



Telecommunications

## TELECOMMUNICATIONS INSTRUMENTATION MODELS 9401, 9402, 9403, 9404, 9405, AND 9406



### GENERAL DESCRIPTION

The Lab-Volt telecommunications instrumentation modules (Models 9401, Power Supply / Dual Audio Amplifier; 9402, Dual Function Generator; 9403, Frequency Counter; 9404, True-RMS Voltmeter / Power Meter; 9405, Spectrum Analyzer; 9406, RF / Noise Generator) are designed for skills training in telecommunications and are part of the Lab-Volt Analog and Digital Communications

Systems, Models 8080 and 8085. Each instrument is fully protected against short circuits and misconnections made by the student.

Students use the instruments to make measurements in laboratory experiments performed on AM, FM, and digital communications systems.

## TELECOMMUNICATIONS INSTRUMENTATION MODELS 9401, 9402, 9403, 9404, 9405, AND 9406

---

### Model 9401 – Power Supply / Dual Audio Amplifier



The power supply distributes power to the complete system and provides three regulated DC voltage outputs (15 V – 0.5 A; -15 V – 0.5 A; +5 V – 1 A) on the faceplate. Also unregulated voltages are distributed to the system modules through a connector located on each module. These unregulated voltages are regulated within each module to provide the required voltages.

Each regulated supply has an LED indicator that shuts off if the supply is overloaded due to equipment malfunction or if a faulty power connection is made to external equipment.

The Model 9401 Power Supply / Dual Audio Amplifier module forms the physical base for the analog and digital communications training systems. It is double-width to accommodate two instructional modules or two instrument modules in a side-by-side configuration. A two-channel audio amplifier with headphone jacks and speakers accommodates FM stereo and narrowband FM and AM receiver outputs.

---

### Model 9402 – Dual Function Generator



The Model 9402 Dual Function Generator consists of two independent function generators (A and B), each capable of generating a sine-wave signal, a square-wave signal, a triangular-wave signal, a sawtooth-wave signal, and a pulse signal with variable pulse-width. The signal frequency can be varied from 10 Hz to 100 kHz through four ranges. A digital display is pushbutton-selectable between generators A and B to monitor the frequency of each generator. Each generator's output signal level is continuously variable and may be attenuated by pushbutton-selected switch attenuators. TTL output signals are provided to synchronize external equipment, such as an oscilloscope. Generator A may be frequency-modulated by a signal from generator B or from an external source.

---

### Model 9403 – Frequency Counter



The Model 9403 Frequency Counter is a direct-counting frequency counter with an 8-digit display. The frequency counter has three functions; it determines the frequency of the input signal and displays the frequency in Hz, kHz, or MHz; it determines the period of the input signal and displays the period in  $\mu\text{s}$  or ms; it works as an event counter when the counter function is selected. The frequency/period resolution is switch-selectable from 0.1 to 100 Hz (0.1 to 100 ns). As an event counter, each negative-going transition of the input signal adds one to the cumulative count displayed.

The input signal may be attenuated by a switch attenuator.

---

### Model 9404 – True-RMS Voltmeter / Power Meter



The Model 9404 True-RMS Voltmeter / Power Meter is a dual function instrument used to measure RMS voltage or signal power in communications system. Voltage and power can be measured through four ranges on a  $3\frac{1}{2}$  digit panel display. The function is switch-selectable on the front panel.

The input signal frequency range is 20 Hz to 12 MHz. An automatic zero-adjust function readjusts the meter's zero at regular time intervals. This feature provides precise measurements over a wide range of temperature.

# TELECOMMUNICATIONS INSTRUMENTATION

## MODELS 9401, 9402, 9403, 9404, 9405, AND 9406

---

### Model 9405 – Spectrum Analyzer



The Model 9405 Spectrum Analyzer is used for signal observation of the communications system in the frequency domain. It is a frequency-selective instrument that allows the power level of each frequency component of a signal to be displayed on a regular oscilloscope: a dual trace oscilloscope or a single trace oscilloscope with an external sweep input having a sensitivity of 1 volt/div. is required. The Spectrum Analyzer has two selectable

input frequency ranges: DC to 30 MHz, and 85 and 115 MHz. The center frequency is indicated on a 3½ digit display. The Spectrum Analyzer has an output for use with an optional Dual Trace Oscilloscope (Model 797) or an X-Y Recorder (Model 9492).

Two digital memories of 1024 horizontal points by 256 vertical levels provide a stable display at a refresh rate of 30 Hz. The frequency span is switch-selectable in five ranges from 2 kHz to 1 MHz per volt. With the oscilloscope set at 1 volt/div., total spans of 20 kHz to 10 MHz are possible.

The bandwidth resolution is automatically optimized between 100 Hz and 50 kHz. Inputs to the spectrum analyzer may be attenuated by 40 dB in five steps. The input impedance is switch-selectable between 50 Ω and 1 MΩ. The input signal may be displayed in linear or logarithmic form (10 dB/volt) up to a maximum display range of 60 dB.

