

SEPTEMBER 1986

**AN OVERVIEW OF THE WJ-8969  
MICROWAVE RECEIVING SYSTEM**

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Figure 1-1. The WJ-8969 Receiver

## SECTION 1

INTRODUCTION TO THE  
WJ-8969 MICROWAVE RECEIVING SYSTEM

## 1-1. GENERAL DESCRIPTION

The WJ-8969 Microwave Receiving System is designed for wideband and narrowband applications in the Microwave frequency range. The receiving system's RF tuning range is determined by interchangeable tuner units which provide the appropriate conversion scheme and RF preselection for the desired frequency range. Four fully synthesized tuner units provide a choice of 1 to 4.5, 4 to 12.4, 12 to 18 or 1 to 12.4 GHz tuning ranges. Other tuning ranges can also be accomplished for special purposes. Receiver detection modes include simultaneous AM and FM as well as CW and Pulse. An optional Log detector is also available.

The standard receiver system is comprised of the WJ-8969/IFC IF Demodulator/ Controller and the WJ-8969/TUXXXX Tuner Units. These two half-rack units, both 3½ inches high, can be attached side by side and installed in a standard 19-inch equipment frame, or the tuning unit may be installed in a remote location. Signal and control interconnection is provided by a single 50-ohm coaxial cable that can be as long as 300 feet. Using special coaxial cables, this length may be increased up to 1000 feet (maximum cable loss of 15 dB allowable). A two-way data link on the same cable permits remote control and status indication of the tuner unit.

Four wideband IF bandwidths (160 MHz center frequency) of the customer's choice are supplied as standard with each receiver. The system can provide up to eight operator-selectable IF bandwidths comprised of four narrowband (10 kHz to 5 MHz) and four wideband (5 MHz to 50 MHz) bandwidths. Other IF bandwidth combinations are possible. The installation of any narrowband IF bandwidths (21.4 MHz center frequency) requires the installation of an optional downconversion module. Also, an optional version of the entire system allows for operation at an IF of 70 MHz.

All system control is provided via the WJ-8969/IFC IF Demodulator/Controller unit. It permits operator control from its front panel or through an interface with an external remote controlling device via the IEEE-488 interface. When in the local control mode, all system control is exercised via the front panel controls and indicators. The front panel keyboard permits rapid frequency input for discrete frequency tuning, frequency scanning, and stepping up or down in frequency by a designated step size. Conventional tuning can also be accomplished using the front panel optical encoder tuning wheel which provides variable rate tuning to 1 kHz resolution. The front panel keyboard provides rapid selection of IF bandwidths, detection mode, gain control, and tuning rate. A 24-character alphanumeric display simplifies radio operations, particularly the memory and scan functions.

All control settings are prominently displayed for operator viewing. When in remote control mode, the same control functions are exercised by the remote controlling device via the remote interface. The front panel will display the remote selections but the keyboard is disabled to prevent conflicts in the control operation.

## 1-2. OPERATIONAL CAPABILITIES

The WJ-8969 generally operates in one of four modes: Manual, Step , Scan or Lockout. All operation is accomplished at the front panel of the IFC or over the remote interface. The function of each front panel control is discussed in Section 2 while a description of different system configurations and an overview is discussed in Section 3 of this document. The following section is intended to describe, in general, the overall operation of the receiver highlighting some of the operational flexibility available.

1-2.1. Power-On. When the WJ-8969 is initially powered-up, it runs a self-test to check for any faults in the system. This feature allows for easy troubleshooting or maintenance that may be needed. Error messages are displayed in the alphanumeric display describing any errors that may be present. These error messages include power supply status, 1st and 2nd Local Oscillator lock status, tuner control status and many others. The message reporting may be cancelled if undesired. Receiver operation will continue on a limited basis depending on the error message. Also during power-on, the receiver runs a calibration mode that sets IF gain and all individual gains for each installed IF filter. This is accomplished by sending an internal signal of known amplitude over the interconnecting cable and through each filter. Another power-on software feature identifies connected tuner frequency range and installed IF filter values. After all error checking, identification and calibration is complete, the receiver enters the Manual mode of operation. The receiver continues to check for internal system errors while in operation. The total power-on sequence takes about 5 seconds.

### 1-2.2. Modes of Operation

1-2.2.1. Manual Mode. The receiver's default state of operation is the Manual mode. In this mode, the operator may tune the desired frequency by pressing the **FREQ** key and manipulating the tuning wheel or the **INC/DEC** keys, changing the frequency by an increment determined using the **TUNE RATE** key. This increment can range the 1 kHz to 1 GHz. Frequency may also be input discretely by keypad input.

After the desired frequency is determined, a number of different operations can occur. The operator may choose the detection mode desired (AM, FM, CW or Pulse), set AFC or AGC on or off, select IF bandwidth and set RF attenuation and carrier operated relay (COR) levels according to the mission requirements. The tuning wheel may be disabled on command if a set frequency is desired and accidental rotations are critically undesired. In manual mode, all of the features may be manipulated as the operator deems necessary immediately by front panel commands.

