

Technical Data



WATKINS-JOHNSON

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Digital FDM Demultiplexer WJ-9548 & WJ-9548-1



The WJ-9548 Digital FDM Demultiplexer is a compact, multichannel demodulator that incorporates the accuracy and repeatability of Digital Signal Processing (DSP). Through DSP, exceptional amplitude and group delay characteristics are simultaneously achieved. An analog tuner in the front end of each channel demodulator permits a high-resolution analog-to-digital (A/D) Converter and a significant degree of filtering prior to the sampling process. These effects combine to produce superior noise performance and high dynamic range. The WJ-9548 merges analog and digital techniques to achieve significant performance enhancements relative to demultiplexer implementations that are purely analog or digital.

Due to its modular design, the WJ-9548 is configurable as a 6-, 12-, 18- or 24-channel unit. Units with fewer than 24 channels are field-upgradable by installing 6-channel cardsets into the appropriate Motherboard slots. Other options are also field-installable with similar ease.

HEIGHT	3.5 in (8.89 cm)	DEPTH	20 in (50.80 cm)
WIDTH	8.25 in (20.96 cm)	WEIGHT	20 lbs (9.05 kg)

Features

- ❑ Up to 24 independently tunable FDM channel demodulators in a single unit
- ❑ Tunable from 0 to 20 MHz in 1-Hz steps
- ❑ Compact size: 2 units mount in a 19-in rack, 3.5-in high
- ❑ Very-low-differential group delay & flat amplitude response
- ❑ 4 analog baseband inputs with nonblocking connection to any channel demodulator (8 analog baseband inputs on the WJ-9548-1)
- ❑ Scanning capability & preprogrammed CCITT frequency plans to facilitate tuning
- ❑ Drop-in option cards permitting a variety of analog & digital output formats, as well as additional VGC processing
- ❑ Capability to configure up to 8 units to share digital outputs and allow option cards access to as many as 192 VGC signals
- ❑ Built-in test capability & modular design to facilitate field maintenance
- ❑ Full local & IEEE-488 remote control

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This material provides up-to-date general information on product performance and use. It is not contractual in nature, nor does it provide warranty of any kind.

WJ-9548 & WJ-9648-1

The demodulators within the WJ-9548 are independently tunable over the 0 to 20 MHz baseband in 1-Hz steps. Four different tuning modes are standard.

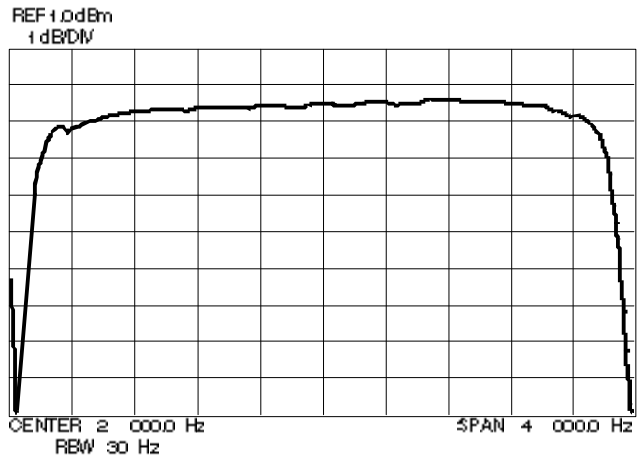
Direct Frequency Tuning allows the entry of a nominal tuned frequency in kHz. Channel Tuning divides the input tuning range into 5001 contiguous 4-kHz increments, and allows the entry of a desired channel number. In addition to these increments, two common CCITT frequency plans (960 and 2700 channel) are pre-programmed. To tune within these modes, specify the appropriate CCITT hierarchies (SMG, MG, SG, G and CH). Scans are possible within each of the four tuning modes. To compensate for frequency offsets between the WJ-9548 reference and the baseband, enter a parts-per-million (PPM) correction factor for each baseband input. This automatically computes and adjusts the tuned frequencies from the nominal frequencies.

