THIS MANUAL APPLIES TO THE P43DEN MODEL

MOTOROLA

FM RADIO

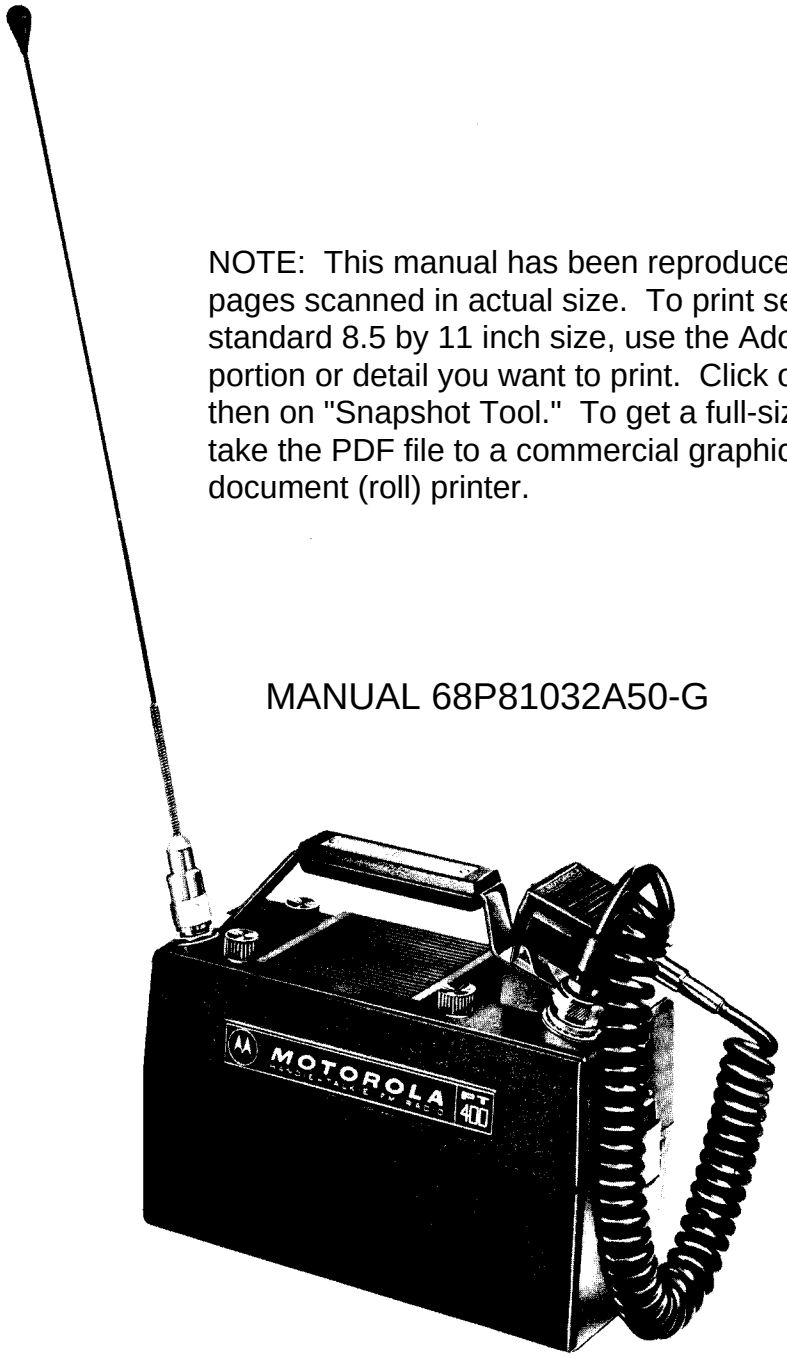
PORTABLE "HANDIE-TALKIE"

10 W RF POWER

132-174 MHz

NOTE: This manual has been reproduced in "Full Page" format, with all pages scanned in actual size. To print sections of long pages in standard 8.5 by 11 inch size, use the Adobe "Snapshot" tool to select the portion or detail you want to print. Click on "Tools" then on "Basic" and then on "Snapshot Tool." To get a full-size reproduction of this document, take the PDF file to a commercial graphics shop for printing on a document (roll) printer.

MANUAL 68P81032A50-G



Model P43DEN-1110AM

MOTOROLA INC. **Communications Division**

ENGINEERING PUBLICATIONS 8000 WEST SUNRISE BOULEVARD FT. LAUDERDALE, FLORIDA 33313

5/31/74 - AP

68P81032A50
Issue - G

CONTENTS

PERFORMANCE SPECIFICATIONS

GENERAL

BATTERY DRAIN	Model	P43DEN-1000 Series	P43DEN-3000 Series	
	Standby	4 mA at 14.0 V	9 mA at 14.0 V	
	Receive - 2 W audio	255 mA at 14.0 V	260 mA at 14.0 V	
	Transmit	2.0 amp at 13.5 V	2.0 amp at 13.5 V	
BATTERY LIFE	Power Supply	22 - #1150 Industrial "D" Cells	24 - Alkaline "C" Cells	Nickel-Cadmium
	Full Audio Output (2 W)	5 days	3 days	8 hours per charge
	Reduced Audio Output (500 mw)	6 days	4 days	8 hours per charge
WEIGHT (with batteries)		11 lbs. 13 oz.	9 lbs. 9 oz.	9 lbs. 15 oz.
DIMENSIONS L x W x H	Speaker-Microphone	9" x 10-1/4" x 3-3/4"	9" x 7-1/4" x 3-3/4"	9" x 7-1/4" x 3-3/4"
	Speaker-Handset	9" x 11-1/4" x 3-3/4"	9" x 8-1/4" x 3-3/4"	9" x 8-1/4" x 3-3/4"

