

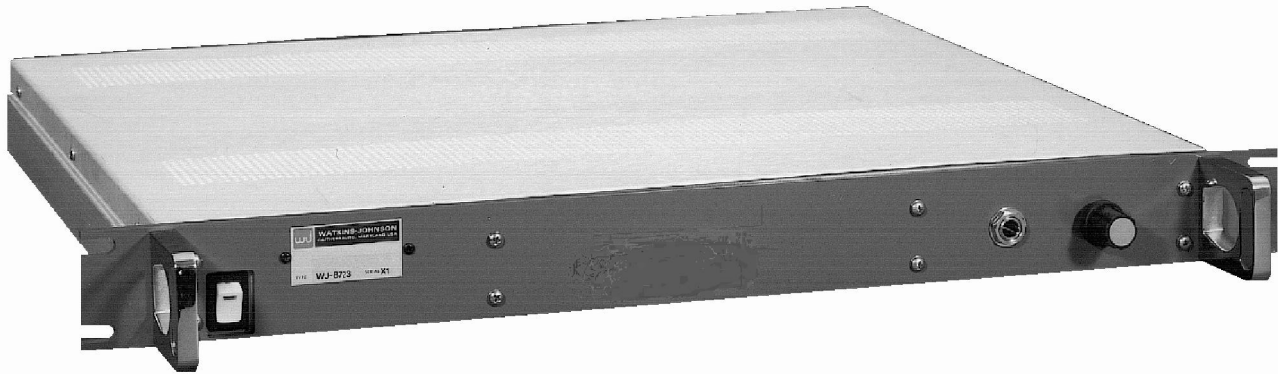
Developmental Specification



WATKINS-JOHNSON

April 1996

Digital HF Receiver WJ-8723



Description

The WJ-8723 is a fully synthesized, general-purpose HF receiver that monitors RF communications from 5 kHz to 30 MHz with 1-Hz tuning resolution. The unit is packaged in a 1.75 x 19.0 x 20.0 inch (4.44 x 48.26 x 50.80 cm) full-rack enclosure with a blank front panel, and utilizes the same RF and Digital printed circuit boards as the WJ-8711A. By combining analog and digital signal processing (DSP), the WJ-8723 achieves high performance at low cost.

The WJ-8723 operates remotely making it ideal for commercial frequency management system applications. Receiver parameters are controllable and accessible via an RS-232 multidrop remote interface.

In addition to fixed-frequency tuning, the WJ-8723 provides a fast, flexible scanning capability. 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.

Functions such as noise blanking, tunable notch filter, IF filtering, Automatic Gain Control (AGC), demodulation,

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 IFBWs up to 16 kHz with exceptional shape factors
- AM, SAM, FM, CW, USB, LSB & ISB detection mode standard
- Fast, flexible scanning with 100 memory channels
- 1.75 in (4.44 cm), full-rack configuration
- Noise blanking & passband tuning
- Tunable IF notch filter
- Internal switchable Preamplifier & Attenuator
- Multidrop RS-232 high-speed remote interface 300 to 19.2 kBaud
- Extensive built-in selftest

HEIGHT 1.75 in, (4.44 cm) *DEPTH 20 in, (50.80 cm)
WIDTH 19 in, (48.26 cm) WEIGHT <12 lbs, (5.5 kg)

