

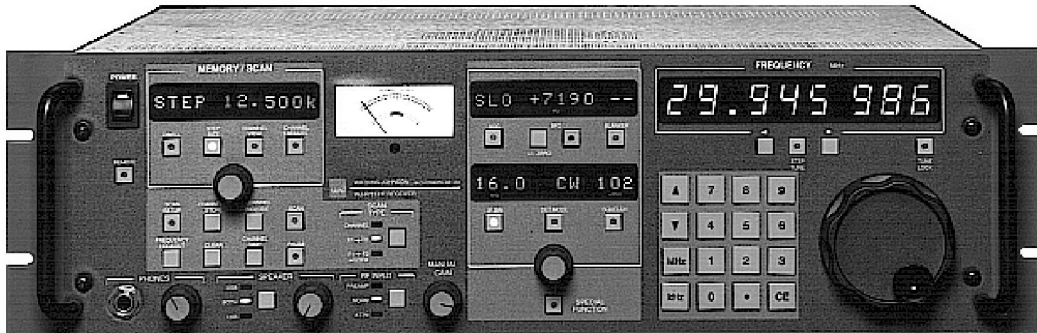
# Technical Data



WATKINS-JOHNSON

May 1996

## Digital HF Receiver WJ-8711A



The WJ-8711A is a fully synthesized, general-purpose HF receiver for surveillance and monitoring of RF communications from 5 kHz to 30 MHz with 1-Hz tuning resolution. By combining analog and digital signal processing (DSP), the WJ-8711A achieves high performance at low cost.

Functions such as noise blanking, IF filtering, AGC, demodulation, Beat Frequency Oscillator (BFO) and passband tuning are accomplished through the use of DSP techniques. Filters with superior amplitude and group delay characteristics are achieved with digital stability and repeatability. Standard selectable IF bandwidths (66 in all) are shown in Table 1. Available detection modes are AM, SAM, FM, CW, USB, LSB and ISB. A tunable BFO is adjustable in 10-Hz steps over a  $\pm 8000$  Hz range, and passband tuning is available to further enhance the reception of CW signals. Gain control is accomplished manually or automatically, with fast, medium, and slow AGC modes available. The squelch threshold is adjustable from 0 to -135 dBm, or it can be disabled. Enabling the noise blanking feature effectively eliminates the adverse effects of impulsive noise.

In addition to fixed-frequency tuning, the WJ-8711A provides fast, flexible scanning. Three scan modes are available: channel scan, F1-F2 scan and F1-F2 scan with lockouts. For all scan modes, the dwell time can be set from 0.5 to 20 seconds or infinite. In channel scan mode, 100 programmable memory channels are available. Sectors of memory can be specified for individual channel scans,

### Features

- Frequency coverage from 5 kHz to 30 MHz in 1-Hz steps
- High dynamic range: +30 dBm 3rd-order intercept typical
- Digital filtering provides 66 IF bandwidths up to 16 kHz with exceptional shape factors
- AM, SAM, FM, CW, USB, LSB & ISB Detection Modes Standard
- Fast, flexible scanning with 100 memory channels
- Large readable LED displays & user-friendly controls
- 3 variable AGC decay settings
- Noise blanking & passband tuning
- Tunable IF Notch Filter
- Internal switchable preamplifier & attenuator
- Standard remote interface (optional Multidrop RS-232, RS-485, RS-422, CSMA, or IEEE-488)
- Built-in self test
- Optional Suboctave Preselector
- Optional Digital Data Output

HEIGHT 5.25 in (13.36 cm) DEPTH 20.0 in (50.80 cm)  
WIDTH 19.0 in (48.26 cm) WEIGHT 15 lbs (6.78 kg)

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WJ-8711A

allowing the subdivision of available memory into multiple search scenarios. The operator can specify certain channels to be skipped without having to delete them from memory. Memory channels can also be single-stepped manually. In both F1-F2 scan modes, the step size is user-selectable from 1 Hz to 25 kHz. Up to 100 independent frequency lockouts can be stored.