Features, in addition to baseband selection and tuned frequency, include independent channel control of gain, upright/invert detection, scan threshold, head-phone selection, and routing to installed option cards. A thorough built-in test feature detects circuit faults to the module level. The WJ-9548 is controlled either locally via the front panel Liquid Crystal Display (LCD) and keypad controls, or remotely via the standard IEEE-488 interface. The menu-driven display is an 8 x 40 character LCD with LED back-lighting. Unit and demodulator level parameters are presented in a variety of formats. Parameters are entered via the numeric keypad, or the cursor and edit control knobs on the front panel. Except for head-phone volume control and the bus address, all operator-selectable parameters are controlled and accessed via the standard IEEE-488 interface. (Consult factory for alternates).

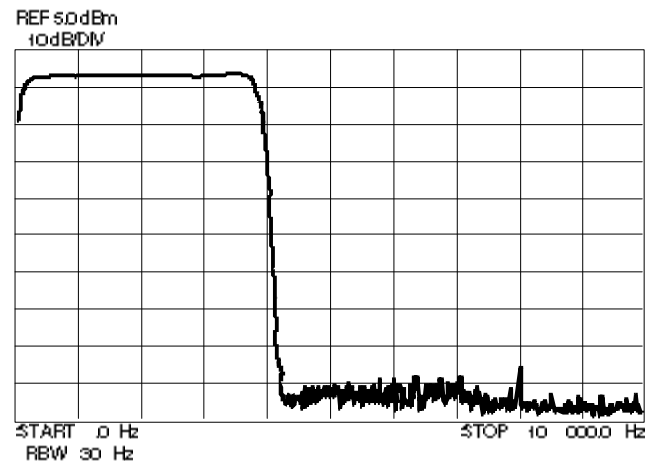
The modularity of Voice Grade Channel (VGC) Option Cards allows tailoring of the WJ-9548 to meet specific system requirements. Each Option Card can access one or more operator-selected VGCs and perform a specific operation on them, including but not limited to:

- Analog reconstruction
- PCM formatting
- Data storage interfacing
- Signal characterization
- Dialed number recognition
- Data demodulation

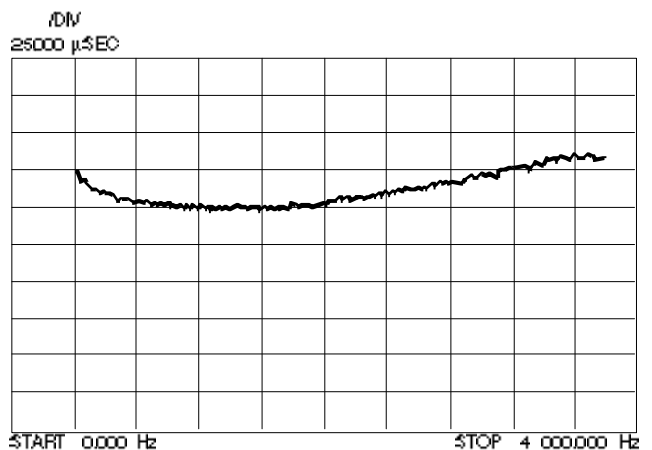
For all of its capability, the WJ-9548 is extremely compact. Two units, mounted side-by-side, fit into a standard 19-inch (48.26 cm) equipment rack.



