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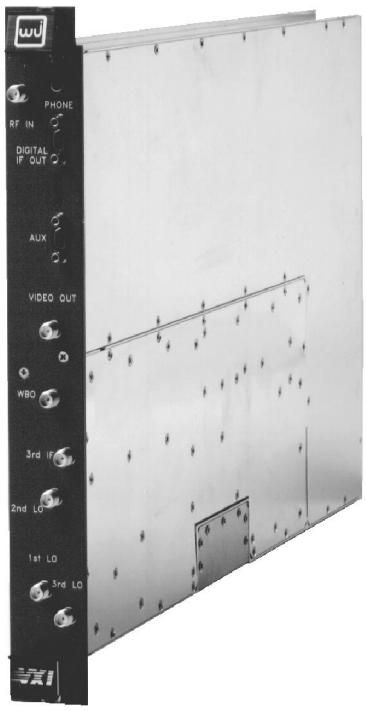
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Technical Data

WATKINS-JOHNSON

January 1997

# Digital VXI VHF/UHF Receiver
# WJ-8629




The WJ-8629 is a general-purpose VHF/UHF receiver covering a 20 to 2700 MHz frequency range that utilizes Digital Signal Processing (DSP) techniques. WJ packages the unit in a single-slot C-size VMEbus Extensions for Instrumentation (VXI) module. The WJ-8629 is ideal for applications requiring both digital signal data and broad-frequency coverage in a highly integrated package. Combining receiver control and digital signal data directly on a standard instrumentation and computing bus adds significant system capabilities, while reducing the complexity of system integration.

The WJ-8629 Receiver features DSP, low-phase-noise frequency synthesizers, a preselected front end, 10-Hz tuning resolution, and high dynamic range. The use of digital IF and demodulator signal processing provides the WJ-8629 with highly stable and repeatable IF filter characteristics. Typical IF filter shape factors are better than 1.5:1. The high-performance suboctave preselector filters incoming RF signals, and rejects undesired out-of-band signals. The WJ-8629 receiver is unsurpassed in its ability to

- ❑ *Frequency coverage from 20 to 2700 MHz with 10-Hz resolution*
- ❑ *+10 dBm 3rd-order intercept point, typical*
- ❑ *12-dB noise figure, typical*
- ❑ *Suboctave preselection*
- ❑ *Switchable RF pre-amp*
- ❑ *DSP fine tuning, IF filtering, & demodulation*
  - *AM, FM, CW, LSB, USB & ISB detection modes*
  - *15 IF filters from 200 Hz to 200 kHz*
  - *Flexible digital IF I & Q output on front-panel connector*
  - *Digital audio, video, IF I & Q data, or direct A/D data available on VXI interface*
  - *Digital data available in either D16- or D32 VXI formats*
- ❑ *Configurable for multichannel phase-coherent operation*
  - *LO inputs/outputs*
  - *Synchronized A/D clocks & signal processing*
  - *2-channel system (via 2 WJ-8629s) without additional modules*
- ❑ *Powerful built-in search capabilities*
- ❑ *VXI message-based control*
- ❑ *Built-in reference oscillator*
- ❑ *12.5-MHz wideband IF output*
- ❑ *Front-panel-mounted RS-232 auxillary control port*

