



WJ-8615A, WJ-8616A, AND WJ-8617A RECEIVERS



FEATURES

- Fully Synthesized Tuning
 - 100 Hz Resolution
 - 300 μ sec maximum for 10 kHz steps and greater
 - Low phase noise
- AM, FM, CW and Pulse Detection Modes (SSB, PSK and LOG optional)
- High Dynamic Range
- Built-in Automatically Selected Preselectors
- Built-in, Log/Lin Spectrum Monitor
- Modular Construction for Low MTTR
- High Operational Availability (A₁)
- Low RFI – Designed to MIL-STD-461A
- Up to 5 Selectable IF Bandwidths
- AFC Provides “Lock-on” Capability in SCAN/STEP and MANUAL Modes
- Internal Microprocessor-Based, Computing Controller Provides:
 - SCAN/STEP Operational Modes
 - Operator-Programmable, 16-Channel, Non-Volatile Memory (96 channels optional)
 - Master/Slave Automatic Handoff without the need for an additional controller
 - Flexible I/O Structure for Remote Control
 - Externally Accessible Bus Structure
 - Optional Built-in Test (BITE)
 - Systems Support Capability by Internal Signal Processing/Decision Functions

- IEEE-488, RS-232C, or MIL-STD-188C Remote Control Interface

RECEIVER	FREQUENCY RANGE
WJ-8615A	20 - 120 MHz
WJ-8616A	20 - 500 MHz
WJ-8617A	20 - 1100 MHz

DESCRIPTION

This series of receivers is designed to fill the need for general purpose, cost-effective, digitally controlled receivers in the VHF/UHF frequency range.

Integrating the decision and control power of the internal 6800 microprocessor and advanced receiver technology, each receiver is capable of either Local Control as a stand-alone receiver, or with Remote Control as a basic building block for larger system requirements.

In MANUAL or STEP mode of operation the built-in memory provides 16 operator-programmable channels of memory (96 optional) for all receiver functions (including programmable Threshold Level COR) or 8 programmed (48 optional) frequency search bands in the SCAN mode.

Additional to the STEP/SCAN modes of operation, the microprocessor provides decision capability for: special user-defined processing, signal acquisition and handoff operation in Master/Slave configurations.

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Expansion capabilities built into the receiver provide a full range of optional module plug-ins, all of which have complete access to the internal microprocessor bus. These options may either be purchased with the receiver or field-installed at a later date to upgrade the receiver for new requirements.

Standard options include:

	<u>Number to Order*</u>
● Built-in Test (BITE)	WJ-861XA/BITE
● Pan with Digitally Refreshed Display	WJ-861XA/DRD
● Variable BFO	WJ-861XA/VBFO
● IEEE-488 Interface Bus	WJ-861XA/488
● RS-232C Interface Bus	WJ-861XA/232
● MIL-STD-188C Interface Bus	WJ0861XA/188
● 96 Channel Memory	WJ-861XA/EM
● Programmable Antenna Switch	WJ-861XA/PAS
● Front-Panel Pluggable Keyboard Control	WJ-861XA/PKC
● Yellow LED Display	WJ-861XA/YEL
● Green LED Display	WJ-861XA/GRN
● 1X 10 ⁻⁷ Reference	WJ-861XA/REF
● Mainframe Spares Kit	WJ-861X/MFS

Also available are unique user-defined modules which have access to the bus system:

- Special Demodulators, including SSB with 10 Hz Tuning Resolution
- Special Software Control (firmware)
- Special Signal Recognition Modules
- Unique Signal/Data Processing
- User-Defined Front-Panel Switches
- LOG detection
- PSK Detection
- 5th Selectable IF Bandwidth

OPERATING MODES

Receiver operating modes include: MANUAL (MAN), SCAN, STEP or REMOTE (REM).