The Model 9405 Spectrum Analyzer is also available as a stand-alone (Model 9405-10). The 9405-10 is a low-cost alternative to high-cost spectrum analyzers necessary for spectral analysis of communications signals.

---

### Model 9406 – RF / Noise Generator



The Model 9406 RF / Noise Generator contains two independent generators capable of generating a tone signal in the frequency range from 100 kHz to 32 MHz and a "white" noise signal in selected frequency bands from 0 to 11.2 MHz.

The radio frequency (RF) generator produces a signal output in five frequency ranges to cover the frequencies in the analog communications system. This generator has FM and AM capabilities.

The noise generator provides white noise in five independent frequency bands. The noise output may be used for measuring the frequency response of filters or the signal-to-noise ratio in any part of the system.

## SPECIFICATIONS

<b>Model 9401 – Power Supply / Dual Audio Amplifier</b>		<b>120 V – 60 Hz</b>	<b>220 V – 50 Hz</b>	<b>240 V – 50 Hz</b>
Power Requirement		3.5 A	2 A	2 A
Power Outputs	Unregulated Power Bus Regulated Front Panel	±25 V typ. – 3 A max.; –25 V typ. – 3 A max.; +11 V typ. – 5 A max. ±15 V – 0.5 A; +5 V – 1 A		
Dual Audio Amplifier Rating	Bandwidth	50 Hz to 15 kHz		
	Input Impedance	10 kΩ		
	Nominal Output Power	250 mW		
	Sensitivity (at nominal output power)	140 mW		
	Output Impedance (intermediate outputs)	1 kΩ		
	Maximum Output Level (open-circuit)	20 V p-p		
Protection	AC Line Input	Circuit Breaker		
	DC Regulated Outputs	Foldback Current-Limiting		
	DC Unregulated Outputs	Circuit-Breaker		
Physical Characteristics	Dimensions (H x W x D)	104 x 687 x 305 mm (4.1 x 27 x 12 in)		
	Net Weight	15.8 kg (34.8 lb)		
<b>Model 9402 – Dual Function Generator</b>				
Power Requirement		±25 V – 230 mA; +11 V – 160 mA; –25 V – 120 mA		
Generators (A & B) Rating	Waveforms	Sine, Triangle, Square, Sawtooth, or Pulse		
	Pulse Duty Cycle	10 to 90 %		
	Frequency Ranges	10-100 Hz, 100-1000 Hz, 1-10 kHz, 10-100 kHz		
	Frequency Display (switchable between A & B)	4 digits		
	Output Impedance	50 Ω		
	Output Level (open circuit)	10 mV p-p to 10 V p-p		
	Attenuator	0, 20 or 40 dB		
	Synchronization Outputs	One for each channel(SYNC/TTL)		
Frequency Modulation (Channel A only)	Input Impedance	100 kΩ		
	Maximum Frequency Deviation	50 % of each side of Rest Frequency		
	Input Level for Maximum Deviation	10 V p-p		
Physical Characteristics	Dimensions (H x W x D)	162 x 330 x 300 mm (6.4 x 13 x 11.8 in)		
	Net Weight	4.4 kg (9.7 lb)		
<b>Model 9403 – Frequency Counter</b>				
Power Requirement		+25 V – 425 mA; –25 V – 325 mA		
Rating	Input Frequency Range	10 Hz - 10 MHz, 10 MHz-200 MHz		
	Input Period Range	0.1 s – 4 μs (10 Hz-2.5 MHz)		
	Count Range	1 - 99 999 999		
	Input Impedance	1 MΩ		
	Sensitivity (Sine Wave RMS Value)	10 Hz - 100 MHz: 25 mV; 100 MHz-200 MHz: 60 mV		
	Attenuator	0, 20 or 40 dB		
	Resolution	0.1, 1, 10, 100 Hz (ns)		
	Frequency Display	8 digits		
Physical Characteristics	Dimensions (H x W x D)	112 x 330 x 300 mm (4.4 x 13 x 11.8 in)		
	Net Weight	3.2 kg (7 lb)		
<b>Model 9404 – True-RMS Voltmeter / Power Meter</b>				
Power Requirement		+25 V -125 mA; +11 V - 350 mA; –25 V - 75 mA		
Rating	Measurement Bandwidth	20 Hz - 12 MHz		
	Input Impedance	1 MΩ		
	Voltage Ranges	10 mV, 100 mV, 1 V, 10 V		
	Power Ranges	–27, –7, +13, +33, (50 Ω input)		
	Accuracy	10 and 100 mV Ranges: ±3 % (20 Hz - 12 MHz) 1 and 10 V Range: ±5 % (20 Hz-12 MHz)		
Physical Characteristics	Dimensions (H x W x D)	112 x 330 x 300 mm (4.4 x 13 x 11.8 in)		
	Net Weight	3.0 kg (6.7 lb)		

