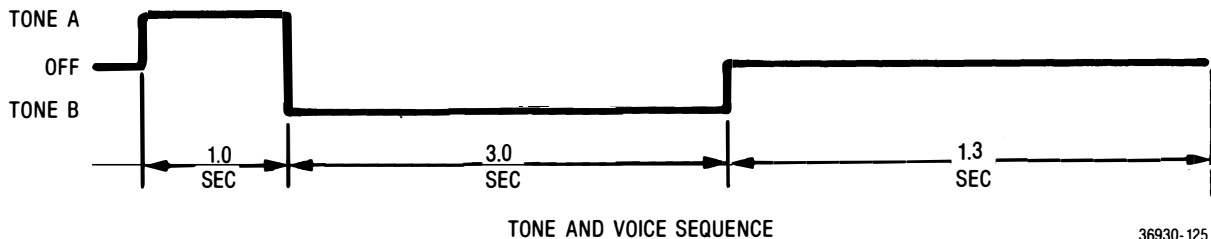
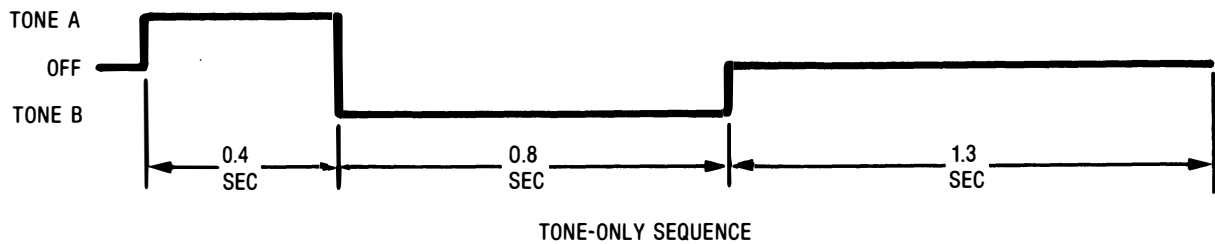
Characteristics	Description
GENERAL FUNCTIONS Spectrum Analyzer	
Dynamic range	75 dB minimum
Frequency Range: Scan width: Sensitivity:	1 MHz to 1 GHz 100 kHz per division to 1 MHz per division, continuously adjustable. -95 dBm minimum
Duplex Generator	
Frequency offset Frequency resolution Frequency 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 $\pm .002\%$ -35 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 35 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
Signaling Sequence Encode/Decode	
Code Synthesizer Frequency range: Resolution: Frequency accuracy: Distortion: Signaling Sequences General Sequence Two Tone A/B (Encode only; use General Sequence to decode)	5 Hz to 19.9999 kHz sinewave encode. 50 Hz to 9999 Hz decode 0.1 Hz $\pm 0.01\%$ $\leq 1\%$ 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. Tone-Only Sequence Tone and Voice Sequence Two-user programmable (See Figure 1-1 for sequence timing)

Table 1-2. Electrical Characteristics (Cont)

