Technical Data

WATKINS-JOHNSON

February 1997

Digital HF/VHF/UHF Receiver
WJ-8611

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

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 17 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*
- ❑ *European CE Approved for EMC and Low voltage Directives compliance*

HEIGHT 5.25 in (13.34 cm) **WIDTH** 8.25 in (20.96 cm)
DEPTH** 18.0 in (13.34 cm) **WEIGHT** 15 lbs (6.8 kg)
**Excluding control knobs & connectors

WATKINS-JOHNSON COMPANY
700 Quince Orchard Road, Gaithersburg, Maryland 20878-1794
Phone: (800) WJHELPS or +(301) 948-7550
FAX: +(301) 921-9479 Email: wj.helps@wj.com Website: www.wj.com

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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.

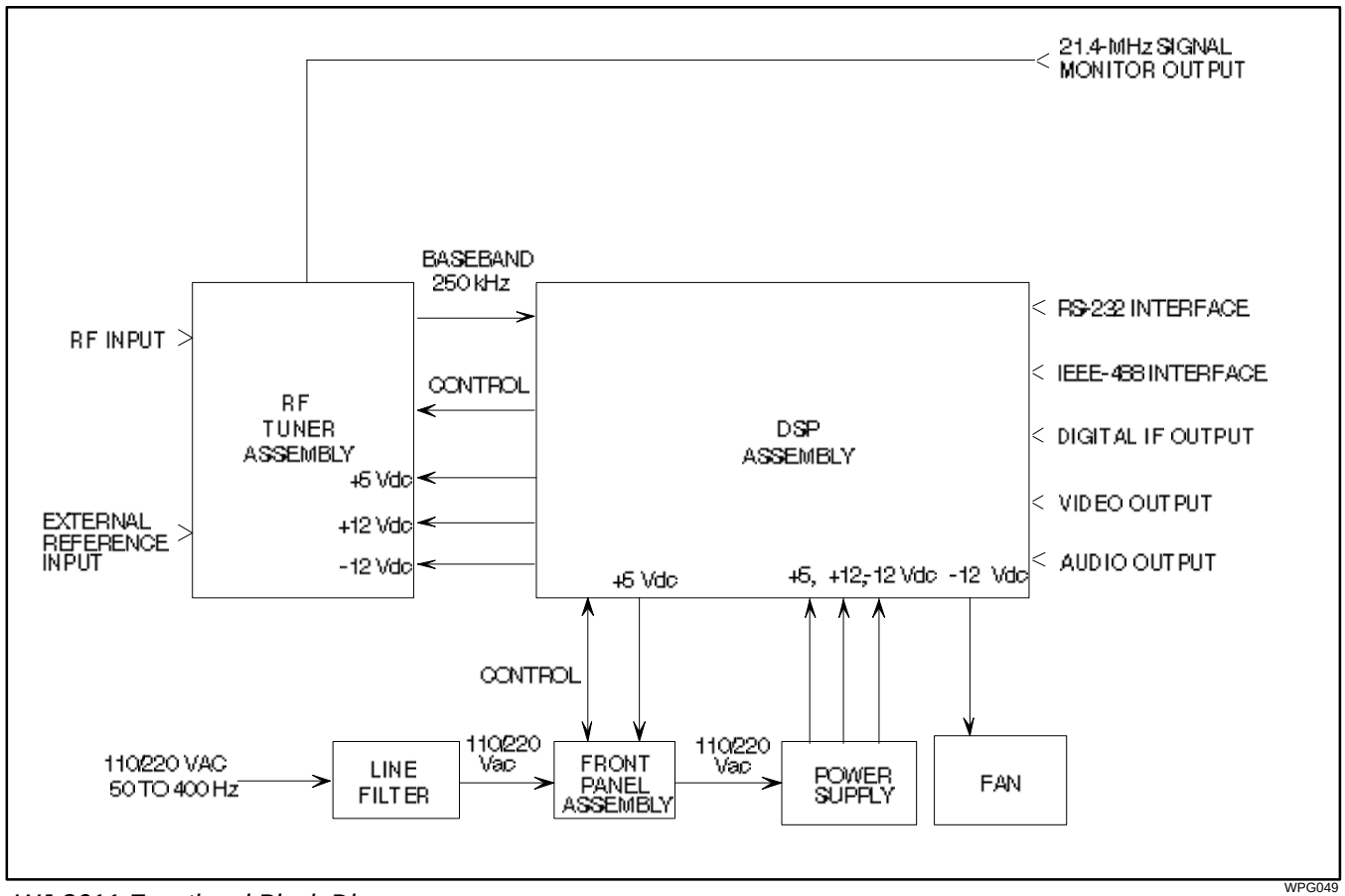
Functional Description

The WJ-8611 main chassis functional block diagram shows 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.