An operator can control the WJ-8711A locally via the front panel or remotely via the serial interface. Measuring 5.25 x 19 inches, (13.34 x 48.26 cm), the microprocessor-controlled front panel provides a user-friendly operator interface with dedicated, logically arranged controls and large, easy-to-read LED displays. Figure 1 illustrates the organization of the front panel and highlights some of the features available to the local operator.

A majority of the WJ-8711A operator-selectable parameters are controllable and accessible via an RS-232 remote interface. RS-485, RS-422, and IEEE-488 interfaces are optional.

All receiver inputs and outputs are available on the rear panel of the unit with the exception of the front-panel-mounted headphone jack. The antenna and external reference inputs, as well as the signal monitor and predetected IF outputs, are available on BNC connectors. Speaker and dual-balanced line audio outputs are available on a terminal strip along with

dc-coupled audio, RSSI and squelch outputs, and a mute control input. The RS-232 interface is available on a 25-pin D-shell connector.

An operator can use the WJ-8711A as a tabletop receiver or mounted in a standard 19-inch (48.26 cm) equipment rack occupying 5.25 inches (13.34 cm) of vertical rack space. The internal power supply accepts 97 to 253 Vac (47 to 63 Hz) line power and automatically adjusts to the input line voltage. Total power consumption of the unit is less than 35 watts.

A tunable IF notch allows an operator to tune a Digital Notch Filter through the selected IF Bandwidth (IFBW), in order to eliminate undesired signals within the IF Passband. Typical notch 3-dB bandwidth is 10 to 20 percent of the selected IFBW and provides 50-dB of rejection (typical). The notch filter is a nonlinear phase IIR Filter and should not be used when flat group-delay response is required. Not available in CW detection mode.

