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THE WJ-8969
MICROWAVE RECEIVING SYSTEM

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RSU-642

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Figure 1-0. 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 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. 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 (10 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.

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. 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 the receiver block diagram description 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. After all error checking 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 which includes 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 over all 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.

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 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, the channel information may be placed in the signal queue and continue with the scan or step operation.

Hold After One Pass: When selected, the receiver goes through the 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.

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.

1-2.3.1. Lockout Channels

Lockout channels contain specific frequencies to be avoided during SCAN operations thereby allowing a large scan to take place and avoiding a particular frequency or set of frequencies. 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

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
Tuning scheme	Frequency synthesized local oscillators locked to an internal or external frequency reference
Noise figure	15 dB, maximum

Noise power ratio	Dependent on the characteristics of the selected IF bandwidth, typically 40 dB
Third Order Intercept	-5 dBm, typical
Image rejection	70 dB, minimum
SSB phase noise	1 to 12.4 GHz f_o -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 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.
Video Outputs	AM (Lin), FM, selected video, AM (Log) - Optional
Video response	dc to 1/2 selected IF bandwidth, minimum
Video output level	1 volt peak-to-peak into 50 ohms
SM outputs	2 provided: 160 MHz at 40 MHz bandwidth 21.4 MHz at 8 MHz bandwidth (option)
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

Table 1-1. Available IF Bandwidths*

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

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.

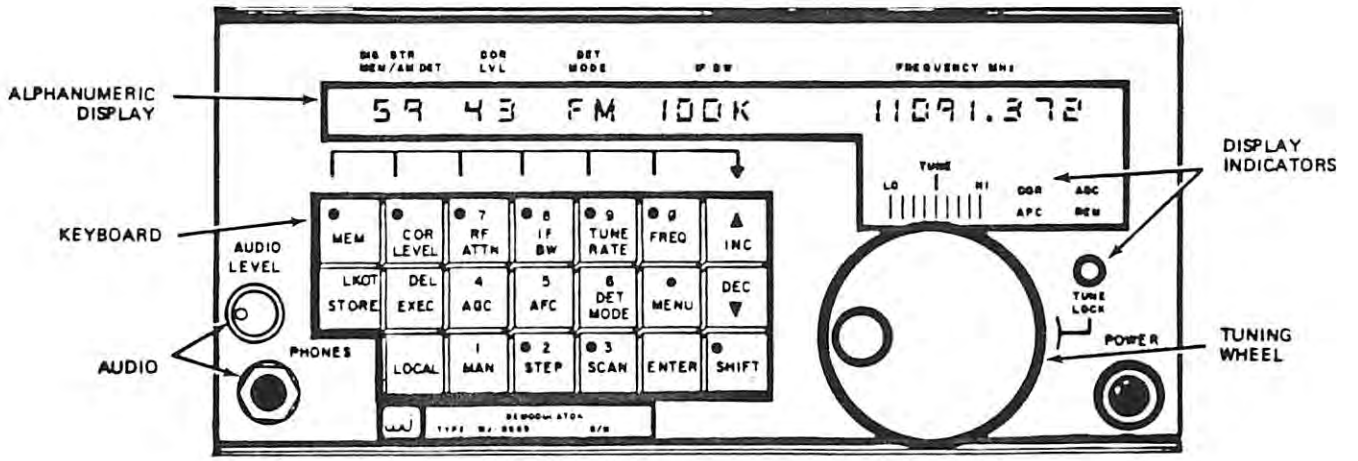

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Figure 2-1. Front Panel IFC Demodulator/Control Unit

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
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 Rate Selection FREQ - Manual Tune Frequency Selection AGC - Automatic Gain Control Selection AFC - Automatic Frequency Control Selection DET MODE - Detection Mode Selection MENU - Selection of menus INC - Increment of values and functions DEC - Decrement of values and functions

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

Keyboard - continued	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 ¼-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 1 kHz synthesized frequency steps. The tuned RF frequency is displayed on the alphanumeric display. 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. 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 and will be specifically mentioned when discussing those functions.

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, 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 receiver parameters.

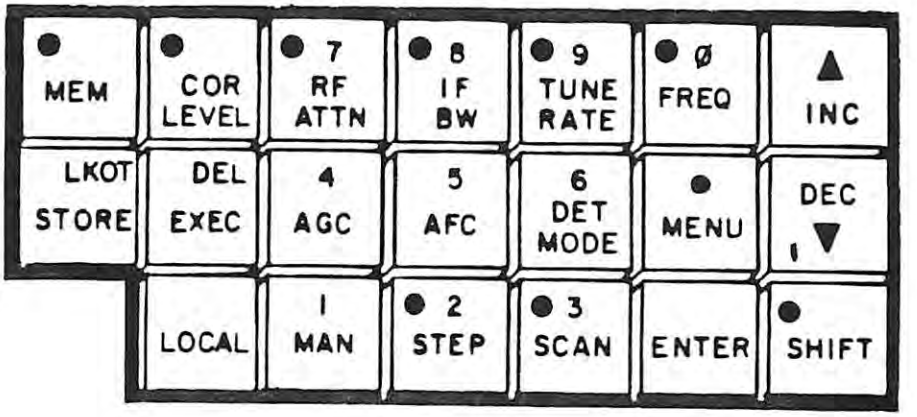

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Figure 2-2. Front Panel Keyboard

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.

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 minus dBm variable from 00 to 80. This feature is 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.

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 frequency lockout segments within the channel memory. Frequency and IF bandwidth may be selected and set into these lockout segments.

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. 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. 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.

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. There are four 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 the usual manner for that particular parameter. The parameters are displayed in sequence.

b. SCAN/STEP OPTIONS Sub-Menu

This menu allows the operator to determine the action taken by the receiver when a signal is found while scanning or stepping. 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.

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.

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.

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 MICROWAVE RECEVING SYSTEM BLOCK DIAGRAM DISCUSSION

3-1. WJ-8969 MICROWAVE RECEIVER

The WJ-8969 Microwave Receiver is divided into two separate units: the WJ-8969/IFC IF Demodulator and Controller (IFC) and the WJ-8969/TUXXXX RF Tuner Unit. The RF tuner unit provides the frequency translation function of converting the RF input frequencies to an IF output of 160 MHz. The RF to IF conversion is accomplished using synthesized local oscillators with a 1 kHz tuning step size. Frequency coverage of the tuner unit is dependent only on the RF front-end assembly as explained in paragraph 3-2.2. All other modules in the tuner remain unchanged and are independent of frequency coverage.

The IFC performs two main functions, IF demodulation and receiver control. IF demodulation includes AM and FM, as well as CW and pulse. Control of the WJ-8969 receiver is through either front panel controls or by an external computer/controller via the IEEE-488 interface bus.

3-2. WJ-8969/TUXXXX RF TUNER UNITS

The WJ-8969/TUXXXX RF tuner consists of 7 major assemblies (refer to the tuner block diagram in figure 3-1). These assemblies include the power supply/microprocessor assembly, the RF front end assembly, the first LO synthesizer assembly, the YIG oscillator assembly, the IF assembly, the second local oscillator assembly, and the reference/multiplexer assembly. Each of these RF tuner assemblies is described briefly in the following paragraphs. Information is given to explain the function, performance and design considerations of the particular tuner assembly.

3-2.1. A4 - Microprocessor/Power Supply Assembly

The power supply and microprocessor discussions have been combined as they form a separate assembly in the tuner. The power supply is a switching type power supply that operates from 110/220 Vac, 48 to 440 Hz single phase input power. The power supply outputs consist of regulated 8 Vdc and unregulated ±20 Vdc.

The ac input to the tuner is passed through line filter board to assist in meeting RFI/EMI standards. The power supply outputs are routed to a separate dc regulator board that supplies the majority of tuner modules with their dc voltages. The purpose of the separate regulator board is to allow the microprocessor to turn the dc regulators on or off with a TTL command.

The power on/off feature enables the RF tuner, when remotely mounted, to be powered down and placed into a stand-by mode when not in use. The switching frequency of the power supply is 96 kHz. Because the power supply switching frequency is outside the loop bandwidth of the RF tuner's local oscillators, the switching frequency signals are easily filtered with conventional dc feedthrough and decoupling filters.

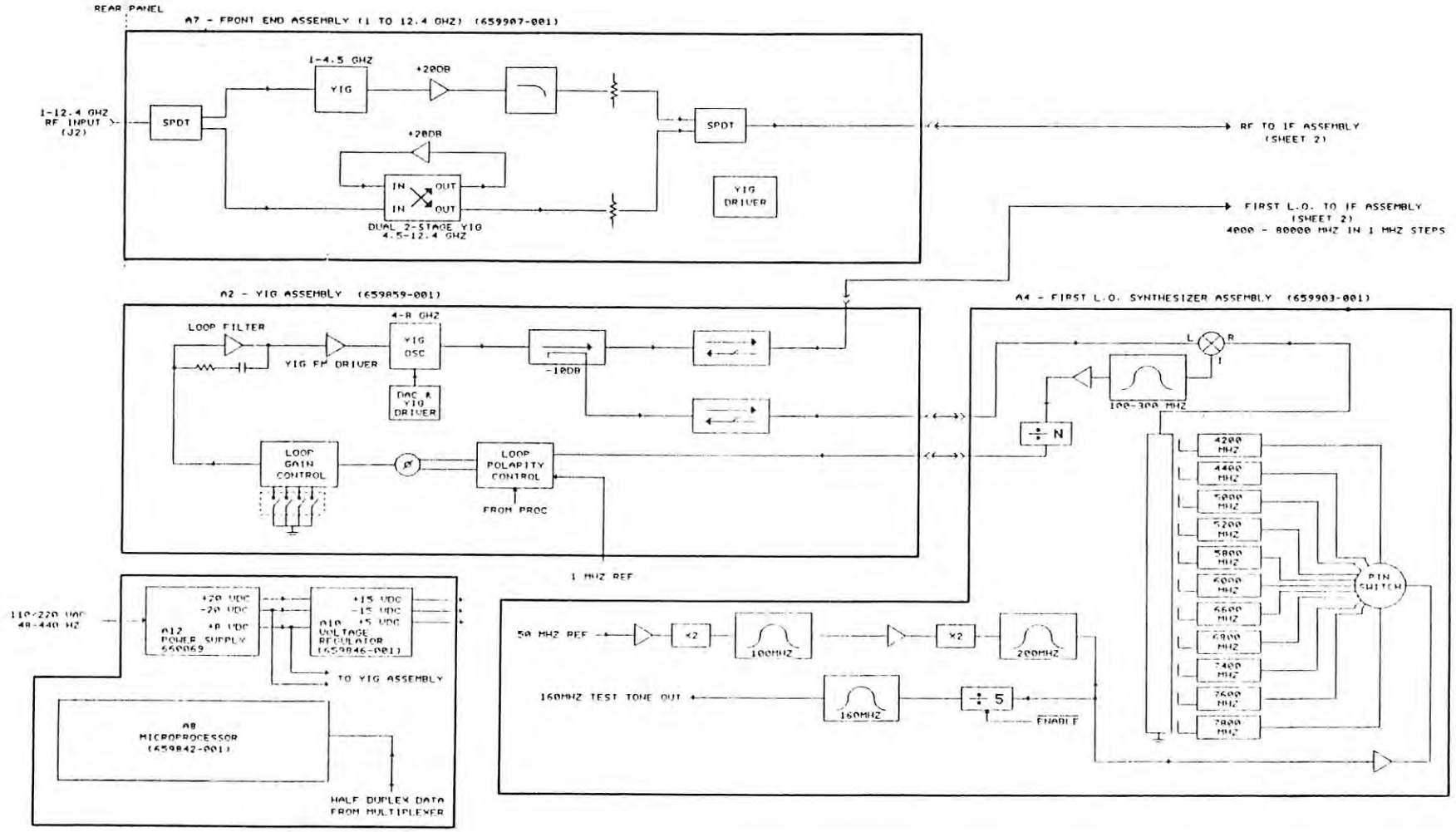

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Figure 3-1. WJ-8969 Tuner Block Diagram (Sheet 1 of 2)