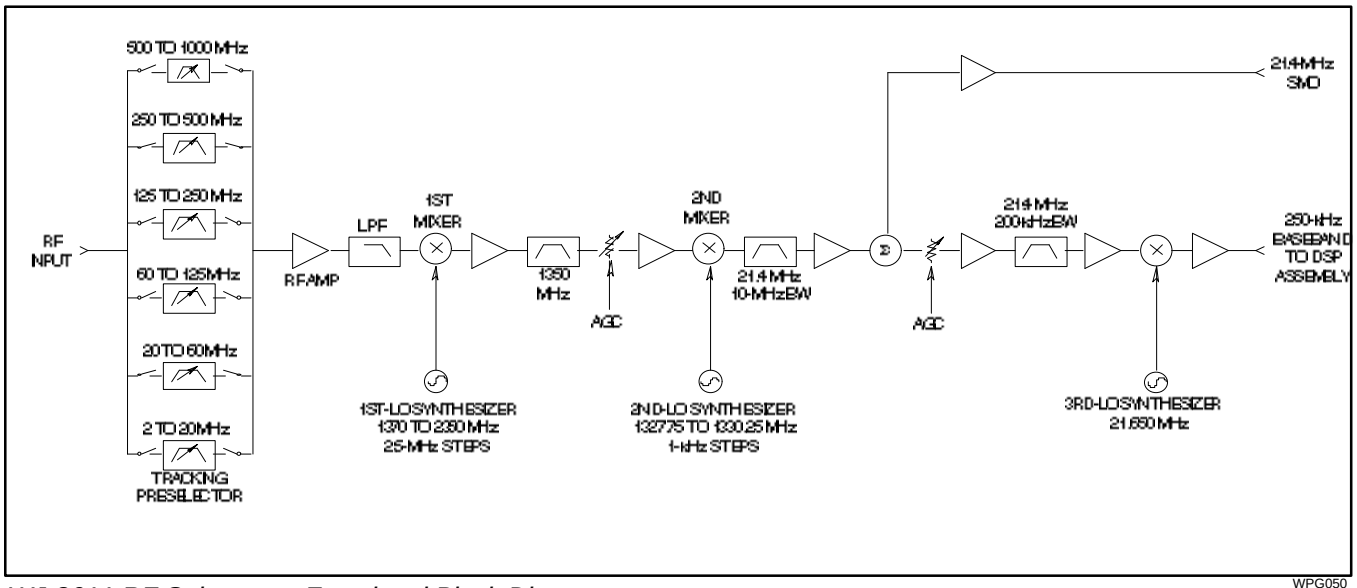
The functional block diagram of the WJ-8611 RF sub-system is provided. A rear-panel type-*N* connector couples RF signals from the antenna to the input of the receiver. The RF bandwidth is limited by a two-pole tracking preselector. The filtered RF signal is passed to a low noise RF amplifier that provides 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 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



WJ-8611 Functional Block Diagram



WJ-8611 RF Subsystem Functional Block Diagram

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.

Sensitivity

Bandwidth (kHz) Modulation	60:6-dB IFBW Shape Factor	Sensitivity (dBm)* 20 to 1000 MHz
0.5 CW	1.5:1 max	-114
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**

