

# FREQUENCY RESPONSE ANALYZERS

Dynamic Response Analyzers  
Servo analyzers



When you need –

- to stabilize feedback loops
- to measure hardware characteristics
- to measure system response

**BAFCO, INC.**

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## SPECIFICATIONS & FEATURES GENERAL

All Bafco analyzers furnish you the measurements for defining the dynamic response and stability of feedback control systems. They operate with optimum speed and with automatic noise and harmonic rejection by Fourier analysis. Test signals have low distortion and are without discontinuities.

We offer several models, which are different in the range of frequency thru which they operate; in their measurement to one point of the system or across any block or blocks of the system; and whether they are to be used manually for point by point measurements or automatically for plotting. Here is a guide to these models.

| ANALYZER TYPES  |   | FREQ. RANGE       | OPTIONS                                     | APPLICATIONS   |
|---|---|-------------------|---|--|
| <b>SINGLE CHANNEL: MANUAL OPERATION, POINT-BY-POINT</b> |   |                   |   |  |
| <b>911A2D</b>   | Universal F.R.A.: very fast operation. Includes carrier and outputs of square and triangle waveforms. Dual digital readout of amplitude ratio (db) and phase. | 0.01 to 10,000 Hz | DC ~ Log Freq.<br>DC ~ Amp Ratio (db ± 60). | Universal: all feedback control systems (DC and carrier) for very rapid results.   |
| <b>TWO CHANNEL: MANUAL OPERATION, SWEEP FREQUENCY</b>   |   |                   |   |  |
| <b>916A</b>   | Display & plots amplitude in db of each channel, amplitude ratio and phase shift. Recorder calibrate and pen lift signals supplied.                           | 0.005 to 10 KHz   | Carrier 50 to 10 KHz                        | Universal: all dynamic response measurements for direct plotting of results  |
| <b>916AXH</b>   |   | 0.10 to 100 KHz   |   |  |
| <b>TWO CHANNEL: PROGRAMMABLE</b>                        |   |                   |   |  |
| <b>920B</b>   | Programmable Two Channel Frequency Response Analyzer IEEE-488 Bus Compatible  | 0.005 to 10KHz    | Carrier 50 to 10 KHz                        | As 916A, except 12 bit word programmable with multiplexed digital data lines and analog outputs. I.E.E.E. – 488 Bus Compatible |

Frequency Accuracy: ±1% of value  
db Accuracy: ±0.15

Output Signal: Sine, Square, triangle, D.C. & Suppressed Carrier Modulation when ordered.

Amplitude: 10 V.F.S., current to ±30 M.A., 1% accuracy

D.C. Offset: up to ±10 V.

Distortion: 1% RMS at F.S., 2% RMS at 10% of F.S.