Characteristics	Description												
Modulation Source													
<p>5/6 Tone</p>	<p>Digit Frequencies (See Figure 1-2 for sequence timing)</p> <table border="0"> <tr> <td>0 – 600 Hz</td> <td>6 – 1446 Hz</td> </tr> <tr> <td>1 – 741 Hz</td> <td>7 – 1587 Hz</td> </tr> <tr> <td>2 – 882 Hz</td> <td>8 – 1728 Hz</td> </tr> <tr> <td>3 – 1023 Hz</td> <td>9 – 1869 Hz</td> </tr> <tr> <td>4 – 1164 Hz</td> <td>R – 459 Hz</td> </tr> <tr> <td>5 – 1305 Hz</td> <td>X – 2010 Hz</td> </tr> </table>	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
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5 – 1305 Hz	X – 2010 Hz												
<p>Mobile Telephone IMTS MTS 2805 Select V ZVEI</p>	<p>Complete IMTS base-station simulation. (See Figure 1-3 for sequence timing) (See Figure 1-4 for sequence timing)</p> <p>Tone length – 70 ms</p> <p>Digit Frequencies</p> <table border="0"> <tr> <td>1 – 1060 Hz</td> <td>7 – 1830 Hz</td> </tr> <tr> <td>2 – 1160 Hz</td> <td>8 – 2000 Hz</td> </tr> <tr> <td>3 – 1270 Hz</td> <td>9 – 2200 Hz</td> </tr> <tr> <td>4 – 1400 Hz</td> <td>0 – 2400 Hz</td> </tr> <tr> <td>5 – 1530 Hz</td> <td>R – 2600 Hz</td> </tr> <tr> <td>6 – 1670 Hz</td> <td></td> </tr> </table>	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	
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<p>Modified ZVEI</p>	<p>Tone length – 70 ms</p> <p>Digit Frequencies</p> <table border="0"> <tr> <td>1 – 970 Hz</td> <td>7 – 1670 Hz</td> </tr> <tr> <td>2 – 1060 Hz</td> <td>8 – 1830 Hz</td> </tr> <tr> <td>3 – 1160 Hz</td> <td>9 – 2000 Hz</td> </tr> <tr> <td>4 – 1270 Hz</td> <td>0 – 2200 Hz</td> </tr> <tr> <td>5 – 1400 Hz</td> <td>R – 2400 Hz</td> </tr> <tr> <td>6 – 1530 Hz</td> <td></td> </tr> </table>	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	
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<p>CCIR (100 ms)</p>	<p>Tone length – 100 ms</p> <p>Digit Frequencies</p> <table border="0"> <tr> <td>1 – 1124 Hz</td> <td>7 – 1640 Hz</td> </tr> <tr> <td>2 – 1197 Hz</td> <td>8 – 1747 Hz</td> </tr> <tr> <td>3 – 1275 Hz</td> <td>9 – 1860 Hz</td> </tr> <tr> <td>4 – 1358 Hz</td> <td>0 – 1981 Hz</td> </tr> <tr> <td>5 – 1446 Hz</td> <td>R – 2110 Hz</td> </tr> <tr> <td>6 – 1540 Hz</td> <td></td> </tr> </table>	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	
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<p>CCIR (70 ms)</p>	<p>Tone length – 70 ms</p> <p>Digit Frequencies Same as CCIR (100 ms)</p>												
<p>EEA</p>	<p>Tone length – 40 ms</p> <p>Digit Frequencies Same as CCIR</p>												
<p>Tone remote access (Encode only; use General Sequence to decode)</p>	<p>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</p>												
<p>Digital private line (DPL) Fixed 1 kHz Accuracy: Distortion:</p>	<p>Codes 000 to 777 and inverted for encode. Decodes all valid DPL codes.</p> <p>Equal to master time base $\leq 1\%$</p>												
<p>External input Microphone: External Jack Frequency range: Level: Impedance:</p>	<p>Standard TMN-6013 microphone interface with IDC.</p> <p>5 Hz to 19999.9 Hz 7 Vrms maximum 10K ohm minimum</p>												
<p>Code synthesizer external output level</p>	<p>0 to 3 Vrms into a 600 ohm load</p>												

Table 1-2. Electrical Characteristics (Cont)

Characteristics	Description
Distortion/SINAD Meter	
Input frequency: Input level range: SINAD accuracy: Distortion range: Distortion accuracy:	1 kHz \pm 1 Hz 0.1V to 10 Vrms \pm 1 dB at 12 dB SINAD 1% to 20% \pm 0.5% of Distortion for 1% \leq THD \leq 10% \pm 2% of Distortion for 10% \leq THD \leq 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: $\pm 1 \times 10^{-6}$ per year Temp: $\pm 1 \times 10^{-6}$ maximum error over the 0° to 55°C temp range Aging: $\pm 1 \times 10^{-6}$ per year Temp: $\pm 0.05 \times 10^{-6}$ maximum error over the 0° to 55°C temp range (warmup to $\pm 5 \times 10^{-7}$ 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