In the MANUAL mode the operator has full control of all receiver functions which include:

Tuned Frequency
 IF Bandwidth
 Detection Mode
 AFC ON/OFF
 AGC ON/OFF
 RF/IF Gain
 Audio Gain
 Operating Mode
 BFO Frequency (Optional)
 COR Threshold
 Memory/Control (STORE, RECALL, CLEAR and EXECUTE)
 Memory Select
 Antenna Select (Optional)
 Signal Monitor Control

These functions are written into memory (e.g., operator-

programmed) while the receiver is operated in the MAN mode, by depressing the Store (STO) control switch. The Recall (RCL) control is used to display status stored in memory.

The STEP and SCAN operating modes provide Semi-Automatic and Automatic Signal Acquisition capability. Once programmed (via the front panel), the microprocessor controls all receiver functions.

When placed into the STEP mode the microprocessor tasks the receiver to step to each frequency stored (channel) in memory. As the receiver steps to each channel, the microprocessor automatically programs all receiver functions (e.g., IF bandwidth, detection mode, COR threshold, etc.). When signal activity is present, the receiver will stop on that signal until COR threshold ceases, or until the operator presses the STEP button. If no signal activity (below COR threshold) is present at a channel, the receiver will pause at that channel for the period programmed by the operator with the DWELL Control. At the end of the DWELL period, the receiver moves to the next channel.

In the SCAN mode the microprocessor tasks the receiver to search operator-programmed bands for signal activity greater than COR threshold (also pre-programmed). The period spent at each frequency is determined by the DWELL setting. A firmware algorithm is used by the microprocessor to find the exact center frequency of the signal when in AFC and stops on signals exceeding COR threshold, or handoff to a "sit-on receiver" and restart SCAN. The STEP function is similar except it finds the center frequency when the AFC is activated.

With the addition of the Remote Control option the receiver will function either as a Master Controller or Slave Receiver.

When the receiver is in the REMOTE mode the MEMORY, SCAN, STEP and DWELL can be controlled via the (optional) IEEE-488 bus, RS-232C or MIL-STD-188C. When in the MANUAL mode the receiver can be interrogated for status of all functions.

Special decision controls are user-defined and can include manual handoff, extra digital refreshed display control, special demodulation recognition and special routines. Pressing the FUNCTION (F) button increases this control to as many as seven special functions. The addition of up to four EROM type ICs in special sockets will activate these decision control functions.

MODULARITY

Ease of maintenance and flexibility is provided by the modular design concept. All functional modules including standard and user-defined options plug directly into the receiver mainframe and have access to the microprocessor BUS. This allows configurations of special receivers by addition, subtraction or modification of specific modules without alteration of unaffected modules.

In addition, performance trade-offs (such as noise figure/intercept point) can be made easily by changing only the affected modules.

RECEIVER DESCRIPTION

A simplified receiver block diagram is shown in Figure 1. Referring to Figure 1, the VHF portion of the receiver incorporates an eight-band suboctave preselector between

*In each number given above the "X" designates a 5, 6, or 7 — whichever is relevant to the receiver on order. Example: When ordering an option for a WJ-8617A Receiver, change the "X" to a "7".