TRANSMITTER

CHASSIS MODEL	NTD6160AA Series with NLD6270A Power Amplifier
RF OUTPUT	10.0 W at nominal battery voltage (13.5 V)
FREQUENCY STABILITY	NTD6160 Series ±.0005% from -30°C to +60°C (+25°C reference)
MODULATION	16F3: ±5 kHz for 100% at 1000 Hz; or 36F3: ±15 kHz for 100% at 1000 Hz
CRYSTAL MULTIPLICATION	18 times
SPURIOUS AND HARMONICS	More than 55 dB below carrier
FM NOISE	At least 35 dB below ±3.3 kHz deviation at 1000 Hz, or at least 40 dB below ±10 kHz deviation at 1000 Hz
AUDIO RESPONSE	+1, -3 dB of 6 dB/octave pre-emphasis characteristic from 300 to 3000 Hz
AUDIO DISTORTION	Less than 8% at 1000 cps, 2/3 rated maximum deviation

RECEIVER

MODULATION ACCEPTANCE*	±5 kHz (split channel models) or ±15 kHz (wide band models)
SENSITIVITY	Less than 0.5 microvolt for 20 dB quieting; .35 uV for 12 dB SINAD
SPURIOUS AND IMAGE REJECTION	More than 70 dB below carrier (except rf image which is 60 dB)
NOISE SQUELCH SENSITIVITY	Noise compensated type: adjustable sensitivity, will open at less than 0.25 microvolt
TONE CODED SQUELCH SENSITIVITY ("PRIVATE-LINE" MODELS)	Fixed sensitivity will open at less than 0.25 microvolt
AUDIO OUTPUT	2 watts to speaker at less than 10% distortion
FREQUENCY STABILITY	±0.0025% from -30°C to +60°C (+25°C reference)
SELECTIVITY	More than 80 dB at +30 kHz or ±60 kHz measured by the 20 dB quieting method, 70 dB by the EIA 2 Generator Method
CHANNEL SPACING*	30 kHz (±5 kHz Bandwidth) 60 kHz (±15 kHz Bandwidth)

*Tone-coded squelch available in split-channel models only.

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

FCC LICENSE DESIGNATION: CC3516

NTMEP email
GERRY SWANSON

MOTOROLA

MODEL CHART

FOR

PT SERIES

"HANDIE-TALKIE" FM RADIO

132 - 174 MHz 10W RF POWER

LEGEND:

[X] = ONE ITEM INCLUDED

◪ = ONE ITEM INCLUDED WITH FIVE (OR LESS) RADIO SETS

⊘ = ONE ALTERNATE ITEM INCLUDED, CHOICE DEPENDENT ON FREQUENCY RANGE

NOTE: = MODELS P43DEN-3130AR/3110AR ARE NO LONGER AVAILABLE

*REPRESENTS A SERIES OF MODELS AND NOT A SPECIFIC MODEL. THE SPECIFIC MODEL, AS STAMPED ON THE CHASSIS, IS DETERMINED BY APPLICATION.

ITEM	DESCRIPTION	REFERENCE DIAGRAM	MODEL NUMBER	TRANSMITTER FREQUENCIES	RECEIVER FREQUENCIES	CHANNEL SPACING	TYPE OF SQUELCH
			SPEAKER - MICROPHONE MODELS				
*NRD1170AA	RECEIVER, WIDE CHANNEL, CARRIER SQUELCH		P43DEN-1000AM	1	1	60 kHz	CARRIER
*NRD1170AB	RECEIVER, SPLIT CHANNEL, CARRIER SQUELCH		P43DEN-1010AM	2	1	60 kHz	CARRIER
*NRD1170AF	RECEIVER, SPLIT CHANNEL, DUAL SQUELCH		P43DEN-1030AM	2	2	60 kHz	CARRIER
NTD6161AA	TRANSMITTER, (132-150.8 MHz)		P43DEN-1100AM	1	1	30 kHz	CARRIER
NTD6162AA	TRANSMITTER (150.8-174 MHz)		P43DEN-1110AM	2	1	30 kHz	CARRIER
NLD6271A	POWER AMPLIFIER (132-150.8 MHz)		P43DEN-1130AM	2	2	30 kHz	CARRIER
NLD6272A	POWER AMPLIFIER (150.8-174 MHz)		P43DEN-3100AM	1	1	30 kHz	TONE-CODED
NCN6067A	CONTROL PANEL		P43DEN-3110AM	2	1	30 kHz	TONE-CODED
NCN6068A	CONTROL PANEL		P43DEN-3130AM	2	2	30 kHz	TONE-CODED
NCN6069A	CONTROL PANEL		SPEAKER - HANDSET MODELS				
NCN6070A	CONTROL PANEL		P43DEN-1000AR	1	1	60 kHz	CARRIER
NCN6071A	CONTROL PANEL		P43DEN-1010AR	2	1	60 kHz	CARRIER
NCN6072A	CONTROL PANEL		P43DEN-1030AR	2	2	60 kHz	CARRIER
NCN6073A	CONTROL PANEL		P43DEN-1100AR	1	1	30 kHz	CARRIER
NCN6074A	CONTROL PANEL		P43DEN-1110AR	2	2	30 kHz	CARRIER
NLD6221A	RECEIVER OSCILLATOR DECK (132-150.8 MHz)		P43DEN-1130AR	2	1	30 kHz	TONE-CODED
NLD6222A	RECEIVER OSCILLATOR DECK (150.8-174 MHz)		P43DEN-3100AR	1	1	30 kHz	TONE-CODED
TLN6492BA	"VIBRASPONDER" RESONANT REED		P43DEN-3110AR	2	1	30 kHz	TONE-CODED
NLN6415A	2-FREQUENCY TRANSMITTER OSCILLATOR DECK		P43DEN-3130AR	2	2	30 kHz	TONE-CODED
NLN6410A	DRIVE LIMITER KIT						
NLD6210A	"PRIVATE-LINE" SQUELCH DECK						
NLN6422A	BOTTOM PLATE KIT						
YMW-35	RECEIVER CONTROL CRYSTAL						
YNW	RECEIVER IF CRYSTAL						
NLD6230A	TRANSMITTER CRYSTAL KIT						
NMN6017A	HANDSET						
NMN6018A	MICROPHONE						
NLN6129A	CARRYING STRAP						
NAD6181A	ANTENNA (132-150.8 MHz)						
NAD6182A	ANTENNA (150.8-162 MHz)						
NAD6183A	ANTENNA (162-174 MHz)						
NLN6429A	TUNING TOOLS						
NLN6439A	NAMEPLATE KIT						
NLN6440A	NAMEPLATE KIT						
NLN6411A	UNIT HARDWARE KIT						
NLN6424A	"PRIVATE-LINE" HARDWARE KIT						

