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Technical Data

WATKINS-JOHNSON

May 1996

HF Tuner
WJ-9119



WJ designed the WJ-9119 HF Tuner for applications requiring maximum dynamic range. The tuner specifically interfaces with the Hewlett-Packard E1430A analog-to-digital (A/D) converter for both single and multichannel applications. It covers the 0.1 to 32 MHz frequency range providing 95-dB instantaneous spur-free dynamic range (SFDR) in a 4 MHz bandwidth.

The tuner uses state-of-the-art architecture and component technology. Direct and frequency converted paths ensure maximum performance for any input frequency. The unit also incorporates special circuit design techniques and components including a WJ proprietary mixer.

The WJ-9119 HF tuner consists of an RF Tuner Module and a Local Oscillator (LO) Synthesizer Module. Each is housed in a single-width *C-size* VXI module.

Features

- ❏ *0.1 to 32 MHz Frequency Coverage*
- ❏ *High SFDR: 95 dB, typical*
- ❏ *4-MHz bandwidth*
- ❏ *VXI register-based control*
- ❏ *Two 6U* C -size *VXI card slots*
- ❏ *250-kHz tuning resolution*
- ❏ *Phase & amplitude stability between channels*
- ❏ *HP E1430A A/D converter compatibility*
- ❏ *Multichannel-ready configuration*
- ❏ *Built-in test Circuitry*

WJ-9119/RF	**HEIGHT**	9.2in(23.37cm)	**DEPTH**	13.4in(34.03cm)
	WIDTH	1.2in(3.05cm)	**WEIGHT**	5.0lbs(3.4kg)
WJ-9119/LO	**HEIGHT**	9.2in(23.37cm)	**DEPTH**	13.4in(34.03cm)
	WIDTH	1.2in(3.05cm)	**WEIGHT**	6.2lbs(2.26kg)

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RF Tuner (WJ-9119/RF)

The RF tuner contains the RF signal path from RF input to baseband analog output including the functions:

- Input protection
- Gain control
- Frequency translation
- Signal amplification and filtering
- Noise source for built-in-test

The RF tuner provides a 4-MHz-wide baseband output. The tuner divides this conversion process into two bands. The low-band frequency range, from 0.1 to 4 MHz, has a no conversion pathway. The high-band frequency range uses two conversions to convert the 4 to 32 MHz frequency range to baseband. The high-band input signal is upconverted to a 70-MHz IF, then downconverted to near baseband.

An input switch routes the RF input signal to either a lowpass filter or a bandpass filter. These filters improve tuner performance for out-of-band signals. The tuner also includes input overload protection for signals greater than +30 dBm. After filtering, the tuner routes the signal through a step attenuator that provides 47 dB of gain control for the tuner. A VXI register-based interface controls the step attenuator.

After passing through the step attenuator, the signal path splits based on the band of frequencies desired. The tuner switches the lower frequency band (0.1 to 4.0 MHz) to a signal path that includes an amplifier and another lowpass filter to provide the necessary anti-aliasing performance. The tuner switches the upper frequency band (4 to 32 MHz) to a signal path that amplifies and upconverts it to a 70-MHz first IF. The tuner then amplifies, filters, and downconverts the signal to near baseband. SAW bandpass filters obtain sharp shape factors and provide consistent group-delay characteristics.

The low- and high-band frequency paths again come together for final amplification, impedance transformation and filtering. It is critical that these baseband amplifiers exhibit extremely low spurious output.

An internal noise source at the front end of the RF tuner provides built-in-test operations.

WJ engineers have given special attention to optimizing the mixer performance. The spurious outputs of the downconversion mixer are critical and can limit the SFDR performance of the tuner. The NxN (2x2, 3x3, etc.) products are key since they fall within the IF passband.