Amplitude Accuracy: ±1% F.S.  
Phase Accuracy: ±1°

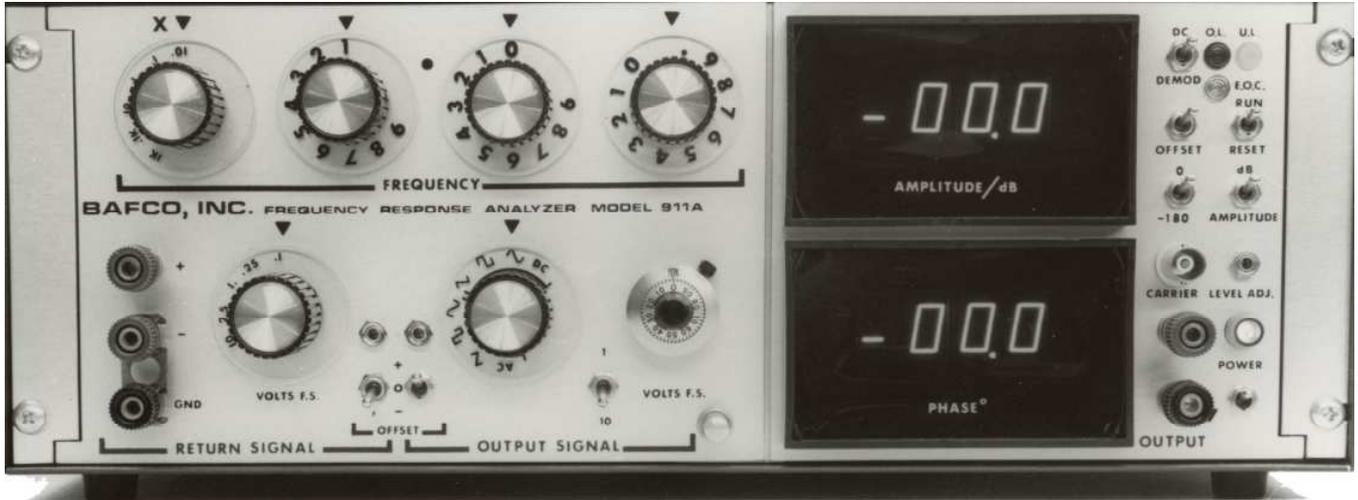
Source Impedance: 5 Ohms

- **COMPUTER PERIPHERALS:** Magtape drives, disc memory head position systems.
- **D.C. POWER SUPPLIES:** Stability of switching regulator high efficiency power supplies.
- **SIMULATORS:** Matching of response of multi-channel actuator systems.
- **AIRCRAFT:** Autopilot, electrohydraulic valve controls, guidance systems.
- **ENGINES:** Engine response characteristics – speed, fuel flow and inlet configuration control systems.
- **Wherever the dynamic characteristics of hardware, structures or systems are needed, either for component or process improvement or for design of controls and networks for stability.**

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## 911A2D SINGLE CHANNEL POINT-BY-POINT ANALYZERS



### WITH DUAL READOUTS FREQUENCY RANGE 0.01 TO 10,000 Hz

#### MEASURES & DISPLAYS:

##### Dual 3 1/2 Digit Readouts of:

**Phase** of the fundamental component of the Return Signal with respect to the Test Signal in degrees to the nearest 0.1° over ±180°

**DB Amplitude Ratio** in 'db' of the fundamental component of the return Signal to the amplitude of the Test Signal. ±66 db to nearest 0.1 db.

**Amplitude** of fundamental component of the Return Signal as a percent of full scale sensitivity (volts peak). '0' to '150%' to nearest 0.1%.

**AUTOMATICALLY REJECTS:** Harmonics (Distortion) & Noise on the Return Signal using Fourier Integral Analysis.

**FAST OPERATION:** A new result every 1 1/2 cycles of test frequency to 1.0 hz. Maximum 2.5 sec/reading above 1.0 hz.

**REPEAT MODE OF OPERATION:** Automatic restart of Analysis Cycle. Bounce in results shows uncertainty due to noise.

**SMALL SIZE:** 5 1/4" High, 14 3/4" Wide, 13" Deep

**TEST SIGNAL:** Low Distortion, High Current, Precise Amplitude Setting, D.C. Offset, Run-Reset switch for Fast Test.

Wave shape – SIN, Triangle & Square Wave.

**RETURN SIGNAL:** Balanced, High Input Impedance, Manual Adjust of D.C. Offset, Full Scale Ranges from 25 volts to 100 mv.