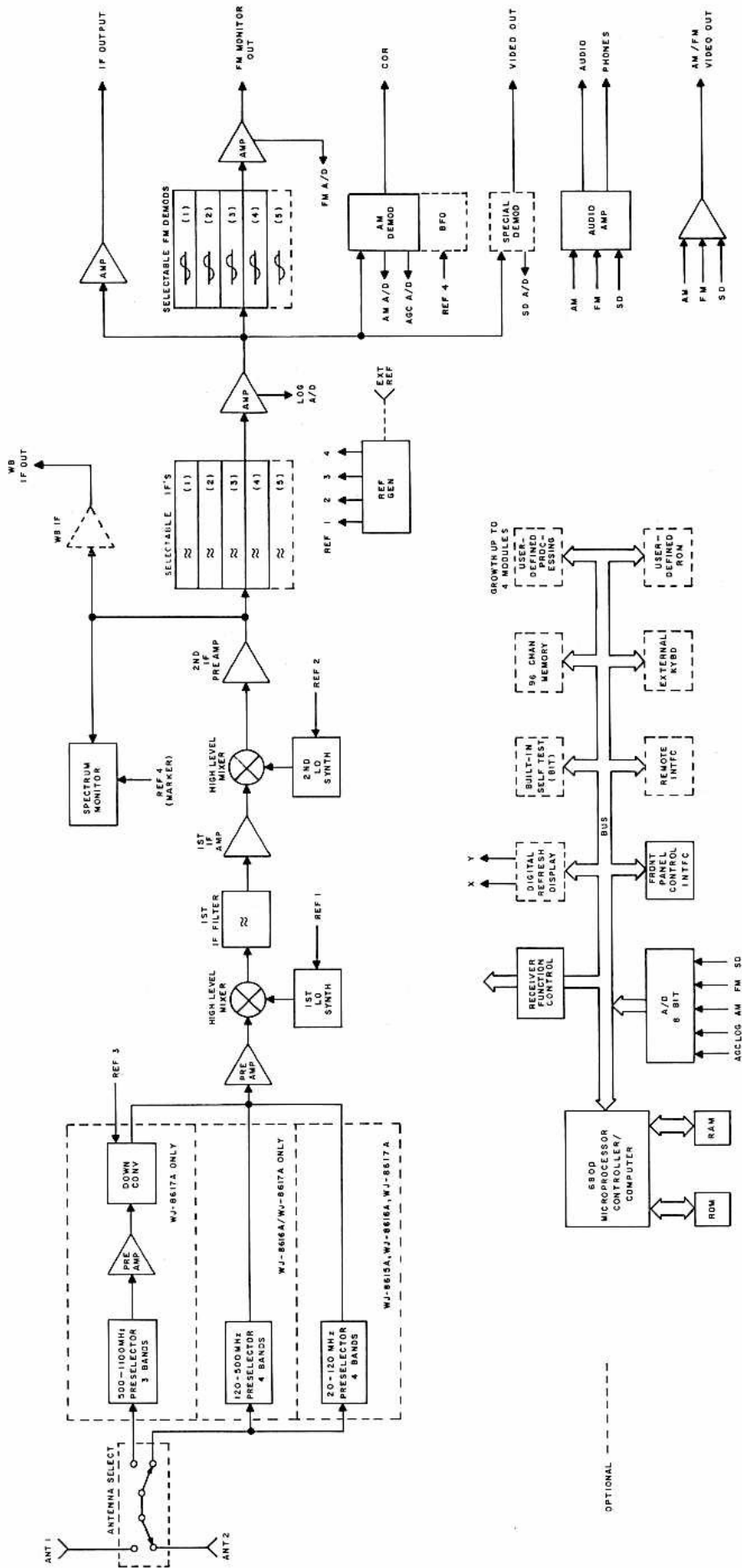


Figure 1
WJ-8615A, WJ-8616A, WJ-8617A Receivers
Simplified Block Diagram

20 - 500 MHz, improving 2nd order intermodulation performance and spurious signal rejection. The 500 - 1100 MHz range is tuned with three additional preselectors and down-converted to 450 - 250 MHz and processed as VHF.

The first mixer converts the 20 - 500 MHz RF signal to 551.5 MHz with a first LO covering the frequency range 572 - 1052 MHz. This LO is synthesized in 1 MHz steps and is free of any spurious signals resulting from products of other mixed frequencies. Low phase noise insures that the selectivity of the receiver is not impaired by large interfering signals close to the tuned frequency.

The first IF Bandwidth is approximately 8 MHz wide. This allows wide IF Bandwidth responses while still providing good selectivity. The double-balanced first mixer holds intermodulation products to a minimum. The second mixer converts the 551.5 MHz IF to 21.4 MHz.

