Digital HF/VHF/UHF Receiver

WJ-8611

Description

The WJ-8611 is a half-rack, fully synthesized general-purpose HF/VHF/UHF surveillance receiver that covers the 2 to 1000 MHz frequency range with 10-Hz tuning resolution. The unit combines a high quality RF front-end with a digital signal processing (DSP) based IF section to achieve high performance at a low cost.

The WJ-8611 accomplishes functions such as IF filtering, demodulation, fine tuning, Automatic Gain Control (AGC), and Beat Frequency Oscillator (BFO) through DSP techniques. Filters with superior amplitude and group delay characteristics are achieved with digital stability and repeatability, and are not subject to variations with operating temperature. Available detection modes include AM, FM, CW, SSB, and ISB. An operator can select 15 standard IF bandwidths (IFBW) in the 200 Hz to 200 kHz range from the front panel or remotely. An operator can adjust the tunable BFO in 10-Hz steps over the ±8 kHz range during CW reception. Over 90 dB of automatic or manual gain control range is available along with a

Features

- ❑ *Frequency Range: 2 to 1000 MHz in 10-Hz steps*
- ❑ *Compact 5.25-in (13.34 cm) high (3U) half-rack package*
- ❑ *Digital IF section providing 15 IF filters from 200 Hz to 200 kHz with exceptional shape factors*
- ❑ *AM, FM, CW, SSB & ISB detection modes*
- ❑ *Low phase noise & highly linear RF performance*
- ❑ *Built-in tracking preselection*
- ❑ *Large front-panel displays & user-friendly controls*
- ❑ *200-channel memory scan & F1-F2 scanning*
- ❑ *RS-232C & IEEE-488.2 remote control*
- ❑ *Built-in self test*
- ❑ *High MTBF*
- ❑ *Optional blank front-panel*

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selectable Automatic Frequency Control (AFC) function. The squelch threshold is adjustable over a 100-dB range.

In addition to fixed-frequency tuning, the WJ-8611 provides fast, flexible scanning. Scan modes include 200-memory-channel scan with channel lockout and dwell capabilities, and F1-F2 (search) scan with band lockout capabilities. In addition, an operator can recall the 200 memory channels individually for fixed-frequency use. An operator can also use all scan and memory functions from the front panel and over the remote control bus of the receiver.

The WJ-8611 front panel uses large, bright, LED displays and individual function keys to achieve user-friendly operation in a half-rack size. The two display sections give an immediate indication of receiver status. Separate function and numeric keys provide straight-forward control of basic receiver functions. In addition, cumbersome multiple-key operations are minimized. Front panel displays include a direct readout of signal strength and a bar graph indication of center tuning. Front panel controls include a lockable, weighted tuning knob; a headphone output; a headphone volume control; and an ac power on/off switch. A blank front-panel version of the unit is also available.

The WJ-8611 is packaged in a standard 5.25-inch (13.34 cm) high half-rack enclosure with an overall depth of 18 inches (45.72) excluding connectors and knobs, and width of 8.25 inches (20.96 cm). Panel ears, slide attachment holes, and special hardware allow rack mounting in a side-by-side configuration. The overall unit weight is less than 15 pounds (6.8 kg). AC power consumption is less than 50 watts using an internal switching supply that operates from 90 to 264 Vac at 48 to 440 Hz.

Control

The WJ-8611 Receiver is controlled via either an asynchronous serial or IEEE-488 interface. The receiver supports one of the following interface standards, which are changeable by setting an internal DIP switch.

- Single-drop full-duplex RS-232C
- IEEE-488 (GPIB)

The RS-232 interface allows an operator to connect a single receiver to a single controlling device with standard baud rates between 1200 and 38.4 K baud. The RS-232 interface also supports the *XON-XOFF*, and *ENQ-ACK/NAK* software interface protocols. The receiver may generate a service request by sending an *ESC* character followed by a status byte. The service request capability may also be disabled.