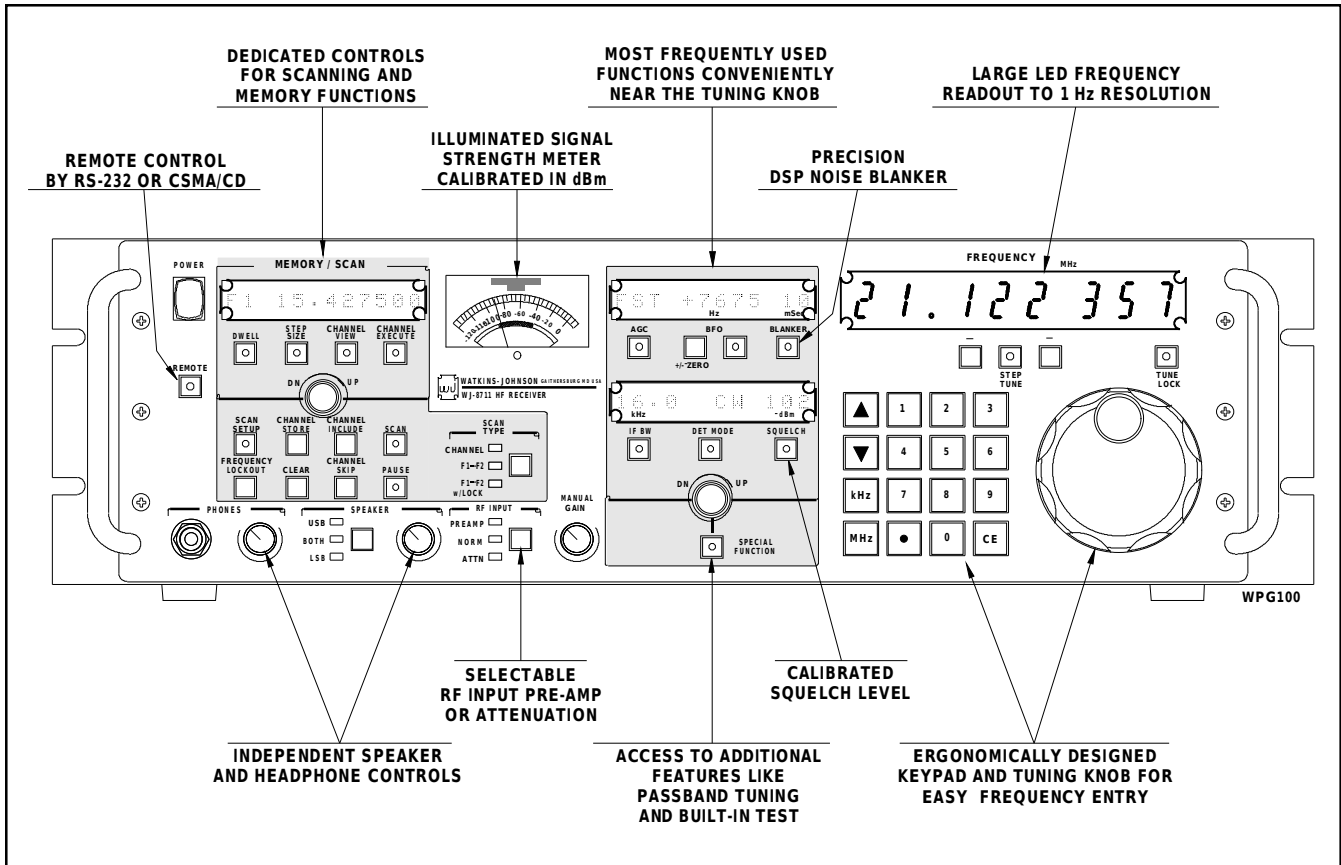
**Options**

The standard Digital HF Receiver is available in a variety of mechanical configurations. Continuous product improvements have also produced significant enhancements and a wide array of options. See separate WJ-871Y Options Matrix data sheet for details.

IF Filters (Nominal 3 dB Bandwidth in Hz)

<b>56</b>	<b>113</b>	<b>225</b>	<b>450</b>	<b>900</b>	<b>1800</b>	<b>3600</b>	<b>7200</b>	<b>14400</b>
<b>63</b>	<b>125</b>	<b>250</b>	<b>500</b>	<b>1000</b>	<b>2000</b>	<b>4000</b>	<b>8000</b>	<b>16000</b>
<b>69</b>	<b>138</b>	<b>275</b>	<b>550</b>	<b>1100</b>	<b>2200</b>	<b>4400</b>	<b>8800</b>	
<b>75</b>	<b>150</b>	<b>300</b>	<b>600</b>	<b>1200</b>	<b>2400</b>	<b>4800</b>	<b>9600</b>	
<b>81</b>	<b>163</b>	<b>325</b>	<b>650</b>	<b>1300</b>	<b>2600</b>	<b>5200</b>	<b>10400</b>	
<b>88</b>	<b>175</b>	<b>350</b>	<b>700</b>	<b>1400</b>	<b>2800</b>	<b>5600</b>	<b>11200</b>	
<b>94</b>	<b>188</b>	<b>375</b>	<b>750</b>	<b>1500</b>	<b>3000</b>	<b>6000</b>	<b>12000</b>	
<b>100</b>	<b>200</b>	<b>400</b>	<b>800</b>	<b>1600</b>	<b>3200</b>	<b>6400</b>	<b>12800</b>	

The 900 through 3200 Hz bandwidths are available in SSB detection mode.