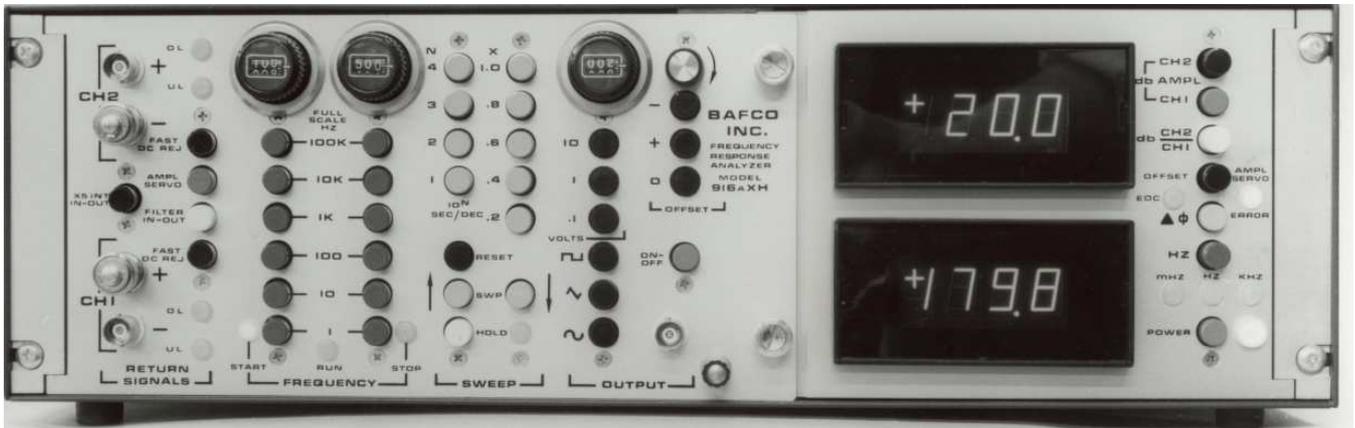
**ACCURATE:** ±1°, ±1%

**CARRIER OPERATION – COMPLETE OPTIONS:** Log Frequency; DB Ratio of Return Signal/Test Signal.

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**916A AND 916AXH  
UNIVERSAL TWO CHANNEL, SWEEP OPERATION FOR PLOTTING**



**916A      Frequency Range: 0.005 to 10 KHz  
916AXH    Frequency Range: 0.1 to 100 KHz  
WITH AUTOMATIC SIGNAL AMPLITUDE CONTROL**

**DESCRIPTION:**

The Automatic Signal Amplitude Control has three modes of operation: when selected, it holds the Amplitude of Channel 1 or 2 constant over the entire frequency range, or it holds the lower of the two amplitudes constant. (Especially useful in Power Supply Switching Regulator Circuit Analysis.) When these functions are not required, the Analyzer operates in normal mode. The Amplitude Servo keeps tests within the linear range of operation and reduces operator intervention in achieving accurate results.

**FEATURES:**

Holds the selected channel amplitude constant within  $\pm 0.1$  db over the entire frequency range • Completely automatic. Uniformly effective and stable, even with high noise levels present • Continuous sweep over any portion of 6 decades • Displays and plots amplitude ratio (db) Phase shift vs. log frequency • Provides plotter calibrate and penlift signals • Open loop results from closed loop test • Automatic Gain Control – 80 db Dynamic range in each channel, with 72 db range in amplitude servo operation • Direct operator control of all functions – sweep speed, sweep sense, integrate time • High noise Harmonic rejection – Fourier integral analysis • Plug in carrier operation option • Low distortion, high current test signal with DC Offset, sine, triangle, or square wave.

**MEASURES & DISPLAYS:** Amplitude Ratio – Ch #2/Ch #1 – in db  
Phase Shift /Ch #2 - /Ch #1 in degrees  
Amplitude Ch #1 in db  
Amplitude Ch #2 in db

**AUTOMATICALLY REJECTS:** Harmonics (Distortion) & Noise on the Return Signals using Fourier integral Analysis. Operator selects Integration Time (2 Ranges)

**AUTOMATIC GAIN CONTROL SYSTEM:** With 80 db Dynamic range in each Channel. Operates with noise as bad as eight times signal amplitude.

