# MESSENGER TWO

CITIZENS RADIO TRANSCEIVER
MODEL NO. 242-162
MODEL NO. 242-163

# TABLE OF CONTENTS



# LIST OF ILLUSTRATIONS

# SECTION I
# GENERAL INFORMATION

## 1.1 GENERAL

The Johnson Messenger Two is a radio transceiver designed for two-way radio service in the 27 MHz Citizens Band. It includes a crystal controlled superheterodyne receiver, a crystal controlled two stage transmitter, and a power supply in a 5 5/8" x 7" x 11 3/8" enclosure. The antenna, power supply and some audio circuits are common to both the receiver and transmitter. A channel switch provides for ten crystal-controlled operating channels for transmitter and receiver. On late models a crystal - VFO switch allows the receiver to be crystal controlled or continuously tunable over the 23 channels of the 27 MHz Citizens Band. The transceiver has provision for plug-in operation of the Tone-Alert selective calling system. The Messenger Two is available as a 117 VAC - 6.5 VDC model (Model No. 242-162) and as a 117 VAC - 13.6 VDC model (Model No. 242-163).

## 1.2 RECEIVER TUBE LINEUP

| TUBE | FUNCTION |
|---|---|
| V1 (6BJ6) | Tuned RF amplifier |
| V2 (12BE6) | Mixer and crystal oscillator |
| V3 (6BJ6) | IF amplifier (455 kHz) |
| V4 (6BJ6) | IF amplifier (455 kHz) |
| V10A (12AU7) | First audio amplifier |
| V5A (6AW8) | Squelch control amplifier |
| V5B (6AW8) | Second audio amplifier |
| V6 (12AB5) | Audio power output |
| V9 (12BW4) | Rectifier, high voltage |
| D2 (1N881) | Automatic noise limiter |
| D3 (1N294A) | Detector, AVC |

## 1.3 TRANSMITTER TUBE LINEUP

| | |
|---|---|
| V7 (7054) | Crystal oscillator |
| V8 (7061) | RF power amplifier, plate and screen modulated |
| V10B (12AU7) | First speech amplifier |
| V5B (6AW8) | Second speech amplifier |
| V6 (12AB5) | Modulator |
| V9 (12BW4) | Rectifier, high voltage |
| D1 (1N881) | DC switch |

# SECTION II
# SPECIFICATIONS

## 2.1 GENERAL

| | |
|---|---|
| Frequency Range | - 26.965 - 27.255 MHz |
| Channels | -Ten |
| Dimensions of Enclosure | - 5 5/8" high x 7" wide x 11 3/8" deep |
| Unit Weight | - 12 lb |
| Shipping Weight (one unit) | - Approximately 17 lb 12 oz |
| Microphone | - High impedance, ceramic element, cycolac case, push-to-talk switch, hang-up stud |
| Ambient Temperature | - ±0.005% crystal, from -22°F to +122°F |
| Power Supply | - 6.5 VDC or 13.6 VDC; 117 VAC |
| Current Requirements at | - 6.5 VDC: Rec. 9.8 amps<br>Trans. 10.8 amps<br>- 13.6 VDC: Rec. 4.9 amps<br>Trans. 5.4 amps<br>- 117 VAC: Rec. 70 watts<br>Trans. 80 watts |

## 2.2 RECEIVER

| | |
|---|---|
| Audio Output Power | - 3 watts minimum at 10% distortion |
| Sensitivity | - 0.4 μV at antenna terminal (30% modulated, 1000 Hz) for 10 dB S/N ratio |
| Selectivity | - 7 kHz bandwidth at -6 dB, 21 kHz bandwidth at -60 dB |
| Frequency Control | - ± 0.005% crystal from -30°C to +50°C, or tunable oscillator |
| Spurious Rejection | - 45 dB except image, 30 dB |
| Squelch Sensitivity | - 6 dB or less signal change for 40 dB of quieting at 1 μV at antenna terminals |
| Squelch Range | - 0.3 to 300 microvolts at antenna terminal |
| Intermediate Frequency | - 455 kHz |
| Circuitry | - Single conversion superheterodyne |
| Antenna Impedance | - 50 ohms, unbalanced |