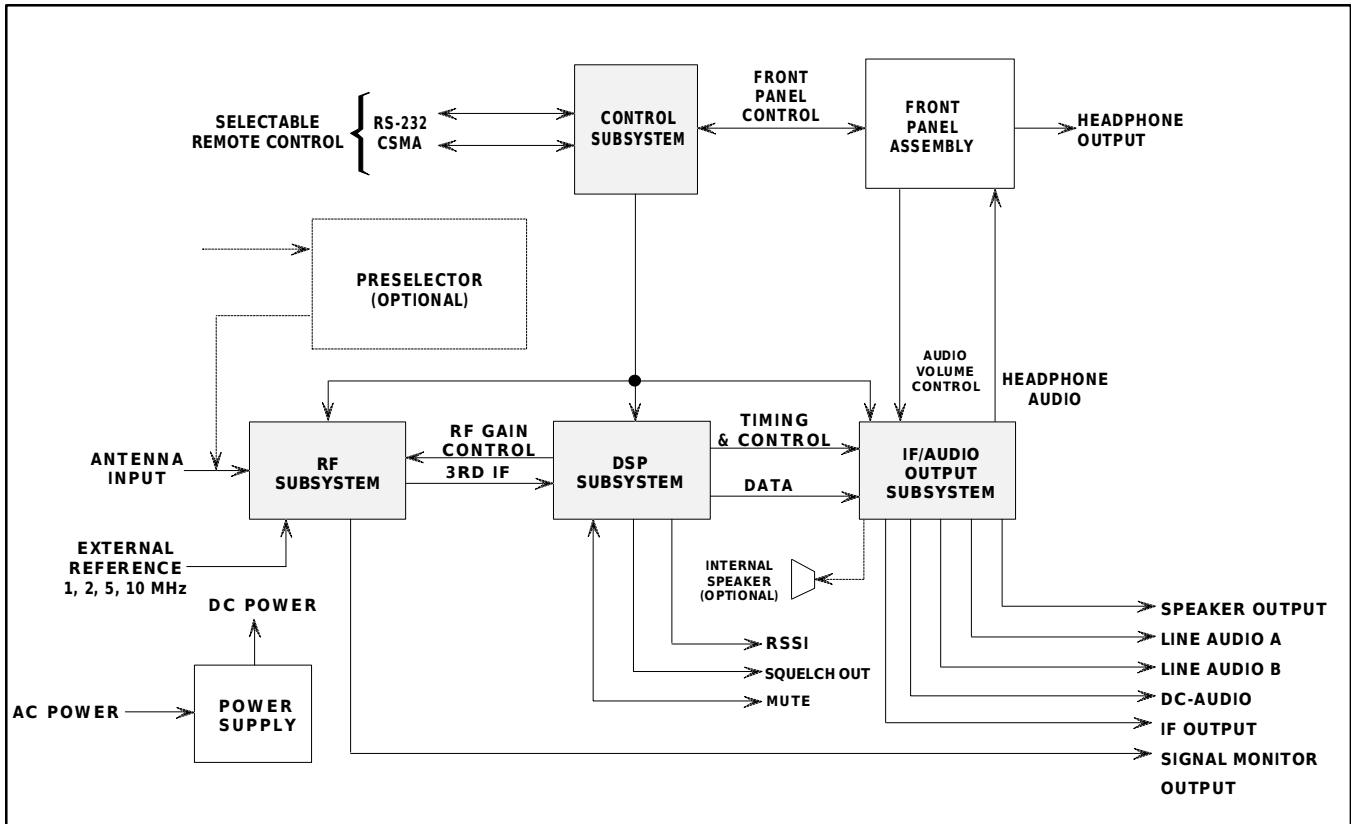


WJ-8711A Front Panel Features

Input/Output Connectors

I/O	Function	Type
<b>Input</b>	Antenna External Reference Power Mute	BNC BNC IEC 3-pin Terminal Block
<b>Output</b>	Signal Monitor IF Line Audio Output A & B Speaker DC-coupled Audio Squelch Headphone Received Signal Strength Indicator	BNC BNC Terminal Blocks Terminal Block Terminal Block Terminal Block Standard 0.25-in (0.63 cm) stereo jack Terminal Block
<b>Bidirectional</b>	CSMA Remote Interface RS-232 Remote Interface	0.12-in (0.30 cm) miniature stereo jack 25-pin female D-shell

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WJ-8711A Functional Block Diagram