The IEEE-488 interface supports basic talker and listener capabilities with service request and serial poll. The RS-232 and IEEE-488 interfaces both support high-level ASCII IEEE-488.2 command mnemonics. The receiver implements a *speak when spoken to* protocol. Data is accepted in a format that is forgiving, while responses are always precise.

Functional Description

Figure 1 shows the WJ-8611 main chassis functional block diagram. The receiver circuitry is divided between two major modules. The RF tuner module contains the circuitry required to downconvert the RF signal to the final IF of 250 kHz. The unit routes the final IF signal to the digital control/DSP module where it is converted to digital form, filtered, and demodulated.

Figure 2 is a functional block diagram of the RF sub-system. A rear-panel type-*N* connector couples RF signals from the antenna to the input of the receiver. The RF bandwidth is limited by a two-pole tracking preselector. The filtered RF signal is passed to a low noise RF amplifier that provides excellent receiver sensitivity. After the signal is amplified, it passes through a lowpass filter that provides image rejection for the first mixer. The first local oscillator (LO) tunes from 1370 to 2350 MHz in 2.5-MHz steps and provides conversion of the signal to the first IF, which is centered at 1350 MHz. A low noise amplifier follows the first mixer, providing sufficient gain to overcome the losses of the first mixer and first IF filter. The output of the first IF amplifier passes through the first IF filter, which provides image rejection for the second mixer. The second mixer combines the first IF signal with the second LO, which tunes from 1327.75 to 1330.25 in 1-kHz steps. The second LO is a three-loop design providing fine frequency resolution, as well as low phase noise and fast tuning.

The output of the second mixer is centered at 21.4 MHz. A 10-MHz roofing filter follows the mixer, which provides LO rejection and limits the bandwidth of the signal passed to the second IF amplifier. The output of the second IF amplifier is split before it is routed to the final IF filter. A sample