## 2.3 TRANSMITTER

| | |
|---|---|
| Emission | - 6A3 |
| DC Power Input | - 5 watts maximum at design supply voltage |
| RF Power Output | - 2.8 watts at design supply voltage |
| Frequency Control | - ±0.005% crystal |
| RF Spurious and Harmonic Attenuation | - Better than FCC and DOT requirements |
| Output Impedance | - 50 ohms |
| Audio Frequency Response | - +1 to -4 dB, 400 to 2500 Hz |
| Modulation | - High level, class AB1 modulator, audio peak clipping, audio filtering |

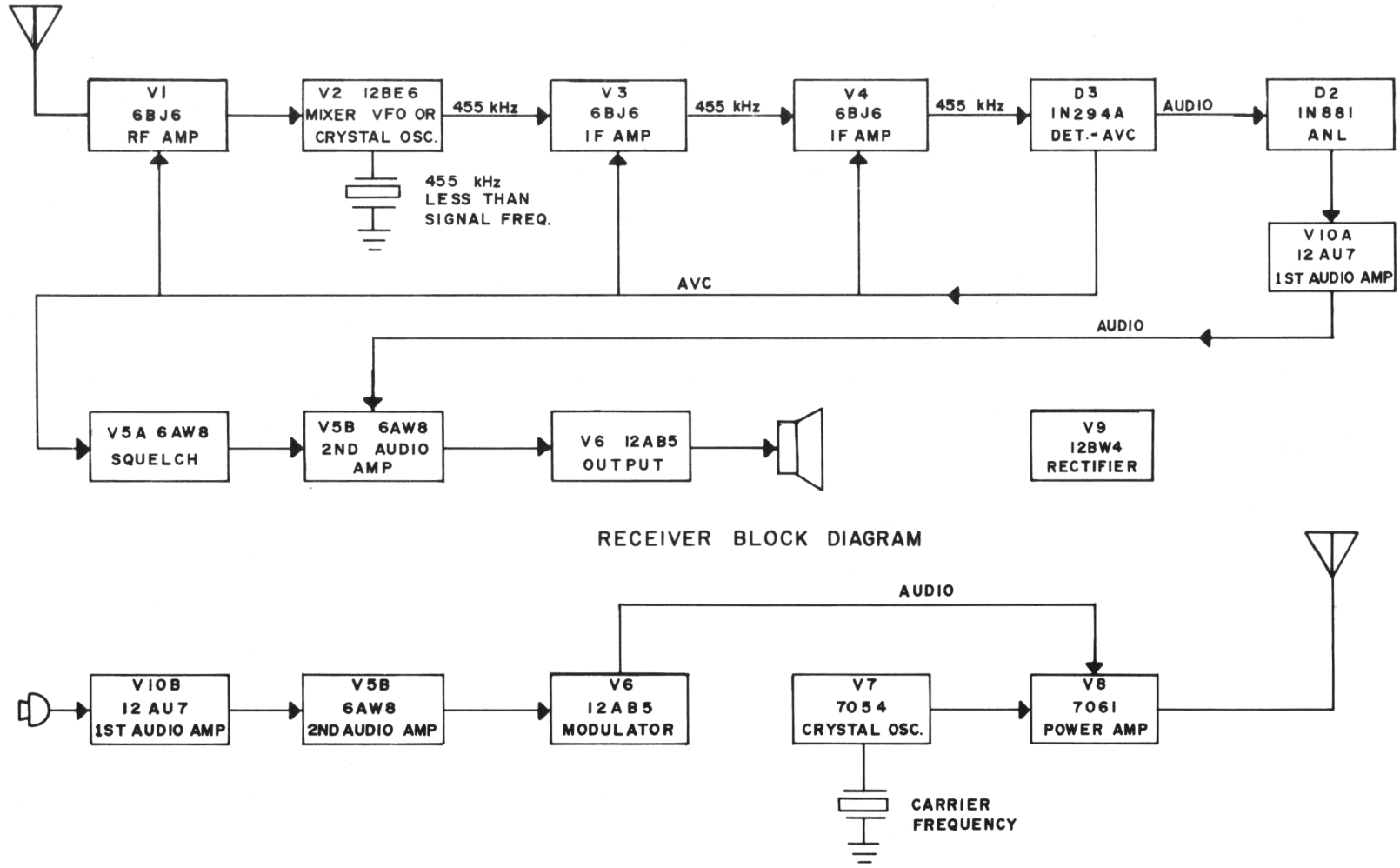
V1
6BJ6
RF AMP
V2 12BE6
MIXER VFO OR
CRYSTAL OSC.
455 kHz
455 kHz
LESS THAN
SIGNAL FREQ.
V3
6BJ6
IF AMP
455 kHz
V4
6BJ6
IF AMP
455 kHz
D3
IN294A
DET.-AVC
AUDIO
D2
IN881
ANL
V10A
12AU7
1ST AUDIO AMP
AVC
AUDIO
V5A 6AW8
SQUELCH
V5B 6AW8
2ND AUDIO
AMP
V6 12AB5
OUTPUT
V9
12BW4
RECTIFIER
RECEIVER BLOCK DIAGRAM
AUDIO
V10B
12AU7
1ST AUDIO AMP
V5B
6AW8
2ND AUDIO AMP
V6
12AB5
MODULATOR
V7
7054
CRYSTAL OSC.
V8
7061
POWER AMP
CARRIER
FREQUENCY
TRANSMITTER BLOCK DIAGRAM