1-2.3. STEP and SCAN Modes. These modes implement part of the memory functions available in the WJ-8969. In short, there are 100 memory "cells" on-board the WJ-8969; each memory cell contains the complete receiver configuration information including tuned frequency, AGC, AFC, COR level, IF bandwidth and detection mode. The memory cells are partitioned such that the allotment of STEP, SCAN and Lockout channels is flexible. This partitioning is accomplished as part of the CONFIGURATION MENU. Over remote interface, there are 256 memory allocations available for programming.

In STEP mode, the receiver is programmed to make discrete steps from one frequency to another as they are programmed into memory. The receiver configuration may change from step to step, as necessary, offering variable detection mode, AGC, AFC or other features for different steps. This configuration flexibility in memory can aid in routine procedures and add considerably to the overall effectiveness of the system in different missions.

In the SCAN mode, the receiver is programmed to SCAN between start and stop frequencies that have been programmed into memory. Each scan segment occupies two memory channels, the first containing the START frequency and the second containing the STOP frequency. The operational software features allow for many different implementations in SCAN mode. The scan memory cells also contain complete receiver configuration information.

In the SCAN/STEP OPTIONS Menu the operator may choose to select the following commands for SCAN and STEP operations:

Multi-Sequence Scan: Allows for either a single sector or for many scan sectors to be performed in a predetermined sequence.

Queue Signal - Don't Stop: If a signal is detected during a scan or step and exceeds the COR threshold setting, the detected information may be placed in the signal queue and continue with the scan or step operation, or the receiver will temporarily pause at the detected frequency until commanded to continue.

Hold After One Pass: When selected, the receiver goes through a single step or scan sequence and does not cycle back through from start until commanded.

Detect Lead-Edge Only: This feature commands the detection mode to only detect the leading edge of a received signal.

Hold if Queue Full: The receiver will automatically queue all detected signals until the entire queue of 16 signals is full. After this occurs, a detected signal will cause the receiver to hold for operator action. For computer interfaced systems, the receiver can continue scanning if queue data is transferred; the queue may be emptied by viewing the FREQUENCY QUEUE menu in manual operation.

Half Bandwidth Scan: This implements only a half bandwidth scan within the the IF bandwidth selected.



Full Bandwidth Scan: This mode implements a full bandwidth scan of the IF bandwidth selected.

Scan Increment: This allows an adjustable frequency resolution that the receiver synthesizes to during scan. A scan is actually a fully synthesized series of steps and this allows that step size to vary from 1 kHz to 1 GHz.

The signal queue may be viewed in the FREQUENCY QUEUE Menu. When an operator enters this menu, the display allows viewing of all frequencies detected during a step or scan mode (up to 16). After one view of the signal queue, the information is erased and space is created for more intercept information.

1-2.3.1. Lockout Channels. Lockout channels contain specific frequencies or sets of frequency ranges to be avoided during SCAN operations thereby allowing a large scan to take place and avoiding a particular frequency or frequency range. When information about a signal at a particular frequency is already known and undesired, this feature helps to decrease false alarms and reduces the amount of unnecessary information an operator may need to process.

1-2.4. Memory Features. As mentioned earlier, the front panel accessible memory contains 100 channels. Over the remote interface, the memory cell allocation is increased to 256 channels. The CONFIGURATION Menu allows selection of which channel number is dedicated as the first STEP channel (default is 30, the channels 00 through 30 are SCAN channels) and the first Lockout channel (default is 60). These channel numbers may be changed to allow for exact allotment of each type of channel desired. Also in this menu, the remote interface address is selected, eliminating the need for internal switching.

When the operator is in manual mode and is operating a configuration that is desired as a memory channel, a simple press of the STORE key and selection of cell numbers enters all the information into memory. Also, if the operator would like to see what is in memory, the MEM key and the cell number of interest allows this examination. Another way to store memory information for SCAN operations is to use the SCAN SEGMENT OPTIONS Menu. This menu prompts the user for all inputs including channel number, start/stop frequencies, IF bandwidth, Detection Mode, COR level, AGC ON/OFF and AFC ON/OFF. This menu approach may help both in the training of new operators and in entering pre-mission strategies.

All channel information is maintained when power is removed; upon command, in power-up, the operator may erase all memory if desired. By pressing the EXEC key while power is applied, the receiver automatically erases all memory information.

### 1-3. SPECIFICATIONS

Tuning scheme

Frequency synthesized local oscillators  
locked to an internal or external  
frequency reference

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Frequency range	Determined by plug-in tuner unit:	
	TU0145:	1 to 4.5 GHz
	TU0412:	4 to 12.4 GHz
	TU1218:	12 to 18 GHz
	TU0112:	1 to 12.4 GHz
	(other ranges may also be accomplished)	
Frequency resolution	1 kHz	
Noise figure	15 dB, maximum 11 dB, typical	
Noise power ratio	Dependent on the characteristics of the selected IF bandwidth, typically 40 dB	
Third Order Intercept	0 dBm, typical	
Image rejection	70 dB, minimum	
SSB phase noise	<b>1 to 12.4 GHz</b>	<b><math>f_o</math></b>
	-80 dBc	1 kHz
	-83 dBc	10 kHz
	-100 dBc	100 kHz
	-118 dBc	1 MHz
Reference accuracy	3 parts in $10^7$ with provision to lock to external 10 MHz or 5 MHz reference	
RF input impedance	50 ohm, nominal	
LO level at RF input	-90 dBm, maximum	
Gain control	Manual and AGC	
Demodulation	AM, FM, CW, and Pulse	
IF bandwidths	See table 1-1.	
Single Tone Spurious-Free Dynamic Range	60 dB, minimum 65 dB, typical	
RF-to-IF Gain	15 dB, minimum	
Differential Group Delay	20 ns, typical	
Gain Control Range	0 to 99 dB	
Video Outputs	AM (Lin), FM, selected video, AM (Log) - Optional	