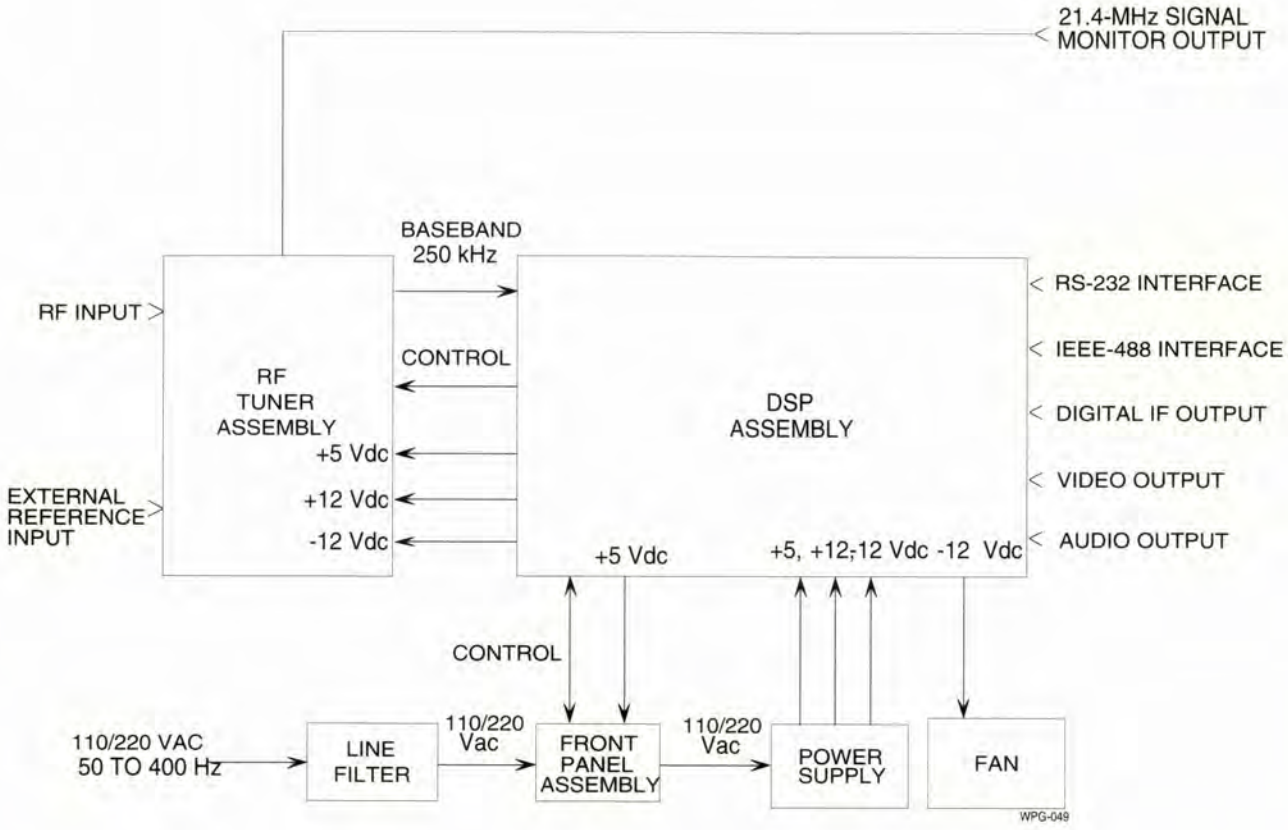

Figure 1. WJ-8611 Functional Block Diagram

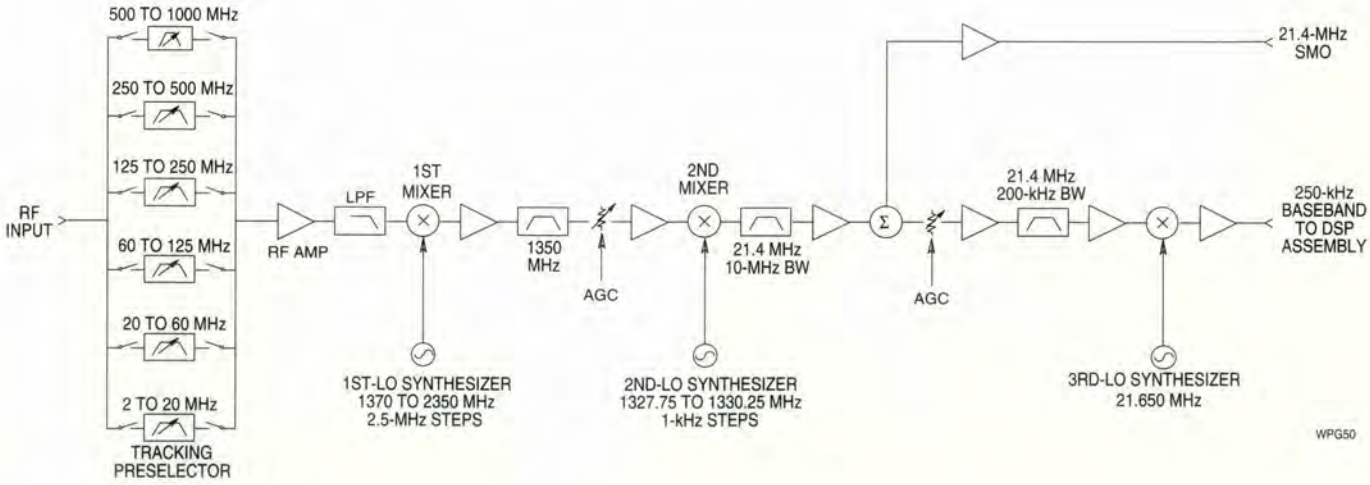

Figure 2. WJ-8611 RF Subsystem Functional Block Diagram

of the 21.4-MHz IF signal is routed to the receiver's rear panel for use with an external signal monitor.

