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VHF/UHF Wide Bandwidth Surveillance Receiver WJ-8609A



The WJ-8609A is a small, lightweight VHF/UHF receiver for use in limited space applications. Its compact size (105 cubic inches; 1,677.63 cubic cm) and flexible capabilities with remote interfaces provide a multitude of independent and system applications. This receiver features high dynamic range, low phase noise and multiple wideband demodulation capabilities.

The fully synthesized, low phase noise local oscillators (LOs) provide accurate tuning over the basic range of 20 to 512 MHz. The range may be expanded to 2000 MHz with the use of the Frequency Extender (FE) option.

Five IF bandwidths are supplied with the unit, ranging from 0.5 MHz to 40 MHz. The WJ-8609A Receiver is capable of providing AM, FM, Pulse and LOG type demodulation of input signals. The AM and FM demodulators use synchronous type detectors that yield greater than 35-dB linear AM dynamic range and less than 2 percent FM distortion. The LOG video output provides 50 dB of dynamic range.

The WJ-8609A Receiver achieves an excellent third-order intercept point of +2 dBm while maintaining a 15-dB maximum noise figure (20 to 512 MHz). A built-in tracking preselector with a nominal 10 percent bandwidth reduces the interference caused by out-of-band signals. The preselector can be switched into a bypass mode when the IF bandwidth is being limited by the preselector.

The receiver provides two IF outputs. The Wideband IF Output is at a 70-MHz center frequency and has a 40-MHz bandwidth

Features

- ❑ 20 to 512 MHz frequency range (20 to 2000 MHz with FE)
- ❑ High dynamic range
- ❑ Wide bandwidth demodulation (40 MHz)
- ❑ Tracking preselector (20 to 512 MHz with 10% nominal bandwidth)
- ❑ Low phase noise
- ❑ 68HC11 microcontroller
- ❑ SWEEP, STEP & LOCKOUT, with channel occupancy
- ❑ Small size: 1.5 x 6.5 x 10.5 in., (3.81 x 16.51 x 26.67 cm)
- ❑ Modular construction: 4 circuit boards using surface-mount technology
- ❑ Low power: 17 W
- ❑ Lightweight: 5.5 lbs.
- ❑ High linearity AM & FM demodulators
- ❑ AM, FM & LOG video outputs
- ❑ Wideband (0.5 to 40 MHz) IF filters at 70 MHz
- ❑ Self-test of power supply & synthesizer operation

HEIGHT 1.5in (3.81) DEPTH 10.5 in.* (26.67)
WIDTH 6.5 (16.51 cm) WEIGHT 5.5lbs ** (2.49kg)

* FE adds 2.85 in. (7.24)
** (Additional with FE Option)

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with an output level 20 dB above the RF input level. The Switched IF Output is a 70-MHz, -30 dBm predetected IF that is bandwidth limited by the selected IF bandwidth. The receiver also provides a Switched Video Output with a bandwidth equal to one-half the selected IF bandwidth and a switched audio output.

Modes of Control

The WJ-8609A Receiver contains two Input/Output (I/O) interfaces for control and data analysis operations. One of the I/O interfaces is the Hewlett-Packard Interface Loop (HPIL). The HPIL is a low power, interruptible, addressable serial interface that is supported by controlling devices, such as various personal computers. All of the receiver operations may be controlled or queried via the HPIL. This interface supports control of SWEEP, STEP, MANUAL, memory and data collection operations. The collected queue of signal activity is available on command via the HPIL. A second asynchronous serial interface is provided with the receiver, which operates as a full duplex RS-232 interface. With a simple switch change, the WJ-8609A can be configured to operate in full duplex RS-232 mode at a data rate of up to 9600 baud. In this configuration, the RS-232 interface supersedes use of the HPIL.