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Video response	dc to 1/2 selected IF bandwidth, minimum
Video output level	1 volt peak-to-peak into 50 ohms
Video output impedance	50 ohms
SM outputs	2 provided:  160 MHz at 40 MHz bandwidth 21.4 MHz at 8 MHz bandwidth (option)
SM output impedance	50 ohms
Digital control	IEEE-488 (RS-232 optional)
Dimensions	3.5 (8.89) by 8.25 (20.95) by 20 (50.8) inches (cm) (each unit)
Temperature range	Operating: 0 to 50°C (32 to 122°F) Non Operating: -20 to 80°C (-4 to 176°F)
Power requirements	115/230 Vac ±15% 47 to 400 Hz single phase 120 watts (total system)
Weight	45 lbs (total system) (20.5 kg)

Table 1-1. Available IF Bandwidths\*

<u>IF BW (kHz)</u>	<u>Center Freq (MHz)</u>	<u>IF BW (kHz)</u>	<u>Center Freq (MHz)</u>
10	21.4	2000	21.4
20	21.4	4000	21.4
50	21.4	5000	21.4
100	21.4	5000	160
200	21.4	10000	160
250	21.4	20000	160
300	21.4	36000	160
1000	21.4	*	160

\* Other IF bandwidths are available upon request. Customers may select a maximum of four narrow (centered at 21.4 MHz) and four wide (centered at 160 MHz) IF bandwidths. Consult factory for details of 70 MHz center frequency.

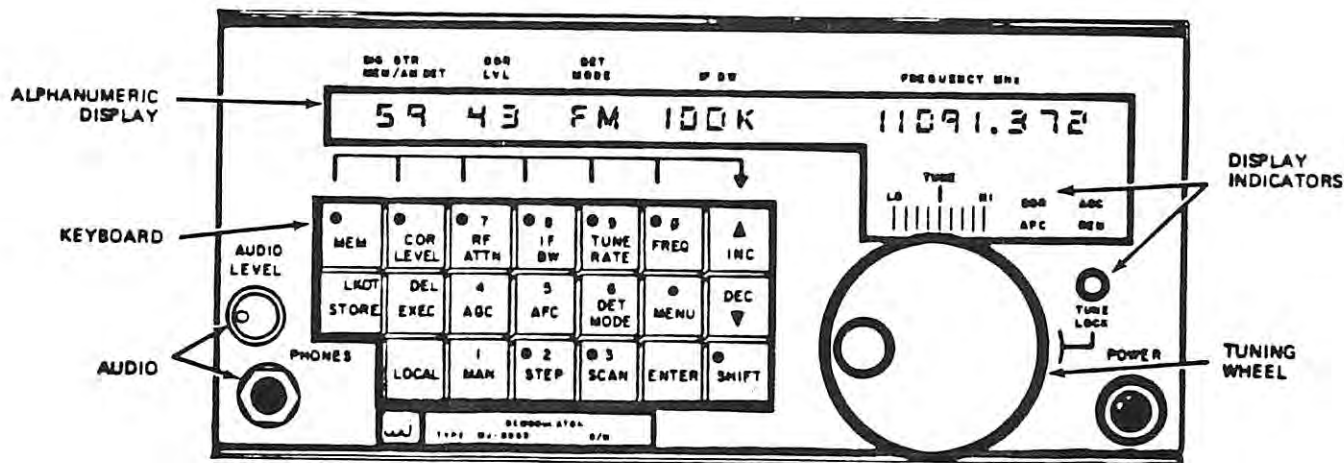
Note: All specifications are subject to change without notice and some specifications may be altered with certain trade-offs for custom applications. Consult factory for absolute specifications and other details.

SECTION 2

WJ-8969/IFC OPERATIONAL DESCRIPTION OF FRONT PANEL CONTROLS

2-1. FRONT PANEL IFC DEMODULATOR/CONTROL UNIT

The front panel of the WJ-8969 IFC Demodulator/Control unit (figure 2-1) enables local operator control and modification of the WJ-8969 Microwave Receiving System. Manual and automatic control is accessed through the front panel keyboard and the optical encoder tuning wheel. Status information is displayed on the WJ-8969 IFC front panel 24-character alphanumeric display.



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Figure 2-1. Front Panel IFC Demodulator/Control Unit

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WJ-8969/IFC Operational Description  
of Front Panel Controls

2-2. FUNCTIONAL DESCRIPTION OF WJ-8969 IFC FRONT PANEL CONTROLS

The front panel is comprised of five sections; these sections are the audio section, the alphanumeric display section, the tuning wheel, the display indicators, and the keyboard. The table below lists the functions within each IFC front panel section.