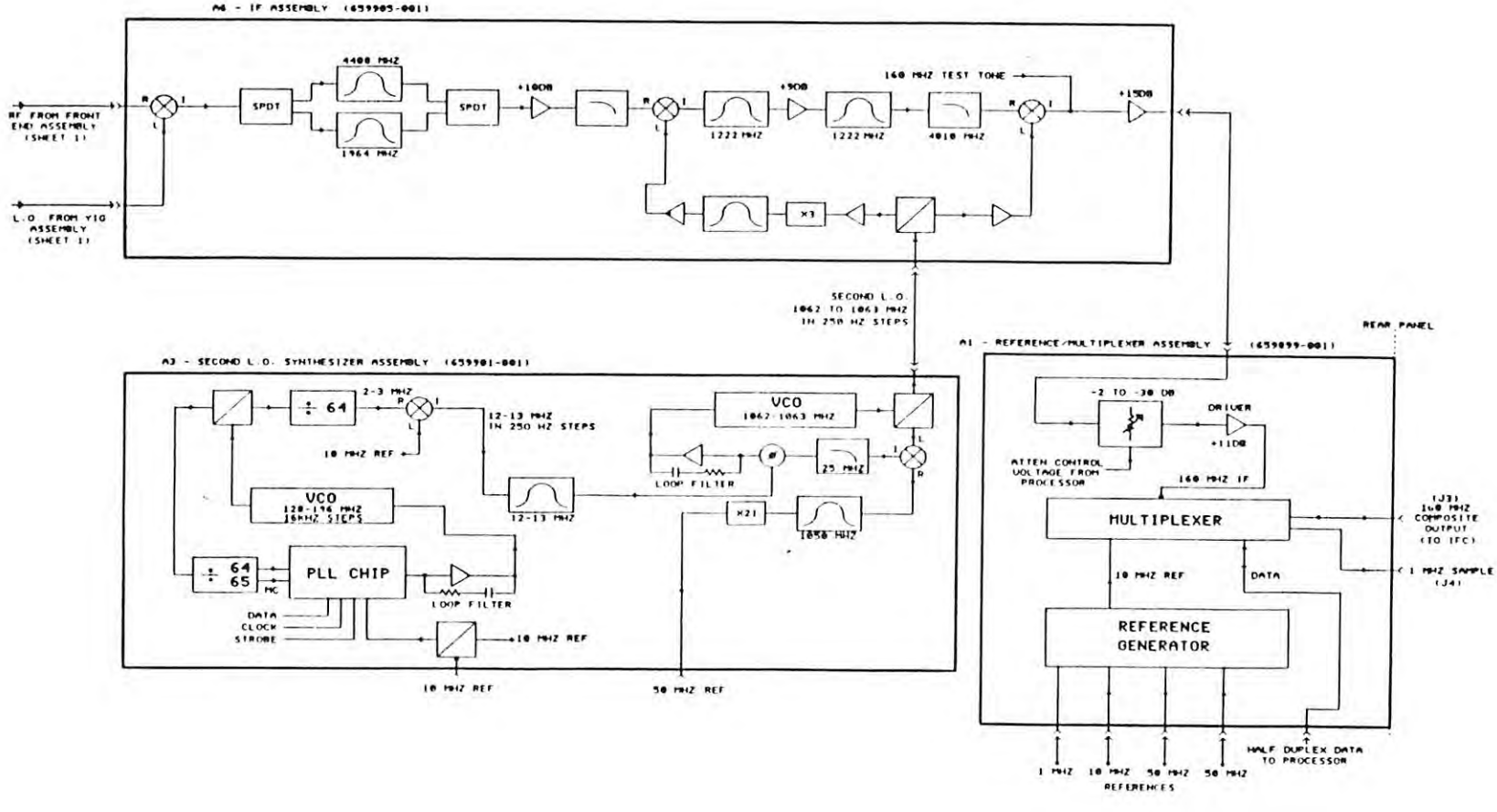

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Figure 3-1. WJ-8969 Tuner Block Diagram (Sheet 2 of 2)

The microprocessor circuit card assembly has its own 8 Vdc to 5 Vdc regulator that maintains dc power to the microprocessor circuits when the RF tuner is placed into the stand-by mode. The incorporation of a microprocessor into the RF tuner unit enables the tuner to manage its own functions through software control. The RF tuner microprocessor communicates with the IFC through serial data commands. In addition, the microprocessor circuit card assembly contains a separate RS-232C port which is used for test and troubleshooting of the tuner when an IFC is not available. The microprocessor receives commands and performs the necessary calculations and sends out control signals to the various tuner modules.

3-2.2. A7 - Front-end Assembly (1.0 to 12.4 GHz)

As mentioned earlier, this assembly is the only assembly that determines the actual RF input frequency range. For the purpose of this discussion, explained below and shown in the block diagram is the front-end that tunes from 1.0 to 12.4 GHz.

RF signals in the 1.0 to 12.4 GHz frequency range enter the RF tuner unit through a rear panel type N female connector and are routed to the RF front end module. The RF front-end module performs the switching, preselection, amplification, and control of the YIG filter driver. An SPDT RF switch is placed at the RF input to switch the received RF signals to one of two preselection selections.

For the 1.0 to 4.5 GHz frequency range, the RF input signals are filtered by a YIG preselector. The YIG filter provides approximately 40 MHz of RF bandwidth with 4 dB of insertion loss. The RF signal is then routed to an amplifier which has a low noise figure and approximately 20 dB of gain.

The low pass filter following the amplifier minimizes the broadband amplifier noise entering the first conversion mixer. In addition, this filter also provides further image rejection and LO radiation beyond that of the preselector filter.

For the 4.0 to 12.4 GHz frequency range, the receiver uses a dual two stage YIG filter for preselection. The YIG filter provides a nominal 50 MHz of bandwidth in addition to its image rejection and LO radiation rejection. Inserted between the pre and post selector sections of the dual stage YIG filter is a 4 to 12.4 GHz amplifier. The 4 to 12.4 GHz amplifier provides the necessary gain and sets the receiver noise figure. By following the amplifier with the post selector section of the YIG filter, broad band noise is rejected before the mixer.

A SPDT RF switch is used to combine the RF signals from the 1.0 to 4.5 GHz and 4.5 to 12.4 GHz frequency ranges and routes the RF signals to the tuner's first conversion mixer.

The YIG driver and control circuit board are also part of the RF front-end assembly. The control circuit board provides the circuitry necessary to apply power to the preamplifiers or YIG filters being used for the particular tuned frequency.

3-2.3. IF Frequency and Local Oscillator Architecture

RF input frequencies are converted to one of two IF frequencies by using a synthesized local oscillator. The first conversion IF frequencies are 4408 MHz and 1964 MHz. The first local oscillator (LO) conversion is accomplished using a single 4 to 8 GHz LO. When the receiver is tuned below 3 GHz, the 4408 MHz IF is used with the LO on the high side. When tuned between 3 and 6 GHz, the 1964 MHz IF is also used with a high side LO. From 6 to 9 GHz, the 1964 MHz IF is used with the LO on the low side. From 9 to 12 GHz, the 4408 MHz IF is used with the LO on the low side.

The selection of the 4408 and 1964 MHz IF frequencies keeps the LO and image frequencies far away from the tuned frequency. This results in rejection of image and LO frequencies and allows for wide band RF frequency coverage with a 4 to 8 GHz LO. The two IF frequencies are necessary to prevent RF feedthrough when tuning through the IF frequency.

3-2.4. A4 - 1st Local Oscillator and A2 - YIG Assemblies

The 1st LO is comprised of two modules: the 1st LO synthesizer assembly and the YIG assembly. Together, these assemblies provide a synthesized LO which tunes with a 1 MHz step size. As with most microwave phase locked loop designs, a sample of the YIG oscillator output is downconverted to a lower frequency for processing in the phase lock loop operation.

The 1st LO assembly uses a 50 MHz crystal-generated reference signal, multiplied to a 200 MHz signal and amplified to drive a step-recovery-diode (SRD)/filter assembly. The output of the SRD/filter assembly is a fixed picket of 200 MHz in the range of 4200 MHz to 7800 MHz. The fixed picket signal provides the YIG downconversion RF signal. The output of the downconverted LO is an IF signal of 100 to 300 MHz, which is then programmably divided and fed to the phase detector loop circuitry.

The phase detector loop circuitry compares the downconverted LO signal to the reference 1 MHz frequency and thus provides the necessary correction to the YIG oscillator, via the oscillator FM coil input lines, to maintain a synthesized tuning step size of 1 MHz. The 1 MHz reference frequency allows the tuner to utilize a wide loop bandwidth, resulting in a low phase noise LO signal output with a 1 MHz resolution.

3-2.5. A6 - IF Assembly

The preselected RF input and the 1st LO signals converge at the first mixer on the IF assembly. When the 1st LO is tuned to produce one of the two IF frequencies, 4408 and 1964 MHz, the IF output from the mixer is passed through one of two 1st conversion bandpass filters by two SP2T switches. Next, a 10 dB gain amplifier is inserted into the signal path to boost the gain and to maintain good noise figure performance. The amplifier is then followed by a low pass filter to limit broad band noise.

The 1st IF frequency is then converted to a secondary IF frequency using the 2nd LO. The 2nd LO at 3186 MHz lies directly between the two 1st IF frequencies and produces a single IF frequency of 1222 MHz. The 1222 MHz

IF frequency passes through filters and an amplifier and arrives at the final conversion mixer. An LO frequency of 1062 MHz is used here to downconvert the 1222 MHz IF to the final IF frequency of 160 MHz.

Following the final 3rd conversion mixer is another amplifier whose function is to restore the signal gain. Note that the two LOs used in these conversions are harmonically related to each other. The 3186 MHz LO is the third harmonic of the 1062 MHz LO. To obtain these signals the 2nd LO signal at 1062 MHz enters the IF assembly and is power divided and buffered. One of the resulting signals is tripled and amplified to become the LO for the 2nd conversion and the other signal is used as the LO for the 3rd conversion.

3-2.6. A3 - 2nd Local Oscillator Assembly

The 2nd LO signal is a variable RF signal. The 2nd LO tunes in 250 Hz steps and increases the tuner resolution from 1 MHz, with the 1st LO, to 1 kHz. Because the 2nd LO is utilized twice in the conversion process (once after being tripled), its 250 Hz resolution is effectively quadrupled to 1 kHz.

The 2nd LO utilizes a dual loop design. While more complex than single loop phase lock loop (PLL) designs, the 2nd LO is able to provide fine resolution (250 Hz) while maintaining high quality phase noise comparable to single loop PLL designs using much larger step sizes.

The 2nd LO main (output) loop is a very simple, non-programmable loop which locks the 1062 MHz output VCO to a 12 MHz reference signal. The VCO output is mixed with a fixed 1050 MHz crystal-generated reference to obtain the 12 MHz needed for phase comparison at the phase detector input. With the high reference frequency a wide loop bandwidth can be utilized to minimize phase noise at the output. The reference loop itself tunes from 128 to 160 MHz in 16 kHz steps. Normally such a small step size portends poor phase noise performance, but since the output frequency is low this is not a problem.

Phase noise is further reduced, and resolution increased to 250 Hz steps, by first passing the output through a fixed divide-by-64 IC. This signal (approximately 2 MHz) is upconverted with a 10 MHz signal to provide the 12 MHz reference to the main loop, transferring its 250 Hz resolution to the 2nd LO output.

3-2.7. A1 - Reference/Multiplexer Module

The remaining module in the RF tuner is the reference/multiplexer module. The reference/multiplexer module serves two purposes. First, the module contains a 50 MHz reference crystal oscillator which is used to generate all the reference frequencies for the tuner's oscillators. The 50 MHz oscillator is itself phase locked to the 10 MHz reference oscillator located in the IFC reference multiplexer module.

Power and frequency divider circuits in the reference generator module provide two 50 MHz signals, one 10 MHz signal and one 1 MHz reference signal required by the tuners' phase locked loops. The reference/multiplexer module's other function is to frequency multiplex the tuner's IF frequency,

the receiver's 10 MHz reference signal and half duplex data from and to the IFC unit onto a single 50 ohm coaxial cable.

The reference/multiplexer module is capable of driving up to 300 feet of cable with a maximum insertion loss of 10 dB at 160 MHz. The single cable receiver interconnection is a unique feature which is particularly useful for situations where the tuner is to be remotely located from the IFC unit and eliminates the need for large bundles of cables in the receiving system.

3-3. WJ-8969/IFC IF DEMODULATOR AND CONTROLLER UNIT

The WJ-8969/IFC IF Demodulator and Controller unit contains four major functional blocks plus the necessary microprocessor and control circuits. The four blocks include the reference/multiplexer module, the 21.4 MHz filter/converter module, the 160 MHz filter/gain module and the demodulator module. Each of these blocks is briefly described, giving information regarding signal paths, performance and design considerations. Refer to the WJ-8969/IFC block diagrams for the following discussions (figure 3-2).