The 21.4-MHz IF signal is routed to a 200-kHz-wide bandpass filter that sets the final analog bandwidth of the receiver. After passing through the filter, the signal is converted to 250 kHz in the third conversion mixer. The third IF is amplified and routed to the analog-to-digital converter.

The analog-to-digital converter digitizes the 250-kHz final IF frequency to 12 bits of resolution at a 1-MHz sample rate. This digitized IF signal is applied to a series of programmable DSP chips that perform the following functions:

- Fine Tuning to 10-Hz Resolution
- IF Filtering
- Gain Control
- Signal Strength and Squelch Functions
- Signal Demodulation and BFO
- Generation of Digital IF Outputs

After digital processing, the filtered and demodulated signal is routed to the analog reconstruction circuitry, which generates the video and audio outputs. A digital I and Q IF output provides digitized IF in a high-speed serial format.

Weights & Dimensions

Height	Width	Depth**	Weight
5.25 in (13.34 cm)	8.25 in (20.96 cm)	18.0 in (13.34 cm)	15 lbs (6.8 kg)

**Excluding control knobs & connectors

Table 1. Sensitivity

Bandwidth (kHz) Modulation	60:6-dB IFBW Shape Factor	Sensivitity (dBm)* 20 to 1000 MHz
0.5 CW	1.5:1 max	-115
1.0 CW	1.5:1 max	-113
5.0 AM	1.5:1 max	-106
10 AM/FM	1.5:1 max	-103
20 AM/FM	1.5:1 max	-100
50 AM/FM	1.5:1 max	-96
100 AM/FM	1.5:1 max	-93
200 AM/FM	1.5:1 max	-90

*Sensitivity Conditions

AM - An input signal AM modulated 50% by a 1-kHz tone produces 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 produces a minimum video output S+N/N ratio of 17 dB. (Note: A 400-Hz modulation rate is required for IFBWs of 10 kHz or less.)

CW - A continuous RF input signal produces a minimum audio output S+N/N ratio of 16 dB.