EPD-12451-B

(Pages v and vi have been omitted as irrelevant)

ACCESSORY TABLE

MODEL	DESCRIPTION
NPN6039	117/234 VAC Power Supply
NLN6426	Mounting Rack
NLN6531	Radio Unit Charger
NLN6312	Back Pack Harness
NMN6009	Headset and Microphone
NKN6042	Antenna Extension Cable - 20' RG-58A/U
NDD6000	Antenna, vehicle rain gutter mounting with 10' RG-58A/U coaxial cable and connector
NLN6480	Nickel-Cadmium Battery Charger (Requires NKN6094 or NKN6095 Cable Kit)
NLN6418	6/12 VDC Vehicular Charger
NKN6094	Battery Charger Cable Kit for use with NPN1006 Battery Kit and NLN6480 Battery Charger
NKN6095	Battery Charger Cable Kit for use with NPN6408 Power Supply and NLN6480 Battery Charger
NKN6108	6 VDC Power Cable Kit for NLN6418 Vehicular Charger
NKN6109	12 VDC Power Cable Kit for NLN6418 Vehicular Charger
NLN6419	Carrying Bag
P-7208	RF Dummy Load
ST455	Service Vise
TEKA-40	Power Extension Cable for ease of repair and/or alignment
TEKA-53	DC Power Cable
TEKA-58	Tuning Adapter and Power Cable
NKN6099	Test Set Metering and Adapter Cable
NPN1004	Industrial D Cell Power Pack, with Batteries
NPN1006	Nickel-Cadmium Power Pack, with Batteries

DESCRIPTION AND OPERATION

1. DESCRIPTION

The Motorola "Handie-Talkie" FM radio is a completely transistorized and weatherproof portable communications radio set. The radios are complete, self-powered, portable FM transmitter and receiver units for two-way communication. The advantages of the transistor -- reliability, lightweight, compact size, reduced maintenance and operating costs -- are fully utilized.

Motorola "Private-Line" tone-coded squelch radios are especially useful when operating under crowded channel conditions. Several networks may share the same carrier frequency in the same area with a minimum of interference when each network uses a different "Private-Line" tone frequency.

The radios are available in one or two frequency models. Refer to the Model Chart in the front of this manual for a complete listing of the models available.

These radios incorporate a new concept in miniaturized circuitry, made possible by arranging components in discrete "decks" or layers on the printed circuit boards. As many as three layers are used in some portions of the unit.

a. Power Supplies

All types of units are available with dry batteries, alkaline batteries, nickel-cadmium batteries or a 117-volt a-c power supply (accessory item). Operation is also possible from either a 6- or 12-volt external battery and vehicular charger when the nickel-cadmium power supply is used.

Power packs are changed by unsnapping two spring snaps located at the ends of the unit and separating the power pack from the radio section. Another power pack (dry battery, alkaline battery, nickel-cadmium battery, or the 117-volt a-c power supply) can then be attached to the radio section to again form an integral package.

b. Antennas

The NAD6181A, NAD6182A, and NAD6183A Antennas are flexible steel whips terminated in uhf type connectors. The Model NAD6181A is a 19-1/2" whip operating in the 132-150.8 MHz range. The NAD6182A is a 18-1/2" whip operating in the 150.8-162 MHz range. The Model NAD6183A is a 17-1/4" whip operating in the 162-174 MHz range. All of the antennas have a plastic sleeve covering the whip and spring portions.