**SWEEPS & PLOTS:** Amplitude Ratio (db) and Phase Shift vs. Log Frequency. Continuous Log Sweep from Start to Stop Frequency over any frequency span up to the entire 6 decade frequency range. Sweep Speed Control from 2 sec. /decade to 10,000 sec. /decade. Change as required during a run. Sweep 'Down' to retrace portion of sweep.

**DIGITAL METER READING:** of all outputs, of DC Offset on Test signal, and of Frequency.

**CALIBRATE LEVELS: Phase, Amp. Ratio** – for X-Y  $Y_1$   $Y_2$  plotter (momentary switches)

**'ON-OFF' SWITCH OF TEST SIGNAL:** for short test run, and for fast shutoff.

**A.C. COUPLING:** of Return Signals to reject  $\pm 100$  volts DC on return signal.

**SMALL SIZE:** 5 ¼ "high, Lightweight, Low Power Consumption.

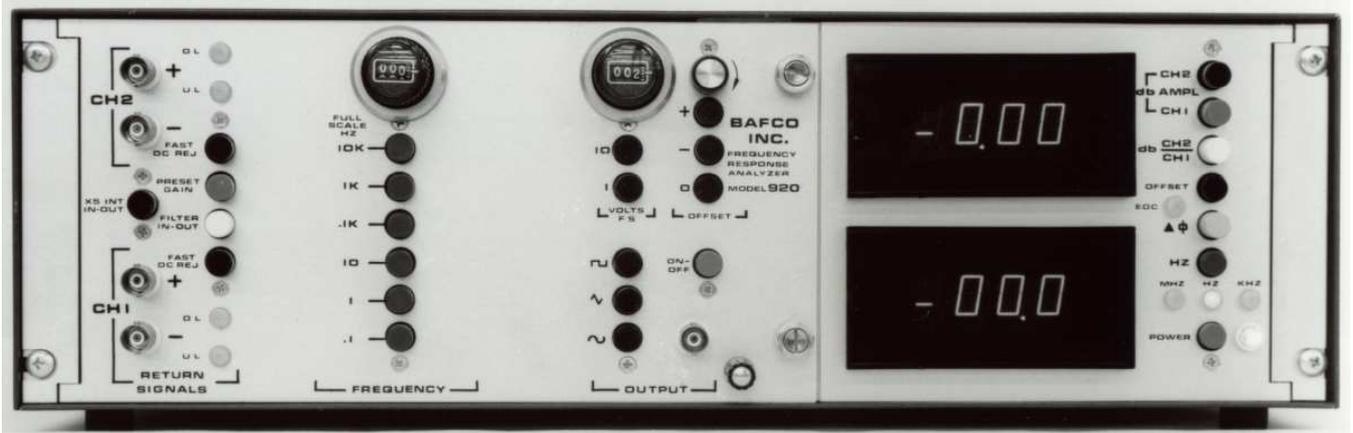
**ACCURATE:**  $\pm 1^\circ$ ,  $\pm .15$  db

**OPTIONS:** Carrier.

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**MODEL 920B PROGRAMMABLE TWO CHANNEL FREQUENCY RESPONSE  
ANALYZER  
IEEE-488 BUS COMPATIBLE**



**FREQUENCY RANGE 0.005 TO 10,000 Hz**

**THE MODEL 920B FURNISHES A PROGRAMMING CAPABILITY IN A TWO CHANNEL  
FREQUENCY RESPONSE ANALYZER THAT PROVIDES TOTAL OPERATING CAPABILITIES.**

**IN PROGRAMMABLE MODE:**

- Choice of IEEE-488 Bus Control or a 12 Bit Parallel Entry Word to program the analyzer by selection of input connector.
- Multiplexed digital data lines for automatic analysis.
- Programs with digital printout or plotting.
- Direct digital readouts of results.
- Outputs for analog plotters.

**IN MANUAL MODE:**

- Simple setup and operation from front panel controls.
- Requires no auxiliary equipment.
- Direct reading results on digital displays.
- Analog outputs simultaneously available.