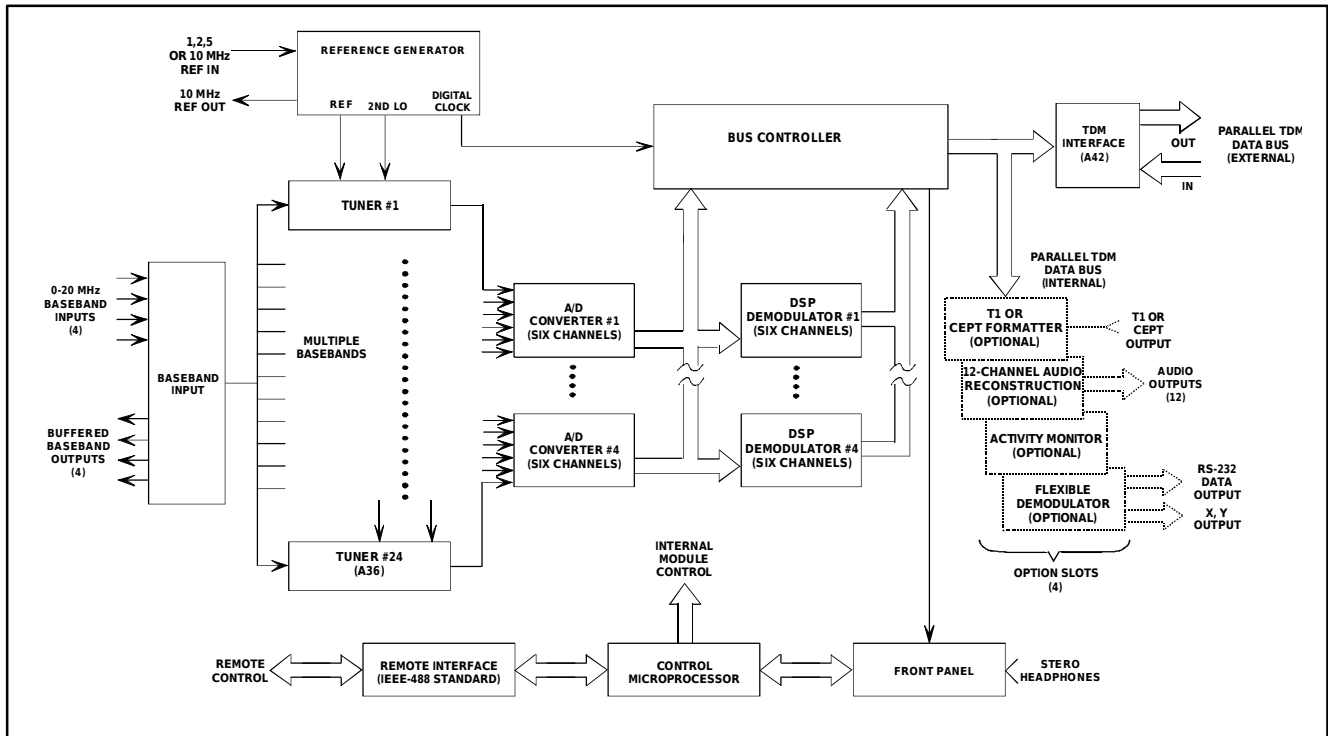
Typical Passband Response (Audio Output)



Typical Channel Filter Response (Audio Output)



Typical Group Delay Response (Audio Output)



WJ-9548 Digital FDM Demultiplexer Functional Block Diagram

Functional Description

The typical Passband Response diagram demonstrates how the WJ-9548 accepts up to four 20-MHz analog FDM basebands and applies each to an automatic gain control (AGC) amplifier with a long response time. This baseband AGC adjusts the front-end gain to optimize noise and distortion performance over a 30-dB composite baseband power range. The baseband signals are then connected, under operator control, to any of the installed channel demodulators in a completely nonblocking fashion. A buffered version of each baseband input provides an output allowing multiple units to access the same basebands.

The WJ-9548-1 differs from the WJ-9548 in that it accepts up to eight 20-MHz analog basebands. It provides no baseband AGC function, and no buffered baseband outputs are available. Like the WJ-9548, all baseband inputs on the W-9548-1 can be connected to the installed channel demodulators in a completely non-blocking fashion.