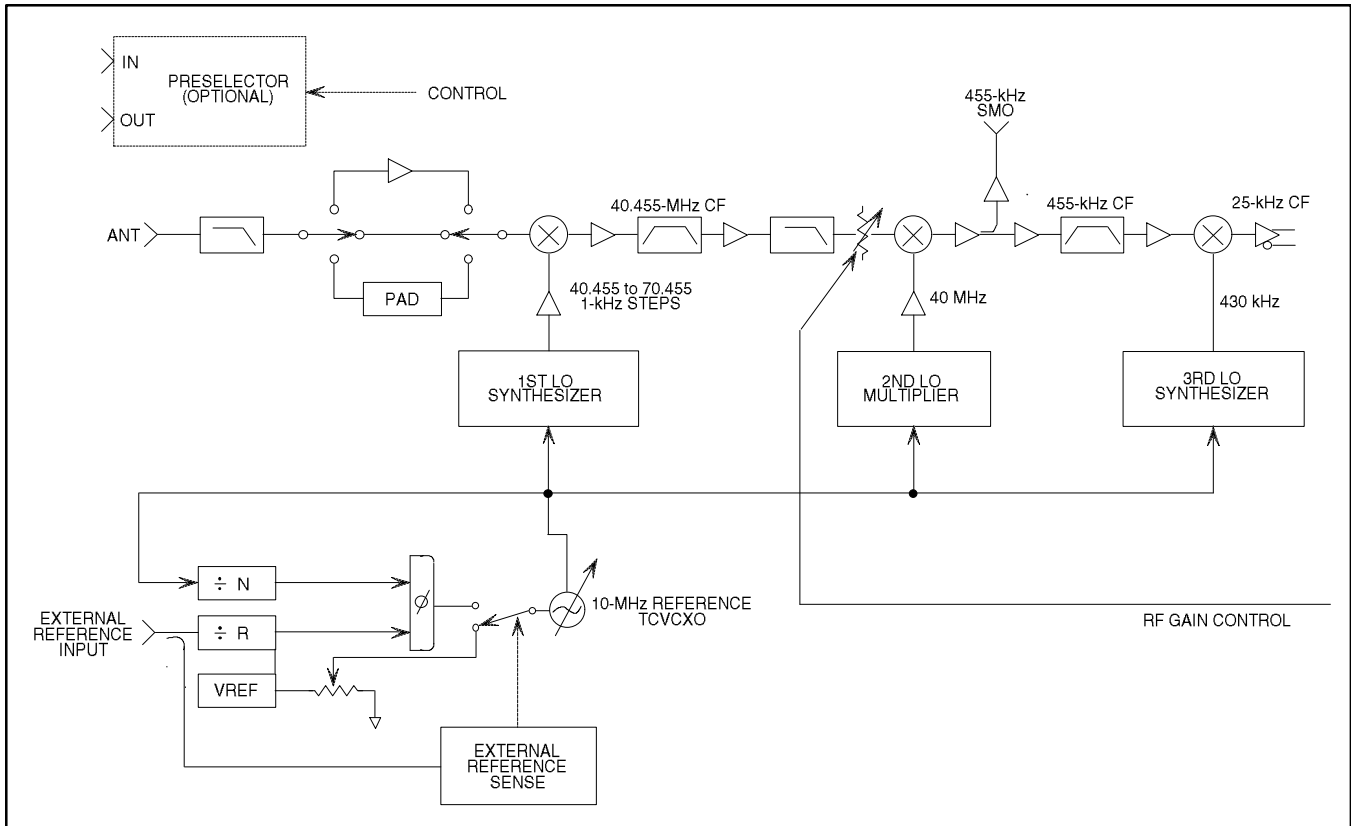
## Functional Description

Figure 2 illustrates how the WJ-8711A is divided into four functional subsystems: RF, DSP, IF/Audio Output and Control. Figure 3 provides a functional block diagram of the RF Subsystem. The 5 kHz to 30 MHz RF signal is applied to the receiver's antenna input, lowpass filtered, and then amplified, attenuated or routed to the normal through-path based on user selection. The signal is then mixed with the first local oscillator (LO), which tunes from 40.455 MHz to 70.455 MHz in 1-kHz steps, to produce a first IF of 40.455 MHz. The first IF filter limits the bandwidths of the signal to approximately 30 kHz before mixing it with the 40-MHz second LO to produce a second IF at 455 kHz. A sample of this second IF is provided on a rear panel for connection to a signal display unit.