36930-125

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

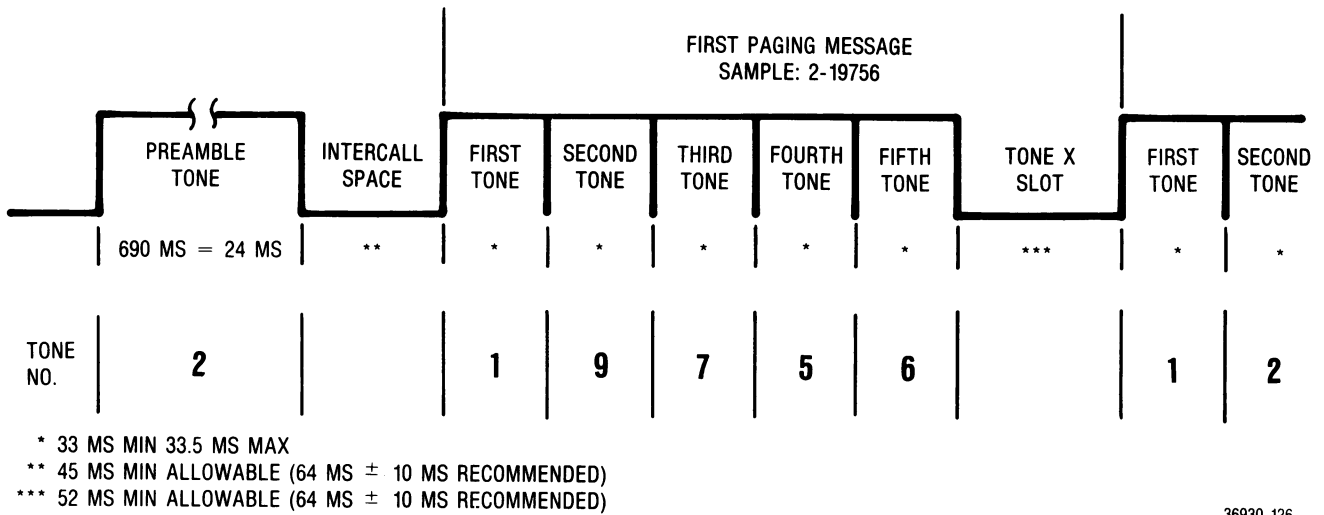


Figure 1-2. 5/6 Tone Sequence Timing

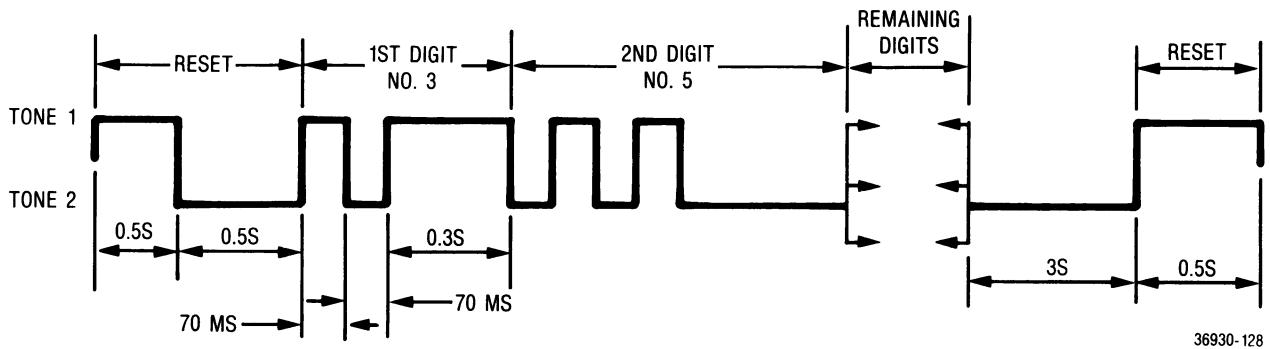


Figure 1-3. MTS Sequence Timing

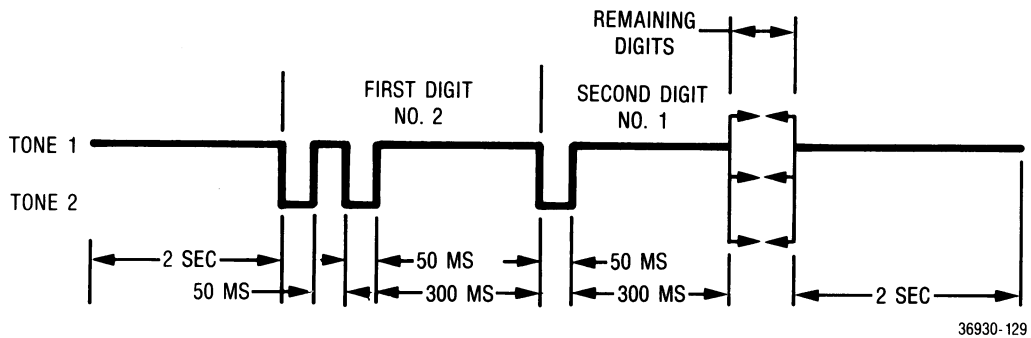


Figure 1-4. 2805 Sequence Timing

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 RF In/Out 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 1.0 Vrms (+13 dBm) to 0.1 μ Vrms (-127 dBm) 50 ohm nominal source impedance. 10 kHz to 1 GHz. -35 dBm typical, 50 ohm nominal source impedance 1 MHz to 1 GHz 250 mVrms nominal output into 50 ohms

1.2 MAJOR ASSEMBLIES

Should it break down, the Communications System Analyzer is designed to be serviced quickly and easily. The majority of the circuitry is on 12 modular, plug-in circuit boards which have built-in test points. These

test points help in locating the problem to a specific board. Simple plug-in replacement gets the instrument back in service.

A list of all subassemblies is given in Table 1-4. The assembly locations are shown in Figures 1-5 and 1-6.

Table 1-4. List of Subassemblies

Ref. Des.	Item	Part Number As Labeled	Replacement Order Part No.
A1	High-Voltage Power Supply	01-P22010E001	RTP-1007A
A2	Scope Amplifier Board	01-P22020E001	RTC-1005A
A3	Battery Charger Board	01-P22030E001	RTP-1008A