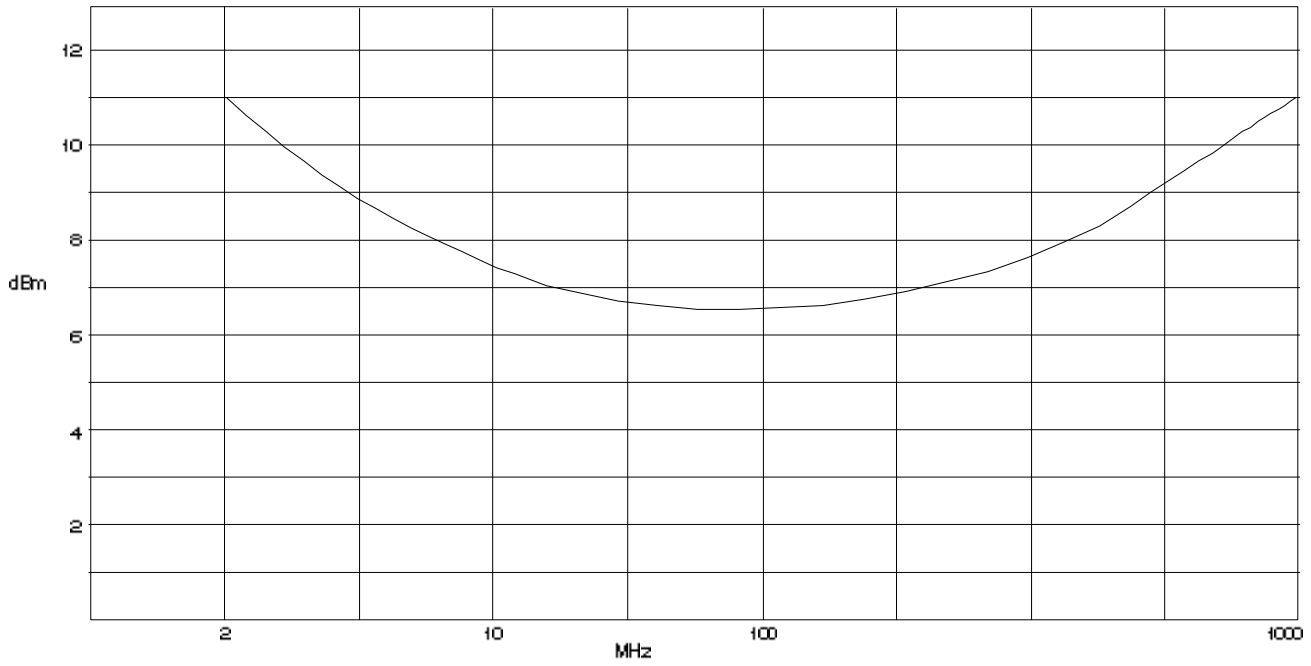
AM - An input signal AM modulated 50% by a 1-kHz tone produces a minimum video output S+N/N ratio of 10 dB.

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.)

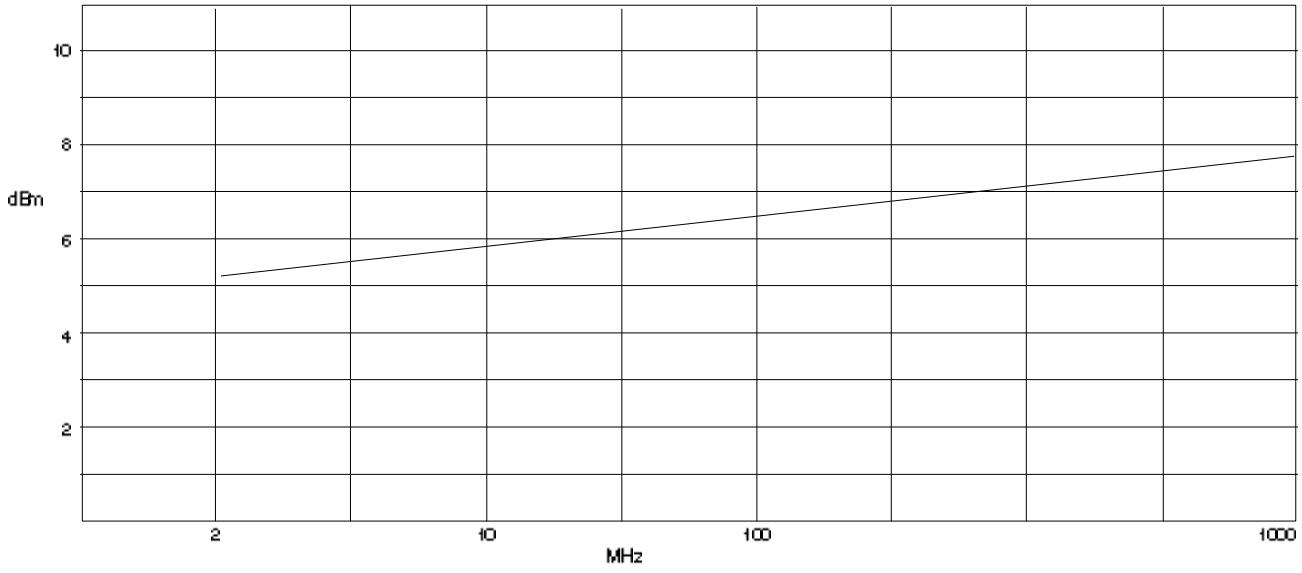
CW - A continuous RF input signal produces a minimum audio output S+N/N ratio of 16 dB.