The demodulators within the WJ-9548 consist of a Tuner, an A/D Converter, and a DSP Demodulator. Each Tuner is dedicated to a single-channel demodulator, while the A/D Converter and DSP Demodulator process six channels simultaneously.

The Tuner Card is a fully synthesized, two-conversion analog front end. It covers the 20-MHz tuning range in 500-Hz steps producing a final IF approximately 8-kHz wide, centered at 8 kHz. This output is applied to an A/D Converter Card where it is digitized to 14 bits of resolution at a sampling rate of 32 kHz. Raw digital data is applied to a DSP Demodulator Card that performs fine tuning, SSB demodulation, critical channel filtering, and gain control.

The Bus Controller generates address, clock, and control signals necessary to the operation of the A/D Converter and the DSP Demodulator cards, as well as the timing and control of the internal TDM data bus. It performs the audio reconstruction of two selected channels for the front-panel stereo-headphone jack, and monitors slot occupancy and run-time error status of the A/D Converter and DSP Demodulator cards. The Bus Controller also plays a role in the built-in test sequence by performing signature analysis on the digital data paths.

The internal TDM data bus supplies digitized VGC data to up to four Option Cards. Resident demodulators, as well as demodulators installed in other WJ-9548s, can place VGC data on the bus. By interconnecting up to eight WJ-9548s via the TDM interface (See Simplified Diagram on page 8), up to 192 channels of voice grade data are available to the Option Cards within each unit.

Specifications

Input Characteristics	
Number of Inputs	4 analog basebands (8 on WJ-9548-1). Each connects to any channel demodulator in a nonblocking manner.
Input Range	150 Hz to 20 MHz (reduced performance below 8 kHz)
Input Impedance	75 ohms, unbalanced
Input Level Range (WJ-9548)	-30 to 0 dBm, composite baseband
Nominal Input Level (WJ-9548-1)	-25 dBm single tone -7 dBm composite baseband for 600-channel input loading
Baseband Gain Control	Long time-constant AGC that optimizes input gain over input level range (No Baseband AGC on WJ-9548-1)
Output Characteristics	
Digital Output (Standard)	Parallel TDM data bus; 16-bit linearly coded VGC data with word & framing clocks
Frequency Response	175 to 3825 Hz (-3 dB)
Bandpass Ripple	±0.35 dB, max (600 to 3400 Hz)
Adjacent Channel Rejection	60 dB, min (at 300 & 3700 Hz)
Total Harmonic Distortion	0.1%, max (820-Hz test tone at nominal output)
Residual Noise	57 dB, min below nominal output
Noise Power Ratio (NPR)	50 dB, min (600 channel noise load at -7 dBm)
Differential Group Delay	75 msec, max (400 to 3825 Hz)
Incidental FM	1.00 Hz rms (0 to 15 MHz tuned frequency) 1.25 Hz rms (15 to 20 MHz tuned frequency)
Analog Output (Optional)	High-fidelity audio; 16-bit DAC with 2X oversampling, available in 12-channel increments
Output Impedance	600 ohms, unbalanced
Nominal Output Level	1 Vrms into 600 ohms (AGC mode, no audio attenuation)
Audio Attenuation Range (All Outputs)	30 dB, nominal
Output Connector	D-type, 25-pin female
Performance Specifications	Compliant with specs under "Digital Output"
T1 PCM Output (Optional)	T1; 24-channel capacity, 1.544 Mbps
Line Length	0 to 655 ft (0 to 42.26 meters)
Output Impedance	100 ohms, balanced
Output Connector	Bayonet-style Triax
Line Code	AMI or B8ZS (operator-selectable)
Encoding Characteristic	u255 or linear (operator-selectable)
Framing Formats	F4, F12 (D4), F24 (ESF) or F72 (SLC-96)
Transmit Clock	Internal or external (operator-selectable)
Internal	On-board phase-locked 1.544 MHz
External	Derived from T1 data input, or from 772-kHz square wave or sine wave signal source
Slip Control (External Clock)	Slips corrected on frame boundaries
CEPT PCM Output (Optional)	Primary level CEPT; 30-channel capacity, 2.048 Mbps
Output Impedance	75 ohms, unbalanced
Output Connector	BNC
Line Code	HDB3 per CCITT G.703
Encoding Characteristic	A-law or linear (operator-selectable)
Framing Format	CCITT G.704 or operator-defined
Pulse Shape	Compliant with CCITT G.703