A4	Control Board	01-P22040E001	RTP-1009A
A5	Output Board	01-P22050E001	RTP-1010A
A6	Switcher Board	01-P22060E001	RTP-1011A
A7	Scope/DVM Control Board	01-P22070E001	RTC-1006A
A8	Receiver Board	01-P22080E001	RTL-1019A
A9	RF Synthesizer Module	01-P22090E001	RTC-1007A
A9A1	Reference and Control Board	01-P22210E001	RTC-4039A
A9A2	310 to 440 - MHz Loop Board	01-P22220E001	RTC-4040A
A9A3	Synthesizer Output Board	01-P22230E001	RTC-4041A
A9A4	60.5-MHz Loop Board	01-P22240E001	RTC-4042A
A9A5	GHz Loop Board	01-P22250E001	RTC-4043A
A9A6	640-MHz Loop Board	01-P22260E001	RTC-4044A
A9A7	Synthesizer Motherboard	01-P22270E001	RTC-4045A
A10	Audio Synthesizer Board	01-P22100E001	RTC-1008A
A11	Processor Interface Board	01-P22110E001	RTC-1009A
A12	Cellular Mobile Telephone Board (Optional)	01-P22120E001	RTC-1012A
A13	IEEE Interface Board (Optional)	01-P22130E001	RTC-1013A
A14	Processor Board	01-P22140E001	RTC-1010A
A15	Front-Panel Interface Board	01-P22150E001	RTC-1011A
A16	Frequency-Standard Interface Board	01-P22160E001	RTL-1020A
A17	RF Input Module	01-P22170E001	RTL-1021A
A17A1	RF Wattmeter Board	01-P22280E001	RTL-4158A
A17A2	Wideband Amplifier Board	01-P22290E001	RTL-4156A
A17A3	Duplex Generator Board	01-P22300E001	RTL-4157A
A18	Front Panel Assembly	01-P22180E001	Not Assigned
A19	System Motherboard	01-P22190E001	Not Assigned