Capabilities & Applications

The WJ-8609A Receiver utilizes the Motorola 68HC11 Micro-controller, which controls receiver functions such as AGC, AFC, synthesizer tuning and the remote interface. The receiver is capable of three basic modes of operation:

- MANUAL (fixed frequency operation)
- SWEEP (Contiguous coverage from start to stop frequency)
- STEP (preprogrammed discrete frequencies)

The receiver is interactive in all of its modes and is capable of alerting the host computer of signal activity. While in either the SWEEP or STEP mode of operation, the receiver is capable of logging individual signals in the coverage area and reporting only changes in signal presence to the host computer. This capability greatly reduces the overhead time required by the host computer; since it eliminates the need to sort data from each receiver SWEEP and determine which signals are new and which are repeats. In SWEEP mode, the receiver is capable of locking out portions of the RF spectrum, allowing previously identified portions of the spectrum to be excluded from the coverage area. Non-volatile memory is included in the receiver for storage of up to 100 SWEEP or STEP setups, and 200 lockout bands.

Applications requiring portable surveillance subsystems with high dynamic range and low power are easily built using the WJ-8609A Receiver. The small size and low weight are particularly attractive when configuring manportable systems. This receiver is also well-suited for applications where low EMI/RFI emissions are important.

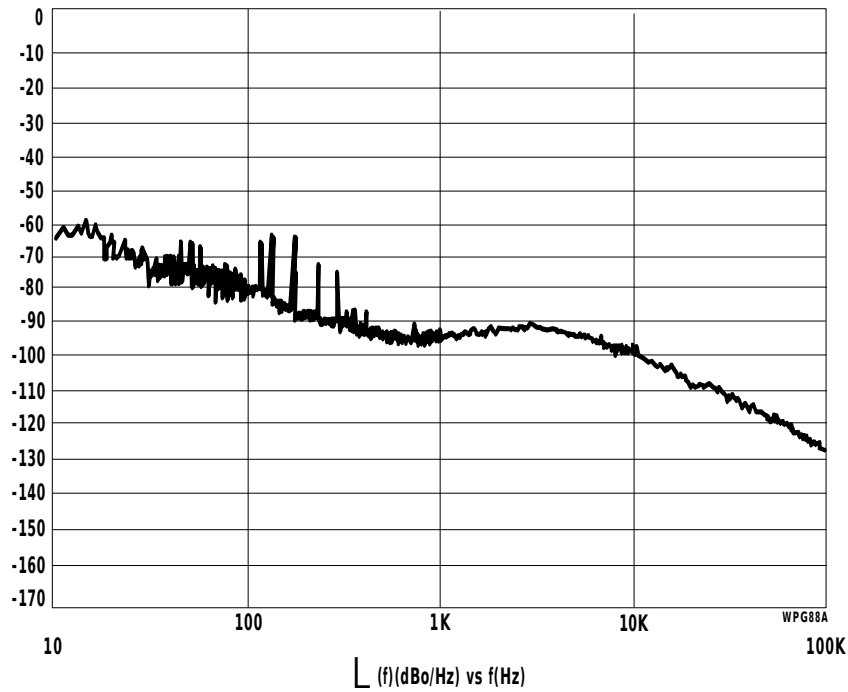
Functional Description

The simplified receiver block diagram in Figure 1 shows the RF input signal passing through a voltage-tuned tracking preselector that rejects out-of-band signals, thus improving the second-order intercept point of the receiver. The bandwidth of the preselector is nominally 10 percent from 20 to 512 MHz. When the FE is used with the unit, signals in the 512 to 2000 MHz range are filtered with suboctave filters and converted to the VHF range in ten bands. After the input signal is filtered, it passes through an RF amplifier and low-pass filter before entering the first mixer where it is mixed with the first LO and upconverted to 691 MHz.

The first LO tunes from 694 to 1204 MHz in 2-MHz steps. The upconverted IF signal at 691 MHz is amplified and filtered before it enters the second mixer, where it is mixed with the second LO that tunes from 620 to 622 MHz in 100-Hz steps. The output from the second mixer is centered at 70 MHz and is filtered, and amplified, before entering the switchable IF bandwidth filters. A sample of the prefiltered signal is provided for the wideband IF output.