The second LO tunes from 529.6 to 530.6 MHz in 100 Hz steps. The tuning speed of both the first LO and second LO is typically 200 μ s for 10 kHz or greater steps allowing the receiver to quickly scan or step to each frequency.

The 21.4 MHz signal is power-divided for further processing by the internal signal monitor, the selectable IF filter/detectors and the rear output for a 4 MHz pre-detected IF.

Four IF bandwidths with matching frequency discriminators can be selected from 10 kHz to 4 MHz. A 5th optional bandwidth may be selected which can be for SSB or a special purpose IF BW. Additionally, special IF filters with stringent phase or ripple responses, etc., are available.

Processing after final IF filtering includes a 40 dB log range IF, AM detector with a range of 100 dB, AGC and simultaneous AM and FM video processing. Two spare PC card slots are available for further special demodulation/detection functions.

ANALOG/DIGITAL CONVERSION

Control and decision capability are provided to the receiver from the microprocessor section. The AC and DC components of the AM and FM detectors are digitized. The DC log IF used for COR and signal strength and optional special demodulators are also digitized. The microprocessor makes decisions based on these receiver outputs and reacts according to special instructions from the expandable EROM memory section of the microprocessor computing area. The built-in AFC is one of the functions that uses this technique.

MICROPROCESSOR

The receivers are controlled by a Motorola 6800 microprocessor. This high-powered microprocessor makes intelligent decisions based on the characteristics of the received signal, allowing sophisticated algorithms for functions such as SCAN and AFC (see Figure 2). In addition, a number of options extend the power and capabilities of the microprocessor.

The microprocessor has complete control of the RF section, the synthesizers and the front panel. This control is exercised via digital and analog control lines. The microprocessor makes decisions based on digital and analog status lines from these other receiver sections. The microprocessor system makes extensive use of the interrupt feature of the 6800, thus enabling the system to quickly respond to

hardware circumstances and not consume time continually checking for these conditions.

A number of microprocessor-controlled options are available. Each of these options may be plugged into the receiver with no additional modifications required.

The External Keyboard Option plugs into the front panel and allows the operator to directly enter the SCAN and STEP frequencies from a digital keyboard.

The digital refresh display option allows the signal monitor to display panoramic presentations while the receiver is in the scan mode.

The Remote Interface Option allows the receiver to interface to other equipment via an IEEE bus, an RS-232C or MIL-STD-188C serial interface. The receiver can thus be controlled from an external source or can be programmed to handoff signals to other receivers.

The 96-Channel Memory Option allows the operator to enter up to 96 channels to be stepped through or scanned between. The Built-In Test diagnostic option tests the receiver. This PC card plugs into the receiver, as do all options, and can be used as a diagnostic aid when a receiver is suspected of malfunctioning. However, its most powerful use is as an automatic test installed in each receiver, so that the receiver is automatically tested in a few seconds each time power is turned on.

The Programmable Antenna Switch option provides Antenna input configurations such as: One input 20 - 1100 MHz or two inputs for Antennas of different frequency ranges or locations. The Programmable Antenna Switch may be controlled manually via front-panel selection or by firmware control in automatic modes of operation.

The Customer-Defined Option allows the user to write firmware to customize the receiver to his particular requirement. The full power of the microprocessor is available as well as complete control over the receiver and all its options including the remote interface. Via the customer-defined option, the receiver can be controlled so as to recognize special circumstances. Internal firmware with special programs can be executed by the microprocessor considerably faster than under remote control commands. Functions such as recognition of special signals and a "smart" interface to a full-scale computer or other receivers are easily implemented. These options allow the user to customize the receiver to his particular needs by adding firmware only. Furthermore, since the customer can develop this firmware "in-house" with a minimum of personnel and equipment, security problems are minimal.

CAPABILITIES

The standard receiver may be used for manual, semi or fully automatic signal collection and demodulation requirements. In these efforts, the receiver may be either manually tuned or placed in the SCAN/STEP modes of operation.

