

# SECTION I

## GENERAL INFORMATION

### 1-1. INTRODUCTION.

1-2. This manual provides general information, installation information, operating instructions, theory of operation, performance tests, maintenance instructions, a parts list and schematic diagrams for the Model 8200-S/10 Modulation Analyzer. The Model 8200-S/10 is manufactured by Boonton Electronics Corporation, Randolph, New Jersey.

### 1-3. DESCRIPTION.

1-4. The Model 8200-S/10 is a versatile, precision, solid-state instrument with features and performance characteristics especially suitable for laboratory and industrial applications. It is a hardware variant of the Model 8200 and covers a frequency range of 100 kHz to 2.5 GHz. With the 4220-S/10, Comstron 9000S, SG1207/U, and SG1219/U the Model 8200-S/10 becomes a complete measuring receiver capable of operation to 18 GHz carrier frequencies, and able to perform level measurements to -127 dBm. Human engineering considerations have been emphasized in both the mechanical and electrical design of the Model 8200-S/10. The result is a modulation analyzer that is easy and convenient to use, despite its flexibility. Among the outstanding features are:

a. **Automatic or manual tuning and leveling.** The Model 8200-S/10 can automatically acquire the largest signal present at the input connector and adjust its local oscillator and measurement channel gain to provide a calibrated display of amplitude, phase, or frequency modulation. Additionally, the operator can manually program carrier frequency to eliminate acquisition time. This may be accomplished using the front panel keys or remotely via the IEEE-488 bus.

b. **Separate displays of all major functions.** The Model 8200-S/10 has three separate displays to present simultaneously carrier frequency, carrier power or tuned level, modulation AM, FM, or PM, and program number or special function. Continuous display of IEEE-488 bus status is also presented.

c. **Separate 455 kHz IF System.** The 8200-S/10 contains a separate 455 kHz IF system for use with an external local oscillator and mixer to provide tuned level measurements from 0 to -127 dBm.

d. **Low Residual Modulation.** The exceptionally low modulation residuals provide excellent measurement accuracy with low noise sources. Direct residual measurements are possible using the Model 8200-S/10 with internal true rms detectors. In addition, active peak detectors insure exceptional baseband detection linearity so that residuals may be easily discounted for enhanced measurement accuracy.

1-5. The features described in the preceding paragraphs, together with those described in Table 1-1, make the Model 8200-S/10 particularly useful for design, production line, and field testing of FM and AM transmitters and signal generators. Because of its flexibility, the Model 8200-S/10 is also a good modulation analyzer for laboratory applications.

### 1-6. OPTIONS.

1-7. There are no options currently available for the Model 8200-S/10.

1-8. Inquiries regarding special applications of the Model 8200-S/10 to specific customer requirements are invited. Direct such inquiries to the Applications Engineering Department of Boonton Electronics Corporation.

### 1-9. PERFORMANCE SPECIFICATIONS.

1-10. Performance specifications for the Model 8200-S/10 and the measuring receiver system are listed in Table 1-1.

## 1-11. OUTLINE DIMENSIONS.

1-12. Outline dimensions of the Model 8200-S/10 are shown in Figure 1-1.

TABLE 1-1. PERFORMANCE SPECIFICATIONS.

**RF INPUT**

<b>Frequency Range</b>	: 500 kHz to 18 GHz for AM, FM, and PM. : 100 kHz to 18 GHz for untuned power. : 2.5 MHz to 18 GHz for tuned power.
<b>Level Range</b>	: -20 dBm to +19 dBm for AM, FM, and PM. ** : -20 dBm to +30 dBm for untuned power. : -110 dBm to 0 dBm for tuned power, Frequency Range: 2.5 to 1000 MHz. : -100 dBm to 0 dBm for tuned power, Frequency Range: 1 to 18 GHz. : -127 dBm to 0 dBm for tuned power, Frf = 30 MHz. : -105 dBm to 0 dBm for tuned power, Frf = 2.0 GHz. : -100 dBm to 0 dBm for tuned power, Frequency Range: 2.5 to 1000 MHz. * : -75 dBm to 0 dBm for tuned power, Frequency Range: 1 to 18 GHz. * * 30 kHz measurement bandwidth, others 200 Hz bandwidth ** Accurate AM indications will require additional attenuation ahead of mixer from 2 to 18 GHz. Maximum usable AM input without adapter pad is approximately -6 dBm.