# TELECOMMUNICATIONS INSTRUMENTATION

## MODELS 9401, 9402, 9403, 9404, 9405, AND 9406

### SPECIFICATIONS (cont'd)

<b>Model 9405 – Spectrum Analyzer</b>			
Power Requirement	Model 9405 Model 9405-1	+25 V – 750 mA; +11 V – 600 mA; –25 V – 475 mA 120/220 V – 50/60 Hz – 600 W	
Rating	Input Frequency Range	0-30 MHz (500 Hz minimum) and 85-115 MHz	
	Input Impedance	50 $\Omega$ or 1 M $\Omega$	
	Input Signal Level	–70 to +30 dBm (50 $\Omega$ input)	
	Maximum Input Signal Levels		7 V (peak AC + DC) at 50 $\Omega$ impedance
			15 V (peak AC + DC) at 1 M $\Omega$ impedance
	Frequency span (Oscilloscope/Plotter at 1 V/div.)	0 Hz; 2, 10, 50, 200 kHz; 1 MHz/div.	
	Resolution Bandwidth (3 dB)	100, 500 Hz; 2, 20, 50 kHz (automatic selection)	
	Frequency Markers	10, 100 kHz; 1, 10 MHz	
	Marker Frequency Stability	$\pm 0.003$ %/ $^{\circ}$ C	
	Frequency Measurement Resolution	1 kHz (using 10 kHz markers)	
	Dynamic Range (input signal measurements)	60 dB	
	Selectivity (60 dB/3 dB)	Better than 13:1	
	Output Display	External oscilloscope set the X-Y mode at 1 V/div. and/or X-Y (oscilloscope and plotter not supplied)	
	Output Mode	HOLD/LIVE	
Output Scale	Linear or Log (10 dB/V)		
Output Level	Variable up to 10 dB from CAL position.		
Memories (A et B)	1024 vertical points x 256 horizontal levels		
Oscilloscope Outputs	X: 0 to 10 V; Y: 0 to 6 V		
Plotter Outputs	X: 0 to 10 V; Y: 0 to 6 V; ground		
Input/Output Signal Connectors		BNC (except plotter output, which is 2 mm banana jacks)	
Accessories	Model 9405	One 2-m (6.5 ft) Plotter Connection Cable	
	Model 9405-1	Two 120 cm (4 ft) BNC/BNC Cables	
		One 2 m (6.5 ft) Plotter Connection Cable	
Physical Characteristics	Dimensions: Model 9405 (H x W x D)	162 x 330 x 315 mm (6.4 x 13 x 12.4 in)	
	Model 9405-1 (H x W x D)	153 x 330 x 437 mm (6 x 13 x 17.2 in)	
	Net Weight: Model 9405	5.6 kg (12.3 lb)	
	Model 9405-1	9.4 kg (20.7 lb)	
<b>Model 9406 – RF / Noise Generator</b>			
RF Generator Rating	Frequency Ranges	100-320 kHz, 0.32-1 MHz, 1-3 MHz, 3-10 MHz, 10-32 MHz	
	Output Voltage (across 50 $\Omega$ )	100 mV p-p	
	Output impedance	50 $\Omega$	
	SYNC Output Level	1.5 V p-p min.	
	Amplitude Modulation Input Level	1 V p-p	
	Amplitude Modulation Input Impedance	10 k $\Omega$	
	Frequency Modulation Input Level	1 V p-p	
Noise Generator Rating	Frequency Ranges	Audio: 2 Hz - 20 kHz Audio/RF: 0 Hz - 2 MHz AM IF Noise: 435-475 kHz SSB RF Noise: 3.6-4.2 MHz FM IF Noise: 10.2-11.2 MHz	
	Output Voltage (across 50 $\Omega$ )	0.5 V rms	
	Output Impedance	50 $\Omega$	
	Physical Characteristics	Dimensions (H x W x D)	162 x 330 x 300 mm (6.4 x 13 x 11.8 in)
	Net Weight	4 kg (8.8 lb)	

## ORDERING NUMBERS

MODEL NUMBER	120 V – 60 Hz			220 V – 50 Hz			240 V – 50 Hz
	ENGLISH	FRENCH	SPANISH	ENGLISH	FRENCH	SPANISH	ENGLISH
9401	9401-00	9401-01	9401-02	9401-05	9401-06	9401-07	9401-0A
9402	9402-10	9402-11	9402-12	9402-10	9402-11	9402-12	9402-10
9403	9403-00	9403-01	9403-02	9403-00	9403-01	9403-02	9403-00
9404	9404-10	9404-11	9404-12	9404-10	9404-11	9404-12	9404-10
9405	9405-00	9405-01	9405-02	9405-00	9405-01	9405-02	9405-00
9405-1	9405-10	9405-11	9405-12	9405-15	9405-16	9405-17	9405-1A
9406	9406-00	9406-01	9406-02	9406-00	9406-01	9406-02	9406-00

Table 1. Equipment Ordering Numbers

Reflecting Lab-Volt's commitment to high quality standards in product, design, development, production, installation, and service, our manufacturing and distribution facility has received the ISO 9001 certification.

Lab-Volt reserves the right to make product improvements at any time and without notice and is not responsible for typographical errors. Lab-Volt recognizes all product names used herein as trademarks or registered trademarks of their respective holders. © Lab-Volt 2009. All rights reserved.