Up to five IF bandwidths can be installed in the WJ-8609A Receiver. An additional feature of the receiver permits the IF filters to be bypassed on command, allowing the bandwidth to be determined totally by the tracking preselector, first IF filter and the final IF roofing filter. With a simple control command, the tracking preselector can also be bypassed. This feature is particularly desirable when relatively wide bandwidths are required at a low-tuned frequency.

After the signal is filtered in the selected IF filter, it passes through several stages of IF amplification and gain control. A sample of the bandlimited IF signal is provided at -30 dBm. AM detection is provided with a synchronous-type detector that provides greater than 35-dB linear dynamic range. The wideband FM detector is a delay-line-type demodulator. Medium band FM detection utilizes a quadrature-type demodulator. LOG Video Output of 50 dB is provided by the LOG detection circuit.



Data Type
 Sphi(f)

Start Freq. (Hz)
 100

Stop Freq. (Hz)
 100.E + 3

Value of Definite Integral
 -42.3dB; 7.67E-3 Rad;
 440.E-Degr.

Integrated Noise WJ-8609A Tuned to 500.55 MHz at SM Out 70 MHz
 [hp] 3048A Carrier: 70.E +6 Hz

Receiver LED Indicators

LED Code	Action Indicated
RUN	active microprocessor
COR	presence of a signal over COR threshold
ERR	functional error
CFG	operating in the configuration mode (non-operational mode for downloading IF bandwidth & options configurations into memory)
POWER	DC power present

IF Bandwidths

Bandwidth Sets	Bandwidths (MHz)
BWS 1	2, 5, 10, 20, 40
BWS 2	1, 2, 5, 10, 20
BWS 3	0.5, 1, 2, 5, 10
BWS 4	0.5, 2, 5, 10, 20
BWS 5	0.5, 2, 10, 20, 40

Connectors (Inputs/Outputs)

I/O	Function	Type
Input	Antenna HPIL DC Power External Reference	SMA Multipin Multipin SMB
Output	HPIL Selected AM/FM Video FM Monitor Headphone Wideband IF Selected 70-MHz IF Switched Audio LOG Video	Multipin SMB SMB 1/8" Miniature Stereo Jack SMB SMB SMB SMB
Other	Serial Control RS-232 Auxiliary Connector	Multipin Multipin COR Spectrum Reversal

IF Shape Factors

Bandwidth (MHz)	Shape Factor 50:3 dB BW	Sensitivity (dBm)* 20 to 512 MHz
0.5	4.5:1	-84
1.0	4.0:1	-81
2.0	2.5:1	-78
5.0	2.0:1	-74
10.0	1.5:1	-71
20.0	1.5:1	-68
40.0	1.5:1 (40:3 dB)	-65

*Sensitivity Conditions: Based on 20 to 512 MHz receiver; add 2 dB for FE option.

AM-An input signal AM modulated 50% by a 1-kHz tone will produce a minimum video output S+N/N ratio of 10 dB.

FM-An input signal FM modulated at a 1-kHz rate with a peak deviation equal to 30% of the selected IFBW will produce a minimum video output S+N/N ratio of 17 dB. (Note: A 400-Hz modulation rate is required for IF bandwidths of 10 kHz or less.)