NOTE

The Motorola "Handie-Talkie" radio may be used with a fixed or elevated antenna. The antenna circuit provides a 50-ohm termination at the antenna receptacle: therefore any 50-ohm antenna resonant to the transmitter frequency can be used. The higher the antenna, the greater the area that can be covered.

c. Handset

The NMN6017A Handset is supplied complete with a rubber covered coiled cord, which extends to about 5 ft., and a weatherproof connector. A push-to-talk bar on the handset turns the transmitter on. The handset connector plugs into a four-prong receptacle on top of the unit housing.

d. Microphone

The NMN6018A Microphone is supplied with a rubber covered coiled cord, which can be extended to about 5 ft. and a weatherproof connector. This palm type microphone is provided with a push-to-talk button which turns on the transmitter. The microphone connector plugs into a four-prong receptacle located on top of the unit housing.

e. Carrying Straps and Harnesses

The Model NLN6129 Carrying Strap may be used for over-shoulder slinging of the "Handie-Talkie" radio. Snap catches at the ends of the web strap easily hook into the upper brackets at the ends of the radio.

The Model NLN6312 Back Pack Harness Kit enables the radio user to carry the radio as a back pack, to allow greater freedom of movement needed for climbing ladders, carrying and rescue operations, and similar movements. The harness attaches quickly and easily to brackets on the ends of the radio.

2. PRE-OPERATIONAL NOTES

Use care when unpacking and handling the "Handie-Talkie" FM radio. Open the shipping carton and carefully remove all items. Check the contents to be sure that all items have been included.

Inspect the equipment thoroughly as soon as possible after delivery. If any part of the equipment has been damaged in transit, report the extent of damage to the transportation company immediately.

IMPORTANT

This equipment contains batteries. Extended storage of the equipment will reduce the operating performance due to reduction in battery voltage and life. Partially used dry batteries, if left standing for long periods, will leak electrolyte and may result in damage to the radio equipment. If equipment is to be stored for a long period of time, remove the batteries and store them in a cool place.

The Motorola "Handie-Talkie" radio is shipped direct from the factory completely assembled, ready for use, except for the installation of the antenna.

3. OPERATION

CAUTION

Do not key the transmitter unless an antenna, dummy load or equivalent is connected to the antenna-receptacle.

a. To Turn On

Remove the microphone or handset from the mounting bracket. The ON-OFF switch is located under the microphone or mouthpiece end of the handset. Press down on the side of the switch labeled PUSH ON. This places the receiver in operation.

NOTE

All power supplies except the a-c power supplies, turn on and off with the ON-OFF switch on the radio housing. To turn on the a-c power supply, always use the ON-OFF switch on the power supply housing.

b. To Adjust Receiver Audio Volume

Turn the squelch control fully counterclockwise. On dual squelch models, turn the "PL" OFF switch to the OFF position. Adjust the volume control until the desired volume is obtained from the speaker.

c. To Adjust Squelch Control

Turn the squelch control fully counterclockwise. On dual squelch models, turn the "PL" OFF switch to the OFF position. With no signal being received, turn the squelch control clockwise until the noise just cuts out (squelches).

d. "Private-Line" Operation (dual squelch models only)

For "Private-Line" operation, place the "PL" OFF switch in the "PL" position. All non-"Private-Line" and incorrectly coded "Private-Line" signals will then be blocked from the speaker. The squelch control is inoperative when the "PL" OFF switch is in the "PL" position and does not require adjustment.

NOTE

Before transmitting, momentarily place the "PL" OFF switch in the OFF position. This enables the operator to check for a clear channel and thus avoid breaking in on the transmission of another on-frequency unit.

e. To Monitor

To monitor all on-frequency transmissions, turn the unit on and adjust the volume and squelch controls to the proper levels. On dual squelch models, the "PL" OFF switch must be OFF. To monitor only properly coded "Private-Line" transmissions, the "PL" OFF switch must be in the "PL" position.

NOTE

All models feature a semi-automatic ON-OFF switch that automatically turns the radio off when the microphone or handset is replaced in its holder. Continuous monitoring of the receiver in microphone equipped models may be accomplished by placing the microphone in its holder face up. Placing the microphone in its holder face down turns the radio off.

f. To Transmit

Hold the mouthpiece 1 to 2 inches from the lips. Press the push-to-talk button in firmly and hold it. Speak slowly and clearly across the mouthpiece in a normal-to-loud voice. Release the button to listen. The receiver becomes inoperative when the push-to-talk button is pressed, therefore, the button must be released at the end of a transmission to receive.

NOTE

Additional range may be obtained when the radio is placed on the hood or top of a car. This furnishes a larger ground plane for the antenna.

g. Frequency Selection (Two-Frequency Models Only)