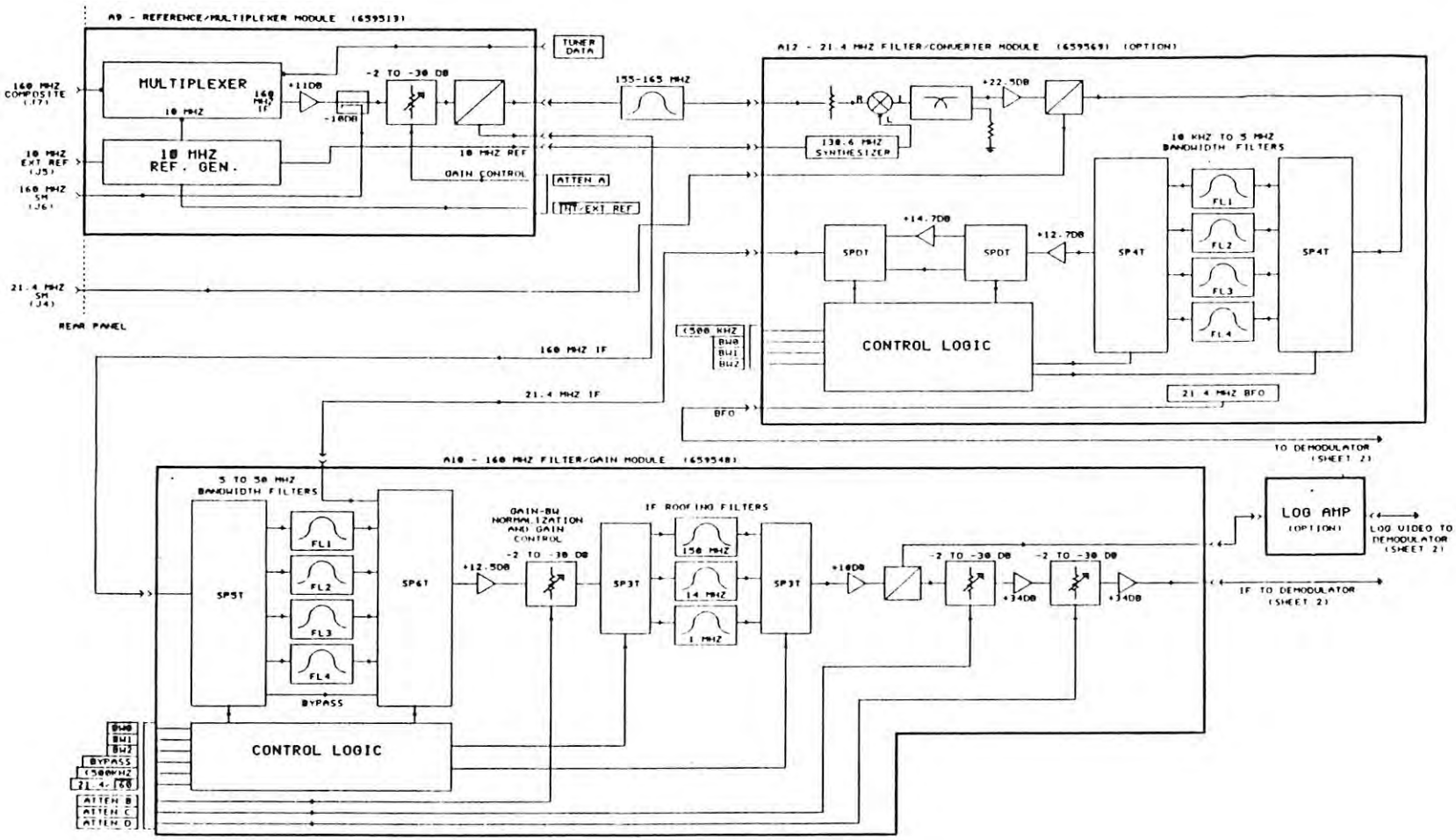
3-3.1. A9 - Reference Multiplexer Module

The WJ-8969/IFC unit contains a reference/multiplexer module very similar to the module located in the RF tuner unit. The reference/multiplexer module generates the necessary reference signals needed by the IFC and RF tuner units and performs a frequency multiplex/demultiplex of the half duplex data, 10 MHz reference, and 160 MHz IF onto the receiving system's single interconnecting cable.

The 10 MHz reference signal is provided by a high stability temperature compensated crystal oscillator. When an external 10 MHz reference signal is applied to the rear panel of the receiver, the internal 10 MHz crystal is switched off. The receiver's frequency accuracy performance is thus dependent upon the external reference used.

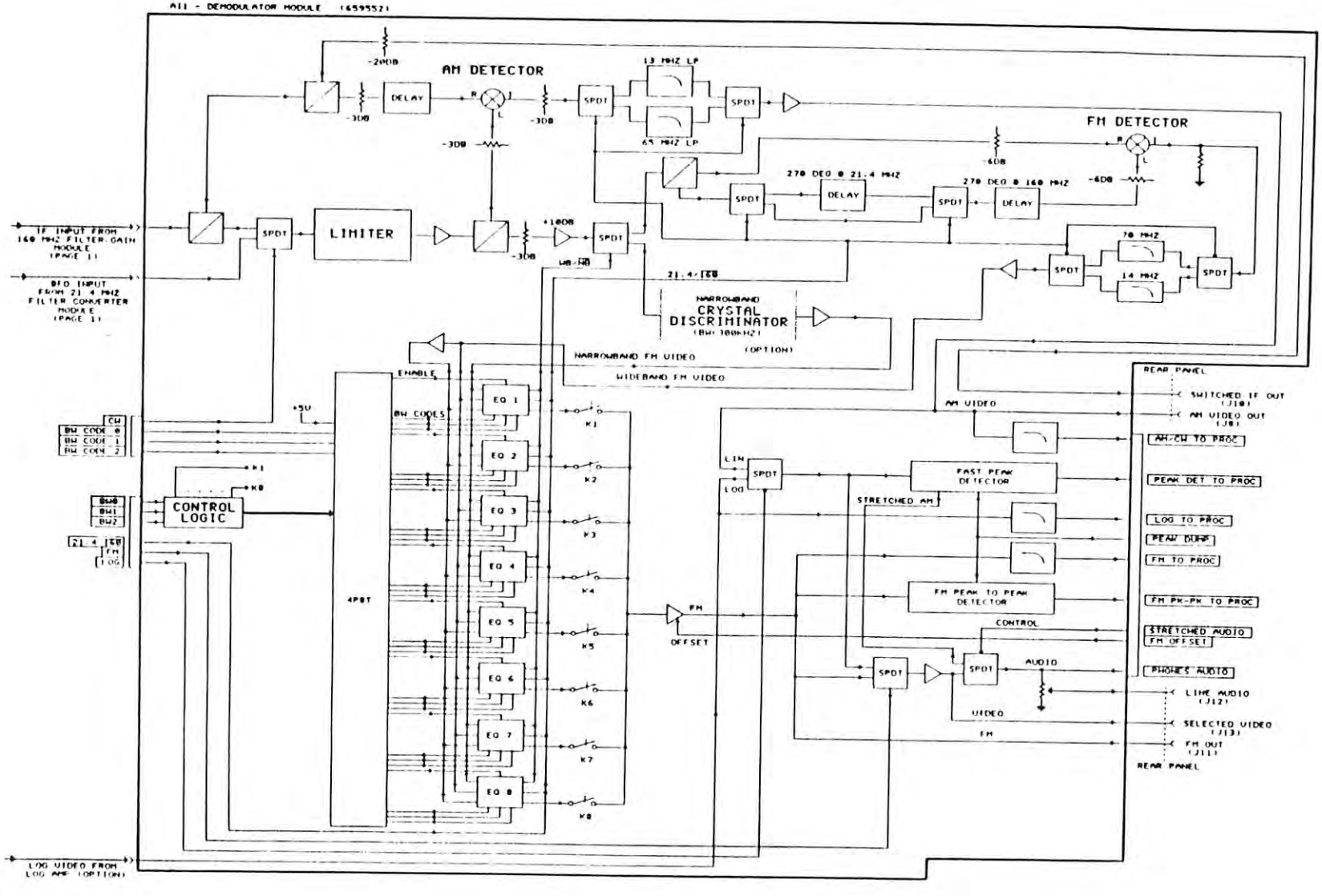
The 10 MHz signal is filtered and sent to the 21.4 MHz filter/converter module as a reference. The 10 MHz signal is also bandpass (multiplexed) filtered and sent out over the interconnecting cable to provide a reference for the tuner. The serial data to and from the tuner is low pass filtered and put on to the same interconnecting cable.

The 160 MHz IF from the tuner is high pass filtered to remove it from the input cable aggregate signal. The IF signal is then amplified. A coupler follows the amplifier with the 10 dB coupled port becoming the WJ-8969 receiver's 160 MHz IF output (J6).



86.C.8132/1

Figure 3-2. Block Diagram WJ-8969 IFC (Sheet 1 of 2)



86.C.8132/2

Figure 3-2. Block Diagram WJ-8969 IFC (Sheet 2 of 2)

The output of the coupler is sent through a variable attenuator which provides up to 30 dB of range and is used to adjust for cable losses and general gain distribution in order to maximize dynamic range of the receiver. Following the attenuator is a power divider, with one output going to the 21.4 MHz converter/filter module and the other output going to the 160 MHz filter/gain module.

3-3.2. A10 - 21.4 MHz Converter/Filter Module (Optional)

The 21.4 MHz converter/filter module performs the special processing of the 160 MHz IF necessary to provide the narrow bandwidth filtering for the 21.4 MHz IF. The 160 MHz IF output from the reference/multiplexer module is passed through a 10 MHz bandwidth filter. This filter removes interfering signals at and about 117.2 MHz, which is the image frequency of the converting process performed in the mixer at the input of the converter module.

A 138.6 MHz crystal oscillator, which is phase locked to the reference oscillator, is used to mix with the 160 MHz IF to produce a 21.4 MHz IF. The output of the mixer is low pass filtered and amplified. The output of the amplifier is power divided. One half of the signal is brought out to the back panel as the 21.4 MHz IF output while the other signal is switched through one of up to four different 21.4 MHz filters.

The bandwidth selection is from a minimum of 10 kHz to a maximum of 5 MHz. The output of the bandpass filters is amplified once for bandwidths greater than 500 kHz and twice for bandwidths less than 500 kHz. The 21.4 MHz signal from this module is sent to the 160 MHz filter/gain module.

3-3.3. A10 - 160 MHz Filter/Gain Assembly

The 160 MHz IF signal from the reference/multiplexer module is also routed to the 160 MHz filter/gain module. The signal is passed to the pin diode switches used to select the desired wideband IF filter. Four filters can be accommodated in the assembly, with bandwidths in the range of 5 MHz to 50 MHz. The filters are plug-in types which are easily field replaceable, but must be configured to correspond to plug-in equalizer packs in the demodulator assembly. The 21.4 MHz bandlimited IF signal is also routed to this module.

The 21.4 MHz IF signal or the 160 MHz IF signal from the selected narrowband filter is passed to the remainder of this IF chain. The selected IF signal is buffered before encountering a voltage controlled attenuator. The majority of the attenuation available at this point is used for bandwidth normalization, while the remainder is used for manual and automatic gain control.

One of three IF roofing filters is switched into the signal path after the attenuator. The bandwidth of the filter is at least three times the IF bandwidth and is used to limit the broadband noise from the preceding amplifier. Following the roofing filters, the IF input signal is passed through the IF gain control circuitry. This circuitry incorporates a series of amplifiers and voltage controlled attenuators to provide the necessary range of gain control.

The 160 MHz filter/gain module allows a minimum of 60 dB of gain control, in addition to the 30 dB of gain control located in the reference/multiplexer

module. The individual attenuators are controlled by the microprocessor in both the automatic and manual modes. The IF output signal is routed to the demodulator assembly.

3-3.4. A11 - Demodulator/Video Switcher Assembly

The demodulator module receives the final IF signal from the 160 MHz Filter/Gain Assembly. As the final IF signal is bandwidth defined and gain controlled, the demodulator module converts the IF signal to baseband video with amplitude and frequency detectors.

Upon entering the demodulator module the IF signal is power split. One half of the IF signal is directed to the limiter circuitry which removes the amplitude information from the IF signal. The other half of the IF signal is split again. One half is attenuated and sent to the back panel to become the switched IF output (J10). The other half is sent to a mixer where it is converted to AM baseband by mixing with the input IF signal coming out of the limiter.

The detection circuitry is called a synchronous detector. This detector provides an extended dynamic range of 40 dB (typical). This compares to a simple diode detector where only 25 dB of dynamic range is typical.

The output of the AM detector mixer is passed through a low pass filter which is switched to remove any 160 MHz or 21.4 MHz interference. The baseband video is then amplified to the proper signal level to drive the low impedance AM video output (J8). A second output of the limiter is used to drive one of three FM discriminators. For wideband signals (10 MHz or greater), a 160 MHz delay line discriminator is used. For medium bandwidths (0.5 to 5 MHz), a 21.4 MHz delay line discriminator is used. For the narrow bandwidths (300 kHz or less), a special crystal discriminator is used.

The outputs of each of these discriminators is sent to equalizer networks. As a function of the selected IF bandwidth, the corresponding equalizer is selected to process the appropriate discriminator output for both gain and video bandwidth. In addition, the equalizers inform the control unit of the operator selected IF bandwidth.

Field replacement or alteration of bandwidths can be accomplished merely by changing the desired filter and video equalizer. The FM video output of the equalizer is amplified to the proper level to drive the low impedance FM video output (J11). With both AM and FM video simultaneously available, an analog switch is used to select the desired video. Once selected, it is buffered and again amplified for the low impedance video output (J13). A part of the selected video signal is tapped off and processed to become the line audio output (J12) and the head phone audio output available on the front panel.