*Excluding connectors & cabling

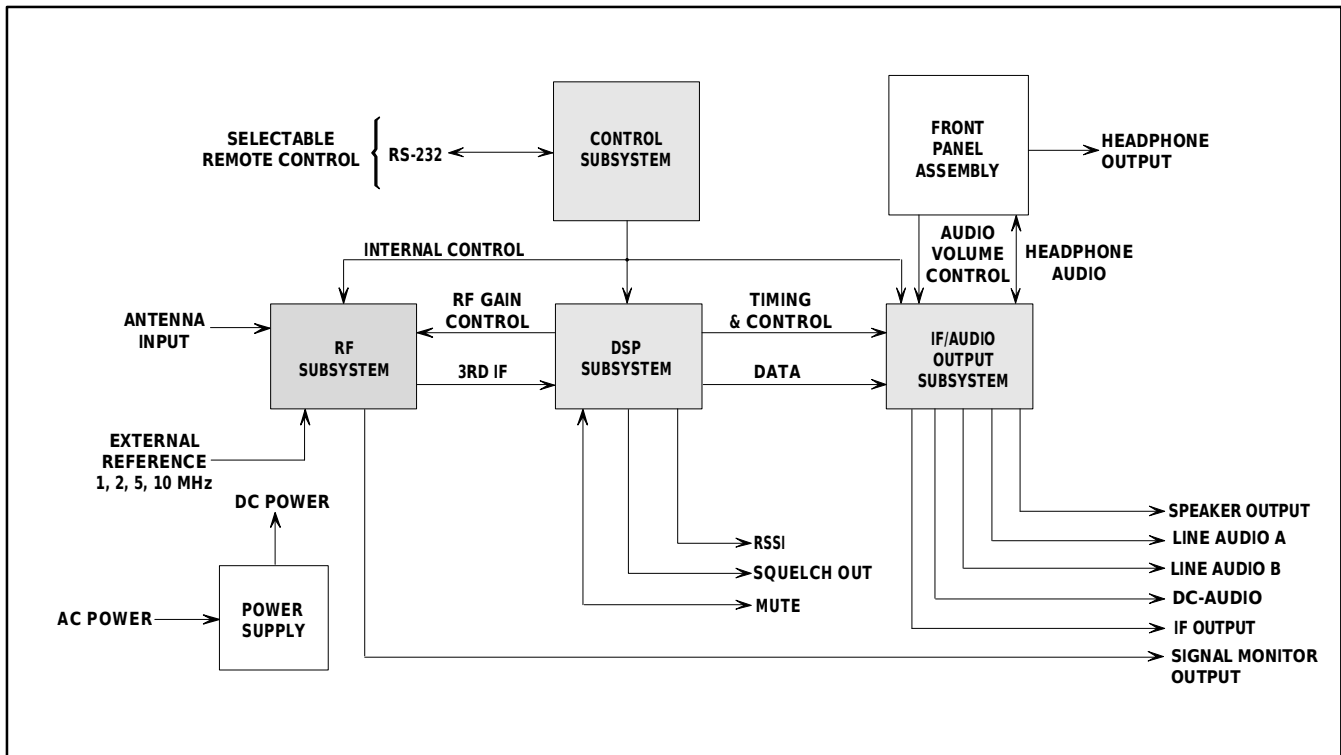
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WJ-8723



Functional Block Diagram

and Beat Frequency Oscillation (BFO) are accomplished through the use of DSP techniques. Filters with superior amplitude and group delay characteristics are achieved with digital stability and repeatability. There are 66 selectable IF bandwidths (IFBW's) ranging from 60 Hz to 16 kHz (Table 2). Available detection modes are AM, synchronous AM (SAM), FM, CW, USB, LSB, and ISB. A tunable BFO can be adjusted in 10-Hz steps over a ± 8000 Hz range. Passband tuning further enhances the reception of CW signals. Gain control can be accomplished manually or automatically, with variable fast, medium, and slow AGC modes. When the signal drops below a user-specified level, a variable AGC threshold forces the receiver into manual gain. The squelch threshold is adjustable from 0 to -135 dBm, or it can be disabled.

A tunable IF notch allows an operator to tune a Digital Notch Filter through the selected 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