Table 2-1. WJ-8969 IFC Front Panel Controls

Audio Section:	Audio Adjustment Knob Headphone Jack
Tuning Wheel:	Tuning Wheel
Display Indicators:	Tuning Indicator Tune Lock COR - Carrier Operated Relay AGC - Automatic Gain Control AFC - Automatic Frequency Control REM - Remote Controlled
Alphanumeric Display:	24 digit alphanumeric display provides:  Tuned RF frequency IF Bandwidth Detection Mode COR Level Signal Strength AM Detection % Memory Cell Number Error Messages RF Attenuation
Keyboard:	MEM - Frequency memory examination STORE - Frequency memory storage EXEC - Configuring receiver to memory cell COR Level - Carrier Operated Relay Level RF ATTN - RF Attenuation IF BW - IF Bandwidth Selection TUNE RATE - Tuning Increment Selection FREQ - Manual Tune Frequency Selection AGC - Automatic Gain Control Selection AFC - Automatic Frequency Control Selection DET MODE - Detection Mode Selection

Table 2-1. WJ-8969 IFC Front Panel Controls - continued

## Keyboard - continued

MENU - Selection of menus  
 INC - Increment of values and functions  
 DEC - Decrement of values and functions  
 MAN - Control of manual mode  
 STEP - Control of STEP mode  
 SCAN - Control of SCAN mode  
 LOCAL - Toggle of remote or local control  
 ENTER - Enters data for values or menus  
 SHIFT - Shifts the keyboard to numeric keys

2-2.1. Audio Section. The audio section is comprised of an audio level adjustment knob and a corresponding  $\frac{1}{4}$ -inch audio output jack. The WJ-8969 receiver provides an audio representation (stretched or unstretched video) of the received RF signals. Audio outputs are provided on an 8-ohm headphone jack and on a 600-ohm unbalanced audio jack.

2-2.2. Tuning Wheel. The tuning wheel provides the control for the tuned frequency when the receiver is in the manual mode. The receiver is capable of tuning in frequency increments defined by the TUNE RATE key (see 2-2.5.5). The tuned RF frequency is displayed on the alphanumeric display with resolution to 1 kHz. Tuning is aided by a signal strength indicator located above the tuning wheel. Clockwise rotation of the tuning wheel increments the tuned frequency while counter-clockwise rotation decrements by the chosen tuning rate. The tuning increment can range from 1 kHz to 10 GHz. One rotation of the tuning wheel accomplishes 64 increments/decrements. The present increment/decrement most significant digit is constantly displayed as a cursor location on the frequency display.

2-2.3. Display Indicators. The display indicators consist of Tune Lock, AGC, AFC, REM, COR and Tune. These indicators aid the operator in recognizing the current status of the receiver. The Tune Lock lamp lights when the tuning wheel is disabled. When the tune lock lamp is lit, rotation of the tuning wheel and pressing the INC/DEC keys in the Frequency mode have no effect on the tuned RF frequency. This condition may be implemented from the keyboard in the TUNE RATE mode. When this condition is selected, the only frequency input is commanded by numeric keypad control in the frequency mode.

The AGC, AFC, REM and COR indicators are lit when their corresponding functions are active. As an example, the AGC indicator is lit when automatic gain control is selected at the keyboard. AFC, REM and COR are abbreviations for Automatic Frequency Control, Remote Control and Carrier Operated Relay, respectively. All these functions are implemented at the keyboard and are discussed in paragraph 2-2.5.

2-2.4. Alphanumeric Display. The alphanumeric display is a 24-character display showing signal strength (-dBm), output level (dB), detection mode, IF bandwidth, and tuned frequency. In different modes the display may also display a memory channel number, COR level (-dBm), IF gain (dB), RF attenuation, error messages, lockout frequencies, menu names, and other information. This display, in conjunction with the display indicators, functions as the primary information source for current receiver status.

2-2.5. Keyboard. The WJ-8969 keyboard is the source of all local control for receiver configuration and operational modes. Figure 2-2 shows the front panel keyboard layout. The keyboard encompasses a numeric keyboard that is operational when the SHIFT function is implemented. The numeric keyboard is shown near the top edge of selected keys (numbers 0-9 and decimal point). When the SHIFT key is pressed, a LED on the key is lit indicating that the shift function is enabled. Other keys on the keyboard operate in a similar manner with the LED indicators. The decimal point on the MENU key should not be confused with LED indicators located in the upper left corner of nine keyboard keys. Two other shift function keys exist (LKOT and DEL) that are discussed in paragraphs 2-2.5.8 and 2-2.5.10.

The keys marked INC and DEC (located in the upper right corner of the keyboard) are global function keys that allow incrementing and decrementing of certain values or functions. The INC/DEC keys employ an auto repeat function that allows automatic repeat of the function desired at a rate of 15 times per second. This feature is implemented by depressing and holding the INC or DEC key for longer than 0.5 seconds.