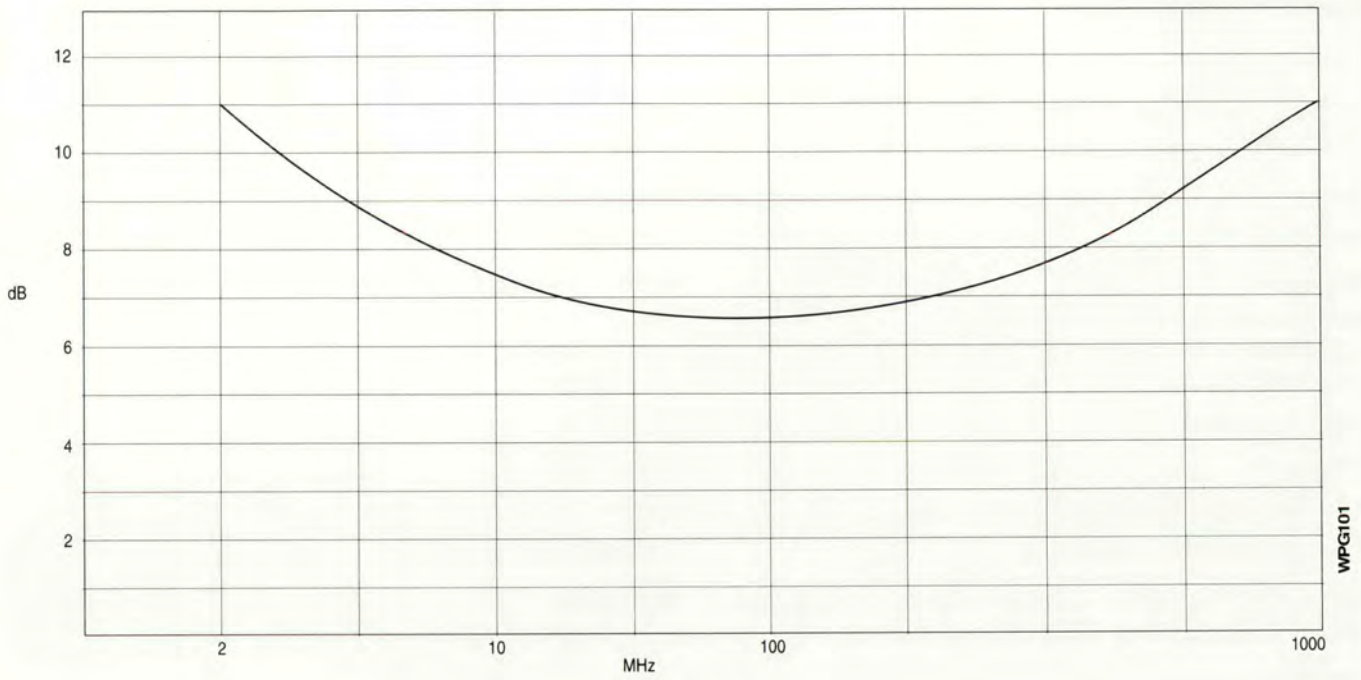

Figure 3. Typical Noise Figure

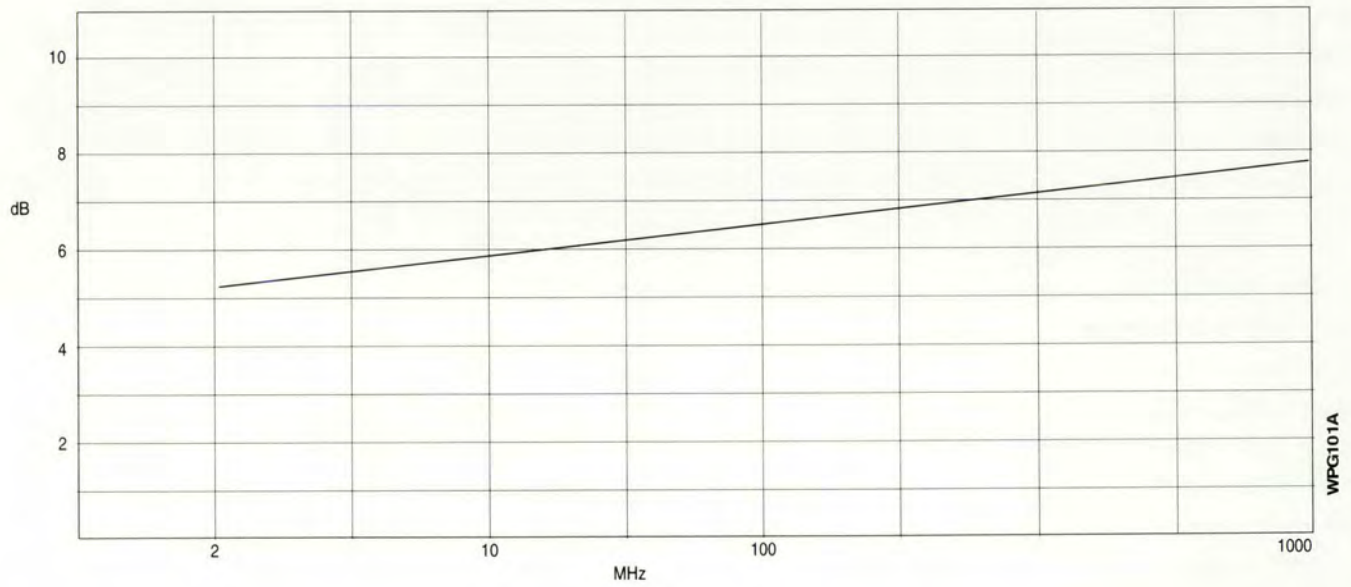

Figure 4. Typical 3rd-order Intercept

Specifications

Frequency Range ..... 2 to 1000 MHz (specs apply 20 to 1000 MHz)

