

Compact Digital HF Receiver WJ-8710



Description

The WJ-8710 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. The blank-front-panel unit is packaged in an enclosure that measures approximately 11.5 x 7.5 x 2.5 inches (29.21 x 19.05 x 6.35 cm), and utilizes the same RF and Digital printed circuit boards as the WJ-8711. By combining analog and digital signal processing (DSP), the WJ-8710 achieves high performance at low cost.

The WJ-8710 is operated remotely via one of two selectable serial interfaces. With the exception of audio output level and remote control mode selection, all receiver parameters are controllable and accessible via an RS-232 remote interface. A Carrier Sense Multiple Access with Collision Detection (CSMA) interface with a limited instruction set may be enabled, in lieu of RS-232, allowing the control of WJ-8710 via a command protocol similar to several popular consumer receivers. Selection of the active interface is made via an internal switch setting. The factory should be contacted for a detailed list of remote control commands in order to eliminate any confusion over the extent of the available commands included in each type of interface.

Features

- Frequency coverage from 5 kHz to 30 MHz in 1-Hz steps
- High dynamic range: +30 dBm 3rd-order intercept, typical
- Digital filtering that provides 5 or more IF bandwidths up to 16 kHz with exceptional shape factors
- Standard AM, FM, CW, USB, LSB & ISB detection modes
- Fast, flexible scanning with 100 memory channels
- Compact 11.5 x 7.5 x 2.5 in configuration
- Noise blanking & passband tuning
- Internal switchable Preamplifier & Attenuator
- Internally selectable RS-232 or CSMA remote control
- Extensive built-in self test
- Optional digital data outputs