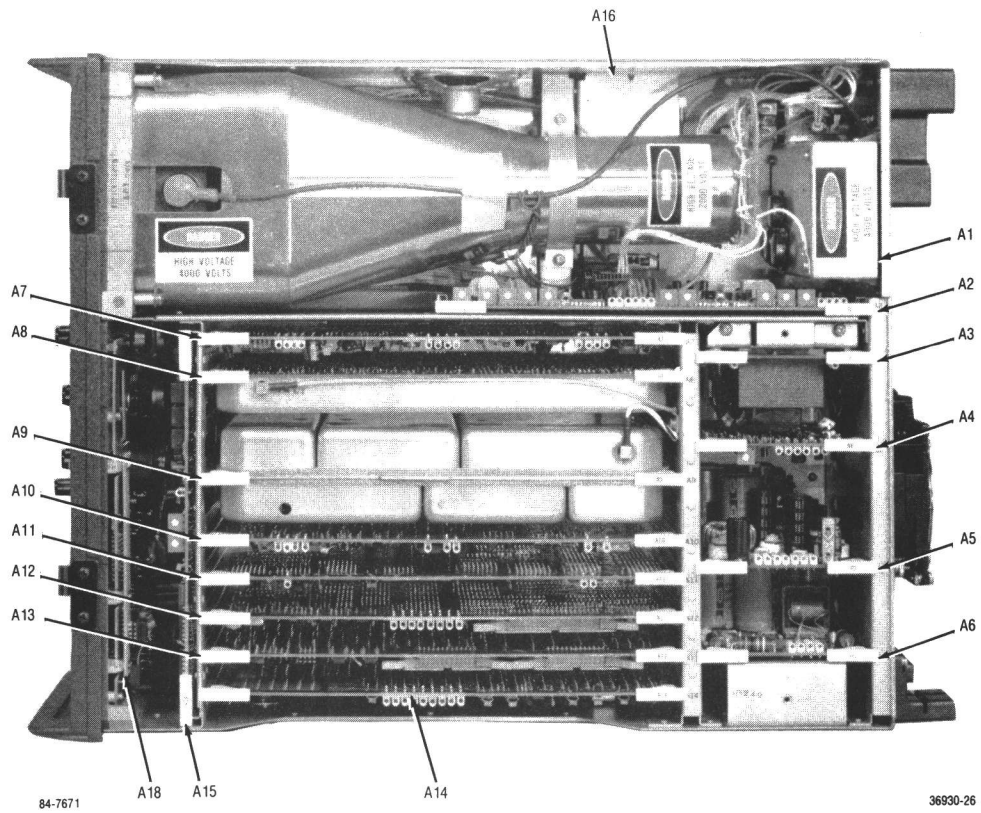


Figure 1-5. Communications System Analyzer — Top View, Cover Removed

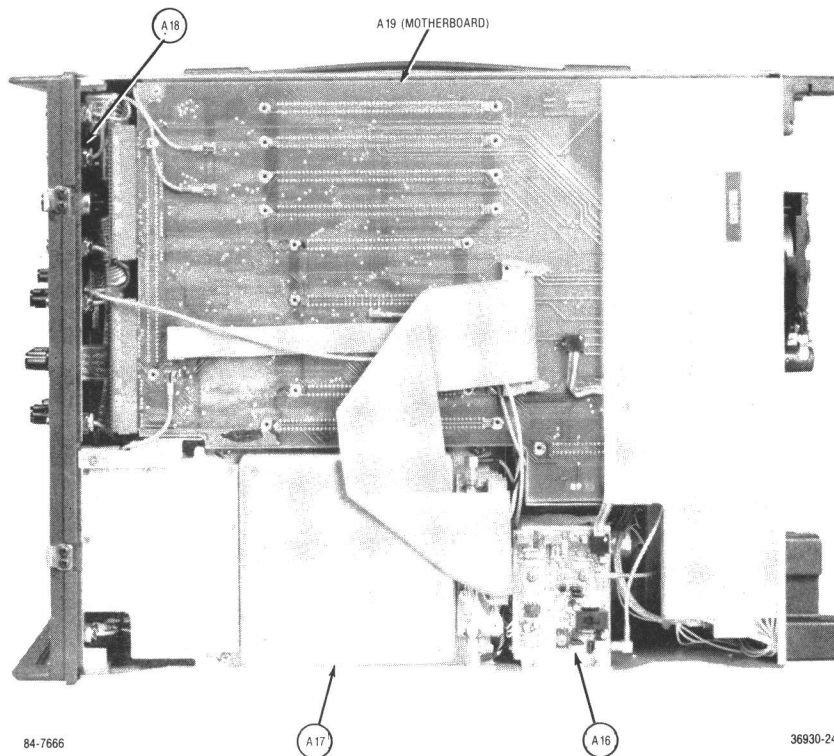


Figure 1-6. Communications System Analyzer — Bottom View, Cover Removed

**MOTOROLA TEST-EQUIPMENT PRODUCTS
LIMITED WARRANTY
(EXCLUDES EXPORT SHIPMENTS)**

Motorola Test-Equipment Products (herein the "product") that are manufactured or distributed by Motorola Communications Group Parts Department are warranted by Motorola for a period of one (1) year from date of shipment against defects in material and workmanship.

This express warranty is extended to the original purchaser only. In the event of a defect, malfunction, or failure during the period of warranty, Motorola, at its option, will either repair or replace the product, providing that Motorola receives written notice specifying the nature of the defect during the period of warranty, and the defective product is returned to Motorola at 1313 East Algonquin Road, Schaumburg, IL 60196, transportation prepaid. Proof of purchase and evidence of date of shipment (packing list or invoice) must accompany the return of the defective product. Transportation charges for the return of the product to the Purchaser shall be prepaid by Motorola.

This warranty is void, as determined in the reasonable judgment of Motorola, if:

- (a) The product has not been operated in accordance with the procedures described in the operating instructions;