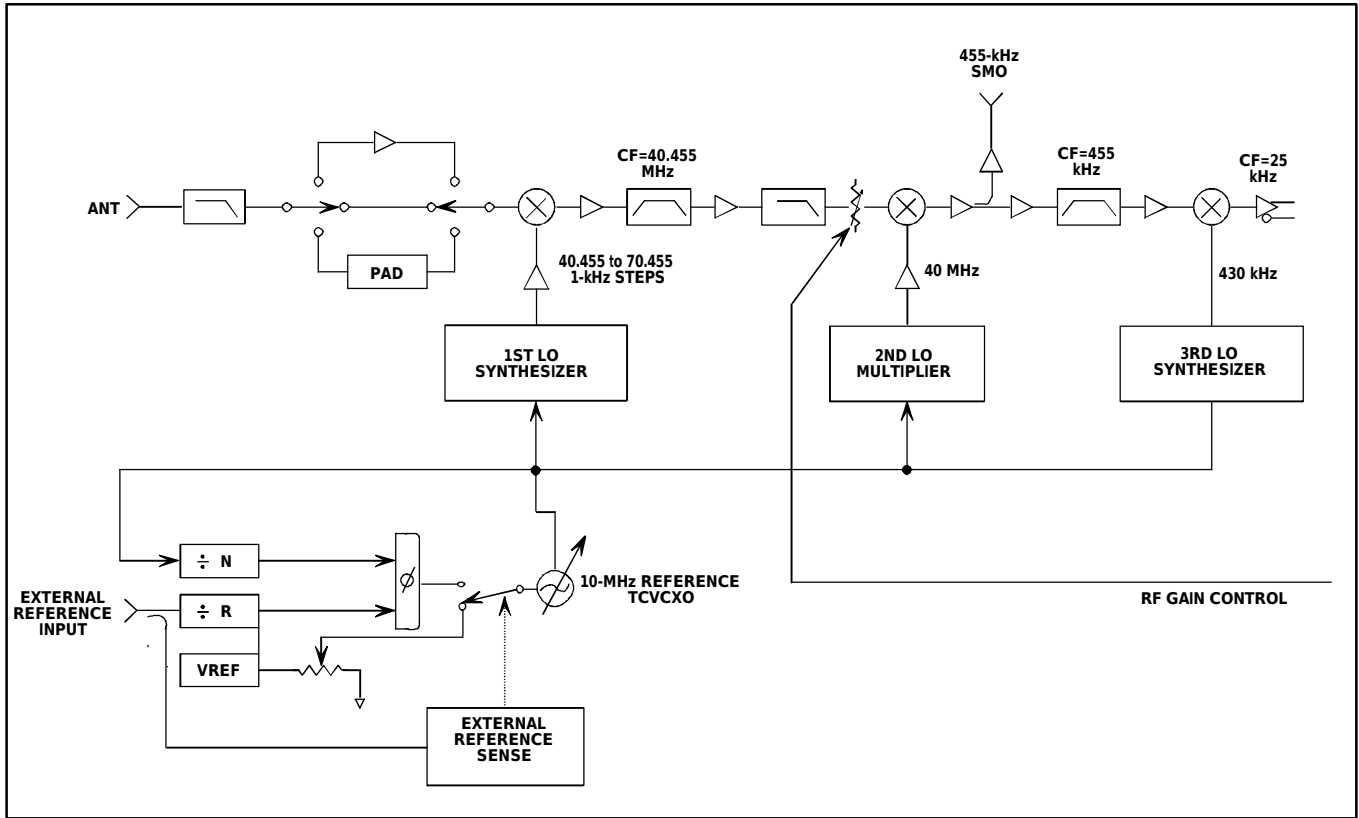
rejection (typical). The notch filter is a nonlinear phase IIR Filter and should not be used when flat group-delay response is required. The notch filter is not available in CW detection mode.

All receiver inputs and outputs are available on the rear panel of the unit, with the exception of the front-panel-mounted headphone jack and associated volume control. The antenna and external reference inputs, are available on BNC connectors.

The WJ-8723 mounts in a standard 19-inch (48.26 cm) equipment rack occupying 1.75 inches (4.44 cm) of vertical rack space. The internal power supply accepts 97 to 253 Vac (47 to 440 Hz line power) and automatically adjusts to the input line voltage. Total power consumption of the unit is less than 20 watts.

Functional Description

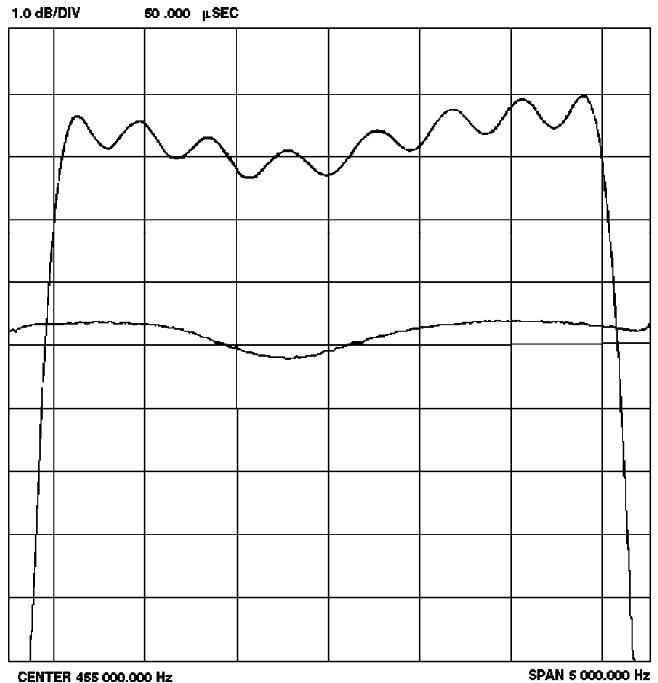
The WJ-8723 is divided into four functional subsystems: RF, DSP, IF/Audio Output and Control. The 5 kHz to 30 MHz RF signal is applied to the