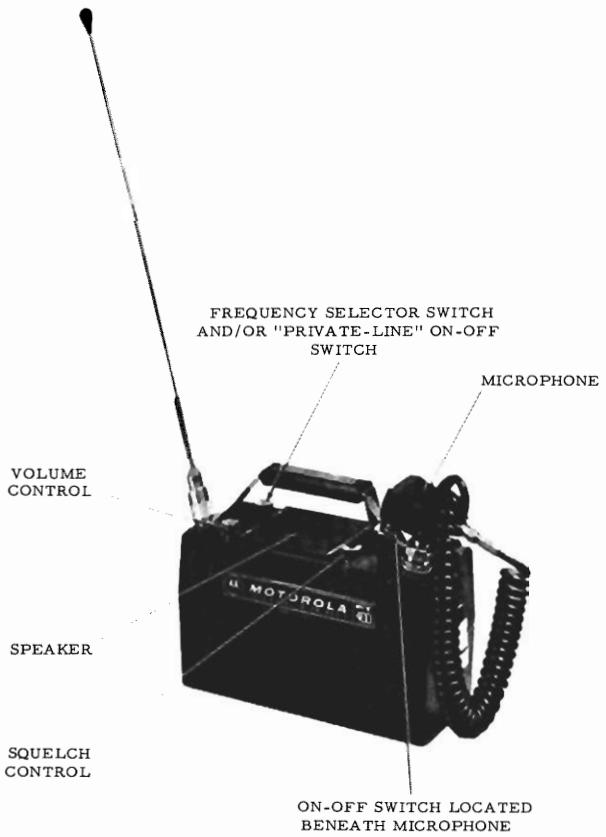
The rotary switch on the top of the unit may be turned to position F1 or F2 to select either of the two operating frequencies.

h. To Turn Off

Replacing the microphone (face down) or handset in the mounting bracket automatically turns the receiver off.

i. Storage

Remove the batteries before storing the unit for a long period of time. If the radio is equipped with nickel-cadmium batteries, refer to the BATTERY REPLACEMENT AND CHARGING SECTION for care and storage of the batteries.



Controls Location Detail

BATTERY REPLACEMENT AND CHARGING

1. BATTERY REPLACEMENT PROCEDURE

Figure 1.

To replace all types of batteries, dry, alkaline, or nickel-cadmium type: (Refer to Fig. 1)

a. Unsnap spring snap at each end of radio.

b. Pull bottom section of radio (battery section) down and away from upper section.

c. Remove battery compartment cover by unscrewing 1/4-turn captive screw and lifting cover up.

d. To replace dry or alkaline batteries, first remove old batteries by turning battery compartment upside down. Place new batteries in compartment so flat (negative) end of batteries make contact with springs and tip (positive) end of batteries make contact with flat contact surfaces.

e. To replace nickel-cadmium battery, proceed as follows:

(1) Remove two screws from corners of battery.

(2) Lift battery out of battery compartment.

(3) Remove four-prong plug from battery.

(4) Insert new battery by reversing this procedure.

Fast battery replacement can be accomplished by changing the entire power supply and replacing the batteries in the used supply at some later time. Additional power supplies can be purchased as separate accessories for fast changeover.

WARNING

Do not discard batteries in fire as they may explode

2. DRY BATTERIES

a. General

All batteries, dry and wet, have a finite shelf life. Storing them for long periods of time reduces their closed circuit voltage and operating life. In some cases, when stored too long, dry batteries may leak electrolyte after partial use and damage the radio. Therefore, if radio equipment is to be stored for long periods of time, remove the batteries and store separately in a cool place. Never store batteries in a warm place as heat increases their chemical action and shortens life.

Shelf life of a dry battery is approximately 3-6 months. Therefore, they should be put into use within 3 months after purchase.

The batteries can be tested at the battery terminals under transmit load conditions.

The batteries should be replaced when the voltage under transmit load is below 11 volts.

IMPORTANT

BATTERY VOLTAGES AND CAPACITY DECREASE MARKEDLY DURING LOW TEMPERATURE PERIODS.

3. NICKEL-CADMIUM BATTERIES

a. General

The battery comprises 12 hermetically sealed cells which are series connected to provide a nominal 15.2-volt output. The cells are cased, and fitted with a cable and connector.

The voltage of a nickel-cadmium battery remains approximately constant under load until the battery approaches the discharged condition.

At this time, a marked decrease in this voltage occurs and the discharged condition is reached abruptly. These batteries should be recharged when the voltage under transmit load reaches 10.0 v.

NOTE

Battery voltage can not be measured at charging contacts.

b. Charging

The Motorola battery chargers and cables listed under ACCESSORIES at the front of this manual are recommended for charging these batteries. The use of other chargers will void the battery guarantee and may result in permanent damage to the batteries. Follow the charging instructions which accompany the charger.

c. Storage

The batteries may be stored at room temperature, in any state of charge without damage. These batteries are subject to self discharge however, and should be recharged after extended storage.

4. BATTERY LIFE

Under operating conditions of 10% transmit, 10% receive at rated audio output and 80% receive standby, dry batteries will give approximately the following life:

NPN1004A -	Standard Power Pack w/NLN6406A Battery Kit - five 8-hour working days at approximately full volume control setting, or six 8-hour working days at lower volume setting, each separated by a 16-hour OFF period.
NPN1005A -	Alkaline C Power Pack w/NLN6407A Battery Kit - three 8-hour working days at approximately full volume control setting, or four 8-hour working days at lower volume setting, each separated by a 16-hour OFF period.
NPN1006A -	Nickel-Cadmium Power Pack w/NLN6408A Battery Kit - one 8-hour working day before recharging is necessary.

Note that most actual transmit duty cycles are much smaller and approach 2% rather than 10%. Also in many types of operation, the unit is not kept turned on continuously. If this type of service is prevalent, battery life may be extended to many times those mentioned previously.

THEORY OF OPERATION

1. GENERAL

The "Handie-Talkie" FM radio consists of a crystal-controlled transmitter and receiver operating in the 132-174 MHz frequency range. The transmitter contains an audio section and an r-f section. The audio section consists of an amplifier clipper and an integrator stage. The r-f section consists of a crystal-controlled oscillator, a modulator, two frequency triplers, one frequency doubler, a driver, two intermediate amplifier stages, and a power amplifier.