FIGURE 1

# SECTION III
# THEORY OF OPERATION

## 3.1 GENERAL

### 3.1.1 INTRODUCTION

Studying the Messenger Two schematic and block diagram while following the theory of operation will enable the technician to understand more completely the operation of the unit.

### 3.1.2 COMMON CIRCUITRY

The transmitter and receiver utilize common power supply and audio circuits and a common antenna.

### 3.1.3 POWER SUPPLY

The common power supply employs a 12BW4 full wave rectifier, V9, followed by a capacitor input filter. The vibrator is a shunt coil, full wave, interrupter type.

### 3.1.4 JUMPER PLUGS

Jumper plug P10 must be in place to make the transceiver operative when the Tone-Alert selective calling unit is not plugged in. It completes audio and squelch circuits.

### 3.1.5 MICROPHONE SWITCHING

A SPDT switch on the ceramic microphone controls transceiver operation in the following manner:

RECEIVE

a. Opens cathode of first speech amplifier, V10B, so microphone will not feed through the speaker.

b. Grounds one end of speaker voice coil to place it in circuit.

c. Opens cathodes of transmitter oscillator and amplifier (V7 and V8) to turn them off.

TRANSMIT

a. Grounds cathode of first speech amplifier, V10B, so microphone will feed through to second speech amplifier.

b. Opens speaker lead to prevent it being driven by modulator.

c. Grounds cathodes of V7 and V8 through the coil of relay, RY1, to turn on transmitter. This energizes RY1 which transfers antenna from receiver input to transmitter output.

d. Rectified PA grid voltage blocks grid of receiver's first audio amplifier, V10A, to keep audio from the receiver section out of the transmitter. It also blocks the grid of receiver's crystal oscillator to prevent receiver's crystal from oscillating. This same negative voltage passes through diode switch, D1, and charges AVC line and opens squelch to allow transmitter audio system to operate.

ANTENNA SWITCHING

The relay, RY1, transfers the antenna from the receiver input to the transmitter output when the microphone switch, SW2, is pressed. The relay is actuated by the cathode current of the 7061 power amplifier, V8.

### 3.1.6 INDICATOR LIGHTS

The channel indicator lights when the high voltage AC supply is turned on. The red light is connected across the transmitter RF amplifier screen resistor, R55, and indicates that the transmitter is turned on. Its intensity increases with modulation. VFO equipped models have a separate channel indicator for the tunable receiver which is illuminated when VFO - crystal slide switch is in the VFO position.

### 3.1.7 FACTORY TUNING

The receiver and transmitter are aligned for operation on all 23 CB channels at the factory. The transmitter output circuit is tuned when working into a 51.5 ohm resistive dummy antenna and no further adjustment should be necessary when using Johnson approved antennas.

## 3.2 RECEIVER CIRCUITS

### 3.2.1 RF INPUT

With the antenna transfer relay, RY1, in the normal position, signals from the antenna are fed to the receiver tuned input circuit made up of L1 and C2. This circuit provides a voltage gain of approximately 10 from the 50 ohm input to the grid of V1, the 6BJ6 RF amplifier. Signals from V1 are then fed to double-tuned transformer T3.