In an unknown environment the SCAN mode allows a rapid method of searching through operator-entered frequency bands-of-interest, stopping at all signals in which activity and signal strength exceed operator-programmed levels (COR). The operator then monitors the signal and makes a determination as to whether or not it is of interest. If the operator decides that the signal is of no interest, he presses the EXCLUDE button (e.g., a user defined front panel switch) and the receiver proceeds to the next frequency where signal activity exists. At the completion of the SCAN mode, the operator is left with only the signals

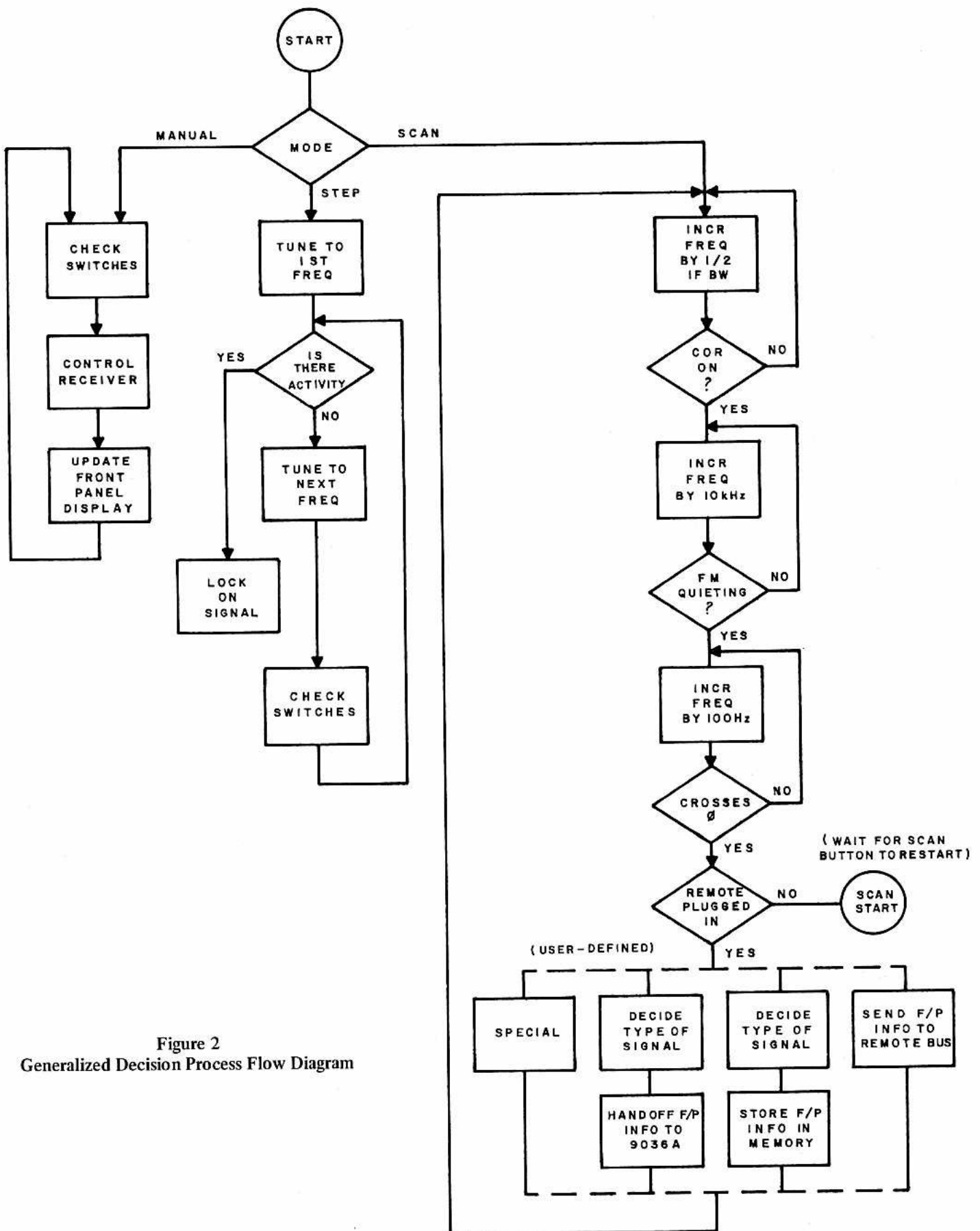


Figure 2
Generalized Decision Process Flow Diagram

of interest (all others have been excluded). Additional receivers can then be set for monitoring or signal analysis.