LO Synthesizer (WJ-9119/LO)

The LO Synthesizer module houses five functions required for RF Tuner operation:

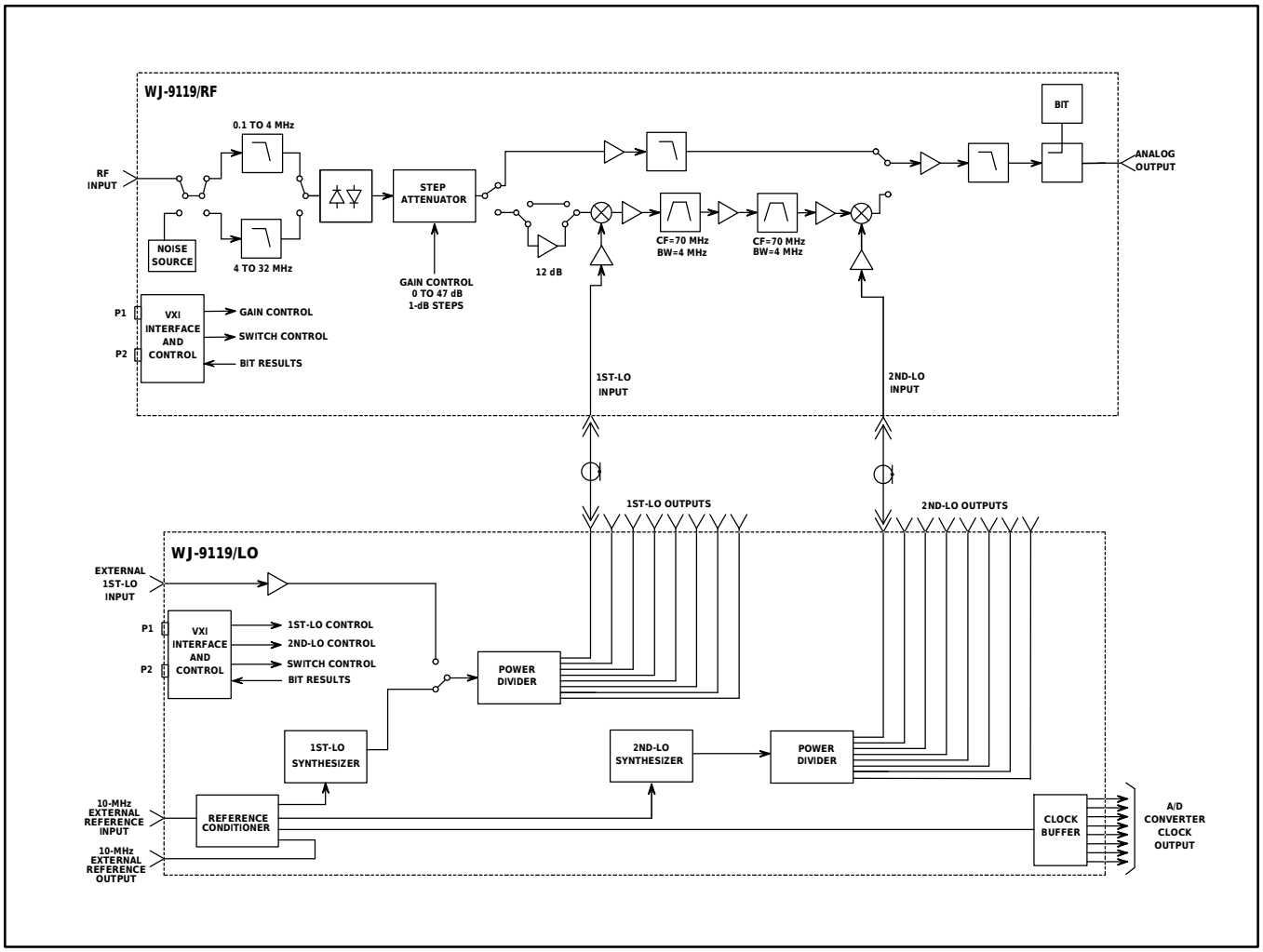
- First LO synthesizer
- Second LO synthesizer
- Reference conditioner
- A/D converter clock
- Multichannel LO switching circuitry

WJ engineers have taken extreme care to design synthesizers that maintain the highest performance possible. WJ has engineered very low phase-noise synthesizers to minimize degradation of the dynamic range provided by the tuner.

The internal 20-MHz reference signal uses a phase-locked loop (PLL) synthesizer to generate the first LO for the tuner. The first LO is tunable in 250-kHz steps and exhibits tuning speeds less than 500 microseconds. A fixed frequency crystal oscillator and PLL generate the second LO and the A/D converter clock.

A reference conditioner provides the low-phase-noise, 20-MHz signal to generate the first LO, second LO, and the A/D converter clock signals. It contains a VCXO that provides the 20-MHz reference signal either directly or locked to an external 10-MHz reference signal for increased frequency accuracy.