### 3.2.2 CRYSTAL OSCILLATOR-MIXER

The output of T3 is fed to the signal grid of V2, the 12BE6 crystal oscillator and mixer. The crystal, Y1, operates at series resonance, 455 kHz below the signal frequency, in an impedance-inverting, electron coupled oscillator circuit. Inductor L3 serves as the impedance-inverting device and the screen (pin 6) of V2 acts as a grounded plate for the crystal oscillator section. There is no frequency multiplication. Feedback for the crystal oscillator is provided by the cathode choke, L4. When the transmitter is operating, the oscillator grid of mixer V2 is blocked by rectified DC grid voltage from the power amplifier, V8. This prevents the receiver crystal from oscillating.

With the Crystal - VFO switch in the VFO position, the frequency is controlled by a series tuned tank circuit consisting of L13, C105, C106, C107, C108, C109, C110 and C111. Feedback for the variable frequency oscillator is obtained from a cathode tap at the junction of C105 and C106.

### 3.2.3 IF AMPLIFIERS

The 455 kHz output from the mixer passes through IF transformer, T1, to V3, the first 6BJ6 IF amplifier; through IF transformers T6 and T7; to V4, the second 6BJ6 IF amplifier; then through IF transformer T2 to D3, the 1N294A detector and AVC diode. Gain of the two IF amplifier stages is adjusted by the variable cathode resistor, R83.

### 3.2.4 NOISE LIMITER

The audio output of the detector, D3, is applied to the anode of a series type noise limiter diode, D2. When audio peaks exceed a certain negative value of the plate, the diode momentarily stops conducting, thereby gating the audio signal and preventing strong pulses from reaching the speaker. The threshold of limiting is set (by the bias taken from the AVC line) at approximately 30% modulation of the incoming carrier. The junction of R19 and R20 is bypassed for audio by C25 and serves as a reference for bias of the diode. The time constant is small enough, however, that this bias changes with AVC voltage and automatically adjusts the threshold of limiting for variations in carrier level.

### 3.2.5 RECEIVER AUDIO

Audio output of the limiter passes through the volume control, R21, and to the 12AU7 1st audio amplifier, V10A. The V10A plate load, R4, is common to the plate circuit of the transmitter first audio stage, V10B. When the transmitter is operating, the grid of V10A is blocked by rectified DC grid voltage from pin 3 of the power amplifier, V8. This is done to prevent receiver audio from reaching the common audio system and modulating the transmitter.

The other half of the 12AU7, V10B, functions as the 1st audio amplifier for the transmitter microphone input. When the receiver is operating, the microphone switch SW2 opens the cathode of V10B, disabling the microphone input.

### 3.2.6 SQUELCH

The squelch control increases the screen voltage on the tetrode section of the 6AW8A tube, V5A, causing V5A to conduct. The resulting voltage drop across R29 blocks the grid of triode V5B, the second audio amplifier, which then stops conducting, blocking audio from the speaker. The squelch can be opened by an incoming signal which

increases the AVC voltage applied to the V5A control grid, causing V5A to stop conduction; this will allow V5B to conduct and amplify the audio signal.

3.2.7 AUDIO AMPLIFIER

The type 12AB5 tube, V6, functions as a class AB1 audio amplifier for the receiver output or as modulator for the transmitter. The speaker is a PM type.

## 3.3 TRANSMITTER CIRCUITS

3.3.1 CRYSTAL OSCILLATOR

The transmitter employs an impedance-inverting, electron coupled oscillator with a series resonant crystal operating at the carrier frequency. There is no frequency multiplication. Inductor L5 is the impedance-inverting element. The type 7054 tube, V7, acts as the crystal oscillator, with its screen acting as a grounded plate. The plate tank circuit of V7 consists of L7 resonated with the output capacity of V7 and the input capacity of V8, plus C70.

3.3.2 POWER AMPLIFIER

The type 7061 power amplifier, V8, operates class C. Its plate circuit is an unbalanced Pi followed by an L section for additional harmonic reduction. It is neutralized by the capacity bridge method to prevent instability. The neutralizing adjustment is made by C44, a tubular ceramic capacitor. This capacitor is adjusted to introduce into the grid circuit an amount of RF voltage equal to that coupled directly from plate to grid, but 180° out of phase with it. The phase reversal takes place when the neutralizing voltage passes from the bottom end of the resonant grid circuit to the grid end.