The operator may also leave the receiver in the SCAN mode and continue to monitor signals which have not been excluded plus new signals as they arise, thus keeping abreast of current activity in the selected frequency band. Periodically the operator may update his entire search band by pressing the CLEAR (CLR) button, clearing all excluded frequencies previously stored and initiating his search strategy anew.

The STEP mode allows the receiver to step through pre-programmed frequencies and stop where activity exists.

Signals may also be qualified by user-defined special demodulators ("Roll-Your-Own") installed onto the microprocessor-based, computing controlled bus. With this additional mode the receiver is tasked to stop on unique signals.

The receiver is adapted for larger signal collection requirements by the addition of remote-control interface (I/O) modules. Remote-control can then be via either IEEE-488, RS-232C or MIL-STD-188C. As with all options, they may be included at the time of purchase or can be field-installed as part of an upgrading program.

With the remote control feature any receiver can be designated as a Master Receiver/Controller. Signal handoff to the Slave receivers may be effected automatically, reducing or eliminating the need for additional data processing, or may be effected via operator control.

The generalized collection system depicted in Figure 3

shows some of the major components that are placed onto the control bus structure. Using Figure 3, a system designer may configure the following simple surveillance collection and monitoring system from 20 to 500 MHz with 16 hand-off positions and DF capability.

<u>FUNCTION</u>	<u>DESCRIPTION</u>	<u>QTY.</u>
Master/Controller Receiver	WJ-8616A Receiver	1 ea.
Handoff Receiver Chassis:	WJ-9036A/QC Quad Receiver Chassis	4 ea.
	WJ-8624A Handoff Receiver (PO WJ-9036A/QC)	16 ea.
Peripherals:	WJ-8971A Direction Finder	1 ea.
	WJ-9871A DF Antenna	1 ea.
	S-9902A Speaker Panel	2 ea.
	Tape Recorder	16 ea.
	WJ-9310 Antenna Multi-coupler	2 ea.

Various systems can be configured up to the most complex where all receivers are master controlled by user processors or computers. Even in these most complex systems, all of the processing does not have to be done by the master controller; the lesser, or time-consuming processing (e.g., frequency search, etc.), can be accomplished by these receivers. This provides distributed processing for increased speed and overall capability.

SPECIFICATIONS

Frequency Range:	
WJ-8615A	20 - 120 MHz
WJ-8616A	20 - 500 MHz
WJ-8617A	20 - 1100 MHz
Detection Modes	AM, FM, CW and Pulse standard, Variable BFO, SSB and LOG optional (other modes are available on special order)
Tuning Scheme	Frequency synthesized local oscillators locked to internal reference
Reference Accuracy	1 part in 10^{-6} or external 1 MHz reference input, (1 part in 10^{-7} optional)
Tuning Resolution	100 Hz
Synthesizer Tuning Speed	200 μ s typical, 300 μ s maximum, integers of 10 kHz and greater step size
Input Impedance	50 Ω
Input VSWR	2.5:1 Typical
	3.0:1 Maximum
Noise Figure*	9.5 dB, maximum 20 - 500 MHz
	10.5 dB, maximum, 500 - 1100 MHz
Third Order Intercept Point	0 dBm typical - 5 dBm max. 20 - 500 MHz
Second Order Intercept Point	+50 dBm, minimum, -5 dBm typical - 10 dBm max, 500 - 1100 MHz
Preselection	Automatically switched, suboctave bandpass filters
LO Radiation	-100 dBm typical; -90 dBm, maximum
Image Rejection	100 dB typical; 90 dB, minimum
IF Rejection	95 dB typical; 90 dB, minimum (552 MHz IF - 80 dB min.)
Internal Spurious	Equivalent to -115 dBm maximum at the RF input
Reciprocal Mixing	With an input signal at a rated sensitivity level; an out-of-band signal removed seven times the IF bandwidth at a level of 70 dB above rated sensitivity will not degrade the desired output signal ratio (S + N)/N by more than 3 dB
IF Bandwidths	4 IF bandwidths standard, 5th optional (see Table 1 for standard available bandwidths)
IF Shape Factor	3.5:1; 6:60 dB, nominal
Final IF	21.4 MHz