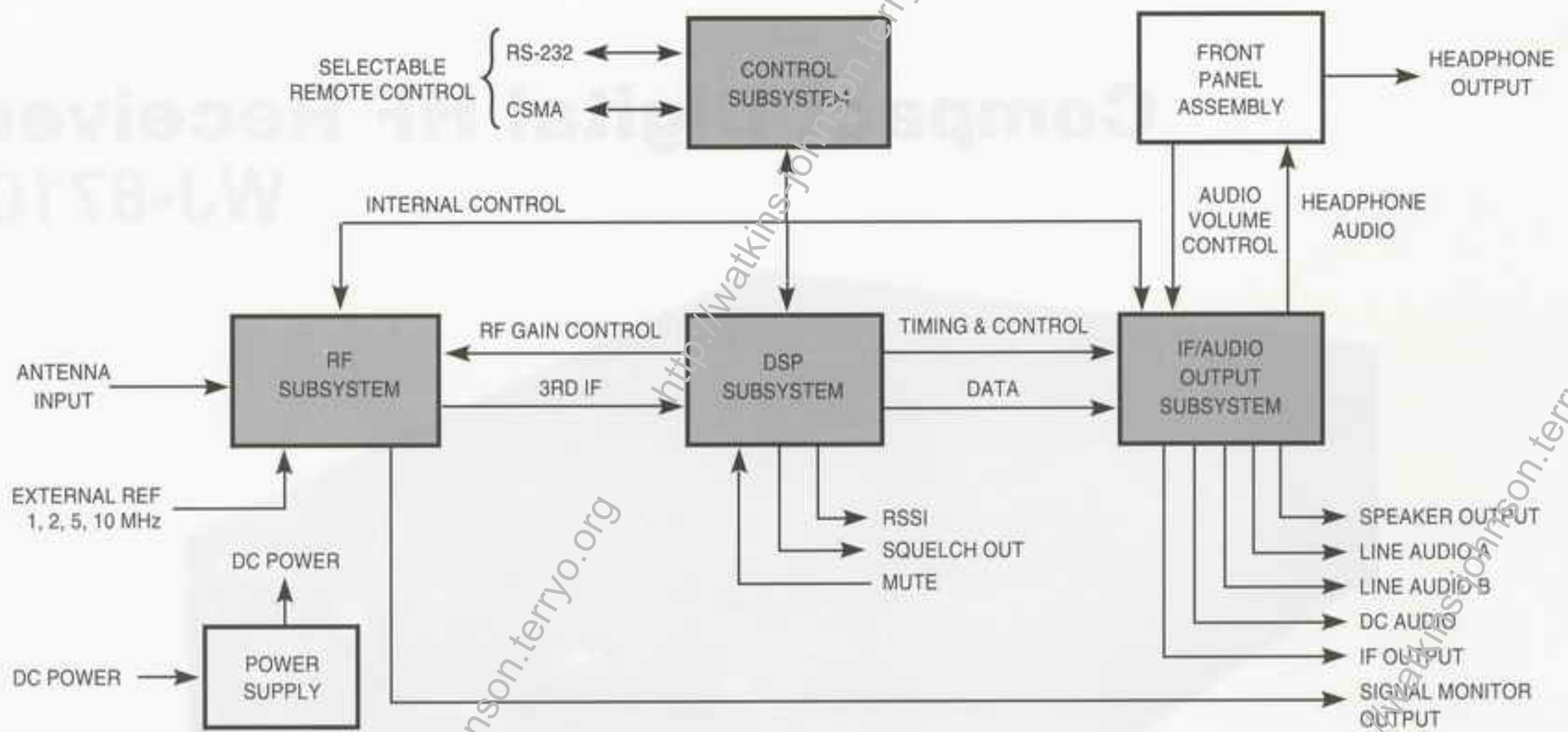


Figure 1. WJ-8710 Functional Block Diagram

In addition to fixed-frequency tuning, the WJ-8710 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, IF filtering, AGC demodulation and Beat Frequency Oscillator (BFO) 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 are 0.3, 1.0, 3.2, 6.0 and 16.0 kHz. A large assortment of digital IF bandwidths are available. (See Table 3, Options.) Available detection modes are AM, FM, CW, USB, LSB and ISB. A tunable BFO can be adjusted in 10-Hz steps over a ± 8000 Hz range, and passband tuning is available to further enhance the reception of CW signals. Gain control can be accomplished manually or automatically, with fast and slow AGC modes available. The squelch threshold is adjustable from 0 to -135 dBm or it can be disabled. A noise blanking feature can also be enabled to eliminate the adverse effects of impulsive noise.

All receiver inputs and outputs are available on the front panel of the unit. 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, and the CSMA interface is provided via a miniature phone jack.

The WJ-8710 operates on +12 Volt power input at 1.5 amps typical without options.

As illustrated in Figure 1, the WJ-8710 can be divided into four functional subsystems: RF, DSP, IF/Audio Output and Control. Figure 2 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 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 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 this second IF is provided on a rear panel for connection to a signal display unit. After