Additional circuitry in the demodulator performs peak detection of both AM and FM video signals which the controller uses to perform AGC and AFC functions. The audio circuitry uses the pulse stretching circuitry to provide stretched audio to enhance the audible detection of pulse signals.

SECTION 4

WJ-8969 SYSTEM CONFIGURATIONS AND OVERVIEW

4-1. 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 the 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.

4-1.1. 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. This section describes the interface connections of the two units.

4-1.1.1. IFC Rear Panel

The IFC rear panel has 13 connectors consisting of the following:

	Description	Type
J1	AC power input	AC line
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

4-1.1.2. Tuner Rear Panel

The tuner rear panel has three connectors consisting of the following.

	Description	Type
J1	AC power input	AC line
J2	RF input	N
J3	IF output, tuner control, reference send	N

4-2. 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.

4-2.1. 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. A full discussion of the bus architecture for the WJ-8969 is provided in Appendix A. Over the IEEE-488 interface, a computer such as an IBM PC could be used to control single or multiple receiver systems. This approach is described in Appendix B. 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 WJ-8610A controller is explained in more detail in Appendix C. 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.

4-3. 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.

4-3.1. 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 may impact the size of the RF tuner but will allow for simpler and more flexible tuner coverage in a very cost-effective manner.

With this control modification, 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 or 10 MHz.

4-3.2. 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.

4-3.3. 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 independant 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.

4-3.4. Multiple Tuner Control (WJ-1240 type)

Implementing the changes necessary to accomplish the stand-alone tuner configuration (explained in 4-3.1.), 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.

4-4. OVERVIEW

In summary, the WJ-8969 is a receiving system that is flexible for many applications. It's 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 and error reporting also make the receiver an easy device to maintain and monitor. The internal structure provides easy access to all active units that may need replacement for shortened down-time in repair or maintenance service.

In addition to its present capability, the WJ-8969 system is expanding to allow even more applications resulting is 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.

APPENDIX A

WJ-8969 REMOTE INTERFACE

A-1. GENERAL

The IEEE-488 remote interface provides talk and listen capabilities between the receiver and external equipment, such as calculators or computers. If the reader intends to understand the remote operation in any detail, he/she should be familiar with IEEE-488 bus operation in general. This information is available from other sources and is not covered here. The WJ-8969 with remote interface will implement the following IEEE-488 bus capabilities.

SH1	Source handshake
AH1	Acceptor handshake
T6	Basic talker with serial poll
L4	Basic listener with serial poll
SR1	Service request
DC1	Device clear

This means that the receiver can talk or listen when commanded by the controller. It can also issue a service request to the controller when it needs service.

A-2. DATA TRANSFER TYPES

Two types of data transfers are supported: one standard for the receiver and one available as an option. One type of transfer is called ASCII mode and uses ASCII characters to communicate over the remote interface. A command sequence may be terminated with a CR, LF (Carriage Return, Line Feed) or LF or with EOI (End of Identity) asserted on the last character transferred. Mnemonics with any required arguments may be strung together with semicolons. (mnemonic arg; mnemonic arg;....) The other type of data transfer is binary mode. The binary mode IEEE-488 interface capability is the receiver's optional supported remote interface capability. The binary mode interface requires less bytes to be transferred over the bus than with ASCII mode. In binary mode, the last byte of a command must assert EOI. Commands may not be strung together and space, semicolon, CR and LF can not be sent.

A-2.1. General Mneumonic Structure

In ASCII mode the mnemonics are sent as two to four ASCII bytes followed by any arguments in base 10 represented by ASCII bytes. Frequencies are in MHz and decimal points are permitted for frequency arguments only. Multiple arguments are separated by commas. Spaces are ignored. Upper or lower case characters may be used. In binary mode each command is sent as one byte and frequency arguments are in packed decimal. (4 bytes; 2 digits per byte, most significant digit in most significant half of first byte). All other arguments consist of one binary byte. Spaces are not allowed.

In ASCII mode only ASCII commands are recognized and all responses are in ASCII. In binary mode only binary commands are recognized and responses are in binary. In addition to the mnemonics, the receiver responds to the

IEEE-488 defined commands of device clear and selected device clear. These commands set SRQ and cause the input and output buffers and the queue to be emptied.

Any message in progress is aborted.

In general the action caused by each mnemonic that is not a query is equivalent to pressing one or more keys on the front panel. To determine the exact action of each mnemonic, the reader should refer to the section on front panel controls and determine the exact action caused by these equivalent keys.

A-2.2. Receiver Commands

Most of this section is organized as a list of commands that may be sent to the receiver when it is addressed by the IEEE-488 as an active listener. For each command that expects a response, the forms that the response may take is listed next in brackets. This is followed by an explanation of the command. All binary commands and responses are in hexidecimal inside parenthesis and follow the ASCII commands and responses. The command and response argument types are listed below.

- n A base 10 number represented in ASCII. The maximum range is 0 to 255 but the nature of the argument will usually limit the permissible range further.
- f A frequency argument in MHz of the form "xxxxx.xxx" represented in ASCII. Digits may be left of either end and the decimal need not be present.
- b A binary byte.
- p Five packed decimal bytes representing a frequency in kHz (See above)
- a An ASCII text string.

COMMAND ASCII	COMMAND BINARY	[RESPONSE] AND EXPLANATION
AFC	(42)	Set AFC mode.
AFC/	(43)	Reset AFC mode.
AFC?	(44)	[AFC,AFC/] (42,43) What is AFC mode?
AGC	(45)	Set AGC mode.
AGC/	(46)	Reset AGC mode.
AGC?	(47)	[AGC,AGC/] (45,46) What is AGC mode?
AM	(48)	Set AM detect mode.
AM?	(4A)	[AM n] (48 b) How much is AM modulation?
	(55)	Set ASCII mode.
BIN	(none)	Set binary mode.
Bw n	(4E b)	Select bandwidth n. (1, 2, etc.)
Bw?	(50)	[BW n] (4E b) Which bandwidth is selected? (1, 2, etc.)

BWC?	(9E)	[BWC f] (9E p) What is selected bandwidth? (1, 1.5, 5.0, etc.) (in MHZ)
CER	(??)	Clear error status. (see below)
CHN n	(0C b)	Enable memory channel n.
CHN/n	(0D b)	Disable memory channel n.
CHN n?	(0E b)	[ENB, ENB/] (0C,0D) Is memory channel n enabled?
CLC	(15)	Clear all lockout channels. (Mark them empty.)
CLL f	(36 p)	Clear lockout at frequency f. (Mark it empty.)
CLM	(6C)	Clear receiver and all memory channels. (Set them to zero and mark them empty).
CLR n	(?? b)	Clear memory channel n. (set it to zero and mark it empty.)
COR n	(57 b)	Set C0R level to n.
COR?	(59)	[COR n] (57 b) What is COR level?
CST?	(9B)	[CST,CST/] (99, 9A) What is COR status?
CW	(5A)	Set CW detection mode.
DET?	(5F)	[AM,FM,CW,PLS] (48,69,5A,78) What is the detection mode.
ENL f	(??)	Enable lockout channel with frequency f.
ENL/ f	(??)	Disable lockout channel with frequency f.
FBW	(D8)	Set full bandwidth scan increment.
FBW/	(D9)	Reset scan increment to half bandwidth.
FBW?	(DA)	[FBW,FBW/] (D8,D9) Is full bandwidth scan increment set?
FM	(69)	Set FM detect mode.
FM?	(6B)	[FM n] (69 b) What is percent FM modulation?
FM0?	(AD)	[FM0 n] (AB b) What is FM offset?
FPL	(CF)	Turn front panel display on. This mode is set whenever the receiver returns to local mode.
FPL/	(D0)	Turn front panel display off.
FPL?	(D1)	[FPL,FPL/] (CF,D0) Is front panel display on?
FRQ f	(3C p)	Set receiver tuned frequency to f.
FRQ?	(3E)	[FRQ f] (3C p) What is receiver tuned frequency?
HER?	(??)	[HER n,n,...] (?? b b ...) What are the hardware error bytes. (see below)
LCH?	(1D)	[LCH n] (1B b) What is number of lockout channels used?
LCK	(94)	Lockout current tuned frequency and currently selected bandwidth.
LGV?	(71)	[LGV n] (6F b) What is value of log video.
LKF f,f	(1E p p)	Lockout (center frequency, bandwidth)
LKR f,f	(?? p p)	Lockout range (start frequency, stop frequency)
MAN	(75)	Manual (Has same effect as pressing MAN key in local mode.)
MOD?	(B3)	[MAN,SCN,STP,SCM,STM] (75,84,8D,B2,B1) What is front panel mode?

MAN Manual
SCN Scan
STP Step
SCM Scan-Pause
STM Step-Pause

OPT?	(??)	[OPT n,n,...] (?? b b ...) What options are installed? The bits in the returned bytes represent the presence of options.
PAR n,n	(21 b b)	Partition memory. Channels numbers less than the first parameter are for scan. Channel numbers greater or equal the second parameter are for lockout. Those between are for step.
PAR?	(23)	[PAR n,n] (21 b b) How is memory partitioned?
PLS	(78)	Set pulse detect mode.
PSE	(??)	Change from SCAN to SCANPAUSE or from STEP to STEPPAUSE states. If not in SCAN or STEP state, no action is taken. This mnemonic is needed because of synchronization problems if the MAN mnemonic is used at the same time a signal causes the receiver to enter the SCANPAUSE state.
QUEUE?	(26)	[QUE f,f,f,...] (24 p p p ...) What are the frequencies in the scan/step queue? This queue is a FIFO que and when the frequencies are sent to the controller they are deleted from the que.
RCE n	(27 b)	Recall (EXAMMEM key) and enter memory channel n.
RCH n	(2A b)	[SCH mch,enb,frq,bw,cor,det,afc,agc,rfg] (30 mch enb frq bw cor det afc agc rfg) What are the parameters of memory channel n? mch [n]memory channel number(b) enb [ENB,ENB/] (0C,0D) frq [f] frequency (p) bw [n]bandwidth slot number(b) cor [n]COR level (b) det [AM,FM,CW,PLS] (48,69,5A,78) afc [AFC,AFC/] (42,43) agc [AGC,AGC/] (45,46) rfg [n] RF gain (b) If it is a lockout channel the response is: [LOC mch,enb,startfreq,stopfreq] (?? mch enb startfreq stopfreq) If it is an empty channel the response is: [CNE MCH] (?? MCH)
RER?	(??)	[RER N,N ...] (?? b b ...) What are the remote error bytes? (see below)
RFG n	(7E b)	Set the RF gain to n.
RFG?	(80)	[RFG n] (7E b) What is the RF gain?
RLK n?	(2D)	[LKF f,f] (1E p p) What are lockout parameters (frequency, bandwidth) of channel n?
RMT	(81)	Set remote mode.
RMT/	(82)	Reset remote mode (local).
RMT?	(83)	[RMT,RMT/] (81,82) What is remote mode?

SCH mch,enb,frq,bw,cor,det,afc,agc,rfg
(30 mch enb frq bw cor det afc agc rfg)
Set memory channel parameters.

mch	[n]memory channel number (b)
enb	[ENB,ENB/] (0C,0D)
frq	[f] frequency (p)
bw	[n] bandwidth slot number (b)
cor	[n] COR level (b)
det	[AM,FM,CW,PLS] (48,69,5A,78)
afc	[AFC,AFC/] (42,43)
agc	[AGC,AGC/] (45,46)
rfg	[n] RF gain (b)

If parameters are omitted (eg...,,...), old values are used. If the channel was empty then default values are used.

SCI f	(06 p)	Set scan increment.
SCI?	(08)	[SCI f] (06 f) What is scan increment?
SCN	(84)	Use to continue scanning from SCANPAUSE state.
SCN n	(84 b)	Start scan using channel n as argument.
SS?	(89)	[SS n] (87 b) What is the signal strength?
SSO n	(??)	Set scan/step options with bits 0 -5 of n corresponding to SSPARMO-5.
SSO?	(??)	[SSO n] (?? b) What are scan/step options?
STM n	(??)	Set status mask for serial poll status. (see below)
STM?	(??)	[STM n] (?? b) What is status mask?
STO n	(8A b)	Store currently active parameters in memory channel n.
STS?	(90 b)	[STS n] (90 b) What is serial poll status byte? (see below)
STP	(8D)	Use to continue stepping from STEPPAUSE state.
STP n	(8D b)	Start step using channel n as argument.
VER?	(93)	[VER a] (none) What is the receiver model and firmware revision level? Response in the form "VER_8969w-xx_u.v.v". Where,

w	= letter designation of receiver (initially blank),
xx	= dash number of receiver (initially blanks),
u	= firmware letter designation (initially "A"),
v.v	= firmware revision level (initially "1.0").

The status byte is returned in response to a serial poll or in response to an STS? query. The bits in this byte have the following significance:

BIT		
0	COR status	1 = on, 0 = off.
1	activity command	Meaning defined by scan/step options. This bit is cleared by a serial poll or a STS?