RF Subsystem Functional Block Diagram

receiver's antenna input, lowpass filtered, and then either 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 bandwidth 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 the second IF is provided on the 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 is lockable to an external reference input of 1, 2, 5 or 10 MHz. The WJ-8723 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.



Typical SSB IF Filter Group-delay & Passband Ripple

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The DSP Subsystem performs the majority of the signal processing functions within the receiver. 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, based on operator selection of the receiver's parameters:

- Noise blanking
- Fine tuning to 1-Hz resolution
- Tunable notch filtering
- IF filtering
- Gain control (AGC-fast, -medium, -slow, or manual)
- Signal strength and squelch functions
- Signal demodulation and BFO
- Generation of a multiplexed digital data-stream containing one or two demodulated audio channels and a post-filtered IF signal

The IF/Audio Output Subsystem performs the analog reconstruction of the 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 two-channel headphone output.

The microprocessor-based Control Subsystem performs the receiver's internal control and provides a remote control function through the RS-232 interface. 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.

IF Filter Specifications

3-dB Bandwidth (kHz)	Maximum Shape Factor (3/60 dB)	Typical Group Delay Variation (100% of 3-dB Bandwidth)
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

IF Filter Set (Nominal 3-dB Bandwidth in Hz)

56	113	225	450	900	1800	3600	7200	14400
63	125	250	500	1000	2000	4000	8000	16000
69	138	275	550	1100	2200	4400	8800	
75	150	300	600	1200	2400	4800	9000	
81	163	325	650	1300	2600	5200	10400	
88	175	350	700	1400	2800	5600	11200	
94	188	375	750	1500	3000	6000	12000	
100	200	400	800	1600	3200	6400	12800	

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

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)
External Reference Frequency	Accepts 1, 2, 5 or 10 MHz (± 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 Preamp engaged)
Detection Modes	SAM, AM, FM, CW, USB, LSB & ISB

Sensitivity (500 kHz to 30 MHz)

Modulation	IFBW (kHz)	S+N/N (dB)	Without Preamp Min dBm/(μ V)
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 kHz to 500 kHz, without Preamp (0.3-kHz IF Bandwidth)

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 (consult factory for additional IF center frequencies)
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

Gain Control Modes

AGC Range	Manual, AGC-Fast, -Medium & -Slow
AGC Threshold	100 dB, min
	Variable from -108 dBm (0.9 μ V) in 16-kHz bandwidth
	Variable from -125 dBm (0.12 μ V) in 300-Hz bandwidth
	(Threshold minimum matched with IFBW, typically 10 dB above noise floor)

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Specifications (Continued)