**Input impedance** : 50 ohms

**VSWR**

: 1.18 from 0 to -80 dBm level, Frequency Range: 100 kHz to 1 GHz.  
: 1.40 from -80 to -127 dBm level, Frequency Range: 100 kHz to 1 GHz.  
: 1.33 from 0 to -80 dBm level, Frequency Range: 1 GHz to 2 GHz.  
: 1.5 from -80 to -110 dBm, Frequency Range: 1 GHz to 2 GHz.  
: 1.25 for all levels, Frequency Range: 2 to 18 GHz, Untuned Power.  
: 1.28 for all levels, Frequency Range: 2 to 18 GHz, Tuned Power.

**FREQUENCY MODULATION**

**Measurement** : + peak, -peak, peak average, and RMS.

**Rates** : 30 Hz to 10 kHz, Frequency Range: 0.5 to 10 MHz.  
: 30 Hz to 200 kHz, Frequency Range: 10 MHz to 18 GHz.

**Range** : 0 to 50 kHz peak, Frequency Range: 0.5 to 10 MHz.  
: 0 to 500 kHz peak, Frequency Range: 10 MHz to 18 GHz.

**Resolution** : 1 Hz, 0 to 5 kHz deviation.  
: 10 Hz, 5 to 50 kHz deviation.  
: 100 Hz, 50 to 500 kHz deviation.

**Accuracy\*\*** : 2% of reading, 20 Hz to 10 kHz rates, Frequency Range: 0.5 to 10 MHz.  
: 1% of reading, 50 Hz to 100 kHz rates, Frequency Range: 0.01 to 18 GHz.  
: 5% of reading, 20 Hz to 200 kHz rates, Frequency Range: 0.01 to 18 GHz.  
\* peak residuals must be accounted for.  
\*\* for RMS and + - 3% of reading.

TABLE 1-1. PERFORMANCE SPECIFICATIONS CONTINUED.

<b>Distortion</b>	: < 0.1% for deviations < 10 kHz, Frequency Range: 0.5 to 10 MHz. : < 0.1% for deviations < 100kHz, Frequency Range: 0.01 to 18 GHz.
<b>Residual FM*</b>	: < 8 Hz RMS @ 1300 MHz carrier, decreasing linearly with frequency. : < 1.7 Hz RMS at 100 MHz. : < 17 Hz RMS , Frequency Range: 1.3 to 6.2 GHz. : < 33 Hz RMS, Frequency Range: 6.2 to 12.4 GHz. : < 49 Hz RMS , Frequency Range: 12.4 to 18 GHz. * 30 Hz to 3 kHz measurement bandwidth.
<b>AM rejection</b>	: < 20 Hz peak deviation at 50% AM, 30 Hz to 3 kHz measurement bandwidth.
<b>AMPLITUDE MODULATION</b>	
<b>Measurement</b>	: + peak, -peak, peak average, and RMS.
<b>Rates</b>	: 30 Hz to 10 kHz for carriers from 0.5 to 10 MHz. : 30 Hz to 50 kHz for carriers from 10 MHz to 18 GHz.
<b>Range</b>	: 0 to 99.9%.
<b>Resolution</b>	: 0.01% from 0.00 to 50.00% AM. : 0.1% from 50.1 to 99.9% AM.
<b>Accuracy* **</b>	: 2% of reading, 50 Hz to 10 kHz rates, Frequency Range: 0.5 to 10 MHz. : 3% of reading, 20 Hz to 10 kHz rates, Frequency Range: 0.5 to 10 MHz. : 1% of reading, 50 Hz to 50 kHz rates, Frequency Range: 0.01 to 18 GHz. * peak residuals must be accounted for. ** for RMS and + - 3% of reading.
<b>Distortion</b>	: 0.3% for depths of 50%, Frequency Range: 0.5 to 1300 MHz. : 0.6% for depths of 95%, Frequency Range: 0.5 to 1300 MHz. : 1.0% for depths of 50%, Frequency Range: 1300 MHz to 18 GHz.
<b>Residual AM</b>	: 0.02% RMS, 30 Hz to 3 kHz bandwidth.
<b>FM rejection</b>	: < 0.2% AM peak at 50 kHz deviation, Frequency Range: 10 to 1300 MHz. : < 0.2% AM peak at 5 kHz deviation, Frequency Range: 0.5 to 10 MHz.
<b>PHASE MODULATION</b>	
<b>Measurement</b>	: + peak, -peak, peak average, and RMS.
<b>Rates</b>	: 200 Hz to 20 kHz.
<b>Range</b>	: 0 to 150 RADS, Frequency Range: 0.5 to 10 MHz : 0 to 500 RADS, Frequency Range: 10 MHz to 18 GHz.