**PROGRAMMABLE FUNCTIONS:**

- |  |  |
|--|--|
| <ul style="list-style-type: none"> <li>• Frequency</li> <li>• Amplitude of test signal</li> <li>• Signal select-sin, square or triangle</li> <li>• DC Offset</li> <li>• Integration time – 'X1 or X5'</li> <li>• Input filter – 'In, Out'</li> <li>• Present gain – 'In, Out'</li> </ul> | <ul style="list-style-type: none"> <li>• Unity gain – 'In, Out'</li> <li>• DC Reject</li> <li>• Reset – analyzer, test signal or both.</li> <li>• Carrier operation – optional<br/>Channel I – DC or Demod.<br/>Channel II – DC or Demod.</li> <li>• A/D convert signal for data readout.</li> </ul> |
|--|--|

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## MODEL 920B (CONTINUED) SPECIFICATIONS

- **FREQUENCY RANGE** - .005 HZ to 10 KHZ  
Accuracy is within  $\pm 1\%$  of programmed value.
- **TEST SIGNAL AMPLITUDE** – 10 volt & 1 volt full scale ranges with a part in 1000 resolution.  
Accuracy is within  $\pm 1\%$  of programmed value.
- **SINE WAVE DISTORTION** – Under 1% total RMS at F.S.
- **AMPLITUDE RATIO** – Dynamic range -  $\pm 80$ db  
Accuracy – (to S/N = 1/1)  
Channels I and II inputs (signal) Error  
2.5 MV to 10 volts Peak  $\pm .15$ db ( $\pm 72$ db)  
1.0 MV to 2.5 MV Peak  $\pm .20$ db ( $\pm 80$ db)
- **PHASE SHIFT** – Degrees  $\pm 180^\circ$   
Meter – Direct reading over  $\pm 180^\circ$  to nearest  $0.1^\circ$   
DC Voltage –  $\pm 1.80$  Volt. =  $\pm 180^\circ$   
Accuracy – (to S/N = 1/1) (signal) Error  
2.5 MV to 10.0 Volt Peak  $\pm 1^\circ$   
1.0 MV to 2.5 MV Volt Peak  $\pm 1.5^\circ$   
Worse Case Error -  $\pm 2^\circ$  Usual Errors  $\pm 0.75^\circ$

### INCLUDES:

High Pass Input Filter for D.C. offset reject.  
Gain of Input Amplifier – 1 V/V to 1024 V/V  
In 'X2' steps.  
2<sup>nd</sup> High Pass Input Filter. Break frequency  
matched to Frequency Range in use. In-  
creases low frequency noise rejection

### AUTOMATIC GAIN CONTROL:

Maintains each channel's sensitivity to pre-  
vent Overload, or Underload. Insures that in-  
correct results due to noise overload do not  
reach output.  
Gives excellent results at S/N as bad as 1/8.  
Continue to operate at S/N = 1/10.

### COORDINATE COMPUTER

Converts Cartesian Coordinate output of  
Fourier Integral to Polar Coordinates with  
Read-Hold on all outputs.  
Solves for AMP. Ch #1 (db), AMP. Ch #2 (db),  
AMP. Ratio (db), Phase Shift.

### SUMMARY:

These subsystems combine to provide a com-  
plete automatic two channel Frequency Response  
Analyzer. The Model 920B is further designed to:

- Completely define sharp resonances in the item under test.
- Operate accurately under very adverse signal-to-noise ratios.
- Reject D.C. and low frequency upsets more effectively than Fourier Integral Analysis alone (high pass input filters built in).
- Clearly show the limits of confidence that can be placed on the results by the variations in the answer from one cycle of analysis to the next.