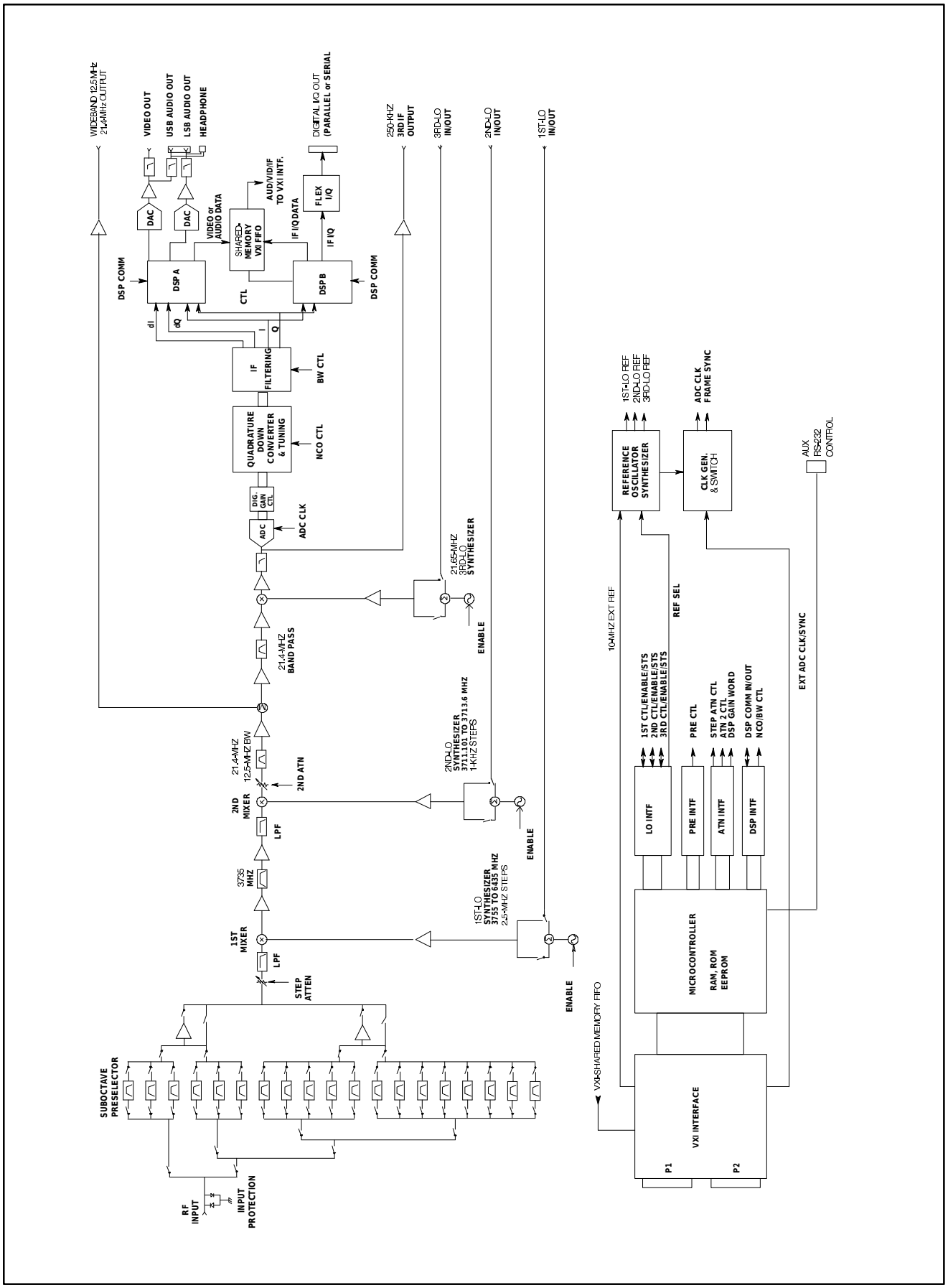
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*WJ-8629 Digital VXI VHF/UHF Receiver Block Diagram*

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reject adjacent channel interference. The receiver uses digital IF filters in conjunction with very low phase noise synthesizers to accomplish high rejection of adjacent channel interference. This is an extremely important performance parameter when operating in a dense signal environment.

WJ uses surface-mount technology in the printed circuit board design of the WJ-8629 Receiver. A milled-aluminum chassis provides RF isolation between multi-layer PC boards. The front panel of the unit provides RF/analog interconnections and the dedicated, digital I&Q IF output. SMA-type connectors pass the RF/Analog signals in and out of the unit. Microminiature D-type connectors provide the digital IF I&Q data outputs and analog audio outputs.

A high-speed message-based VXI interface provides remote control and access to digital signal data. This interface provides accessibility to all functions except power. An operator may also control the WJ-8629 from its auxillary RS-232 port on the receiver front panel.

Internal switching allows the WJ-8629 to route a sample of the Local Oscillators (LOs) to another receiver, or to apply external LOs to the unit. An operator can cable together a pair of WJ-8629 Receivers to form a two-channel phase-coherent system. Systems needing more than two channels require an external LO divider/buffer module. The VXIbus provides for the synchronization signals required for ensuring phase coherence of the digital signal processing.

## Functional Description

A front-panel SMA connector couples the RF signals from the antenna to the input of the receiver and routes the signals to a multiband, suboctave preselector. The preselector-filtered RF signal is then applied to a low-noise RF amplifier that provides for excellent receiver sensitivity. The WJ-8629 amplifies the signal and passes it through a lowpass filter that provides image rejection for the first mixer. The control microprocessor sets the step attenuator, preceding the first mixer, to optimize the dynamic range of the receiver based on the incoming signal strength.

The first LO tunes from 3755 to 6435 MHz in 2.5-MHz steps and upconverts the RF signal to the first IF. The first LO synthesizer uses a YIG oscillator to provide excellent phase noise. A low-noise amplifier follows the first mixer, and provides 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, centered at 3735 MHz, and rejects the second mixer image frequency at 42.8-MHz offset. A low-noise amplifier following the first IF filter provides additional signal gain. A step attenuator follows the second mixer and is set by the micro-processor, based on the incoming signal strength.

The second mixer combines the first IF signal with the second LO, which tunes from 3711.101 to 3713.6 MHz in 1-kHz steps. The second LO is a three-loop design providing 1-kHz frequency resolution, low phase noise, and fast tuning.