2	hardware error	An error of a hardware nature has been detected. (See below.)
3	remote error interface	An error associated with the remote interface has been detected. (See below.)
4	not used	
5	not used	
6	SRQ	A service request has been initiated.
7	ready	The LOs are locked and the receiver is ready to receiver commands on the remote interface. If the remote interface has sent a query command, the response is waiting.

The status mask command (STM) sends to the receiver a byte whose bits correspond to bits in the status byte. (If the remote interface is in ASCII mode, this byte is sent in base 10 as 3 ASCII digits. (Range 0 to 255) If a bit in the status byte is set and the corresponding bit in the status mask is also set, then, if status mask bit 6 is set, an SRQ is initiated and status but 6 is set. Bit 6 of the status byte is reset after a serial poll.

A-2.3. Errors

The hardware error status bit (bit 2) is a function of the hardware error conditions. These conditions are queried by the remote interface using a HER mnemonic. The receiver responds by sending (TBD) bytes with bits corresponding to possible error conditions. (If the remote interface is in ASCII mode, each byte is sent in base 10 as 3 ASCII digits. Range: 0 to 255.) Errors may be of type 0, 1 or 2.

Type 0 errors will set the appropriate bit but after HER query the bit will be cleared and not reset. In effect the error is the leading edge of the condition not the condition itself.

Type 1 errors will set the appropriate bit and the bit will stay set as long as the error condition persists. However, after a HER query, the error condition will not cause bit 2 of the status byte to be set and it will not cause an SRQ to be initiated. Only the leading edge of these error conditions effect the status byte or cause SRQs.

Errors of types 0 and 1 will cause status byte bit 2 to be set once and one SRQ to be issued for each error type even if the error condition reoccurs or continues.

Errors of type 3 will cause the appropriate bit to be set and the bit will be reset after a HER query. However, if the error reoccurs, the bit will again be set and will again cause an SRQ. This error type is used for errors that are events in time rather than conditions.

Hardware errors will not cause an SRQ if the status mask bit 2 is not set.

With power up, all error firmware is reinitialized and all appropriate error conditions checked. Previously reported error conditions will be re-reported if still in effect. With power up the power up type 0 "error" is always set. Since the status mask will also be set to all ones with power up, power up will always assert an SRQ.

The CER mnemonic will reinitialize the error firmware so that all errors conditions will be rechecked and if appropriate they will set status bit 2 and cause an SRQ. Previously reported error conditions will be re-reported if still in effect. The power up bit will not be set and the status mask will not be effected. If one hardware error causes SRQ to be asserted and another error occurs before the serial poll, the second error will also be considered serviced by the serial poll.

"Power up" is handled as an error and is an example of error type 0. The remote controller wants to know of this condition only once after it happens. "Plus 5 volt supply voltage low" is an example of a type 1 error. The remote controller wants to know of this condition when it happens and wants to be able to check for this error at any time; but the receiver cannot continue to assert SRQ constantly or the control of other units will be impaired. The remote error "parameter out of range" is an example of a type 2 error. The controller wants this error reported each time it occurs. The hardware error conditions are listed in the section on errors.

The remote error status bit (bit 3) is a function of the remote error conditions. These conditions are queried by the remote interface using a RER mnemonic. The receiver responds by sending (TBD) bytes with bits corresponding to possible error conditions. Errors may be of type 0, 1 or 2. (See hardware errors.) This error firmware is reinitialized by power up and by the CER mnemonic. These errors are listed in the section on errors.

APPENDIX B

WJ-8969 REMOTE CONTROL USING AN IBM PC AT INDUSTRIAL COMPUTER

This section describes one approach to multiple receiver system control using an IBM PC AT industrial computer. This approach is also valid for other such computers providing that the system is IEEE-488 compatible. Variations of the control shown here by adding or subtracting control capability are possible.

B-1. IBM PC AT INDUSTRIAL COMPUTER CONTROLLER/EXTENDER

The remote control configuration explained below allows control of up to fourteen receivers and is based on an industrial version of the IBM PC AT configured with dual IEEE-488 interfaces, keyboard, trackball and monitor. The following paragraphs describe the modes of operation, purpose and functions of pushbutton keys, and the various types of displayed information.

B-1.1. Power-up Sequence

The IBM PC AT Industrial Computer Controller/Extender (hereafter referred to as the controller) automatically invokes the software that provides the control functions described below upon power-up. No operator action is required to commence system operation.

B-1.2. Remote Operation

The controller automatically enters the remote mode of operation upon power-up. In the remote mode, each controller functions as a bus extender and command distribution point, interfacing up to fourteen WJ-8969 receivers to a single host computer. Upon entering the remote mode, the CRT monitor displays a continuously updated receiver table which contains the status of all receivers under its control. The receiver table lists each receiver and indicates its tuned frequency, IF bandwidth, selected detection mode, and control mode. If any receiver is monitoring a signal, an asterisk (*) will be present to the immediate right of the tuned frequency of that receiver to indicate which receivers have encountered active signals. Figure B-1 shows the controller remote mode monitor display.

While in the remote mode, the controller periodically queries each receiver for status information for purposes of updating the monitor display. It simultaneously accepts command inputs or status requests from the host computer over the computer IEEE-488 bus. The commands are relayed to the appropriate receiver over the "receiver" IEEE-488 bus, while responses to status requests and error messages are returned to the host computer using information from the controller's status memory.

B-1.2.1. Menu Line Operator Interface

At the bottom of the monitor display is a menu line (figure B-1) which displays operator options. Options are selected via the controller keyboard by moving a cursor (reverse video block) to the desired menu option. The movement of the cursor is performed by using the cursor control keys on the keyboard or the trackball supplied with the unit.

B-1.2.2. Individual Receiver Status

The operator can elect to display detailed status information for a specific receiver from the group status display by moving the cursor to the INDIVIDUAL-STATUS option and striking the ENTER key. The menu line will then be replaced by a prompt for the entry of the desired receiver number (1 through 31, corresponding to IEEE-488 address). After entering the receiver number, the monitor display will change and display the detailed status information for the selected receiver (figure B-2).

The individual receiver status display offers several operator options. The INDIVIDUAL-STATUS option allows the operator to view the detailed status of another receiver without returning to the group status display. Selection of this option results in a prompt for the receiver number as described above.

The GROUP-STATUS option allows the operator to return to the group status display.

B-1.2.2.1. Examine Memory Mode

The MEMORY option on the individual status display menu line allows the operator to examine the contents of one of the selected receiver's 99 memory channels. When selected, the MEMORY field on the menu line at the bottom of the display flashes to indicate that the "examine memory" mode is active. The lower half of the individual receiver status display is then used to display the contents of the selected channel. To exit the "examine memory" mode the operator presses the ESC key.

B-1.2.2.1.1. Memory Channel Selection

The selected memory channel is displayed above the menu line at the bottom of the individual receiver status display. The default channel number is 00 when entering the "examine memory" mode. The contents of the memory channel are not displayed until the operator presses the ENTER key after loading the desired channel number into the selected channel field. To change the selected channel number the operator may use the UP (↑) and DOWN (↓) cursor control keys on the keyboard, the trackball, or may enter the channel number directly.

B-1.2.2.1.2. Memory Channel Display

The memory channels contain scan, step, and lockout information, as described in section 1-2.4. The memory channel display format is similar to that shown in Figure B-6, although the menu line options are limited.

B-1.3. Manual Operation

Both status display menus (group and individual) allow the operator to enter the Manual Mode of operation. This mode allows manual alteration of the operating parameters of the selected receiver from the keyboard and trackball of the controller. The Manual mode is entered by moving the menu line cursor to the MANUAL-CONTROL field and pressing the ENTER key. The menu line is then replaced by a prompt for entry of the number of the receiver which is to be manually controlled. The number of the desired receiver is entered

GROUP STATUS DISPLAY

RECEIVER	FREQUENCY	IF BW	DETECTION MODE	CONTROL MODE
1	1000.000	20M	AM	REMOTE
2	12000.000 *	1M	FM	REMOTE
3	846.225	250K	AM	REMOTE
4	1090.366 *	500K	CW	REMOTE
5	0.256	4M	AM	REMOTE
6	10000.000	4M	AM	MANUAL
7	3487.188	10M	FM	REMOTE
8	12000.000 *	10M	CW	LOCAL
9	3776.000	20M	PULSE	REMOTE
10	2344.659	10M	FM	REMOTE
11	11500.000	1M	CW	REMOTE
12	355.087	20M	AM	REMOTE
13	2400.500	250K	AM	REMOTE
14	3600.477	500K	FM	MANUAL
15	2200.000	10M	AM	REMOTE

INDIVIDUAL_STATUS MANUAL_CONTROL

86.R.8133

Figure B-1. Receiver Group Status Display

RECEIVER 12 STATUS

FREQUENCY	10550.123 *	LOW LIMIT	0.250
TUNING RATE	100 KHZ	HIGH LIMIT	12000.000
IF BANDWIDTH	4 MHZ	AVAILABLE BW'S:	
DETECTION MODE	AM	250K, 500K, 1M, 4M, 10M, 20M	
CONTROL MODE	REMOTE	AGC	ON
COR LEVEL	80	AFC	OFF
RF ATTENUATION	36	SIGNAL STRENGTH	-90 DBM

INDIVIDUAL_STATUS GROUP_STATUS MEMORY MANUAL_CONTROL

86.R.8134

Figure B-2. Individual Receiver Status Display

via the keyboard. (When on the individual receiver status display, the operator may simply press ENTER, without typing the receiver number, if he wishes to manually control the receiver whose status is currently displayed.)

B-1.4. Manual Mode Bus Operation

In the Manual mode of operation, the controller functions as a central controller on the "receiver" IEEE-488 bus, just as in the Remote mode.

The status of the receivers in the controller's group is monitored and may be displayed. The host computer, however, is denied control of those receivers placed in the Manual Control Mode. Any attempt on the part of the host computer to issue commands to receivers in the Manual Mode results in an error message to the host computer indicating that remote control is locked out for that receiver.

Those receivers in the Remote Control Mode may still be controlled by the host computer, without significant degradation of response time, even though another receiver's parameters are currently being altered from the controller's keyboard.

B-1.5. Manual Mode Display

After the Manual Mode is entered, the monitor display changes to that shown in Figure B-3. This display is similar to the individual receiver status display shown in Figure B-2, with different menu options. The CONTROL MODE status for the receiver is automatically changed to MANUAL to reflect the fact that the receiver is being controlled by the controller in the manual mode.

B-1.6. Terminating Manual Operation

The operator may exit the Manual Control Mode and return to the group status display at any point during manual operation by selecting the RETURN-TO-STATUS option on the menu line. Selection of this option causes the controller/extender to prompt the operator for an indication of whether the selected receiver is to be returned to remote control by the host computer. It is possible to return to the group status display without placing the receiver in the Remote Control Mode. A negative response (N) to the prompt leaves the receiver in the Manual mode, where remote control from the host processor will be prevented. This feature allows the operator to override the control from the host computer for more than one receiver at a time.

A positive response to the prompt will return the receiver to the Remote Control Mode as well as returning the operator to the group status display.

B-1.7. Altering Receiver Parameters

The operating parameters for the selected receiver can be altered by the operator in the Manual Mode by selecting the appropriate menu line option. The menu line options allow full control of all receiver functions accessible over the IEEE-488 interface (Appendix A).

With the exception of the RETURN-TO-STATUS option, the selection of one of the parameter control options on the manual control display menu line

activates the corresponding front panel function and causes the menu line field to flash. The value of the parameter can then be changed using the UP (↑) and DOWN (↓) keys on the keyboard (similar to the INC and DEC keys on the receiver's front panel keyboard), the trackball, or, in most cases, by entering the desired value from the numeric keypad. Those parameters with constraints placed upon the method of input by the receiver itself (such as IF Bandwidth, which only allows use of the INC and DEC keys, and not direct entry of desired bandwidth) are similarly constrained at the level of the controller.

After setting the parameter as desired, the function is deactivated by pressing the ESC key. The trackball and cursor control keys can then be used to move the menu line cursor to the next desired field.

B-1.7.1. Frequency Control

Selection of the FREQUENCY option allows control of the tuned frequency of the selected receiver. The frequency may be entered directly by typing the desired value from the numeric keypad (which overwrites the displayed frequency status) and pressing the ENTER key. If an invalid or out-of-range frequency is input directly, an audible tone is produced and the previous frequency is returned to the status display. This method of handling erroneous input is used for all applicable parameters.

The frequency may be changed when the FREQUENCY menu field is flashing using the trackball or the UP (↑) and DOWN (↓) keys. The step size of each frequency increment is determined by the value of the Tuning Rate status.

B-1.7.2. Tuning Rate Control

The tuning rate (see section 2-2.5.5) may be changed when the TUNE-RATE menu field is flashing through the use of the trackball, UP (↑) and DOWN (↓) keys, or numeric keypad. The tuning rate is variable from 1 kHz to 1 GHz.