The receiver is a double-conversion, superheterodyne unit consisting of one r-f amplifier, two oscillators, two mixers, one first i-f amplifier, five second i-f amplifiers, a 455 kc filter, a limiter, discriminator, squelch amplifier, squelch switch, noise rectifier and three audio amplifiers.

Dual squelch "Private-Line" models include additional stages, some of which are shared by both the transmitter and receiver.

The common stages of the "Private-Line" circuit function as cascaded amplifiers in the receive mode, and the loop gain of the circuit (with a feedback path) provides an oscillator function for the generation of the "Private-Line" tone in the transmit mode.

2. CIRCUIT THEORY

a. Transmitter

A dynamic microphone produces a low level audio output which is directly coupled to a preamplifier in the microphone housing. The output from this stage is capacitively coupled to the amplifier-clipper stage.

The amplifier-clipper and integrator stages comprise an "Instantaneous Deviation Control" (IDC) circuit. Since the transmitter is phase modulated, the frequency deviation is dependent upon both the amplitude and frequency of the audio signal applied to the modulator. The combination of the integrator and phase modulator results in a "flat" response being produced since the pre-emphasis characteristic of the phase modulator is offset by the de-emphasis of the integrator. Therefore, the frequency deviation of the modulator is dependent only upon the amplitude of the integrator input. The audio signal amplitude is limited in the amplifier-clipper prior to insertion into the integrator, thereby limiting maximum deviation to a fixed value within the desired frequency range. Audio frequencies above 3000 Hz are attenuated in a "splatter" filter, consisting of L116 and C114, prior to insertion into the integrator.

Oscillator stage Q101 (and Q201 in two-frequency transmitters) is a fundamental, crystal-controlled, anti-resonant circuit. It generates a radio frequency which is multiplied 18 times in suceeding stages to produce the desired carrier frequency. A variable capacitor across the crystal provides an adjustment (warping) of the operating frequency. The oscillator output is coupled to the modulator stage, Q102.

RF is applied to the base of modulator Q102 while audio is applied to the emitter. The internal r-f gain of Q102 is varied by (and at the rate of) the applied audio voltage. With a fixed phase shift circuit shunting the transistor and a variable phase shift being developed by the transistor, an overall variable phase shift is obtained at the output. The variable inductance in the output of the modulator stages allows matching of the output reactance of the stage to insure minimum distortion and maximum linear deviation. Generally, phase modulators are capable of modulating with low distortion over a small phase angle. This necessitates the addition of frequency multiplier stages which increase the frequency deviation to the desired value.

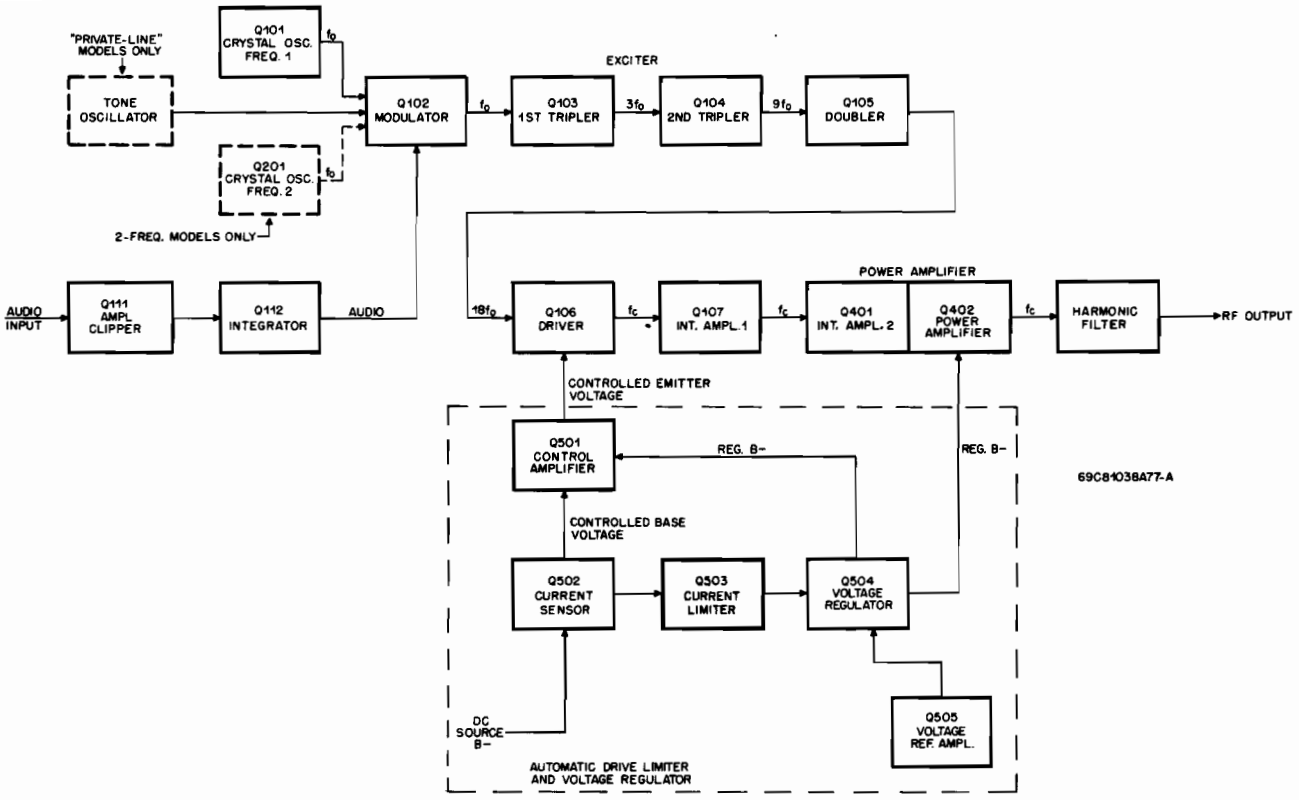
Transistor frequency multipliers, or class B amplifiers in general, do not require forward biasing. Without signal drive, a zero-biased class B frequency multiplier stage will not draw any emitter current. With drive present, the transistor will draw current and this current is easily monitored by measuring the d-c voltage developed across the emitter resistor. An exception to this is the first tripler stage, Q103, where, since the signal input level is very low, a small amount of forward bias is supplied to increase the gain of the stage.