- (b) The seals on non-user-serviceable components or modules are broken;
- (c) The product has been subject to misuse, abuse, damage, accident, negligence, repair or alteration.

In no event shall Motorola be liable for any special, incidental, or consequential damages.

In the event Motorola elects to repair a defective product by replacing a module or subassembly, Motorola, at its option, may replace such defective module or subassembly with a new or reconditioned replacement module or subassembly. Only the unexpired warranty of the warranty product will remain in force on the replacement module or subassembly. EXCEPT AS SPECIFICALLY SET FORTH HEREIN, ALL WARRANTIES EXPRESS OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE OR MERCHANTABILITY, ARE EXCLUDED.

EPS-30828-O

SUPPORT SERVICES

For service on your Motorola test equipment in the U.S., contact the Test-Equipment Service Center, Schaumburg, 1313 E. Algonquin Rd., Schaumburg, Illinois 60196 or call the Test-Equipment Service Hotline: 800/323-6967 during normal business hours. In Illinois call 1-312-576-7025. Outside the U.S., contact your nearest Motorola representative.

MODULE EXCHANGE PROGRAM

Modular construction of the R2001 allows field replacement of individual assemblies. Contact the Test-Equipment Service Center for pricing and delivery. Outside the U.S., contact your nearest Motorola representative.

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