Flexible Demodulator (Optional)	
Demodulator Modes	See separate Flexible Demodulator data sheets for specific Modem, FAX, & VFT modulations & protocols supported.
Output	
Digital	RS-232 serial data at 9.6 or 19.2 kbps (transmit only)
Analog	I, Q baseband or symbol synchronization signals used for eye diagram & constellation display
Output Connector	D-type, 25-pin female
Headphone Audio (Standard)	
Output Impedance	Toll quality stereo; independent channel selection & volume control for each side
Nominal Output Level	600 ohms, unbalanced
Adjustable up to	8 dBm into 600 ohms
Video Baseband Output (Not Available on WJ-9548-1)	
Number of Options	4 buffered outputs; 1 for each baseband input
Output Impedance	75 ohms, unbalanced
Gain Relative to Input	0 dB, nominal
Passband	150 Hz to 18 MHz (-1 dB)
Control	
Local Control	
	LCD display (8 x 40 characters), keypad, cursor & edit control knobs, & headphone volume controls
Remote Control	
	IEEE-488 interface (standard); consult factory for alternate interfaces
Gain Control Modes	
	Manual or AGC, applied to individual VGCs
Gain Range	
	42 dB, min
Tuning Modes	
	Direct frequency, channel, number, CCITT 960 & CCITT 2700 (operator-selectable for each VGC)
Tuning Range	
	0 to 20 MHz
Tuning Resolution	
	1 Hz (offsets may be entered as PPM corrections)
Scans	
	Selectable (start, stop, step) or formatted (SMG, MG, SG, G) based on CCITT 960 & 2700 frequency plans
Detection Modes	
	SSB upright or inverted spectrum (operator-selectable for each VGC); USB/LSB tuning convention selectable via internal switch
Frequency Reference	
Internal Reference Stability	$\pm 5 \times 10^{-7}$, max
Internal Reference Aging	$\pm 3 \times 10^{-9}$ drift per day, max
External Reference	Accepts 1, 2, 5 or 10 MHz; ± 1 PPM, 200 mV peak-to-peak min into a high impedance load; automatically switches to external reference upon application of signal
Reference Output	10 MHz, 0 dBm nominal into 50 ohms

Physical Environment

Temperature Range	
Operating	0 to 50°C
Meets All Specifications	10 to 40°C
Power Requirements	
	115/230 Vac $\pm 10\%$ (48 to 72 Hz)
	108 to 118 Vac (380 to 420 Hz)
Power Consumption	
	35 W (12 Channel) } Approximate, no output options installed
	60 W (24 Channel) }