Tuning Resolution ..... 10 Hz

RF Input Impedance ..... 50 ohms, nominal

Input VSWR ..... 2:1, typical; 3:1 max

Noise Figure ..... 12 dB, max

Preselection ..... 20% BW, tracking filter

Intermodulation Performance:
2nd-order Input Intercept Point ..... +40 dBm, typical
3rd-order Input Intercept Point ..... +4 dBm, min

Image Rejection ..... 80 dB, min

IF Rejection ..... 80 dB, min

Maximum Input Signal (without damage) ..... +20 dBm

Internally Generated Spurious ..... <-110 dBm equivalent input

LO Level at RF Input ..... -90 dBm, max

LO Phase Noise ..... <-95 dBc/Hz @ 10-kHz offset

Synthesizer Lock Time ..... 10 msec, max to within 1 kHz

Internal Frequency Accuracy ..... $\pm .5 \times 10^{-6}$ (5 to 40°C)

IFBW (6 dB BW) ..... 200 kHz, 150 kHz, 100 kHz, 60 kHz, 50 kHz, 35 kHz, 20 kHz, 15 kHz, 10 kHz, 6.4 kHz, 5 kHz, 3.2 kHz, 1 kHz, 500 Hz, 200 Hz,

IF Shape Factor ..... <1.5:1, 60 dB/6 dB, typical

Gain Control Modes ..... Manual, AGC

Gain Control Range ..... 90 dB, min

Manual Gain Resolution ..... 1 dB, nominal

COR/Squelch Range ..... Adjustable from -130 to -30 dBm

COR/Squelch Resolution ..... 1 dB, nominal

Detection Modes ..... AM, FM & CW, all BWs
USB & LSB for 3.2 kHz BW
ISB for 6.4 kHz BW

Variable BFO Range ..... ±8 kHz

Variable BFO Resolution ..... 10-Hz steps

Signal Monitor Output ..... Nominally 12 dB above the RF input, 10-MHz BW

Switched Video Output Level ..... 1.0 V peak-to-peak into 50 ohms (30% deviation in FM or 50% AM modulation)

Video Frequency Response ..... dc to 1/2 the IFBW

Line Audio Output Level ..... 0 dBm into 600 ohms, nominal

Control Interface ..... RS-232 & IEEE-488

Power Requirements ..... 90 to 264 Vac, 48 to 440 Hz

Power Consumption ..... 50 W, max

Environmental

Operating Temperature ..... 0° to 50°C
Storage Temperature ..... -40° to 80°C
Full Specification Compliance ..... +5° to 40°C
Humidity ..... 10 to 90%, noncondensing
Altitude ..... 0 to 12,000 feet (3,658 meters) MSL

Table 2. Connectors (Inputs/Outputs)

	I/O	Function	Type
Rear Panel	Input	• Antenna (2 to 1000 MHz range)	N
		• 1, 2, 5 or 10 MHz auto-selectable external reference	BNC
		• AC Power (90 to 264 Vac; 48 to 440 Hz; 50 W, max)	3-pin IEC
	Output	• 21.4-MHz Signal Monitor (10-MHz BW; 12 dB above RF input, nominal)	BNC
		• Selected Video (AM, FM, SSB, 1.0 Vp-p, nominal into 50 ohms)	BNC
		• Line Audio (200 Hz to 16 khz; 0 dBm, nominal into 600 ohms)	6-Pin Terminal Block
		• Digital IF Output	15-Pin D
		• COR (Squelch), TTL Output	BNC
		• RS-232 Remote Control	25-pin D
		• IEEE-488	IEEE-488 standard
Front Panel	Output	• Headphone Audio (Adjustable up to 10 mW, min into 600 ohms; 200 Hz to 16 kHz)	1/4 in (0.64 cm) Stereo phone jack