Specifications

Frequency Range	20 to 512 MHz (2000 MHz with FE)
Tuning Resolution	100 Hz, synthesized
RF Input Impedance	50 ohms, nominal
Preselection	Tracking Preselector, 20 to 512 MHz 10% nominal bandwidth Bypass mode provided Five suboctave filters, 512 to 2000 MHz
Input VSWR	2.5:1 typical, 3:1 maximum
Noise Figure	15 dB maximum, 20 to 512 MHz (Preselector on) 17 dB maximum, 512 to 2000 MHz 11 dB typical, 20 to 512 MHz tracking preselector bypass mode
Intermodulation:	50 ohms, nominal
2nd-Order Intercept Point	+45 dBm, 20 to 512 MHz with tracking Preselector +35 dBm, 500 to 2000 MHz
3rd-Order Intercept Point	+2 dBm, 20 to 512 MHz with tracking Preselector -5 dBm, 500 to 2000 MHz
Internal Reference Frequency Accuracy	$\pm 1 \times 10^{-6}$ (0 to 50°C)
External Reference Frequency	10, 5, 1 MHz selectable, 0 dBm nominal input
Image Rejection	80 dB minimum, 20 to 2000 MHz
IF Rejection:	
70-MHz	90 dB
691-MHz	90 dB
FE IF Rejection	80 dB
LO Phase Noise at 20-kHz Offset	-95 dBc/Hz, 20 to 2000 MHz
Integrated Phase Jitter	2° RMS, maximum (Integrated from 100 Hz to 20 MHz offset)
Tuning Speed	12 msec, maximum to within 10 kHz (after receipt of last data byte)
Wideband IF Output	Nominal 20 dB above RF input, 70-MHz center frequen- cy
Gain Control Modes	Manual & automatic, 80-dB range minimum
Internally Generated Spurious	>-100 equivalent input (20 to 512 MHz)
LO Level at RF Input	-90 dBm, maximum
Demodulation Modes	AM, FM & Log Video
Switched Video Output	0.5 V peak-to-peak into 50 ohms (30% deviation in FM or 50% AM modulation)
Video Response	Dc to 1/2 the IF bandwidth

Log Video Output	0 to 0.5 V into 50-ohm load for 50-dB dynamic range (from noise floor)
Switched Audio Output	400 mV RMS into 600 ohms
Headphone Audio Output	5 mW, minimum into 32 ohms
FM Monitor Output	0.5 V peak-to-peak with 30% FM deviation; DC coupled; 100-kHz maximum bandwidth; 10-k ohm load
AM/FM Audio Response	100 Hz to 15 kHz
COR/Spuelch	Adjustable threshold to 45 dB above noise floor for IF bandwidth selected
IF Bandwidths	5 (See Table 2)
Selected IF Output	Centered at 70 MHz, -30 dBm nominal output level at sensitivity level
IF Shape Factor	See IF Shape Factors
Temperature Range	
Operating	0 to 50°C
Non-Operating	-20 to +80°C
Power Requirements	12 Vdc (+10 to 16 Vdc)
Power Consumption	17 W, nominal (20 to 512 MHz); add 4 W for FE

Environmental Specifications

Temperature	
Operating Temperature Range	-25 to +55°C
Full Specification Compliance	+20 to +30°C
Non-operating	-40 to +70°C
Shock	Meets the environmental conditions of MIL-E-5400T, paragraph 3.2.24.6.1 pertaining to equipment shock
Vibration	Meets the environmental conditions of MIL-STD-810D, method 514.3, section I-3.2.4, category 4-propeller aircraft. Figure 514.3-25(a) defines the power spectral density with $L_i = 0.3 \text{ (g}^2/\text{Hz)}$, & $F_i = 68 \text{ Hz}$.
Humidity	95% relative humidity, non-condensing

Options

Nomenclature	Function	Physical Characteristics
8609A/IFBW IF Bandwidth	<ul style="list-style-type: none"> provides up to 5 IF bandwidths 	<ul style="list-style-type: none"> 2 additional IF bandwidths see Table 1 for available choices
8609A/FE Frequency Extender	<ul style="list-style-type: none"> Extends tuning range from 512 MHz to 2000 MHz by block-converting 10 bauds of RF spectrum above 512 MHz into normal tuning range 	<ul style="list-style-type: none"> bolts onto rear of unit, adding 2.85 in. (7.24 cm) to overall length Includes 2 additional PC assemblies: <ul style="list-style-type: none"> - 5-baud oscillator - RF converter with suboctave preselectors
8609A/MCS-1 Miniceptor Control Software	<ul style="list-style-type: none"> Provides applications software for: <ol style="list-style-type: none"> Receiver control/RF Pan display Mnemonic control Quick, reset/flush receiver operations Missions storage & retrieval Sweep data logging Sweep data analysis 	<ul style="list-style-type: none"> MS-DOS* based application software Requires as a minimum: <ol style="list-style-type: none"> 386/16 MHz PC EGA, VGA, or SVGA monitor COM port Supplied on 5.25-in. & 3.5-in disks with manual

* MS-DOS is a trademark of Microsoft Corporation