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



Typical Noise Figure



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	**Tracking filter, bandwidth typically 20% of the tuned frequency**
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**
Receiver Tuning	**20 msec, max to within 1 kHz - measures from the last byte of a tuning command, to the FM video output**
Internal Frequency Accuracy	**$\pm$.5 x 10^{-6} (5 to 40°C)**
IFBW (6 dB BW)	**200 kHz, 150 kHz, 100 kHz, 60 kHz, 50 kHz, 35 kHz, 30 kHz, 20 kHz, 15 kHz, 10 kHz, 8 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	**$\pm$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 (90 VA max)**
Blocking	**Attenuation of a desired -90dBm RF signal by a -5 dBm interfering signal offset by 20 MHz is<3 dB.**
Reciprocal Mixing	**With an input signal at rated sensitivity level in the 50-kHz bandwidth, an out-of-band signal removed by 350 kHz, and 70-dB higher in level will not degrade the S-N/N ratio of the desired signal by more than 3 dB.**

Environmental Specifications

Operating Temperature	**0° to 50°C**
Storage Temperature	**-40° to 80°C**
Full Specification Compliance	**+5° to 40°C**
Vibration	**MIL-STD-810E method 514.4 categories 1, 8, & 9 (Basic Trasportation, Ground Mobile and Shipboard)**
Shock	**MIL-STD-810E method 516.4, procedure VI, Bench Handling**
High & Low Operating Temperature	**MIL-STD-810E methods 501.3 & 502.3**
Humidity	**MIL-STD-810E method 507.3, procedure III**
Altitude	**MIL-STD-810E method 500.3**
MTBF	**In excess of 10,000 hrs per MIL-HDBK-217E, Ground-fixed environment**
MTTR	**<30 minutes**
CE Approvals	**Low voltage DIrective 72/23/EEC EMC Directive 89/336/EEC**

Technical Data

WATKINS-JOHNSON

MAY 1997

Digital VHF/UHF Receiver
WJ-8611

Model #	Function	Physical Characteristics
8611/SM Signal Monitor	• Provides IF-Pan data to an external computer	• WJ-9168 Signal Monitor Module resides inside WJ-8611

The 8611/SM option provides digitized IF-Pan data from up to two 21-4 MHz signal monitor input sources. One of the sources is a WJ-8611 Receiver with the 8611/SM option installed. The second source can be any receiver with a 21.4-MHz signal-monitor IF output, such as a second WJ-8611 without the 8611/SM option. An operator can use the data from the 8611/SM option to create a near real-time IF-Pan display on a PC. The standard configuration of the 8611/SM option makes the IF-pan data available on the IEEE-488 interface of the receiver, or an operator can configure it to provide the IF-Pan data on the 8611/SM RS-232 port that comes with the option.

The 8611/SM adds the WJ-9168 Signal Monitor Module, internal mounting hardware, and internal interconnect cables to the WJ-8611. The WJ-8611 supplies power to the WJ-9168. One IF input for the WJ-9168 comes from the WJ-8611 signal monitor output. An additional WJ-9168 IF input is available on the rear panel of the WJ-8611 to connect to another receiver. The RS-232 pass through and control ports of the WJ-9168 are also available on the rear panel of the WJ-8611 with the 8611/SM option. These ports are only available when the WJ-8611 is configured for serial operation.

WJ-RCS™ software controls the receiver and displays the IF-Pan data from the receiver on a PC running MS Windows. See the WJ-RCS data sheet for details.

WATKINS-JOHNSON COMPANY
700 Quince Orchard Road, Gaithersburg, Maryland 20878-1794
Phone: (800) WJHELPS or +(301) 948-7550
FAX: +(301) 921-9479 Email: wj.helps@wj.com Website: www.wj.com

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