TABLE 1-1. PERFORMANCE SPECIFICATIONS CONTINUED.

<b>Resolution*</b>	: 0.001 RAD, 0 to 5 RAD deviation. : 0.01 RAD, 5 to 50 RAD deviation. : 0.1 RAD, 50 to 500 RAD deviation. * Up to 1 kHz modulation rate. Above 1 kHz resolution is determined by the product of deviation and modulation rate.
<b>Accuracy* **</b>	: 4% of reading, 200 Hz to 20 kHz rates, Frf < 10 MHz. : 3% of reading, 200 Hz to 20 kHz rates, Frf > 10 MHz. * peak residuals must be accounted for. ** for RMS and + - 3% of reading.
<b>Distortion</b>	: 0.1% at 75 RAD deviation, Frf < 10 MHz. : 0.1% at 100 RAD deviation, Frf > 10 MHz.
<b>Residual PM</b>	: < 0.1 RAD RMS, 30 Hz to 3 kHz bandwidth.
<b>AM rejection</b>	: < 0.02 RAD peak at 50 % AM.
<b>CARRIER FREQUENCY</b>	
<b>Range</b>	: 500 kHz to 18 GHz.
<b>Resolution</b>	: 10 Hz for carriers < 1000 MHz. : 100 Hz for carriers > 1000 MHz.
<b>Sensitivity</b>	: 13 mV RMS from 150 kHz to 650 MHz. : 28 mV RMS from 650 MHz to 1300 Mhz. : 0.22mV RMS in the sensitive frequency mode.
<b>Accuracy</b>	: reference accuracy + - 3 counts, Frequency Range: 0.15 to 100 MHz. : reference accuracy + - 3 counts or 30 Hz whichever is greatest, Frequency Range: 100 MHz to 18 GHz.
<b>Reference</b>	: 10.0000 MHz, 1 X 10 <sup>-9</sup> /day aging. (after 30 days ) : 2 X 10 <sup>-10</sup> /degree C temperature influence. : 6 X 10 <sup>-10</sup> /5-10% change in line voltage : 1 X 10 <sup>-9</sup> short term stability. (1 second average )
<b>CARRIER POWER (untuned)</b>	
<b>Power Range</b>	: -20 to +30 dBm.
<b>Frequency Range</b>	: 100 kHz to 18 GHz.
<b>Linearity</b>	: + 2,-4% from +30 to -20 dBm. : + -1% from +20 to -20 dBm.

TABLE 1-1. PERFORMANCE SPECIFICATIONS CONTINUED.