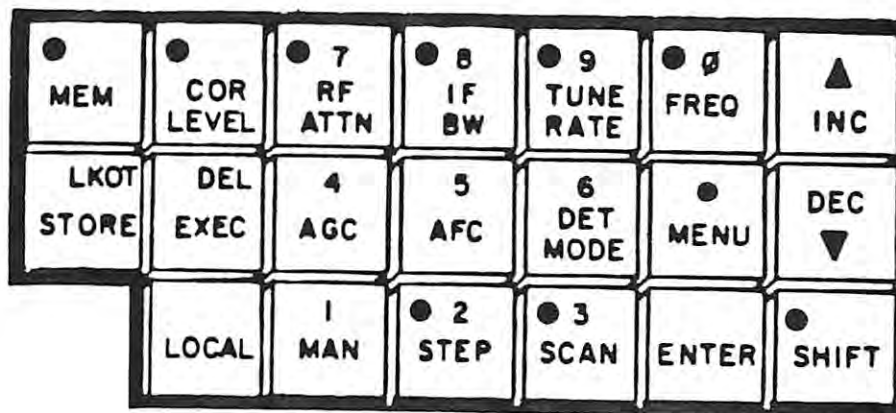
The ENTER key is used primarily to enter numeric values selected from the keyboard. Other functions require the enter key as a utility function key such as entry of menu information.

The following paragraphs describe the functions of the remaining keys beginning from the top left of the keyboard. Use Figure 2-2 for location references of all keys.

2-2.5.1. MEM Key. This is the memory key. When depressed, the LED indicator on the key lights indicating that the examine memory function is active. In this mode the display reports the memory channel number, COR level, detection mode, bandwidth and channel frequency.

The channel number being examined may be incremented/decremented by the INC/DEC keys. All channel parameters may be changed in this mode using specific edit operations. This feature allows the operator to easily determine memory status and to change memory parameters.

The 99 memory channels consist of either scan, step or lockout information, all which contain tuned frequency and other receiver status data programmed by the operator. These memory channels aid in setting up automatic scan, step and lockout strategies for routine operations or signal acquisition. Incrementing through all memory cells reports scan type (scan, step or lockout), channel number and receiver configuration on the front panel. A lockout segment requires two pressings of the INC key to view both the start and the stop frequencies of lockout.



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Figure 2-2. Front Panel Keyboard

2-2.5.2. COR LEVEL Key. This key activates the edit mode of the Carrier Operated Relay function. When pressed, the LED on the key indicates the edit mode is active. COR level may be set using the INC/DEC keys or by the numeric keypad. The display shows this level in dB referenced from carrier to noise ratio variable from 00 to 80. This feature may be set in memory channels and for the manual mode. Setting this level at different values for different scan strategies allows the operator to distinguish different thresholds within the chosen passband of the receiver.

2-2.5.3. RF ATTN Key. This key activates the edit mode of the RF attenuation function. When pressed, the LED on the key indicates the edit mode is active. RF attenuation levels may be set using the INC/DEC keys or by the numeric keys. The display shows attenuation level (in 1 dBm increments) in place of IF BW in the alphanumeric display and is variable from 00 to 99. This feature can be set in memory channels and for the manual modes. Setting this level at different values for different scan strategies allows the system to operate under varying conditions of RF energy levels. In hardware, this feature actually adjusts the IF gain through the cable.

2-2.5.4. IF BW Key. This key activates the edit mode of the IF bandwidth selection function. When pressed, the LED on the key indicates the edit mode is active. IF bandwidths may be selected using the INC/DEC keys. The system will cycle through the possible choices of IF bandwidth reflecting those bandwidths (up to eight) that are installed. The current selection is shown in the alphanumeric display. This function may be set in memory channels and for the manual mode. Selection of IF bandwidth allows particular intercept capability for varying signals, both narrowband and wideband; this



creates very flexible analysis and capture capabilities for the operator. Also at the top of the cycle of bandwidths is a bypass mode that allows full IF bandwidth unfiltered.

2-2.5.5. TUNE RATE Key. This key activates the edit mode of the variable tune rate function. When pressed, the LED on the key indicates the edit mode is active. The tuning rate may be selected using the INC/DEC keys, the tuning wheel, or numeric keys. Tuning rate may be selected between 1 kHz and 1 GHz. A cursor in the alphanumeric display shows the current most significant digit of the tune rate chosen.

After a tuning rate has been selected, the tuning wheel or INC/DEC keys will change the tuned frequency (in the frequency mode) by the selected increment. This feature allows the operator to tune using desired steps for particular intercept applications and adjustable fine and coarse tuning. This function is especially helpful when the auto repeat function of the INC/DEC keys is implemented, allowing discrete stepping without using memory channels.

One position of the tune rate choices is a Tune Lock choice. This choice is indicated by the Tune Lock lamp near the tuning wheel. When this choice is implemented, the tuning wheel and INC/DEC keys have no effect on the tuned frequency. Only discrete frequency input from the numeric keyboard is on command in the frequency mode.

2-2.5.6. FREQ Key. This key activates the tuned frequency mode of the receiver. When pressed, the LED on the key indicates this mode is active. The tuned frequency may be adjusted using the numeric keys, the tuning wheel, or the INC/DEC keys. This function works in conjunction with the Tune Rate setting. The tuned frequency is always displayed in the alphanumeric display in MHz with a resolution down to 1 kHz.

2-2.5.7. STORE Key. This key initiates a store operation to be executed in conjunction with the current memory channel number. Selection of the channel number is executed by the INC/DEC keys (see 2-2.5.1 MEM key). This key works in conjunction with the MEM key and allows storage of newly selected parameters into a selected memory channel number.