The WJ-9119/LO's first LO, second LO, and A/D converter clock are each distributed to eight outputs on the front panel. This makes multichannel common-LO operation possible. With this technique, a single LO Synthesizer module (with up to eight RF Tuner modules) provides phase-locked multichannel acquisition. Properly configuring eight LO Synthesizer modules and eight RF Tuner modules provides eight independently tuned channels that are switchable via software to an eight-channel phase-locked acquisition system. Through specific cabling, an operator can designate one tuner as the master from which the unit derives the multichannel common LO. This allows all synthesizers (master or slave) to be identical and eliminates the need for specially modified tuners in sensor-array applications. An operator may distribute the A/D converter clock outputs to up to eight external synchronous A/D converters.



WJ-9119 HF Tuner Block Diagram

Tuner Connectors

Module	I/O	Functions	Type
WJ-9119/RF Tuner	Inputs	RF 1st LO 2nd LO Power/Control	BNC SMA SMA VXI Interface
	Outputs	Analog Baseband	BNC
WJ-9119/LO Synthesizer	Inputs	External Reference External 1st LO Power/Control	SMA SMA VXI Interface
	Outputs	A/D Converter Clock (8) 1st LO (8) 2nd LO (8) Reference Out Sample 1st LO (future option)	Sub D (8 coax conductors) Sub D (8 coax conductors) Sub D (8 coax conductors) SMA SMA

System Cable Options

WJ Part #	Description
283483-X*	1st-LO SMA to D-Sub Coaxial Pin
283531-X*	2nd-LO SMA to D-Sub Coaxial Pin
283486-X*	ADC Clock BNC to D-Sub Coaxial Pin

*X = Cable length in inches (customer specified)

Specifications -- Electronic

Frequency Range ..... 0.1 to 32 MHz, with degraded performance from 0.1 to 0.5 MHz

Conversion Scheme
- 0.1 to 4 MHz ..... Direct path, no conversions
- 4 to 32 MHz ..... Double conversion

Tuning Resolution ..... 250 kHz

Tuning Time ..... 500 µsec, max; 250 µsec, typical

Internal Reference Stability ..... 5×10^{-7} (over 0° to 50°C)

External Reference Input/Output
- Frequency ..... 10-24 MHz
- Level ..... 0 to +3 dBm
- Impedance 50Ω

A/D Converter Clock Output
- Frequency ..... 10.24 MHz
- Level ..... ECL

1st-LO Output
- Frequency ..... 70 to 102 MHz
- Level ..... 0 to +3 dBm
- Impedance 50Ω
- Resolution ..... 250 kHz

2nd-LO Output
- Frequency ..... 67.44 MHz
- Level ..... 0 to +3 dBm
- Impedance 50Ω

RF Input
- Impedance ..... 50Ω, unbalanced
- VSWR ..... 2.5:1 max.

RF Gain
- Direct Path ..... 20 dB ±2 dB (@25°C, ±3 dB over full temp. range)
- Conversion Path
  - Without Preamplifier Engaged ..... 8 dB ±2 dB (@ 25°C, ±3 dB over full temp. range)
  - With Preamplifier Engaged ..... 20 dB ±2 dB (@ 25°C, ±3 dB over full temp. range)

RF Attenuator
- Maximum Attenuation ..... 47 dB
- Resolution ..... 1 dB
- Adjustment Speed ..... 500 µsec, max; 250 µsec, typical

Damage RF-input Signal Level ..... +30 dBm, min.

Dynamic Range (referenced to full-scale of the A/D)
- Spurious Free ..... 95 dB, typical (when used in combination with HP E1430A)

Dynamic Performance

Specification	Direct Path	Conversion Path, preamp in, no attenuation	Conversion Path, preamp out, no attenuation
3rd-order output in-band IP	33 dBm, min	33 dBm, min	33 dBm, typical
3rd-order input out-of-band IP	20 dBm, min	20 dBm, min	35 dbm, typical
2nd-order output in-band IP	78 dBm, min	78 dBm, min	78 dBm, typical
2nd-order input out-of-band IP	60 dBm, typical	60 dBm, typical	72 dBm, typical
Input 1-dB compression point	+2 dBm, typical	+2 dBm, typical	+14 dBm, typical

Specifications -- Electronic

Noise Figure ..... 15 dB, max; 13 dB, typical

IF-Filter Shape Factor (2 dB:95 dB) ..... 1.56, max.