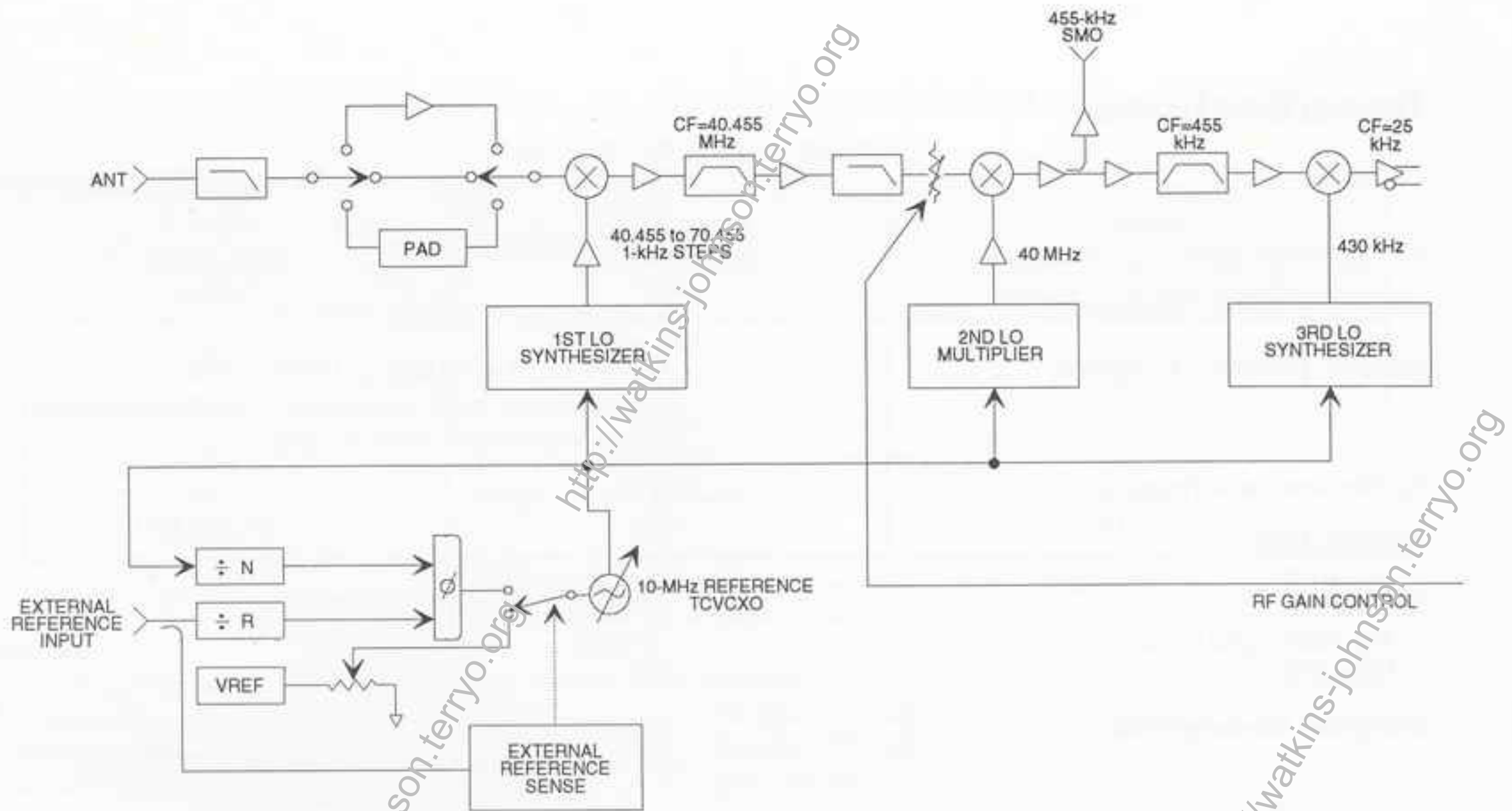


Figure 2 WJ-8710 RF Subsystem Functional Block Diagram

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 1, 2, 5 or 10 MHz. The WJ-8710 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 signal processing functions within the receiver. The third IF signal from the RF Subsystem is digitized to 16-bits 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
- IF filtering
- Gain control (AGC fast, AGC slow or manual)
- Signal strength & squelch functions
- Signal demodulation & BFO

- Generation of a multiplexed digital data stream containing one or two demodulated audio channels & 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 two-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, and provides a remote control function through either the RS-232 or CSMA 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.

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 w/preamplifier engaged)
Detection Modes	AM, FM, CW, USB, LSB & ISB (Consult factory for additional demodulation modes)
Sensitivity (500 kHz to 30 MHz)	

Table A

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 mode)	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 IF Bandwidth)**

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

IF Bandwidths See typical plots in Figures 3, 4 & 5

Table B. IF Shape Factors

3-dB Bandwidth (kHz)*	(Maximum) Shape Factor (3/60 @B)	(Typical) Group Delay Variation (100% of 3-dB bandwidth)
0.3	1.25:1	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