2-2.5.8. LKOT Key. This key is the shifted function of the STORE key and initiates the first lockout state. This mode sets lockout frequencies or segments within the channel memory. Frequency and IF bandwidth may be selected and set into these lockout channels. When the LKOT key is pressed, the display reads "ENT-TO LO" (Enter to lockout) and the present frequency and bandwidth. The bandwidth may be altered by the INC/DEC keys while the frequency may be altered using the tuning wheel. When ENTER is pressed, the receiver automatically enters this information in the first available lockout memory cell as a lockout frequency. For a lockout segment, pressing SHIFT and LKOT again prompts the operator to enter start frequency and stop frequency. A lockout segment only takes one memory cell but requires two viewings during examine memory operation (see 2-2.5.1).

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2-2.5.9. EXEC Key. This key works in conjunction with the MEM key and when pressed executes the selected memory channel parameters. The receiver parameters are activated to the selected channel parameters.

2-2.5.10. DEL Key. This key is the shifted function of the EXEC key and acts as a correction key for the numeric keypad. In the shift mode, the numeric keys are active for setting frequency, RF attenuation, COR level, etc., and the DEL key simply cancels the last action for corrections. The key may be pressed as many times as necessary to make the correction. Commands are not executed until the ENTER key is pressed.

2-2.5.11. AGC Key. This key simply toggles the automatic gain control function of the receiver. The display indicator marked AGC lights when AGC is active. AGC may be implemented in memory mode and the manual mode. When activated in memory modes, AGC is only active after detecting a signal. Automatic gain control is useful to the operator to maintain the desired signal levels required for signal-to-RF-to-baseband video demodulation.

2-2.5.12. AFC Key. This key toggles the automatic frequency control function of the receiver. The display indicator marked AFC lights when AFC is active. AFC may be implemented in memory and the manual modes. When activated in memory modes, AFC is only active after detecting a signal. The AFC performs within  $\pm 10\%$  of the selected IF bandwidth. Automatic frequency control is useful to the operator to maintain an unstable RF signal within the receiving passband.

2-2.5.13. DET MODE Key. This key causes the receiver to cycle through the possible detection modes of the receiver. The alphanumeric display indicates the selected mode (AM, FM, CW and pulse). This mode may be implemented in memory mode and the manual mode. The detection modes enhance the receiver's capability to intercept particular signals and allow the operator to capture and identify many types of RF signals. This key also incorporates an auto-repeat function that cycles through all detection modes at a rate of two times per second. This mode is entered by pressing and holding the key down for 0.5 seconds.

The AM and FM video outputs are not effected by the selection mode. A separate selected video output is switched according to the selection mode at the keyboard.

2-2.5.14. MENU Key. This key initiates the selection of the various menus of the receiver. Pressing this key displays the name of the first sub-menu. The INC/DEC keys display other sub-menus. ENTER causes the currently selected sub-menu to initiate the prompts of that menu (see section 1-2.3 for further clarification). There are five sub-menus:

a. SCAN SEGMENT Sub-Menu

This menu provides a means of entering the information in a scan memory channel by answering a series of questions. This information may also be entered by setting the receiver parameters and using the STORE key. A new or occasional operator will benefit from this menu driven approach. Each prompt displays the name and current

value of a parameter. The value may be saved unchanged with the ENTER key or may be changed with the keys in the usual manner for that particular parameter. The parameters are displayed in the sequence shown below.

Channel Number  
Start Frequency  
Stop Frequency  
IF Bandwidth  
Detection Mode  
COR Level  
AGC (On/Off)  
AFC (On/Off)

b. SCAN/STEP OPTIONS Sub-Menu

This menu allows the operator to determine the action taken by the receiver during a scan or step operation. Each prompt displays the name of an option and a YES or a NO indicating the current status of the option. The INC key sets the option to YES while the DEC key sets it to NO. The enter key leaves the answer unchanged and the next option is displayed. The prompts are displayed in the sequence shown below:

Multi-Sequence Scan  
Queue Signal - Don't Stop  
Hold After Signal Gone  
Hold After One Pass  
Detect Leading Edge Only  
Hold If Queue Full  
Half BW Scan  
Full BW Scan  
Scan Increment (Enter Discrete Value)

c. CONFIGURATION Sub-Menu

This menu displays the configuration parameters names and current values. Each parameter may be changed with the INC/DEC or numeric keys. The parameters are the first step channel, the first lockout channel, the remote interface address, and any parameters associated with installed options. There are 100 memory cells that may be allocated to scan, step or lockout. The first set of memory cells are SCAN (S); the cell number chosen for the first step channel determines the total number of scan cells (00 through chosen value minus 1) and the first STEP (T) cell. Likewise, the cell number chosen for the first LOCKOUT (L) channel determines the total number of step cells and total number of lockout cells (through 99).

d. ERROR DISPLAY Sub-Menu

Unless disabled, error messages are displayed on the alphanumeric display when associated errors occur. This menu is a convenient way to reexamine these messages. An error message is displayed for each

active error state (eg. +15 volt power low), the last remote error is displayed (eg. Parameter out of range) and the last front panel error is displayed (eg. Inappropriate key). This menu also allows the operator to disable error reporting.

e. FREQUENCY QUEUE Sub-Menu

This menu displays the intercept frequency information obtained during a SCAN or STEP operation. The internal signal queue contains 16 frequency spaces. Upon entering this menu the ENTER key allows viewing of all intercepts. After one view of the queue, the intercept information is erased to create space for more intercepts.