B-1.7.3. IF Bandwidth Control

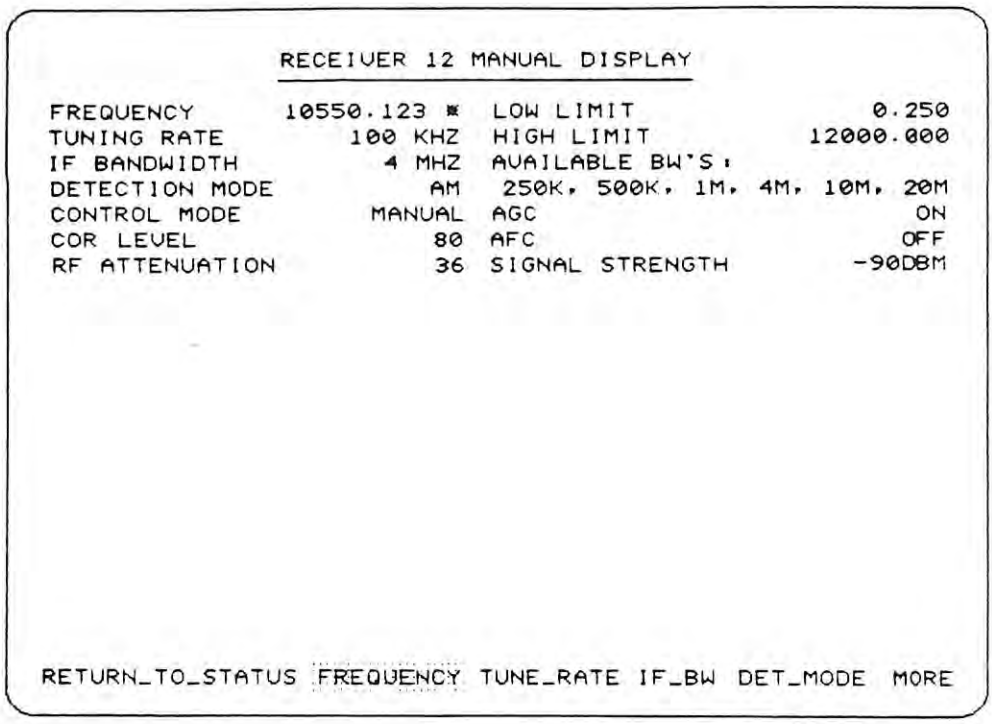
The IF Bandwidth of the receiver may be selected when the IF-BANDWIDTH menu field is flashing by using the trackball or the UP (↑) and DOWN (↓) cursor control keys. The IF bandwidth status is changed to successively higher or lower available bandwidths in response to operator inputs.

B-1.7.4. Detection Mode Control

The receiver may be cycled through the four detection modes when the DET-MODE menu field is flashing, using the UP (↑) and DOWN (↓) cursor control keys or the trackball. Pressing the CTRL key simultaneous with the UP (↑) or DOWN (↓) key on the keyboard causes the receiver to cycle through the detection modes at a rate of two times per second (see section 2-2.5.13).

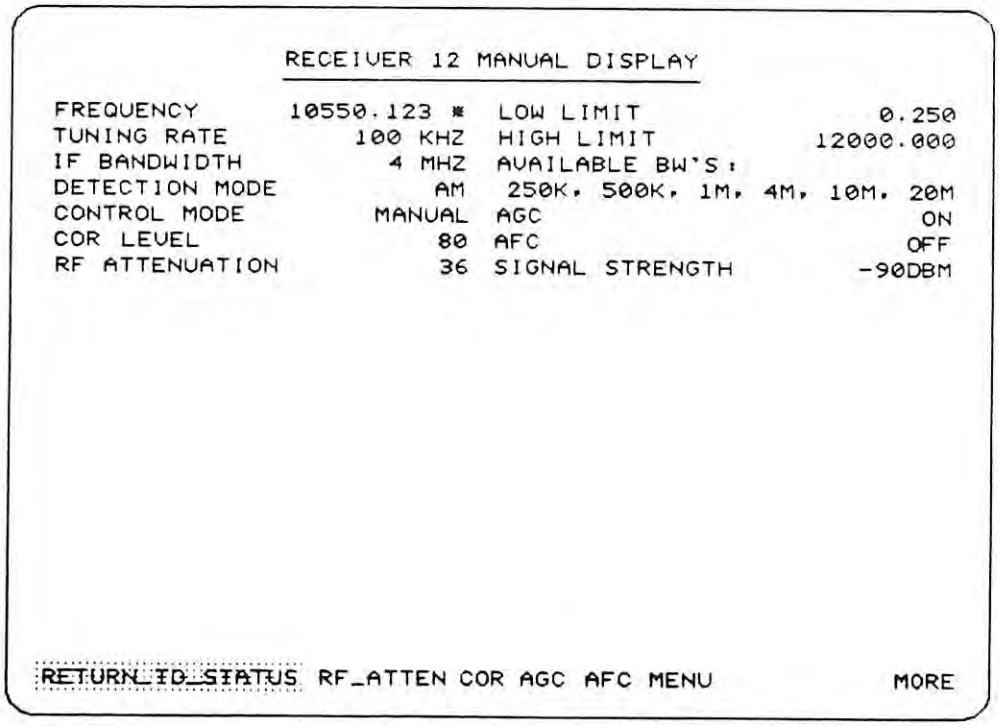
B-1.7.5. MORE Option

Selecting the MORE field cycles through the various pages of menu options at the bottom of the receiver manual control display (Figures B-4, B-5).



86.R.8135

Figure B-3. Manual Control Receiver Display (P.1)



86.R.8136

Figure B-4. Manual Control Receiver Display (P.2)

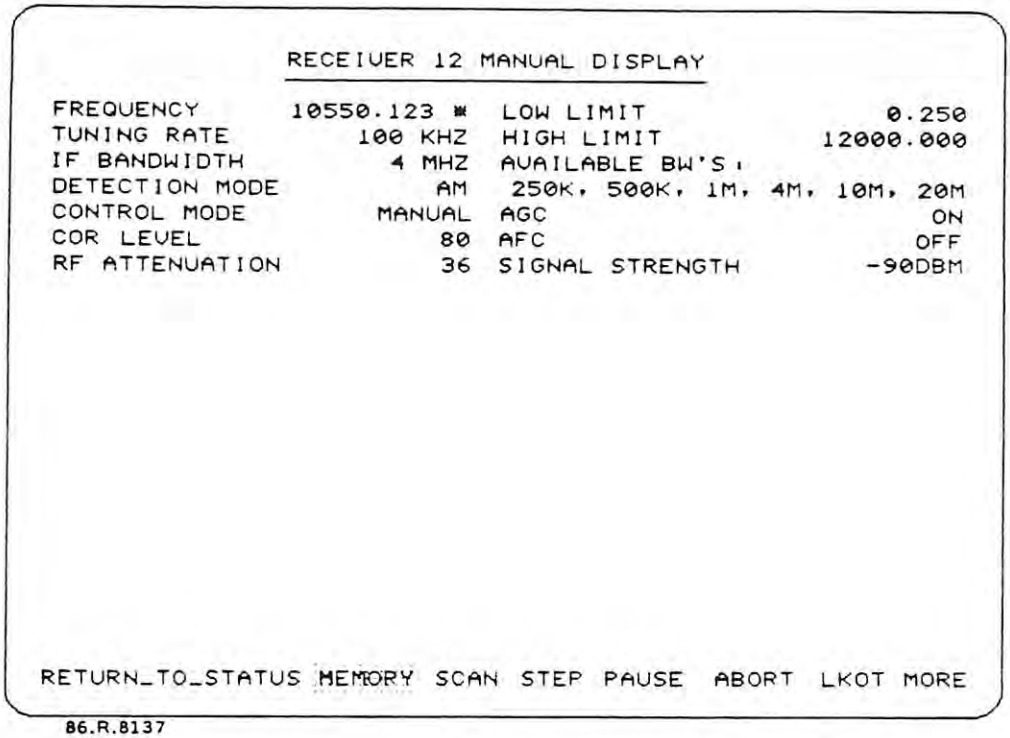


Figure B-5. Manual Control Receiver Display (P.3)

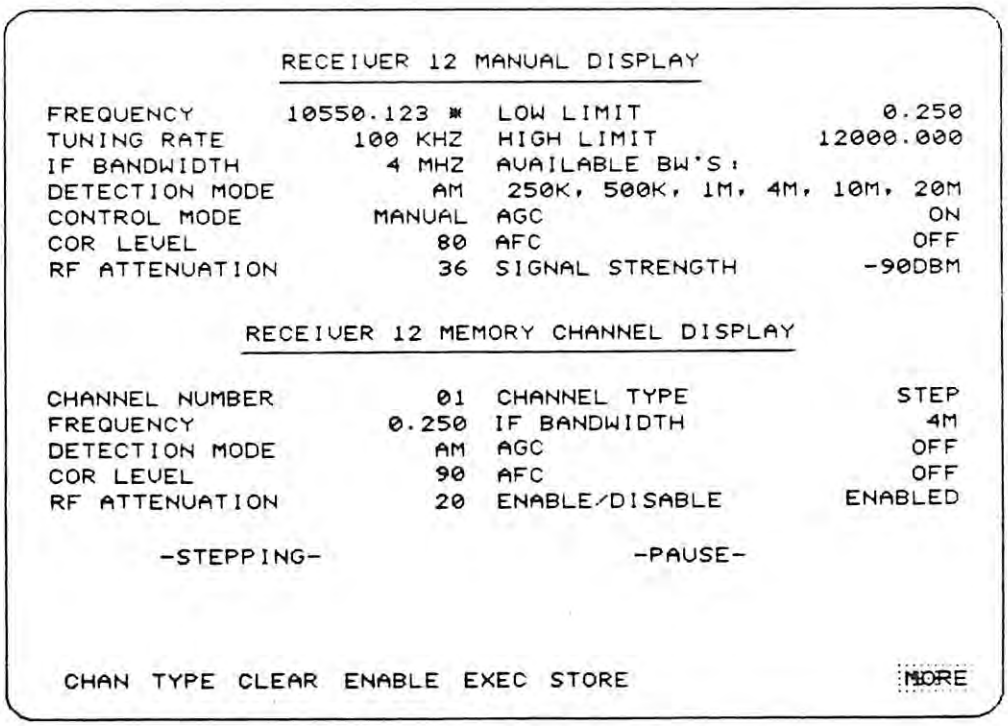


Figure B-6. Modify Memory Receiver Display

B-1.7.6. RF Attenuation Control

The RF Attenuation may be changed when the RF-ATTEN menu field is flashing, using the UP (↑) and DOWN (↓) keys, the trackball, or the numeric keypad. The RF Attenuation status display reflects the changes. The RF Attenuation may be set from 00 to 90 dB.

B-1.7.7. COR Control

The COR level may be changed when the COR menu field is flashing, using the UP (↑) and DOWN (↓) keys, the trackball, or the numeric keypad. The COR level status display reflects the changes. The COR level may be set from 00 to 99 (-dBm).

B-1.7.8. AGC Control

When the AGC option has been selected and the AGC field is flashing, the AGC function may be toggled ON or OFF using the UP (↑) and DOWN (↓) keys or the trackball.

B-1.7.9. AFC Control

Selecting the AFC option allows the AFC function to be toggled On or OFF using the UP (↑) and DOWN (↓) keys or the trackball.

B-1.7.10. Menu Option

Selecting the MENU option allows the operator to select one of four sub-menus, as described in section 2-2.5.14. Selecting a sub-menu initiates a series of operator prompts and displays of configuration parameters. Responses to the prompts and changes to the configuration allow the operator to set up scan segments, select scan/step options, change configuration options and select error displays.

B-1.7.11. Memory Option

Selecting the MEMORY option on the menu line of the manual control display places the controller in the "modify memory" mode. This mode allows the operator to change the receiver parameters in any of the receiver's 99 memory channels. After the MEMORY option is selected, the display changes as shown in Figure B-6. The default channel number upon entry of the "modify memory" mode is 00.

The receiver parameters associated with channel 00 are displayed in the lower half of the screen. The parameters can be changed using the menu line options as described above. The channel number is changed using the CHAN option.

B-1.7.11.1. Channel Type

The channel is declared as one of three types - scan, step, or lockout. The type is established using the TYPE option in conjunction with the UP (↑) and DOWN (↓) keys or the trackball.

B-1.7.11.2. Clearing Memory

The memory channel displayed can be cleared using the CLEAR option.

B-1.7.11.3. Enabling Channels

A specific memory channel can be enabled or disabled using the ENABLE option in conjunction with the UP (↑) and DOWN (↓) keys or the trackball.

B-1.7.11.4. Executing Memory Parameters

The contents of a memory channel can be executed by selecting the EXEC field and pressing the ENTER key.