WJ-9548 & WJ-9648-1

Options*

Model #	Functions**	Physical Characteristics
9548/6CH 6-Channel Cardset	<ul style="list-style-type: none"> • Provides hardware to add 6-channel demodulators • Installs easily in field • Requires no software updates to the Control Processor 	<ul style="list-style-type: none"> • Does not use any of the 4 option slots • Consists of: <ul style="list-style-type: none"> -6 Tuner PC Assemblies -A/D Converter PC Assembly -DSP Demodulator PC Assembly
9548/ACT1 Activity Monitor (Level 1)	<ul style="list-style-type: none"> • Provides automatic signal classification for up to 12 selected VGCs simultaneously • Categorizes signals as Voice, Data, Signalling Tones or No Activity 	<ul style="list-style-type: none"> • Uses 1 of 4 option slots • Consists of an Activity Monitor PC Assembly
9548/ACT2 Activity Monitor (Level 2)	<ul style="list-style-type: none"> • Provides signal classification as in the ACT1 Option, except data signals are classified as FSK signals (includes FSK modems & VFT signals) or PSK signals (includes BPSK, QPSK & QAM modems) 	<ul style="list-style-type: none"> • Uses 1 of 4 option slots • Consists of an Activity Monitor PC Assembly
9548/AUD 12-Channel Audio Reconstruction	<ul style="list-style-type: none"> • Provides high-fidelity analog reconstruction of any 12 selected VGCs • Provides operator-adjustable nominal output levels of all 12 outputs over a 30-dB range (up to max of 1 Vrms into a 600-ohm load) 	<ul style="list-style-type: none"> • Uses 1 of 4 option slots • Consists of: <ul style="list-style-type: none"> - Audio Reconstruction PC Assembly - Internal Cable Assembly - Set of rear panel identification (ID) plates & decals - External Cable Assembly (makes each of 12 audio output signals available on individual BNC connector)
9548/T1 T1 Formatter	<ul style="list-style-type: none"> • Provides standard T1 PCM data stream containing up to 24 selected VGCs • Allows assignment of VGC outputs, from the various demodulators, to arbitrary T1 channels, in a nonblocking fashion • Allows selection of linear & u-law encoding on a channel-by-channel basis • Allows the derivation of T1 timing from an external clock source 	<ul style="list-style-type: none"> • Uses 1 of 4 option slots • Consists of: <ul style="list-style-type: none"> - T1 Formatter PC Assembly - Cable Assembly - Set of rear panel ID plates & decals - Accessory Cable Assembly with ID plates & decals to allow for external T1 clock sources
9548/CEPT CEPT Formatter	<ul style="list-style-type: none"> • Provides a standard, primary level CEPT PCM data stream containing up to 30 selected VGCs • Allows the assignment of VGC outputs, from various demodulators within the WJ-9548, to arbitrary CEPT channels in a nonblocking fashion • Allows the selection of Linear & A-law encoding 	<ul style="list-style-type: none"> • Consists of: <ul style="list-style-type: none"> - CEPT Formatter PC Assembly - Cable Assembly - Set of rear panel ID plates & decals

Options* (Continued)

Nomenclature	Functions**	Physical Characteristics
9548/FLX Flexible Demodulator	<ul style="list-style-type: none"> • Provides a single-channel voice frequency demodulator capable of demodulating & decoding a variety of Modem, VFT & FAX signal formats • Performs: <ul style="list-style-type: none"> - Symbol timing recovery - Adaptive blind equalization - Carrier recovery - Data derandomizing - Data decoding • Provides demodulated character data via an RS-232 output port • Outputs eye diagrams & constellation patterns on 2 analog ports • See separate Flexible Demodulator data sheets for a list of protocols supported • In VFT applications, all data cannals, or a single-selected data cannal, can be output through the RS-232 port 	<ul style="list-style-type: none"> • Uses 1 of 4 option slots • Consists of: <ul style="list-style-type: none"> - Flexible Demodulator PC Assembly - 2 Cable Assemblies - Set of rear panel ID plates & decals - A 5.25-in floppy disk providing FAX reconstruction & data display/storage programs (MS-DOS compatible) - Up to 4 Flexible Demodulator Option Cards installed & cabled to a single rear-panel multipin connector
8615/BR Blank Rack	<ul style="list-style-type: none"> • Allows the mounting of a single WJ-9548 into a standard 19-in rack 	

* The basic WJ-9548, as ordered from the factory, contains no channel demodulators. To order the desired number of factory-installed demodulators, specify the appropriate number of six-channel Cardsets (WJ-9548/6CH) up to a maximum of four per unit. In addition to the six-channel Cardset slots, the WJ-9548 contains four option slots for the installation of a variety of output formatters or special signal processing options. Option Cards can be installed in any combination, subject only to the four-slot restriction and the availability of rear panel space for I/O connectors. Some options may require an upgrade of the control software and/or hardware. Contact the factory to satisfy unique system requirements such as additional baseband inputs (up to eight), digital baseband inputs, special VGC processing options, or alternate remote control interfaces.