Analog Baseband Output

0.1 to 4 MHz Path

- Center Frequency ..... 2.05 MHz
- Bandwidth (2 dB) ..... 3.9 MHz
- Impedance 50Ω

4 to 32 MHz

- Center Frequency ..... 2.56 MHz
- Bandwidth (2 dB) ..... 4.0 MHz
- Impedance 50Ω

Image Rejection ..... > 90 dB, min.

IF Rejection ..... > 100 dB, min.

Internally Generated Spurious ..... -130 dBm, typical

Conducted LO Radiation ..... -100 dBm, max

LO Phase Noise (Typical)

Offset		
	1 kHz	-125 dBc/Hz
	10 kHz	-125 dBc/Hz
	100 kHz	-130 dBc/Hz
	1 MHz	-140 dBc/Hz

A/D Clock Phase Noise (Typical)

Offset		
	1 kHz	-130 dBc/Hz
	10 kHz	-140 dBc/Hz
	100 kHz	-145 dBc/Hz

VXI Interface

- Device Type ..... Register-Based, VXI Servant
- Data Transfer Capability ..... A16, D16 circuitry provided
- Module Size ..... C-Size
- Slots Used 2
- Control Library ..... C drivers available

Specifications — Environmental

Operating Temperature ..... 0 to 50°C

Storage Temperature ..... -40 to +70°C

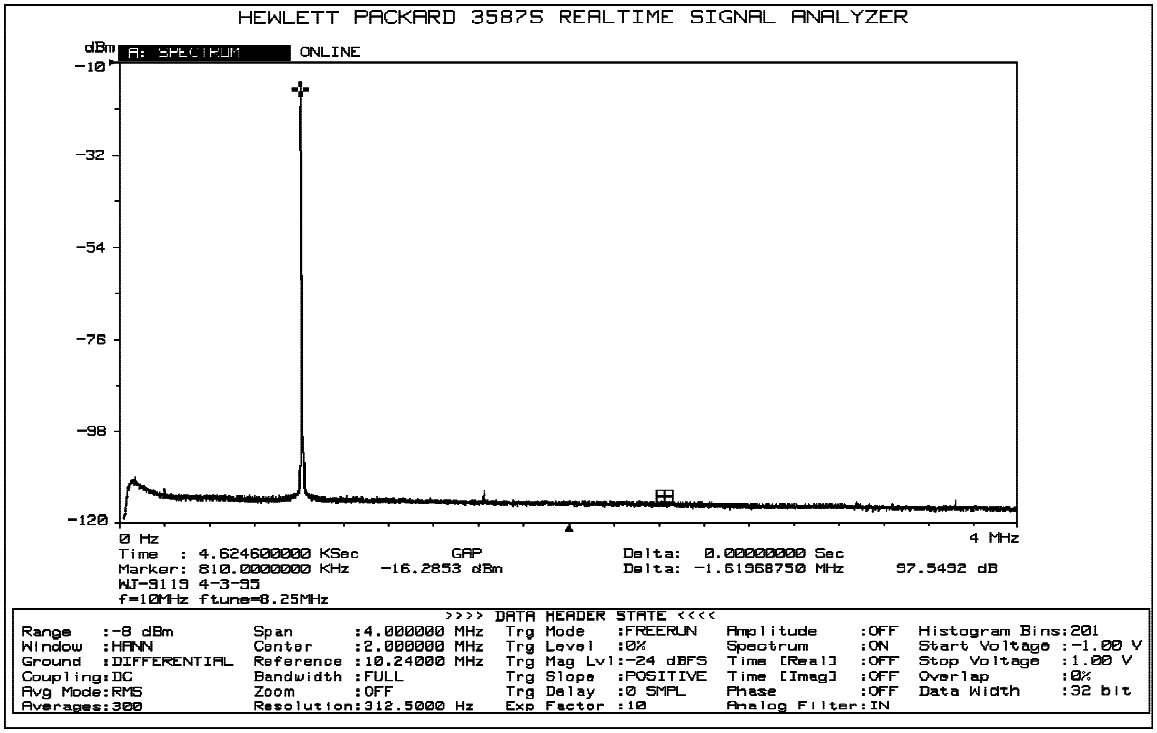
Humidity ..... 0 to 95%, non condensing

Altitude ..... 50,000 ft (15250 meters), non-operating
24,000 ft (7300 meters), operating