B-1.7.11.5. Storing Parameters

Changes made to the parameters of a memory channel from the controller/ extender must be saved in a particular channel before exiting the "modify memory" mode (using the ESC key). To save a configuration in a particular channel the operator selects the SAVE option, which generates a prompt for the memory channel number. The channel number can be typed at the keyboard and then entred using the ENTER key, or the ENTER key alone may be used to store the parameters in the currently displayed channel number.

B-1.7.12. Scan Control

Selecting the SCAN option on the manual control display menu line causes the SCAN field to begin to flash. The channel number is displayed, and can be incremented or decremented using the UP (↑) and DOWN (↓) keys or the trackball. When the desired channel number is displayed the operator presses the ENTER key to begin scanning from the frequency of the selected channel to the frequency stored in the next higher channel. While scanning, the word SCANNING is displayed to indicate the operation of the receiver. The RF Attenuation and COR level may be changed while scanning.

B-1.7.13. Step Control

Selecting the STEP option on the manual control display menu line causes the STEP field to begin to flash. The channel number is displayed, and can be changed using the UP (↑) and DOWN (↓) keys or the trackball. When the desired channel number is displayed the operator presses ENTER to begin stepping through all enabled memory channel settings to the displayed channel number. While stepping the word STEPPING is displayed.

B-1.7.14. Pause Control

Selecting the PAUSE option allows the operator to place the receiver in the Scan-Pause or Step-Pause state. While the receiver is paused, the operator can modify any of the receiver parameters. Selecting the STEP or SCAN options while in the Pause state resumes the previous operation.

B-1.7.15. Exiting Step or Scan Modes

The Scan and Step modes of operation are exited by selecting the ABORT option on the menu line.

B-1.7.16. Lockout Control

The selection of the LKOT option causes the receiver to enter the first lockout state. In this state the frequency and IF Bandwidth may be changed. Pressing the ENTER key, while in the lockout state, causes the updated frequency and bandwidth parameters to be stored in the lockout channel. The UP (↑) and DOWN (↓) keys or the trackball can be used to move to subsequent lockout channels. The ESC key is used to exit the lockout state.

B-1.8. Hardcopies

The controller allows the operator to obtain a hardcopy printout of any display. This is accomplished by pressing the PrtSc key on the numeric keypad.

B-1.9. Additional Capabilities

The software for the controller can be modified to provide additional capabilities, to satisfy individual customer requirements. The powerful microprocessor utilized in the IBM PC AT allows flexible routines to be created with minimal impact on system cost. Displays of system status, receiver errors, enhanced editing capabilities, and intercept logging functions are examples of possible enhancements.

APPENDIX C

WJ-8610A CONTROLLER/EXTENDER

C-1. REMOTE OPERATION

In the remote mode of operation, the WJ-8610A Controller/Extender functions as a bus extender and command distribution point. A CRT display on the front panel functions during the remote operating mode, providing a continuously updated receiver table to display the status of all of the receivers. This table lists each receiver and indicates its tuned frequency, IF bandwidth and selected detection mode. If any receiver is monitoring a signal, an asterisk (*) will be present to the immediate right of the tuned frequency of that receiver to provide a visual indication of which receivers have encountered active signals. The soft keys to the right of the CRT are active and allow the operator to select more detailed displays of any receiver to obtain additional data.

C-2. LOCAL OPERATION

In the local mode of operation, the WJ-8610A Controller/Extender functions as a central controller. From this location, the status of each receiver can be monitored and the operator can take control of any receiver as desired. The front panel CRT and five soft keys, to the immediate right of the CRT, permit the operator to monitor the status of all fourteen receivers simultaneously or he can select a specific receiver to obtain more detailed displays pertaining to the selected receiver. Each of the CRT displays, in addition to providing receiver data, define the functions of the soft keys as they pertain to the active display. The soft keys can then be used to perform the control functions defined by the CRT display.

The Table of Receivers display, figure C-2, provides a list of up to fourteen receivers. For each receiver, the selected detection mode, IF bandwidth (in kHz) and tuned frequency (in MHz) is listed. An asterisk, immediately to the right of the tuned frequency, is displayed for each receiver that has an active signal present. In addition, space is provided for a five character, user defined label, for each receiver. Using this display, the soft keys are defined as follows:

C-2.1. SEL RCVR (Select Receiver)

This key is used to select one of the fourteen receivers and display the Receiver Parameters table for the selected receiver. The receiver is selected by pressing the SEL RCVR key and then entering the receiver number on the front panel keyboard.

C-2.2. EDIT

The EDIT key displays a menu to allow the operator to update the receiver order and the user defined label on the Table of Receivers display. It permits the operator to select an Auto Configure Mode, Manual Configure Mode or it permits the operator to enter a five character label into the LABEL column of any of the receiver rows.

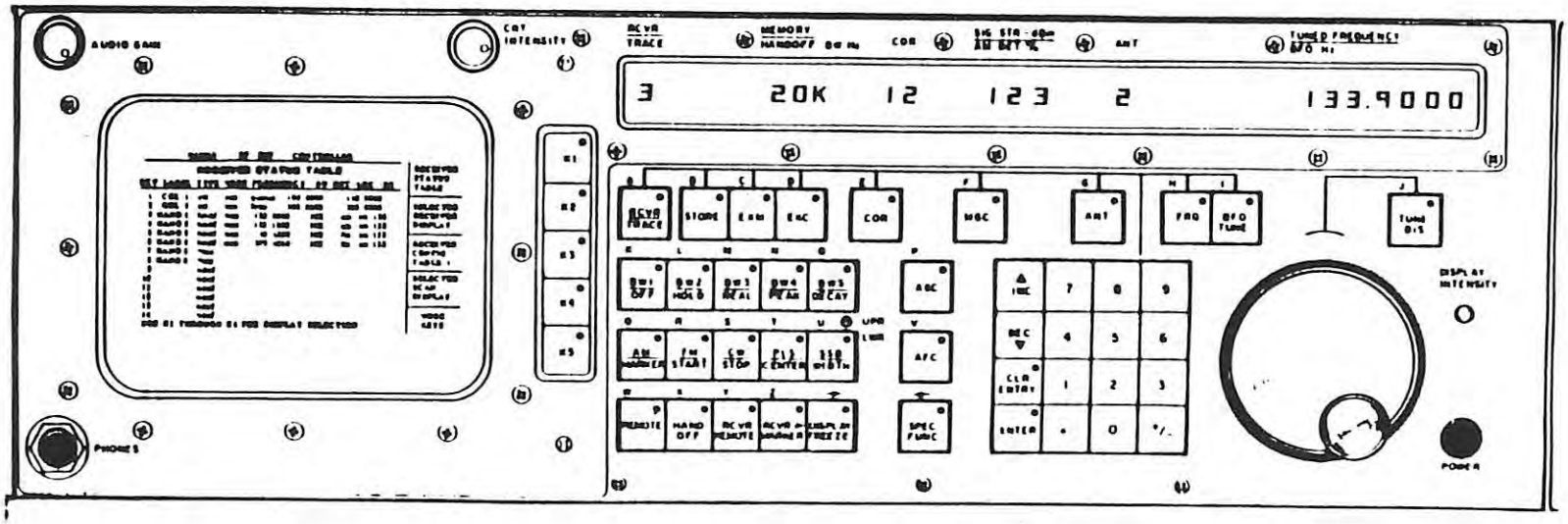


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Figure C-1. WJ-8610A Controller/Extender Front Panel

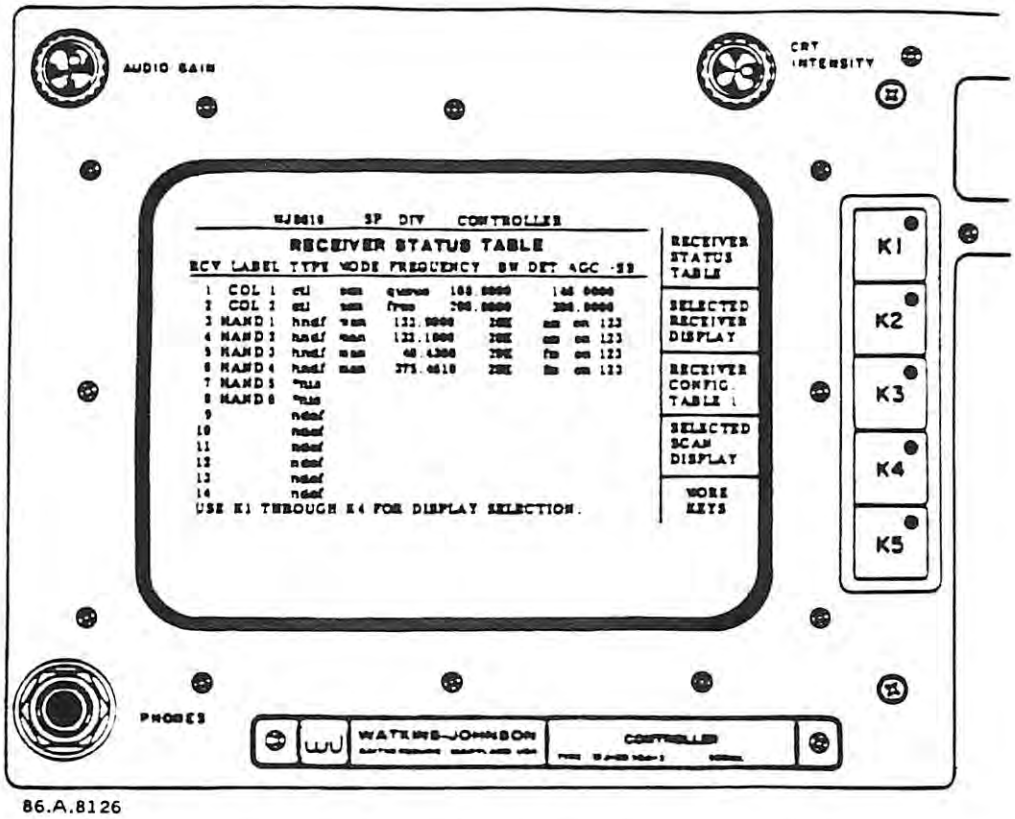

Figure C-2. Table of Receivers Display

In the Auto Configure mode, the controller will query each receiver for its status and its capabilities and sort the receivers in order of their IEEE-488 bus address. The Manual Configure mode permits the operator to modify the receiver manually, regardless of receiver capabilities or signal activity.

When updating the five character label, the operator uses the front panel pushbuttons to enter the desired alpha characters into the LABEL column. In all cases the EDIT display provides operator instructions to perform the edit tasks.

C-2.3. CNFG TBL (Configuration Table)

This key causes the CRT to display a Configuration Table which provides a detailed description of the capabilities of all the receivers.

C-2.4. HELP

The HELP key is provided as an aid to the operator. It provides information describing the data displayed on the Table of Receivers display, defining symbols and abbreviations used.

C-2.5. MORE

The MORE key provides additional soft key definitions to allow for future expansion of soft key capabilities.

C-3. CONFIGURATION TABLE DISPLAYS AND ASSOCIATED KEYS

The Configuration Table (figure C-3) provides the operator with information pertaining to the capabilities of all of the receivers connected to the WJ-8610A Controller/Extender bus. It is comprised of two displays which describe the capabilities of each receiver.

The first display, CONFIGURATIONS TABLE 1, lists each receiver and provides its IEEE-488 bus address and maximum tunable frequency. It also provides the same five character label that is present on the Table of Receivers Display. The CONFIGURATIONS TABLE 2 display provides an extension of Table 1. This table lists all of the IF bandwidths of each receiver, in kHz. On these displays, the soft keys are defined as follows:

C-3.1. SEL RCVR (Select Receiver)

This key function is identical to that of the SEL RCVR key on the Table of Receivers display. It is used to select one of the fourteen receivers and activate a display containing detailed information pertaining to the selected receiver.

C-3.2. EDIT

The EDIT key displays a menu providing instructions to reconfigure the receiver table and change the five character label of any receiver. It functions in the same manner as the EDIT key of the Table of Receivers display.

C-3.3. RCVR TBL (Receiver Table)

This key returns the Table of Receivers Display to CRT.

C-3.4. CNFG TBL1/2 (configuration Table 1 and 2)

This key toggles the display between Configuration Table 1 and Configuration Table 2.

C-3.5. MORE

The MORE key provides additional soft key definitions to allow for future expansion of soft key capabilities.

C-4. RECEIVER PARAMETERS DISPLAY AND ASSOCIATED KEYS

The Receiver Parameters display (figure C-4) is presented when the operator selects a receiver. It provides all of the parameters of the selected receiver on a three-section display.

The first section provides the information found in Configuration Table 1 for that receiver. It provides its assigned receiver number, its tuning rangeand its IEEE-488 bus address. It also displays the five character user defined label that is assigned to the receiver.