The second LO centers the output of the second mixer at 21.4 MHz. A 12.5-MHz-wide bandpass filter follows the mixer, providing rejection of the LO and setting the bandwidth of the wideband analog IF output. A bandpass filter limits the 12.5-MHz-wide 21.4-MHz IF signal bandwidth to 200 kHz. The receiver converts the output of this filter to a third IF of 250 kHz and provides it to both the front panel and the DSP section.

The DSP section digitizes the 200-kHz-wide third-IF signal centered at 250 kHz with a 12-bit Analog to Digital (A/D) converter sampling at a 1-MHz rate. The WJ-8629 then applies the digitized signal to a series of programmable DSP chips that perform:

- Fine tuning
- IF filtering
- Demodulation
- Beat Frequency Oscillator (BFO) generation
- Automatic gain and frequency control, and
- Digital audio, video, and I & Q IF data outputs.

The DSP section also provides the VXI-shared First-in, First-out (FIFO) buffer memory with the user's choice of A/D, IF I & Q, video, or audio data. The receiver may access this shared-memory FIFO by either 16- or 32-bit VXI bus paths.

After digital processing, the WJ-8629 routes the filtered and demodulated signal to the analog reconstruction circuitry, which generates the video and audio outputs. The WJ-8629 includes a shared-memory FIFO connected to the VXI interface. The data supplied to this FIFO may come from any of four different digital data paths in the receiver. The receiver can fill the FIFO with unprocessed A/D samples, IF filtered I & Q data, video data, or 8-ksps filtered audio data. Unprocessed 12-bit A/D samples are provided at a 1-MSPS rate. See the digital signal data rate chart for data rate of I & Q or video data, based on bandwidth. When the unit selects audio data, it is limited to a maximum 3-kHz bandwidth, regardless of the selected IF bandwidth. An operator may use the FIFO in either continuous or snapshot mode. In continuous mode, the receiver continually fills the FIFO with the most recent data. In snapshot mode, it fills the FIFO after a VXI trigger operation.

A flexible, digital I and Q, IF output provides a digital IF signal to the front panel. A Programmable Gate Array (PGA), configured for either a synchronous-serial or parallel format, provides this output. The serial format allows interfacing with Motorola 56K or Texas

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Instrument C3x-type DSP processors. The parallel format provides interface with the TI C40 series processor. This interface is reconfigurable for other processors. Consult WJ for more information.

The WJ-8629 Receiver supports the comprehensive WJ *Miniceptor/Microceptor* search and command structures, and is compatible with WJ-8634 applications. The receiver provides three operating modes:

- Manual (fixed-frequency operations)
- SWEEP (contiguous coverage of up to 10 start/stop frequency sectors)
- STEP (preprogrammed discrete frequencies).

The WJ-8629 is interactive in all three modes and alerts the host computer of signal activity. While in either the SWEEP or STEP mode, the receiver logs individual signals in the coverage area and reports only changes in signal presence to the VXI controller. This greatly reduces overhead time required by the controller in multi-receiver systems, since it eliminates the need to communicate and sort data from each sweep, and to differentiate between new and repeat signals. In SWEEP mode, the receiver locks out portions of the RF spectrum and excludes previously identified portions of the spectrum from the coverage area. In the SWEEP or STEP modes, the receiver maintains a frequency versus amplitude data block that it provides to the controller for RF pan or display generation. Receiver memory provides storage for up to 200 SWEEP or STEP setups, and 200 lockout bands.

*Digital Signal Data Rate Chart*

| IF Bandwidth (kHz) | Data Rate | |
|---|---|---|
| | I&Q (kHz) | Video (kHz) |
| 200 to 35 | 250 | 250 |
| 20 to 10 | 62.5 | 62.5 |
| 6.4 to 3.2 | 31.25 | 31.25 |
| 1.0 to 2.0 | 3.90265 | 3.90265 |
| 6.4 (ISB) | 15.625 | 15.625 |