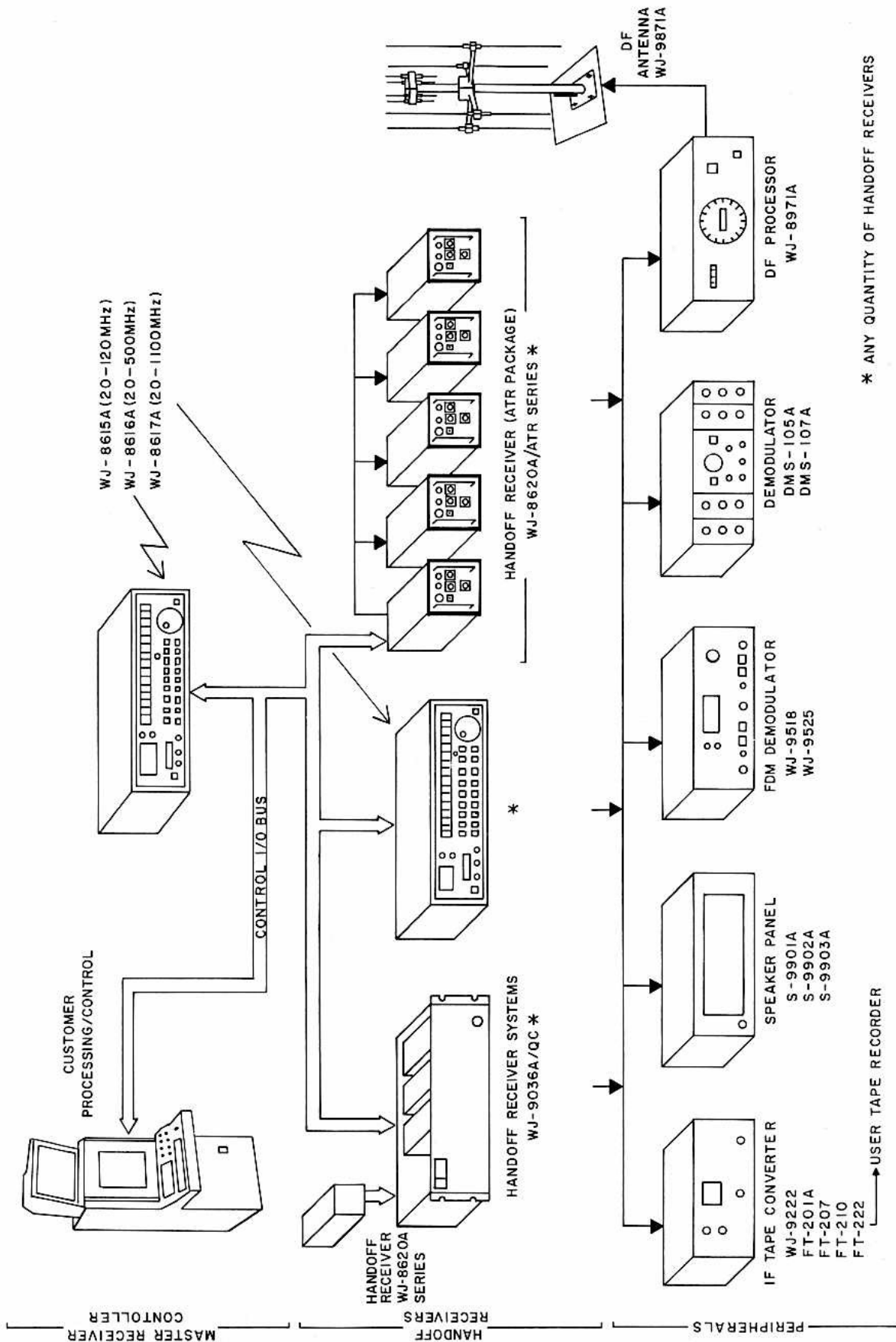


Figure 3
Generalized Collection System

TABLE 1

<u>Bandwidth (kHz)</u>	<u>20 - 500 MHz†</u> <u>Sensitivity (dBm)</u>	<u>500 - 1100 MHz†</u> <u>Sensitivity (dBm)</u>
10	-106	-105
20	-103	-102
50	-99	-98
100	-96	-95
250	-92	-91
300	-91	-90
500	-89	-88
1000	-86	-85
2000	-83	-82
4000	-80	-79

AM Stability	6 dB maximum from AGC threshold to a level 100 dB above AGC threshold
Switched Video Output	1 volt peak, minimum, into 93 ohm load for FM with peak frequency deviation at 30% of the IF Bandwidth and AM with 50% modulation. AC coupled for FM and AM
FM Monitor	DC coupled FM output, 1 volt peak minimum, into 93 ohm load
Video Amplifier Frequency Response	DC to 1/2 IF Bandwidth for FM Monitor; 100 Hz to 1/2 IF Bandwidth for AM/FM switched video output
Audio Output	100 mW, minimum, into 600 ohms for 50% AM or FM peak frequency deviation equivalent to 30% of the IF bandwidth
COR/Squelch	Adjustable from noise level to approximately 40 dB above noise. COR provides 100 mA current "sink-to-ground" for switching; +24 Vdc maximum external voltage
Signal Monitor:	
Sweep Width	0 - 4 MHz continuously adjustable
Resolution	10 kHz
Sweep Rate	Adjustable to 15 - 25 Hz
Marker	Center frequency (locked to receiver frequency standard)
Display	Lin/Log