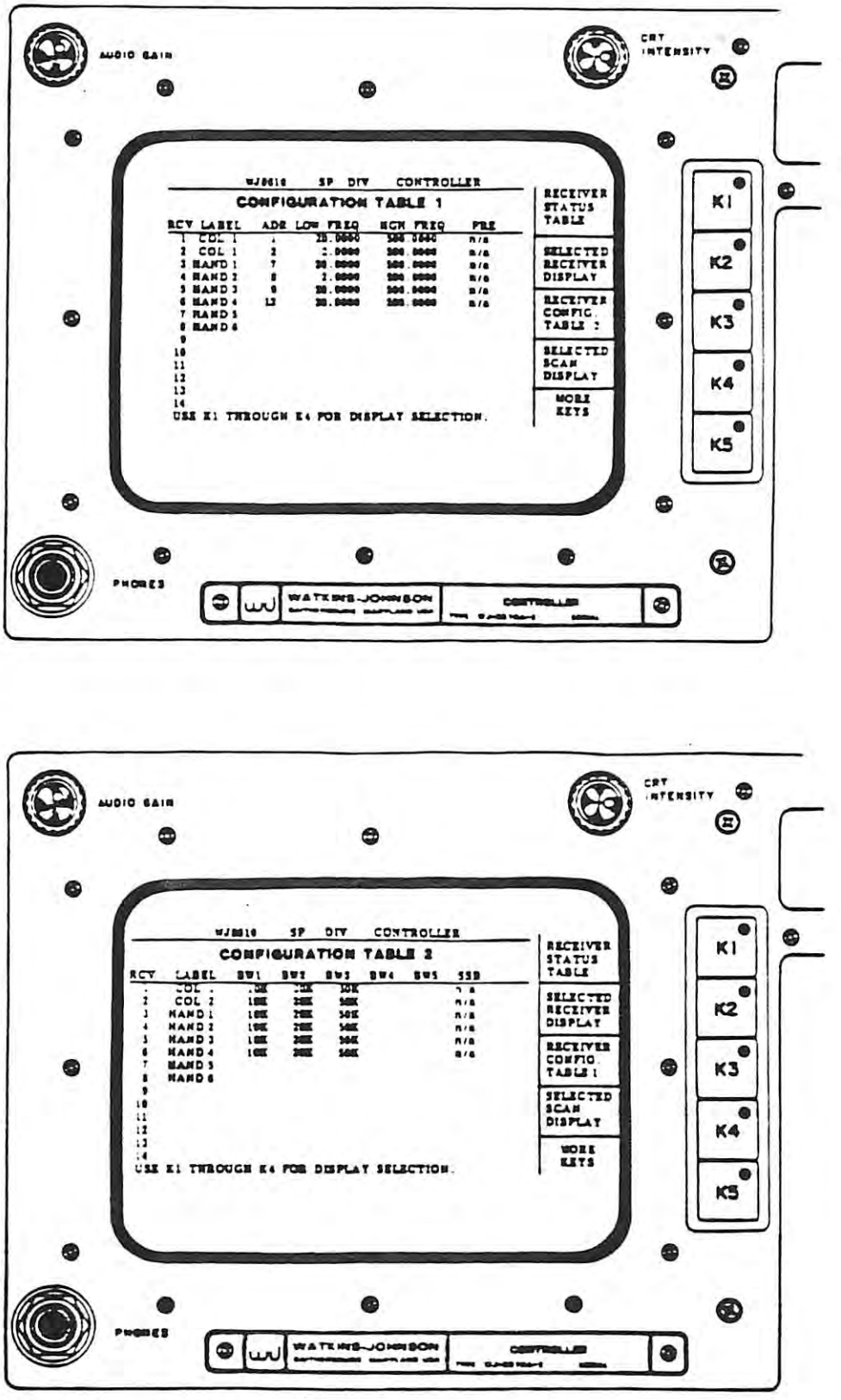

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Figure C-3. Configuration Table Displays

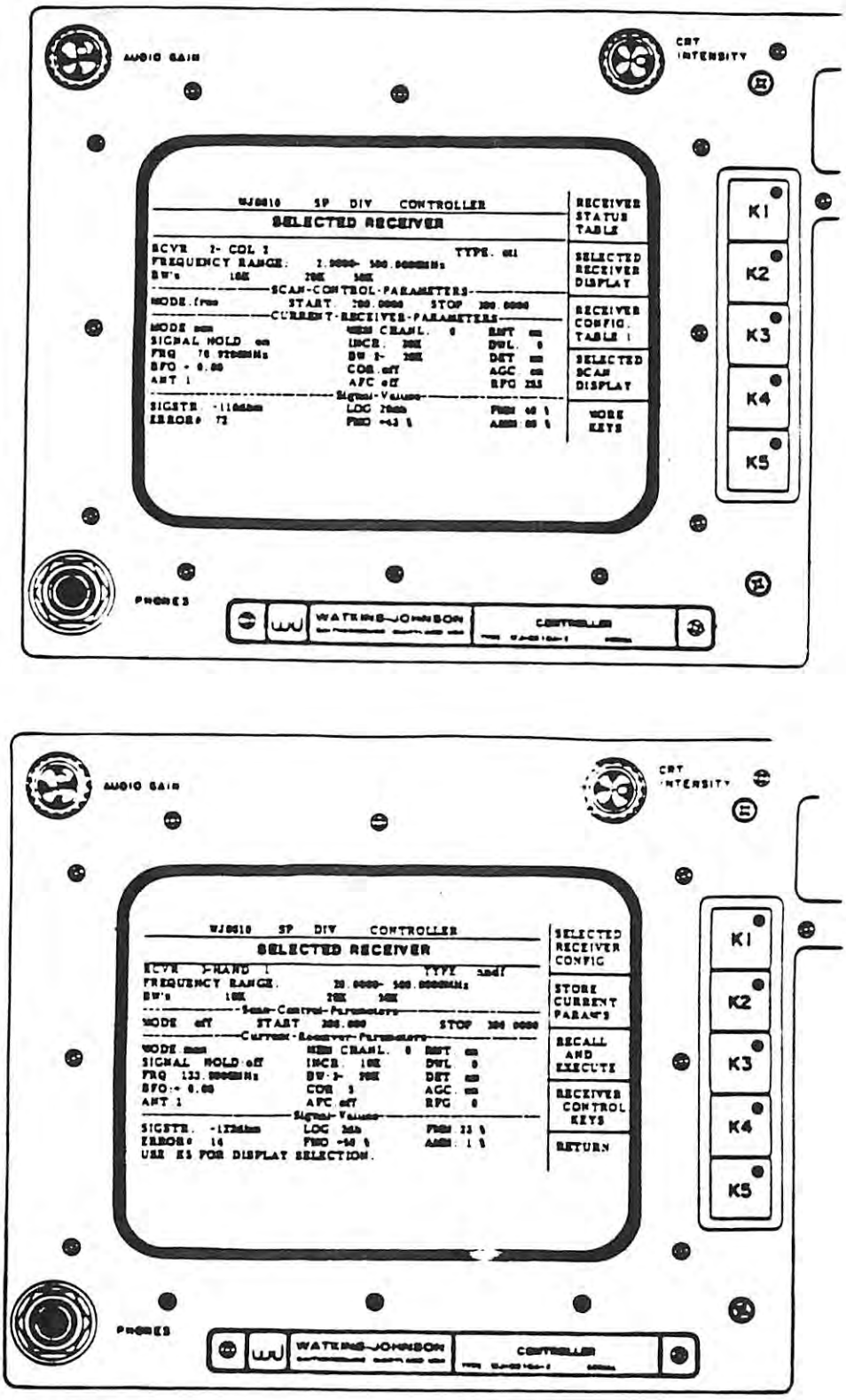

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Figure C-4. Receiver Parameters Display

The second section of the display provides information pertaining to the receiver settings. It indicates the receiver tuned frequency, the control mode (local or remote) and all of the available IF bandwidths, in kHz. An asterisk (*) is displayed to the right of the selected IF bandwidth. In addition, the active detection mode, COR setting, RF Gain Setting and the status of AFC and AGC are displayed.

The third section of the display provide information pertaining to acquired signals. It indicates if a signal is present and displays the signal strength in dBm. Other information available on active signals includes AM modulation and FM modulation.

On this display, the softkeys are defined as follows:

C-4.1. SEL RCVR (Select Receiver)

The SEL RCVR key permits the operator to select a different receiver without returning to the Table of Receivers or the Configuration Tables. By pressing this key and entering the new receiver number on the front panel keyboard, the new receiver is selected and its Receiver Parameter display is placed on the CRT.

C-4.2. TAKE CTL (Take Control)

This key permits the operator to take control of the selected receiver. When TAKE CTL is pressed, the WJ-8610A Controller/Extender front panel takes full control of the selected receiver. All changes in the control settings are displayed on the front panel displays and the CRT display is updated to reflect the changes.

C-4.3. RCVR TBL (Receiver Table)

This key returns the Table of Receivers display to the CRT.

C-4.4. HELP

The HELP key assists the operator by providing information describing the data displayed on the CRT. It defines the symbols and abbreviation used.

C-5. DEDICATED CONTROLLER FUNCTION

When the TAKE CTL soft key is pressed, all of the front panel controls are active and the WJ-8610A Controller/Extender functions as a dedicated controller for the selected receiver. The pushbutton LEDs and the digital display reflect the present status of the receiver and coincide with the receiver parameters displayed on the CRT. Any parameters changed via the front panel controls updates the front panel indicators and the CRT display to reflect the new receiver status.

Selection of IF bandwidth, detection mode, AFC, and AGC is accomplished by pressing the keys dedicated to these functions. The LED on the selected key illuminates to indicate the selection and the parameter on the CRT is updated to reflect the change.

Other functions are controlled by directing the keypad to that function and entering the new data via the pad.

C-6. KEYPAD KEYS

The keypad is a fifteen key, multifunction keyboard with its function determined by keypad select keys which direct the keypad to the desired function. When a select key is pressed, the LED on the key lights and the keypad control is directed to that function.

The SEL RCVR soft key causes the keypad entries to select a new Receiver Parameters display. Entires can be made by entering the receiver number, followed by the ENTER key, or the receiver numbers can be incremented or decremented through by holding in the up (↑) or down (↓) CHANGE keys.

The COR key directs the keypad to control the Carrier-Operated-Relay threshold level. The threshold can be increased or decreased using the CHANGE keys or a level (from 00 to 40) can be directly input.

Pressing the MAN GAIN key causes the keypad to control the manual gain of the receiver. Gain can be increased or decreased using the CHANGE keys or a value from 00 to 90 can be directly entered. The manual gain display does not display the entry made but rather displays the percentage of the range used by the incoming signal.

The RECALL key permits the keypad to step through or select a specific channel in the Controller/Extenders 99 channel memory. The selected channel is displayed in the memory window and the front panel displays the parameters stored in that memory channel. The receiver status is not changed to the displayed memory parameters unless the EXECUTIVE key is pressed.

The FRQ key directs keypad control to the receiver tuned frequency. In this mode the frequency is entered by keying in the fixed frequency, in MHz, followed by the ENTER key. The selected tuned frequency is displayed on the front panel. In the frequency modes, the CHANGE keys are used to determine the tuning resolution of the tuning wheel. These keys cause the 100 Hz, 1 kHz, 10 kHz, 100 kHz, or 1 MHz digit of the frequency display to flash, indicating the resolution of the tuning wheel.

C-7. TUNING WHEEL

The tuning wheel permits the receiver tuned frequency, as determined by the FRQ keys, to be increased or decreased. Tuning can be performed in 100 Hz through 1 MHz steps, as indicated by the flashing digit on the frequency display. The TUNE DISABLE key, when selected, disables the tuning wheel to prevent accidental frequency changes. When the tuning wheel is disabled, the LED on the TUNE DISABLE key is lighted. To restore tuning wheel control, the TUNE DISABLE key is again pressed, extinguishing the LED.

C-8. FUNCTION KEY

The Function key (F) places the front panel keys into the upper case mode. In this mode, the keys are assigned alpha characters to permit entry of letters used in the five character labels of the CRT displays.

C-9. WJ-8610 REAR PANEL CONNECTORS

Table C-1 lists each connector, connector type, and connector function for the WJ-8610.

Table C-1. WJ-8610 Connectors

Connector/Label	Type	Function
F1 AC In	Line	Power input and line fuse holder
J1 RCVR Cont	IEEE-488	Receiver Control Port
J2 RMT Cont	IEEE-488	Remote Control Port
J3 RS-232 Port	RS-232	Serial Data Port (additional software required)
J4 Video Out	BNC	Composite Video from Controller CRT
J5 Audio In	BNC	Audio input from receivers
J6 Audio Out	BNC	Buffered audio output
J8 X Out	BNC	Horizontal output to XYZ display
J9 Y Out	BNC	Vertical output to XYZ display
J10 Z Out	BNC	Intensity control to XYZ display
J11 Receiver 1	9 Pin D	Video and sync from receiver 1
J12 Receiver 2	9 Pin D	Video and sync from receiver 2
J13 Receiver 3	9 Pin D	Video and sync from receiver 3
J14 Receiver 4	9 Pin D	Video and sync from receiver 4