*Consult factory for alternate or additional IF bandwidths

IF Output

Center Frequency 455 kHz
 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 (-6 dB), 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 & Slow
 AGC Threshold 100 dB, min
 AGC Threshold Approx -108 dBm (0.9 mV) in 16 kHz bandwidth
 AGC Threshold Approx -125 dBm (0.12 mV) in 300-Hz bandwidth (Threshold is matched with IF bandwidth & is typically 10 dB above noise floor)
 AGC Attack Time 15 msec, typical
 AGC Decay Time Fast: 25 msec, typical
 AGC Decay Time Slow: 4 seconds, typical

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

Image Rejection

Image Rejection 90 dB, min
 Image Rejection 85 dB, min
 Image Rejection >90 dB, typical

LO Phase Noise

LO Phase Noise -110 dBc at 1-kHz offset, typical

Reciprocal Mixing

Reciprocal Mixing With a desired signal of 25 μV in the 3.2-kHz IF bandwidth, the desired signal-to-noise ratio (SNR) is greater than 20 dB, when an undesired signal 70 dB higher in amplitude and 35 kHz removed in frequency is present.

Cross Modulation

Cross Modulation With a desired signal of 10 μV an undesired signal 86 dB higher, 30% AM modulated produces less than 10% cross modulation for frequency separation of >50 kHz in the 1-kHz IF bandwidth.

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 Two center-tapped, balanced outputs
For ISB mode, USB & LSB on separate outputs
All other modes, audio signal common to both outputs

Output Level 0 dBm, nominal (into 600-ohm load)

Connector Type Screw Terminals

Speaker Output

Number of Outputs One
For ISB mode, USB & LSB can be selected individually or combined

Bandwidth 100 Hz to 13 kHz

Output Level 750 mW, nominal (into 8-ohm load)

Total Harmonic Distortion <3%

Connector Type Screw terminals

Headphone Output

Number of Outputs Two unbalanced outputs
For ISB mode, one 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 1/8-in stereo jack

Remote Control

RS-232 RS-232 or CSMA (selectable by internal switch)
Full duplex, 3-wire serial interface; rear panel 25-pin female D-shell connector

CSMA Carrier Sense Multiple Access with Collision Detection; half duplex; rear panel miniature phone jack

Baud Rates (Both Interfaces) 75, 150, 300, 600, 1200, 2400, 4800 & 9600 (selectable by internal switches)

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

MTBF In excess of 13,000 hours; estimated in accordance with MIL-HDBK 217E for Ground Fixed; +40°C environment

Environmental Specifications

Power Requirements +11 to +16 Vdc

Power Consumption <20 W typical (without options)

Weights & Dimensions

Height	Width	Depth	Weight
2.5 in (6.35 cm)	7.5 in (19.05 cm)	11.5 in (29.21 cm)	<7 lbs (<3.17 kg)

Table 1. Connectors (Inputs/Outputs)

I/O	Function	Type
Inputs	Antenna External Reference Power Mute	BNC BNC 3-pin LEMO Terminal Block
Outputs	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 1/8-in stereo jack Terminal Block
Both	CSMA Remote Interface RS-232 Remote Interface	1/8-in miniature stereo jack 25-pin female D-shell

Table 2. Options

Nomenclature	Description	Additional Specifications to Basic WJ-8710
Customer-specific options	<ul style="list-style-type: none"> Supports customer-specific requirements 	<ul style="list-style-type: none"> Additional or alternate IF bandwidths Additional or alternate detection modes Specific I/O control Specific mechanical configurations
WJ-871Y/XBW Extended Bandwidth Set	<ul style="list-style-type: none"> Provides a large assortment of IF filters with superior amplitude & group delay characteristics 	<ul style="list-style-type: none"> 66 IF filters total - ranging in bandwidth from approx 56 Hz to 16 kHz in step sizes of not more than 13%
WJ-871Y/DS01 Digital Signal Output	<ul style="list-style-type: none"> Provides digitized time samples of 25-kHz 3rd IF, switched IF &/or audio data 	<ul style="list-style-type: none"> Contact factory for details & alternate formats