After passing through the second IF filter, the signal is mixed with the 430-kHz third LO to produce the third IF centered at 25 kHz.

All LOs are derived from an internal 10-MHz oscillator that can be locked to an external reference input of 1, 2, 5 or 10 MHz. The WJ-8711A automatically senses and switches to the external reference upon application of signal. All critical timing signals used in the DSP and IF/Audio Output Subsystems are also derived from this reference.

The DSP Subsystem performs the majority of the receiver's signal processing functions. The third IF signal from the RF Subsystem is digitized to 16 bits of resolution at a sampling rate of 100 kHz. This digitized IF signal is applied to a programmable DSP chip that performs the following functions



WJ-8711A RF Subsystem Functional

based on operator selection of the receiver's parameters:

- Noise blanking
- Fine tuning to 1-Hz resolution
- IF filtering
- Gain control (AGC Fast, AGC Medium, AGC Slow, or Manual)
- Signal strength and squelch functions
- Signal demodulation and BFO
- Generation of a multiplexed digital data stream containing 1 or 2 demodulated audio channels and a post-filtered IF signal

The IF/audio output subsystem performs the analog reconstruction of the IF and audio signals provided by the DSP subsystem in digital form. The analog audio signals are routed through two distinct signal paths to accommodate ISB detection mode. In all other

detection modes, both paths contain identical audio signals. These two audio paths are processed to provide a 2-channel headphone output, two balanced 600-ohm line audio outputs and an 8-ohm speaker output containing one or both audio channels in ISB mode. After analog reconstruction, the IF signal is upconverted to 455 kHz, passed through a bandpass roofing filter to remove mixer products, buffered and routed to the rear panel IF output connector.

The microprocessor-based control subsystem performs the receiver's internal control, acts as an interface with the front panel, and provides a remote control function through either the RS-232 or the optional RS-485, RS-422, or IEEE-488 interfaces. The control subsystem also monitors hardware status within the receiver and, when commanded, performs a built-in test sequence that isolates circuit faults to the module level.

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Specifications

**Frequency Range** ..... 5 kHz to 30 MHz (tunable to 0 Hz, degraded performance below 500 kHz)

**Tuning Resolution** ..... 1 Hz

**Internal Reference Stability** ..... Better than 0.7 PPM (0 to 50°C)  
Better than 0.2 PPM (0 to 50°C) with REF option

**External Reference Frequency** ..... Accepts 1, 2, 5 or 10 MHz ( $\pm 1$  PPM or better, 200 mV rms into high impedance load); automatically switches to external reference upon application of signal

**Synthesizer Lock Time** ..... <10 msec, typical

**Antenna Input**

**Impedance** ..... 50 ohms, nominal

**VSWR** ..... 2:1, max at receiver's tuned frequency

**Maximum Input Signal** ..... +30 dBm

**Connector** ..... BNC, female

**3rd-Order Intercept Point** ..... +30 dBm, typical  
+ 25 dBm, min (for signals separated by 50 kHz, min)

**2nd-Order Intercept Point** ..... +60 dBm, typical

**Noise Figure** ..... 14 dB, max (11 dB, max with preamplifier engaged)

**Detection Modes** ..... AM, SAM, FM, CW, USB, LSB & ISB (consult factory for additional demodulation modes)

**Sensitivity 500 kHz to 30 MHz**

Modulation	IFBW (kHz)	(Minimum) S+N/N (dB)	Without Preamp Min dBm/(mV)
AM (50% mod. at 400 Hz)	6.0	10	-103/(1.58)
FM (4.8 kHz dev. 400 Hz mod)	16.0	17	-99/(2.50)
USB/LSB/ISB	3.2	10	-112/(0.56)
CW	0.3	16	-116/(0.35)