After multiplication, the r-f signal is applied to the driver-amplifier, Q106. The gain of this stage is controlled by the DRIVE ADJ control and the action of the "Automatic Drive Limiter" circuit. Q106 provides the proper amount of r-f power to drive Q107, the first intermediate amplifier.

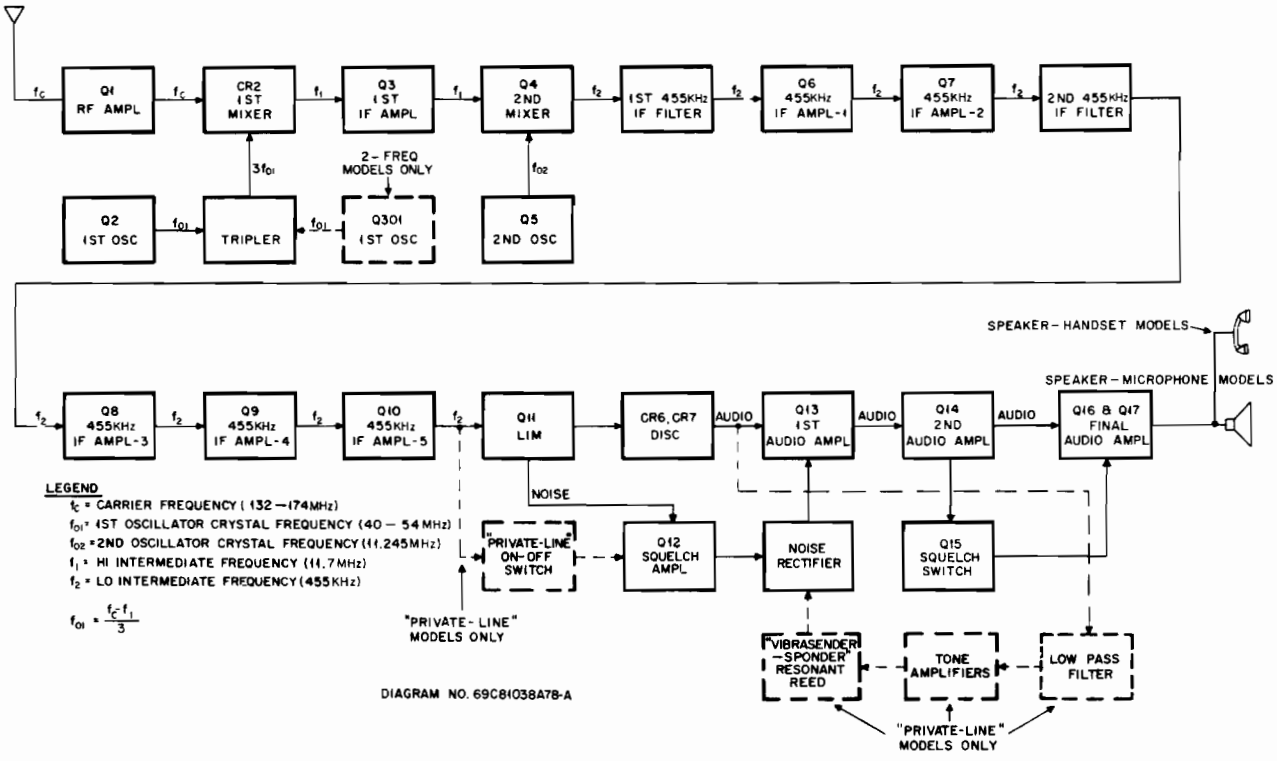
The output of Q107 is coupled to the power amplifier module consisting of Q401, a second intermediate amplifier, and Q402, the power amplifier stage. The r-f output is filtered by a harmonic filter network and coupled through antenna relay contacts to the antenna.

The automatic drive limiter (ADL) circuit protects the driver and power amplifier transistors from being damaged by excessive current. This condition can exist if the transmitter is keyed with its resonant circuits misaligned, the output circuit shorted or the antenna removed. In addition, the ADL circuit maintains the proper output power level of the transmitter when a "fresh" battery, with its higher terminal voltage, is placed in the unit. The feature results in the rated power output of the transmitter being maintained, but with less drive power required, thereby conserving the battery. Supply voltage to the transmitter is regulated by Q503, Q504, and Q505, to compensate for variations caused by changes in load or fresh batteries. Q501 and Q502 reduce drive when the power amplifier stages draw heavy current and increase it when the current drain is diminished.