AGC Attack Time	5 msec, typical
AGC Decay Time	Fast: 10 to 100 msec Med: 100 msec to 1 sec Slow: 1 to 5 sec
Selectable Front-End Gain/Attenuation	
Preamplifier Gain	10 dB (± 2 dB)
Attenuation	15 dB (± 2 dB)
BFO	
Tuning Range	± 8000 Hz
Tuning Resolution	10 Hz
1st Image Rejection	90 dB, min
IF Rejection	85 dB, min (>90 dB, typical)
LO Phase Noise	-110 dBc at 1-kHz offset, typical
Reciprocal Mixing	With a desired signal of 25 μ V in the 3.2-kHz IFBW, the desired SNR ratio is >20 dB, when an undesired signal 70-dB higher in amplitude & 35-kHz removed in frequency is present
Cross-Modulation	With a desired signal of 10 μ V, an undesired signal 86-dB higher & 30% AM modulated produces <10% cross-modulation for frequency separation of >50 kHz in the 1-kHz IFBW
Internal Spurious	< -114 dBm referred to the RF input
Blocking	An unwanted signal 1 mV separated 20 kHz from a desired signal of 1 μ V will not cause the IF output to fall by more than 3 dB
Line Audio Outputs	
Number of Outputs	2 center-tapped, balanced ISB mode: USB & LSB on separate All other modes: audio signal common to both outputs
Output Level	0 dBm, nominal into 600-ohm load
Connector Type	Screw terminals
Headphone Output	
Number of Outputs	2, unbalanced ISB mode: 1 output contains USB (left channel), the other contains LSB (right channel) All other modes: audio signal common to both outputs
Output Level	Adjustable up to 10 mW into 600-ohm load
Connector Type	Standard 1/4-in stereo jack
Remote Control	Multidrop RS-232, up to 8 units
RS-232	3-wire serial interface; hardware address & baud select
Baud Rates	300 to 19,200 baud (selectable by internal switches)

Environmental Specifications

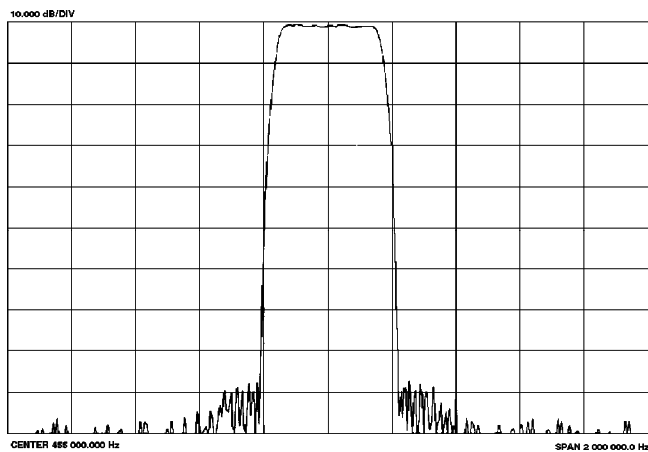
Operating Temperature	0 to +50°C
Storage Temperature	-40 to +70°C
Humidity	10 Cyclic days (240 hours); procedure III for continuous exposure to 95% RH (non-condensing)
Altitude	50,000 ft (15,240 meters) non-operating 24,000 ft (7,315 meters) operating
Shock	Bench handling (field service) 8 drops total onto a horizontal hard wooden surface - operating

Environmental Specifications (Continued)

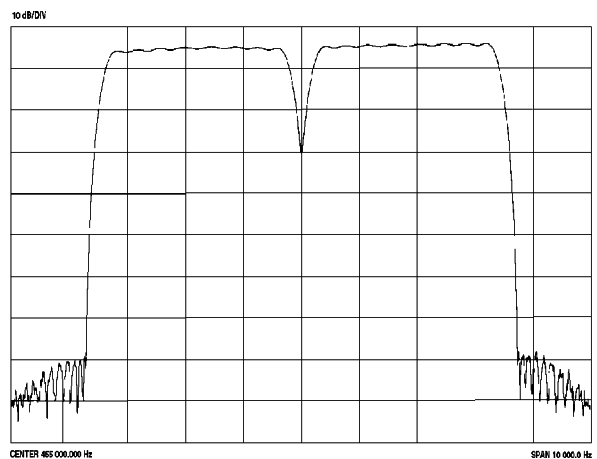
MTBF	In excess of 13,000 hours (Estimated in accordance with MIL-HDBK 217E for ground fixed +40°C environment)
Power Requirements	97 to 253 Vac, 47 to 440 Hz
Power Consumption	<20 W

Receiver Connectors

I/O	Function	Type
Input	Antenna External Reference Power Mute	BNC BNC IEC 3-pin Terminal Block
Output	Signal Monitor IF Line Audio Output A Line Audio Output B Speaker dc-coupled Audio Squelch Headphone Received Signal Strength Indicator	BNC BNC Terminal Block Terminal Block Terminal Block Terminal Block Terminal Block Standard 1/4-in jack Terminal Block
Bidirectional	RS-232 Remote Interface	25-pin female D-shell



Typical 300-Hz IF Filter Amplitude Response



Typical ISB (USB/LSB) IF Filter Amplitude Response