*Specifications*

| | |
|---|---|
| **Frequency Range** | **20 to 2700 MHz** |
| **Tuning Resolution** | **10 Hz at demodulated output, 1 kHz at analog IF outputs** |
| **Internal Reference Accuracy** | **±1.0 ppm, max (0 to 40°C)** |
| **External Reference Input** | **10 MHz (across VXI backplane)** |
| **RF Input** | **50 ohm, 1.5:1 VSWR, typical** |
| | **3.0:1 VSWR, maximum at the tuned frequency** |
| **Preselection** | **Switched suboctave bandpass filters, 19 bands** |
| **Noise Figure (Pre-amp on)** | |
| **20 to 1200 MHz** | **12 dB, max** |
| | **11 dB, typical** |
| **1200 to 2400 MHz** | **13 dB, max** |
| | **12 dB, typical** |
| **2400 to 2700 MHz** | **14 dB, max** |
| | **12 dB, typical** |
| **RF Input Protection** | **1 W, max input without damage** |
| **Input 3rd-order Intercept (Pre-amp on)** | **+8 dBm min, +10 dBm typical, at 21.4-MHz IF output with -20 dBm signals spaced 10-MHz apart** |
| **Input 2nd-order Intercept** | **+55 dBm, typical at 21.4-MHz IF output** |
| **Wideband IF Output** | **Centered at 21.4 MHz (inverted spectrum)** |
| | **12.5-MHz 3-dB bandwidth, min** |
| **Gain-to-wideband IF Output** | **17 dB, min** |
| **Gain Control Modes** | **Manual, AGC, 100-dB range** |
| **Adjacent Channel Rejection** | **60-dB typical rejection to an interfering signal offset by 25 kHz, measured in a 20-kHz bandwidth** |
| **Image Rejection** | **90 dB** |
| **IF Rejection** | **90 dB** |
| **Blocking** | **Attenuation of a desired -90 dBm 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 20-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 to <7dB.** |
| **Phase Noise** | **Better than -97 dBc/Hz @ 20-kHz offset** |
| | **Typically -115 dBc/Hz @ 100-kHz offset** |
| **Memory Channel Step Time** | **100 channels per second, minimum** |
| **F1 to F2 Sweep Time** | **3 mSec, typical per sweep point** |

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| | |
|---|---|
| **LO Level at RF Input** | **-90 dBm, max** |
| **Internally Generated Spurious** | **-110 dBm equivalent RF input, max** |
| **Detection Modes** | **AM, FM, CW, LSB, USB, ISB** |
| **IF Bandwidths (kHz, -6dB BWs)** | **200, 150, 100, 60, 50, 35, 20, 15, 10, 6.4, 5, 3.2, 1.0, 0.5, 0.2** |
| **IF Shape Factor** | **<1.5:1, 60/6 dB** |
| **Variable BFO range** | **±8 kHz, 10-Hz steps** |
| **AFC** | **Digital frequency tracking within +/- 1/2 the IF bandwidth** |
| **Switched Video Output level** | **1.0 V p-p into 50 ohms (30% deviation in FM or 50% AM modulation)** |
| **Video Frequency Response** | **dc to 1/2 the IF bandwidth** |
| **Third-IF Output** | **250-kHz center<br>200-kHz bw<br>Upright spectrum** |
| **Line Audio Output Level** | **0 dBm into 600 ohms, nominal** |
| **Headphone Output** | **10 mW into 32Ω** |
| **VXI Interface** | |
| **Device Type** | **Message-based device, VXI servant** |
| **Module Size** | **VXIbus C-size module, 1-slot wide** |
| **Data Transfer Handshake** | **Normal transfer mode** |
| **Data Transfer Capability** | **A24, D16 circuitry provided (shared memory option D32)** |
| **EMI Shielding** | **Completely enclosed module** |
| **Power Consumption** | **<46 watts** |

**Typical Current**

| Vdc | mA |
|---|---|
| +24 | 100 |
| +12 | 1000 |
| -12 | 300 |
| + 5 | 5000 |
| - 5 | 500 |

**Weight** ..... **<7 lbs (3.2 kg)**

*Environmental Specifications*

| | |
|---|---|
| **Temperature** | |
| **Operating Temperature Range** | **0 to +50°C Case** |
| **Non-Operating Temperature Range** | **-40 to +70°C Case** |
| **Full Specification Compliance** | **20 to 30°C Case** |
| **Altitude** | **0 to 12,000 feet (3658 meters) above MSL** |
| **Humidity** | **10% to 90% non-condensing** |

*Sensitivity*

| Bandwidth (kHz) Modulation | 60:6-dB IFBW Shape Factor | 20 to 1200 MHz Sensitivity (dBm)* |
|---|---|---|
| 0.5 CW | 1.5:1 max | -116 |
| 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: IFBWs <10 kHz require a 400-Hz modulation rate.)

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

**Add 1 dB for 1200 to 2400.**

**Add 2 dB for 2400 to 2700.**

*Receiver Connectors*

| I/O | Function | Type |
|---|---|---|
| Input | Antenna | SMA |
| Outputs | Wideband IF output, 21.4-MHz center, 12.5-MHz bandwidth | SMA |
| | Digital I/Q | Multipin D |
| | Video | SMA |
| | 250 kHz 3rd-IF output | SMA |
| | Line Audio | Multipin D |
| | Phone Audio | Phone jack |
| *Bi-directional | 1st-LO Input/Output | SMA |
| | 2nd-LO Input/Output | SMA |
| | 3rd-LO Input/Output | SMA |
| | RS-232 Control | Multipin D |

*** Operating with more than one slave receiver requires an external LO divider/buffer module.**

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