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**PRICE LIST – NEW UNITS  
FREQUENCY RESPONSE ANALYZERS and ACCESSORIES**

Effective January 1, 2014

| MODEL  | BASIC SPECIFICATION  | PRICE       |
|--------|--|-------------|
| 911A2D | Single Channel, 0.01 to 10,000 HZ, With dual digital readout of phase, amplitude and Amp. Ratio (in DB). Includes carrier. | \$17,911.00 |
| 916A   | Universal Two Channel sweep Frequency Response Analyzer – AGC-80DB. Extended Sweep. 0.005 Hz to 10 KHz                     | \$21,916.00 |
| 916AXH | 0.1 HZ to 100,000 HZ.  | \$25,916.00 |
|        | OPTIONS:   |             |
|        | For 916A Carrier   | \$2,140.00  |
|        | For 916AXH Carrier   | \$2,140.00  |
| 920B   | Programmable Two Channel Frequency Response Analyzer 0.005 Hz to 10 KHz<br>IEEE-488 Bus Compatible                         | \$26,920.00 |

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**TERMS & CONDITIONS  
FREQUENCY RESPONSE ANALYZERS**

**PRICES:**

ALL PRICES ARE F.O.B. PLANT, WARMINSTER, PENNSYLVANIA, U.S.A. THEY DO NOT INCLUDE ANY FEDERAL, STATE OR LOCAL SALES, USE, EXCISE OR SIMILAR TAXES THAT MAY BE IN EFFECT. ALL PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE, ALTHOUGH FORMAL PRICE QUOTATIONS ARE PROTECTED FOR A PERIOD OF 45 DAYS. BAFCO CAN SUPPLY A FIRM QUOTATION FOR ANY PERIOD, ON REQUEST.

**TERMS:**

NET 30 DAYS UPON APPROVAL.

**SPECIFICATION CHANGES:**

BAFCO, INC. RESERVES THE RIGHT TO DISCONTINUE ANY ITEM WITHOUT NOTICE, AND TO CHANGE SPECIFICATIONS OF ANY INSTRUMENT OR ANY PART AT ANY TIME AND WITHOUT INCURRING OBLIGATIONS TO INCORPORATE NEW FEATURES IN INSTRUMENTS OR PARTS PREVIOUSLY SOLD.

**WARRANTY:**

WE WARRANT EACH NEW INSTRUMENT MANUFACTURED BY US TO BE FREE FROM DEFECTS IN MATERIAL AND WORKMANSHIP. OUR OBLIGATION UNDER THIS WARRANTY SHALL BE LIMITED TO REPAIRING OR REPLACING AT OUR FACTORY ANY INSTRUMENT OR PART THEREOF WHICH WITHIN ONE YEAR AFTER SHIPMENT TO THE ORIGINAL PURCHASER, IS RETURNED TO US PREPAID AND WHICH OUR EXAMINATION SHALL DISCLOSE TO HAVE BEEN THUS DEFECTIVE. THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER OBLIGATIONS OR LIABILITIES ON OUR PART, CONTRACTUAL OR OTHERWISE, EITHER TO THE ORIGINAL PURCHASER OR ANY OTHER PERSON. WE ASSUME NO LIABILITY FOR CONSEQUENTIAL DAMAGES OF ANY KIND EXCEPT WHERE THIS EXCLUSION IS PROHIBITED. THE PURCHASER, BY PLACING AN ORDER WITH US SHALL BE DEEMED TO ASSUME ALL LIABILITY FOR ANY AND ALL DAMAGES CONSEQUENTIAL UPON THE USE OR MISUSE OF THE EQUIPMENT BY THE PURCHASER, ITS EMPLOYEES OR OTHERS. NO AGENT IS AUTHORIZED TO ASSUME FOR US ANY LIABILITY EXCEPT AS ABOVE SET FORTH. THIS WARRANTY APPLIES TO ALL BAFCO, INC. MANUFACTURED EQUIPMENT. THE WARRANTIES WE RECEIVE FROM THE ORIGINAL MANUFACTURER OF OTHER THAN BAFCO EQUIPMENT WILL BE PASSED ON TO THE PURCHASER.

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