# SECTION IV
# TROUBLE SHOOTING

## 4.1 GENERAL

4.1.1 INTRODUCTION

The following procedures serve as a guide for trouble shooting, repair and the necessary alignment required for proper maintenance of the Messenger Two. Consult the schematic diagram and the tables of typical readings (Section 5) for further trouble shooting assistance. To further your familiarity with the transceiver, study the schematic diagram, the theory of operation and the block diagram.

4.1.2 EQUIPMENT REQUIRED

DC Power Supply 6.5 volts, 11 amp
or 13.6 volts, 6 amp

NOTE: DC Power Supply should be capable of reducing output voltage 15%.

AC Source, 117 VAC, 60 Hz.

Oscilloscope - Modified Heath IO-12 or better.

RF Signal Generator, 25 - 30 MHz, with attenuated output of 1 microvolt to 0.1 volt capable of 30% modulation at 1000 Hz - Hewlett Packard 606A or equivalent.

6 dB 50 ohm pad - connect to RF signal generator output for all trouble shooting and alignment procedures.

Frequency Meter - accurate to ±0.0002%, frequency range 25 to 30 MHz.

Dummy Antenna - 51.5 ohms resistive, 5 watts or more.

VTVM - Triplett Model 850 with RF probe, or equivalent.

Audio Generator - 1000 Hz - Heath Model IG72 or equivalent.

4.1.3 GENERAL INFORMATION

The Messenger Two with four IF transformers in the receiver provides better selectivity than the early version with two IF transformers. Since certain IF transformers are overcoupled to produce a flat "nose" on the selectivity curve (see Figure 4), it is important to follow specified alignment procedures for best results (see alignment charts). Simply tuning each transformer for maximum in the usual manner will give a selectivity curve too narrow at the nose and too wide at the skirts. The alignment procedure gives a short-cut method which saves time.

The Messenger Two receiver front end is stagger-tuned on channels 1, 12 and 22 so that operation on any CB channel is possible without readjustment. Before trouble shooting or alignment, install receiver crystals for channels 1, 12 and 22 (marked R1, R12, R22) and a transmitter crystal for channel 12 (marked T12).

The Messenger Two transmitter is adjusted at the factory to couple to a 51.5 ohm resistive antenna on channel 12.

4.1.4 GENERAL TROUBLE SHOOTING

Most equipment malfunctions will be the result of tube failures. A quick visual check may spot an open filament. Use a known good tube for replacement of suspected tube rather than rely on the tube tester.

If high voltage failure occurs on DC operation, check vibrator. Always check buffer capacitor, C57, before plugging in a new vibrator.

Whenever the cabinet is removed for service, clean relay contacts by rubbing a clean strip of paper between both sets of contacts to burnish them. A relay contact burnishing tool may be used but do not use sandpaper or other abrasive materials.

Check cathode voltages first when checking operating potentials in trouble shooting as this will give the first clue of possible trouble and may speed isolation of the circuit area at fault.

If it is necessary to unsolder and resolder components at ground points where coaxial cable shields are grounded, grasp the tail of the coax shield with long nose pliers when heat is applied so that the plier heat sink will prevent melting of the coax center conductor insulation.

When the transmitter is turned on, sufficient voltage is developed on the AVC line to cut off the squelch control tube, V5A, thus permitting the second speech amplifier, V5B, to conduct and pass the audio signal through to the modulator. If audio fails to get through, check both V5 and V1, the receiver RF amplifier, as malfunction of either tube or circuit can result in failure of V5A to be cut off.

## 4.2 RECEIVER TROUBLE SHOOTING

4.2.1 TEST EQUIPMENT CONNECTIONS (FIGURE 2)

a. The test equipment called for in the equipment list is connected as shown in Figure 2.

b. Connect the AC-VTVM across the speaker leads.

c. Connect the RF signal generator to the antenna jack through a 6 dB pad except where otherwise indicated.

4.2.2 PRELIMINARY RECEIVER TEST

a. Connect the AC-VTVM from the green wire on the speaker voice coil to the chassis.

b. Set AC-VTVM switch to 3 volt scale.

c. Set the signal generator to 27.105 MHz. Feed a 1.0 microvolt signal modulated 30% at 1000 Hz into a 6 dB 50 ohm pad connected to the antenna terminal.

d. Audio output should be 2.0 volts (1.3 watts) or more. Other specifications should be obtained as listed in the Specifications Section. If measurements indicate trouble, proceed with trouble shooting.

4.2.3 AVC

a. Since the AVC affects many stages, it is important to make checks on this system first.