CW Sensitivity 5 to 500 kHz, without Preamp (0.3 kHz IFBW)

50 to 500 kHz	-113 dBm/0.5 mV typical for 16 dB S+N/N
20 to 50 kHz	-105 dBm/1.27 mV typical for 16 dB S+N/N
5 to 20 kHz	-78 dBm/28 mV typical for 16 dB S+N/N

**IF Output**

**Center Frequency** ..... 455 kHz, nominal (see factory for additional frequencies)  
12.5 kHz w/IFDS option

**Output Level** ..... -20 dBm, nominal

**Output Impedance** ..... 50 ohms, nominal

**Connector Type** ..... BNC, female

**Signal Monitor Output**

**Center Frequency** ..... 455 kHz, nominal; inverted

**Bandwidth** ..... 30 kHz (-6dB), min

**Output Level** ..... 30 dB above RF input, nominal

**Output Impedance** ..... 50 ohms, nominal

**Connector Type** ..... BNC, female

<b>Gain Control Modes</b> .....	Manual, AGC Fast, Medium, Slow
<b>AGC Range</b> .....	100 dB, min
<b>AGC Threshold</b> .....	Approximately -108 dBm (0.9 mV) in 16-kHz BW Approximately -125 dBm (0.12 mV) in 300-Hz BW (Threshold matched with IFBW, typically 10 dB above noise floor)
<b>AGC Attack Time</b> .....	5 msec, typical
<b>AGC Decay Time</b> .....	Fast: 10 to 100 msec, variable Medium: 100 msec to 1 second, variable Slow: 1 to 5 seconds, variable
<b>Selectable Front End Gain/Attenuation</b>	
<b>Preamplifier Gain</b> .....	10 dB (+2 dB)
<b>Attenuation</b> .....	15 dB (+2 dB)
<b>BFO</b>	
<b>Tuning Range</b> .....	±8000 Hz
<b>Tuning Resolution</b> .....	10 Hz
<b>First Image Rejection</b> .....	90 dB, min
<b>IF Rejection</b> .....	85 dB, min (>90 dB, typical)
<b>LO Phase Noise</b> .....	-110 dBc at 1-kHz offset, typical
<b>Reciprocal Mixing</b> .....	With a desired signal of 25 mV in the 3.2-kHz IFBW, the desired signal-to-noise ratio (SNR) is >20 dB, when an undesired signal 70-dB higher in amplitude and 35-kHz removed in frequency is present.
<b>Cross Modulation</b> .....	With a desired signal of 10 mV, an undesired signal 86-dB higher, 30% AM modulated produces <10% cross modulation for frequency separation of >50 kHz in the 1-kHz IFBW.
<b>Internal Spurious</b> .....	<-114 dBm referred to the RF input
<b>Blocking</b> .....	An unwanted signal 1 mV separated 20 kHz from a desired signal of 1 mV will not cause the IF output to fall by more than 3 dB.
<b>Line Audio Outputs</b>	
<b>Number of Outputs</b> .....	2 center-tapped, balanced outputs ISB mode, USB & LSB on separate outputs All other modes, audio signal common to both outputs
<b>Output Level</b> .....	0 dBm, nominal into 600-ohm load
<b>Connector Type</b> .....	Screw terminals
<b>Speaker Output</b>	
<b>Number of Outputs</b> .....	One output. For ISB mode, USB & LSB can be selected individually or combined. (Internal speaker optional).
<b>Bandwidth</b> .....	100 Hz to 13 kHz
<b>Output Level</b> .....	Adjustable up to 1 W into 8-ohm load
<b>Total Harmonic Distortion</b> .....	<3% at 1 W
<b>Connector Type</b> .....	Screw terminals
<b>Headphone Output</b>	
<b>Number of Outputs</b> .....	2, unbalanced ISB mode: 1 output contains USB (left channel), 1 output contains LSB (right channel) All other modes, audio signal common to both outputs
<b>Output Level</b> .....	Adjustable up to 10 mW into 600-ohm load
<b>Connector Type</b> .....	Standard 0.25-in (0.63 cm) stereo jack
<b>Remote Control</b> .....	RS-232 or CSMA; selectable by internal switch or front panel entry
<b>RS-232</b> .....	Full duplex, 3-wire serial interface; rear-panel 25-pin female D-shell connector
<b>Baud Rates (Both Interfaces)</b> .....	75, 150, 300, 600, 1200, 2400, 4800 & 9600; selectable by internal switches or front panel entry