Cal Factor uncertainty	: 2.3% , Frequency Range: 100 kHz to 2 GHz. : 6.9% , Frequency Range: 2 to 18 GHz.
Cal Factor data	: 18 points from 1 to 18 GHz for each sensor configuration, displayed on sensor.
Maximum power	: 100 watts pulse, not to exceed 2 watts average.
Sensor switches	: mechanical, 1 million operations minimum.
<b>CARRIER POWER ( tuned )</b>	
Frequency Range	: 2.5 MHz to 18 GHz
Power Range	: 0 to -110 dBm, Frequency Range: 2.5 MHz to 1 GHz. : 0 to -100 dBm, Frequency Range: 1 to 18 GHz. : 0 to -127 dBm at 30 MHz. : 0 to -105 dBm at 2 GHz.
Resolution	: 0.01 dB
Accuracy	: 0.625 dBm rss at -110 dBm. * : 1.0 dBm rss from -110 to -127 dBm. * : 0.02 dB/10dB incremental accuracy. * includes mismatch errors, receiver and generator.
<b>POWER REFERENCE</b>	
Frequency	: 50 MHz.
Accuracy	: 0.7% initial accuracy. : + - 1.2% over 1 year.
<b>AUDIO FILTERS</b>	
High-pass	: < 10, 30, 300 and 3000 Hz, 3-pole butterworth, except < 10 which is gaussian.
Low-pass	: 3, 15, 20, 50, and 220 kHz. : 3 and 15 kHz, 3-pole Butterworth. : 50 and 220 kHz , 7-pole Butterworth. : 20 kHz, 3-pole Bessel.
De-emphasis	: 25, 50, 75, and 750 us.
Accuracy	: + - 4 % 3-dB corner and time constant.
<b>AM CALIBRATOR</b>	: internal, 50.00% depth, 0.1% accuracy.
<b>FM CALIBRATOR</b>	: internal, 83.33 deviation, 0.1% accuracy.

TABLE 1-1. PERFORMANCE SPECIFICATIONS CONTINUED.

**POWER INPUT**

: 103 to 130 volts, 50-60 Hz, single phase.  
 : supplied with power cord, 6 feet long with NEMA 5-15P vinyl plug.

**ENVIRONMENTAL****Temperature**

: 4 to 40 degrees C continuous, operating.  
 : -55 degrees for 12 hours storage.  
 : + 60 degrees for 12 hours storage.

**Humidity**

: 0 to 90%.

**Altitude**

: 0 to 10,000 feet continuous, operating.  
 : 40,000 feet for 12 hours, storage.

**Shock**

: 15 g half-sine for 11 milliseconds, vertical and horizontal.

**Tilt drop**

: 4 inch drop on each side, using the opposite side as a pivot.

**Vibration**

: 0.01 inch double amplitude + 0.006,-0.00 from 10 to 52 Hz.  
 : frequency varying from 10 to 52 Hz and back in 5 minutes.  
 : done on each axis(3).

**SUPPLEMENTAL SPECIFICATIONS, TUNED LEVEL****Relative Accuracy**

: Summation of the following terms plus VSWR of generator and sensor.

**Detector Linearity**

: 0.02 dB/10dB change for synchronous detector.  
 : 0.04 dB/10dB change for average detector.

**IF range changes**

: 0.02 dB/10 dB the first five range.  
 : 0.05 dB/10dB for the last two ranges.

**RF range changes**

: 0.04 dB per range, 0.06 dB average power to tuned power transfer.  
 Adapter pad is equivalent to one RF range.

**Mixer linearity**

: 0.2 dB for levels from 0 to -10 dBm, Frequency range: 2 to 18 GHz.  
 : negligible below -10 dBm.

**Noise error**

: 0.2 dB for levels < -110 dBm, Frequency range: 2.5 to 1300 MHz.  
 : 0.2 dB for levels < -90 dBm, Frequency range: 1.3 to 18 GHz.

**Frequency Drift error**

: + -0.05 dB per kHz.