2-2.5.15. LOCAL Key. This key toggles the system operation between remote operation and local control. When the system is in remote control the display indicator marked REM lights to show that remote operation is activated. The remote address is set in the configuration sub-menu and remote control can only be accomplished if an interface has been installed in the IFC unit. All front panel functions are available by remote control and the keyboard is locked to prevent conflicts. When the LOCAL key is pressed again, control returns to the keyboard and the REM indicator is extinguished. All display information is maintained while in the remote mode for local status information.

2-2.5.16. MAN Key. This key activates the manual mode of operation when the receiver is in automatic mode. The manual key allows changing of the mode from SCAN/STEP to the Scan-pause or Step-pause modes. In these modes, receiver parameters may be changed. If the MAN key is pressed twice the receiver returns to the complete manual mode. If another control selection is pressed (STEP,SCAN) then the receiver resumes the prior configuration. This feature allows easy manipulation of current automatic modes for quick reaction or change of control.

2-2.5.17. STEP Key. This key activates the step mode for semiautomatic operation; when pressed the LED on the key lights indicating that step function is activated. The memory channel number is selected by the INC/DEC or numeric keys. After a memory channel is chosen, the STEP key LED is lit and the receiver starts stepping from the first step channel through all enabled memory channels up to the selected memory channel. When stepping, the receiver is sequentially set to the parameters stored in the memory channels.

2-2.5.18. SCAN Key. This key operates much like the STEP key with the exception that the SCAN function is activated. In the SCAN mode, a channel is selected and entered. The receiver scans from the frequency in the selected memory channel to the frequency in the next higher number channel. The memory channel provides receiver parameters for the scan. While scanning, the IF gain and COR level may be adjusted.

## SECTION 3

## WJ-8969 SYSTEM CONFIGURATIONS AND OVERVIEW

## 3-1. GENERAL

The WJ-8969, consisting of the IFC and the tuner unit, is a complete receiving system in itself. Using a single interconnecting cable between the two units allows for remote tuner applications up to 1,000 feet in separation. Further remote or multiple receiver applications may be accomplished by interfacing a system controller (such as a computer) to the IEEE-488 interface. With all control and demodulator functions available in the IFC, other peripherals may be added as needed. Many developments are being made that allow for even further expansion of the system.

This section is provided to detail all the inputs and outputs of the receiver system and to describe different system configurations that can be implemented.

3-1.1. System Connections. The WJ-8969 system consists of two units, the IFC and the RF tuner. These two units are connected by a single control (coaxial) cable that is available in standard lengths up to 300 feet. This length may be increased up to as much as 1,000 feet by use of special coaxial cables. The maximum separation distance is dictated by an allowable loss of 10 dB across the cable at the IF frequency of 160 MHz. This section describes the interface connections of the two units.

3-1.1.1. IFC Rear Panel. The IFC rear panel has 13 connectors consisting of the following:

	<u>Description</u>	<u>Type</u>
J1	AC power input	NEMA (L6-15P)
J2	IEEE-488 control	GPIB
J3	Auxiliary outputs	DBU15S
J4	21.4 MHz signal monitor (SM) output	BNC
J5	10 MHz external reference input	BNC
J6	160 MHz signal monitor (SM) output	BNC
J7	160 MHz IF input, tuner control, reference send	N
J8	AM video output	BNC
J9	Log video output (optional)	BNC
J10	Switched IF output	BNC
J11	FM video output	BNC
J12	Line Audio output (fixed)	BNC
J13	Selected video output	BNC

3-1.1.2. Tuner Rear Panel. The tuner rear panel has three connectors consisting of the following.

	<u>Description</u>	<u>Type</u>
J1	AC power input	NEMA (L6-15P)
J2	RF input	N
J3	IF output, tuner control, reference send	N

### 3-2. SYSTEM CONFIGURATIONS

The typical, single receiver system is a simple configuration consisting of two units, the IFC and the RF tuner unit. When both units are mounted side by side, they encompass one 19-inch rack, 3-1/2 inches high. For semi-remote applications, the tuner may be located away from the IFC by as much as 300 feet using a standard cable or up to 1,000 feet using special low loss cable. The single interconnecting cable relieves typical problems associated with multiple interconnecting cables. This same configuration can easily accommodate multiple receiver systems using IFC's and tuner units in matched sets as needed.

3-2.1. Remote Systems. When either multiple receiver systems or full remote systems are needed, the implementation of a master controller interconnected to the IEEE-488 interface is a cost-effective solution. Over the IEEE-488 interface, a computer such as an IBM PC could be used to control single or multiple receiver systems. Also available for system control is the Watkins-Johnson WJ-8610A controller that allows control of multiple receiver systems consisting of the WJ-8969, WJ-8615, WJ-8617 and WJ-8619 receivers. The use of bus extenders could allow for control over fiber optic links or modem/telephone links with any remote system using the IEEE-488 interface; this would allow even further and more flexible remote control.