CRT	1 x 3 inches nominal dimensions
PAN	Provides pan display during SCAN/STEP modes with optional digitally refreshed display
Temperature Range:	
Operating	0°C to 50°C
Non-Operating	-20°C to 80°C
Power Requirement	110, 120/220, 240 Vac, 47 - 400 Hz, 100 watts
Dimensions	19-inch rack mount, 18 inch depth, excluding connectors and handles, and 5.25 inch panel height
Weight	50 pounds, maximum

*Antenna switch option add 1 dB

†Sensitivity Conditions:

AM — Input signal AM modulated 50% by a 1 kHz tone, will produce a minimum video output (S + N)/N ratio of 10 dB.
 FM — Input signal FM modulated at a 1 kHz rate with a peak deviation equal to 30% of the selected IF BW, will produce a minimum video output (S + N)/N ratio of 17 dB. (Note: A 400 Hz modulation rate is required for the 10 kHz IF BW.)

Receiver Inputs/Outputs:

- Antenna Input (Type N)(2)
- External Reference Input (BNC)
- Optional Tuning Input (Front-Panel)
- Optional Remote Control In/Out (IEEE-488)(RS-232C) (MIL-STD-188C)
- Wideband 21.4 MHz IF Output (BNC)
- Selected Bandwidth IF Output (BNC)
- COR (BNC)
- FM Monitor Output (BNC)
- AM/FM Video Output (BNC)
- Audio Output (600Ω BNC, Real-Panel Adjustable)
- Phone Output (Front-Panel, Front-Panel Adjustable)
- Optional Display X-Y Outputs (BNC)
- AC Input