WJ-8711A

Environmental Specifications

<b>MIL-STD-810D Test Method</b>	
A. Low Temperature .....	Test Method 502.2
B. High Temperature .....	Test Method 501.2
C. Humidity .....	Test Method 507.2
D. Altitude .....	Test Method 500.2
E. Vibration .....	Test Method 514.3
F. Shock .....	Test Method 516.3
<b>Operating Temperature</b> .....	0 to +50°C
<b>Storage Temperature</b> .....	-40 to +70°C
<b>Humidity</b> .....	10 cyclic days (240 hours); Procedure III for continuous exposure to 95% RH
<b>Altitude</b> .....	50,000 ft (15,240 meters) non-operating 24,000 ft (7,315 meters) operating
<b>Vibration<sup>(1)</sup></b>	
A. Basic Transportation (secure cargo)	
Category 1 .....	Random vibration 1.04Gs non-operating (2 hours)
B. Ground mobile (wheeled or tracked vehicle) Category 8 .....	Random vibration 6.0Gs operating (15 minutes)
C. Marine (shipboard vessel not specified) Category 9 .....	Random vibration 1.0Gs operating (2 hours)
D. Environmental stress (NAVMAT-P-9492) .....	Random vibration 6.0Gs operating (15 minutes for design qualifications) 3.06Gs nonoperating [10 minutes for production screening (ESS)]
<b>Shock<sup>(1)</sup></b> .....	Bench handling (field service) 8 drops total onto a horizontal hard wooden surface, operating
<b>MTBF</b> .....	In excess of 10,000 hours; estimated in accordance with MIL-HDBK 217E for Ground Fixed; +40°C environment
<b>EMC</b> .....	EN50081-1 (radiated & conducted emissions to EN55022, Class B) EN50082-1 (including IEC 801-2:1984, IEC 801-3:1984 & IEC 801-4:1988) EN55020 (Immunity for Receivers)
<b>Safety</b> .....	IEC 1010-1:1990+A1/EN61010:1993
<b>Power Requirements</b> .....	97 to 253 Vac (47 to 440 Hz)
<b>Power Consumption</b> .....	35 W, typical with options

IF Filter Specifications

3-dB BW (kHz)	(Maximum) Shape Factor (3/60 dB)	(Typical) Group Delay Variation (100% of 3-dB BW)
0.3	1.35:1	50 µS
1.0	1.40:1	30 µS
3.2	1.25:1	30 µS
6.0	1.25:1	40 µS
16.0	1.25:1	60 µS
USB/LSB/ISB (3.2)	1.25:1	30 µS



# Technical Update



WATKINS-JOHNSON

December 1996

## Digital HF Receiver WJ-8711A

### WJ-8711A-3 Configuration Specifications

The WJ-8711A-3 configuration is the same as the standard WJ-8711A with the following exceptions:

- Options ..... REF & PRE standard
- Detection Modes ..... includes FSK
- IF Rejection ..... -90 dBm
- Operating Temperature Range ..... -5 to +50°C

In addition, an operator may use the RS-232 remote interface to output the string message AXXXXXXXX + BXXXXXXXX + CR (where XXXXXXXX is the receiver frequency) upon activation of the A or B front-panel button. These push-button functions become especially useful when the WJ-8711A-3 acts as an RF front end for certain DF applications.

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