### 3-3. NEW DEVELOPMENTS

At Watkins-Johnson Company, we are constantly developing new capabilities for existing systems based on proven designs for the expanding needs of the marketplace. This section is provided as an outline of existing developments that will be implemented for the WJ-8969 system. Other configurations are also available and encouraged so that we may develop our receiving systems for specific customer needs. Some configurations and options will become standard as the requirements become more consistent.

3-3.1. Stand-alone Tuner Units. Currently, the RF tuner units may be individually controlled internally by RS-232. The reason this exists is for our in-house testing allowing manufacturing of the two types of units to be more independent in their cycles. For a stand-alone tuner configuration, the control structure of the tuner can be expanded to allow both RS-232 or IEEE-488 external interface. This system could allow many tuners (or even just one) to be controlled by a terminal or computer deleting the need for

multiple controllers. This configuration will allow for simpler and more flexible tuner coverage in a very cost-effective manner. Also, the command software is being created to allow this type of tuner to integrate directly with the WJ-9040 modular receiving system (see Section 3-3.4).

With this control modification for stand-alone tuners, the RF tuner will be a simple package with connections for RF input, IF output, control bus, external reference input and AC power. The tuner will contain its own internal reference as well as allowing for an external frequency reference of 1, 5, 10 or 50 MHz.

3-3.2. Extended Frequency Coverage. The present design of the RF tuner allows for very flexible frequency coverage. Interchanging only the RF front end module within the tuner unit enables various RF frequency coverages. Currently, available tuners cover the following frequency ranges in the half-rack package described earlier: 1 to 4.5 GHz, 4 to 12.4 GHz, 1 to 12.4 GHz and 12 to 18 GHz. Other units (of the same size) covering 0.250 and 12.4 GHz, 0.15 to 8.0 GHz and other ranges can also be provided. A very simple adaptation of our existing 1 to 12.4 GHz and 12 to 18.0 GHz tuners results in a single full rack tuner covering 0.5 to 18 GHz. Frequency extension beyond 18 GHz is also possible.

The intent of the WJ-8969 Receiver is to offer standard frequency ranges at production prices. As illustrated, the system is very flexible for alternative frequency ranges. Certain specifications may change with varied frequency range and must be discussed if desired. Providing wideband and narrowband IF filters across the frequency ranges allows for very flexible operation. Variations in maximum bandwidth and other specifications can also be accomplished.

3-3.3. Refreshed RF Display. Currently, with the addition of the WJ-8610A controller an option is available for a refreshed RF activity display. The feature of an independent refreshed display will be made available for single or multiple systems as a stand-alone option. The addition of the refreshed display will give an operator a constantly updated picture of the RF activity as the receiver operates and will not require the purchase of the additional controller. This option will require the LOG Detector option mentioned earlier.

3-3.4. Multiple Tuner Control (WJ-1240 type). Implementing the changes necessary to accomplish the stand-alone tuner configuration (explained in 3-3.1.), leads to a system much like the WJ-1240 with added features. A central controller may interconnect with multiple tuners and integrate with multiple or single demodulators to allow for full receiver applications requiring multiple tuners. The refreshed display capability could also be implemented in this system yielding a multiple signal collection and analysis center. The tuners, being synthesized to 1 kHz steps, are more flexible and accurate than those previously available and provide outstanding specifications. Again, the tuners could be remotely located if necessary.

The WJ-9040 modular receiving system integrated with the WJ-8969 tuners also allows this type of configuration and adds the immediate capabilities of the existing WJ-9040 system units.

### 3-4. OVERVIEW

In summary, the WJ-8969 is a receiving system that is flexible for many applications. Its physical design allows for integration into small space requirements while maintaining a wide variety of control capability for varying intercept needs. The receiver is designed to accommodate many platforms with the ability to remote the tuner from the controller with only one interconnection cable and the further ability to connect to other controlling devices with IEEE-488 interface or other control structures. This last capability combined with standard available bus extension units or modems allows for even further remote control capability.

As far as performance is concerned, the WJ-8969 provides full demodulation with AM, FM, CW and Pulse outputs while using a fully synthesized tuning scheme that allows for frequency resolution to 1 KHz. The simultaneous IF outputs allow for multiple IF signal monitoring while still providing the switched IF output for other signal processing. Important specifications such as phase noise and noise power ratio (NPR) performance have been considered in the RF design to provide a system with very good measurement accuracy.

Functionally, the receiver is flexible and provides on-command manual control as well as many automatic features. The front panel is designed such that all control features are easily available and all status information is clearly visible. The built-in-test feature, error reporting and internal modular construction also make the receiver an easy device to maintain and monitor. The internal structure provides easy access to all modules that may need replacement for shortened down-time in repair or maintenance service. The IF filters are field replaceable and also allow for more operational flexibility.

In addition to its present capability, the WJ-8969 system is expanding to allow even more applications resulting in a system that can grow as customer needs grow. Any questions or inquiries about the WJ-8969 and other microwave receiving systems may be directed to Applications Engineering, Watkins-Johnson ESM Division (408) 435-1400, extension 3201.