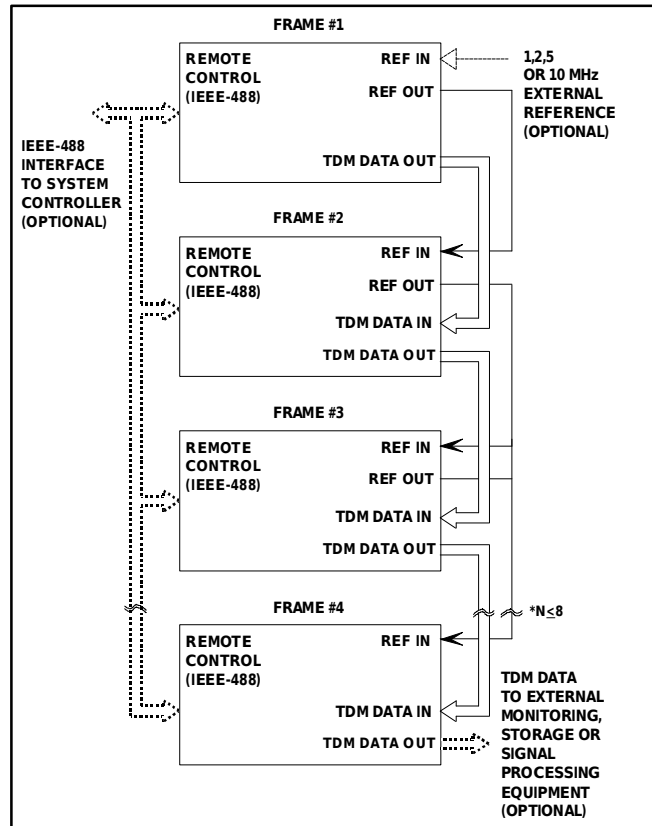
** See specifications for details

Systems Applications

The WJ-9548 incorporates several features that facilitate integration into a system. The flexibility of nonblocking baseband switching improves the use of demodulator resources compared to bridging schemes used in earlier designs. Reference frequency input and output allow easy locking of multiple units to a common system timebase. Buffered baseband outputs allow sharing of input signals among multiple units, without elaborate switching or multicoupler networks. Buffered baseband outputs are not available on the WJ-9548-1.

The WJ-9548 modularity makes it easy to maintain with a minimum amount of down time. A thorough built-in test capability quickly detects hardware faults and isolates them to the board level. Many installed boards exist in multiple quantities, reducing spares inventory. Modularity also allows the best configuration to satisfy specific system operational requirements. In many cases, off-the-shelf or custom Option Cards eliminate the need for additional demodulation or post-processing equipment. Alternate remote control interfaces, available in drop-in form, accommodate a variety of system control schemes.

Simplified Diagram shows how the WJ-9548 architecture allows up to eight units in a *stacked* configuration. In this configuration, VGC data from all units is timeshared on the TDM data bus and therefore available to the Option Cards in each unit. In systems with multiple FDM demultiplexers, as much as an eight-fold increase in the number of option boards available to each demodulator can be achieved.



Simplified Diagram for Connecting Multiple WJ-9548s in a Stacked Configuration

Input/Output Connectors

I/O	Function	Type
Inputs	4 baseband inputs (8 on WJ-9548-1)	BNC
	TDM Data input Reference input AC Power	Multipin BNC IEC Male
	Outputs	4 baseband outputs (None on WJ-9548-1) TDM Data output Reference output Headphones
Bidirectional	Remote Control	IEEE-488