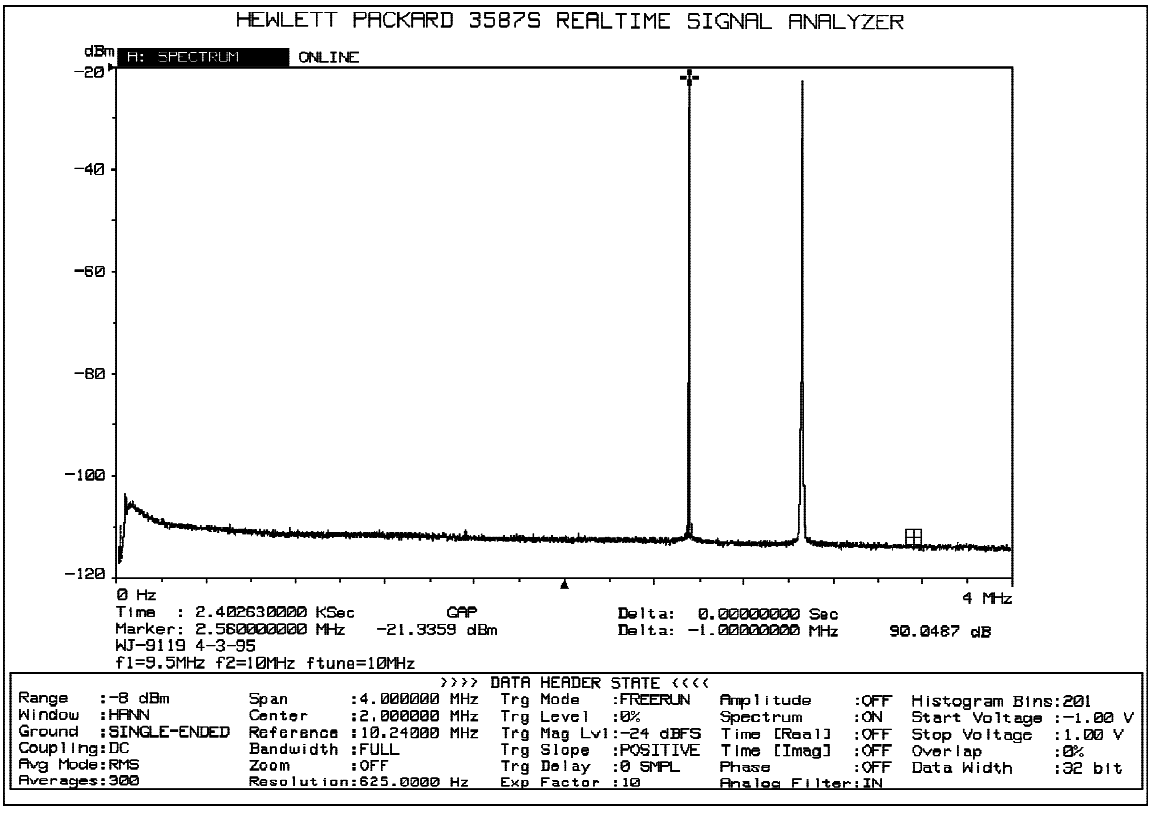
Shock ..... Designed to MIL-STD-810D, bench handling

Power Consumption

Module	Current						Total Watts
	+5V	-5.2 V	+12 V	-12 V	+24 V	-24 V	
WJ-9119/RF	800 mA	5.3 mA	700 mA	30 mA	50 mA	40 mA	15.0
WJ-9119/LO	850 mA	900 mA	400 mA	15 mA	18 mA	0 mA	14.3



Single-tone SFDR with HP E1430A



Two-tone SFDR with HP E1430A

Technical Update

WATKINS-JOHNSON

May 1996

HF Tuner
WJ-9119

External Reference Input/Output Frequency ..... 10 MHz

Analog Baseband Output

4 to 32 MHz
Bandwidth (2 dB) ..... 4.0 MHz

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