In operation, transistor Q501 is normally saturated and Q502 and Q505 are normally cut off. Assume, for example, that the power amplifier, Q401-Q402 begins drawing excessive current due to a short in the output circuit. The current flow path for this stage is from the power source through resistor R505 in the base circuit of Q502, to the emitter. As the current increases, the voltage at the junction of R505 and diode CR502 goes positive (i.e., less negative) which back-biases the diode. As CR502 (and subsequently CR501) stops conducting, the reverse bias is removed from the base-emitter junction of Q502, allowing the transistor to conduct. As stated previously, Q501 is normally conducting to saturation, with forward bias being established by the voltage divider consisting of R501 and R502. When Q502 conducts, it forms a low resistance path to the negative power source potential. This results in the forward bias of Q501 being reduce



Transmitter Block Diagram



Receiver Block Diagram

and a decrease in the transistor's conduction. As Q501 conduction decreases, its collector will approach a less negative potential which is applied, through L112, to the emitter of the driver transistor, Q106. The conduction of Q106 will now decrease, providing less drive power for the intermediate and final amplifiers, thereby limiting their emitter current. The operation of the second current sensor Q503 is identical to that of Q502. It senses excessive current in the final power amplifier stage, Q401 and Q402, and reduces the drive voltage from Q106 to the intermediate amplifier, Q107. This, in turn, reduces the drive to Q401 and Q402, thereby limiting current flow in the transistors. The ADL circuit will return the transmitter final stages to their normal operating condition when the excessive current condition has been corrected.

Voltage regulation is accomplished with the voltage reference amplifier, Q505, and is aided by Q503, CR503, and CR504. When high-current conditions occur through Q503, the effective resistance of Q503 is raised to limit the current to normal.

b. Receiver

The signal from the antenna is coupled to the r-f amplifier, Q1, where it is amplified before being injected into the first mixer. The oscillator, Q2, is a crystal-controlled, series-resonant type. The crystal frequency is multiplied three times before being injected into the mixer. There, the incoming r-f signal and the oscillator frequency mix to produce the first intermediate frequency.

The first i-f signal is amplified in the next stage, Q3, and fed to the second mixer. The second mixer combines the first i-f signal and the output of the 2nd oscillator to produce the second i-f signal of 455 kc.

The 455 kHz signal is selected in the first section of the "Permakay" filter, amplified in the two following stages, Q6 and Q7, and selected again in the second section of the "Permakay" filter. The 455 kHz signal is then amplified in the next three stages.

The limiter stage removes any AM noise present on the incoming signal. The discriminator translates the variations of frequency of the i-f signal to an audio frequency signal which is then coupled to the first audio amplifier.

Squelch action is provided by taking the noise produced at the supply voltage decoupling point of the limiter, removing the residual 455 kHz signal, amplifying that portion of the noise above the normal voice frequency range, rectifying this noise and applying it as positive bias to the base of the audio output stage. When the receiver is not quieted (in the absence of an r-f carrier), this bias cuts off the audio output stage and eliminates the speaker noise. The degree of squelch action is regulated by a potentiometer.

A squelch switch, Q15, is incorporated to reduce battery drain under no-signal or standby conditions. When no carrier is being received, Q15 is switched off. This removes bias from Q16 and Q17, stopping conduction and preventing noise from reaching the speaker.

When an r-f carrier signal is received, Q13 conducts which allows Q14 to conduct. The current through Q14 and R52 develops a control signal to turn on the squelch switch, Q15, which completes the bias path for Q16 and Q17 (audio output) to allow the modulation to be heard in the speaker.

The audio section consists of two low power amplifier stages in series where the recovered audio is amplified to 3 milliwatts. These two stages are directly coupled so that when the first stage is back biased by the squelch rectifier circuit, the second stage is also turned off. The output of the second stage is coupled to the power stage which amplifies the audio signal to 2 watts.

c. Dual Squelch "Private-Line" Transmitters and Receivers

The controlling element in the "Private-Line" circuit is the "Vibrasponder" unit. The unit acts similar to a control crystal in an oscillator stage. When the transmitter is keyed, a resonant reed inside the unit vibrates at a predetermined frequency. The resulting tone is then amplified by tone amplifiers and fed into the modulator circuit. It is then coupled, with the audio signal, to modulate the oscillator frequency.

With the "Private-Line" switch in the OFF position, the receiver squelch action is performed as in any standard, noise-operated squelch unit. Moving the "Private-Line" switch to the ON position injects a portion of the 455 kHz i-f signal into the squelch circuit. The signal is

amplified, rectified, and applied as positive bias to the emitter of the audio input stage, cutting the stage off. This i-f signal will always be present, even when an r-f carrier is not being received. Therefore, whenever the "Private-Line" switch is in the ON position, and a properly coded r-f carrier is not being received, the audio stages will be cut off.

When a properly coded "Private-Line" carrier comes on the air, the tone signal is sent to the "Private-Line" circuitry where it is amplified, detected, and coupled to drive the "Vibrasponder" unit. The "Vibrasponder" resonant reeds used in these "Handie-Talkie" radios are of the two coil, single tine type. When a tone is applied across the input coil at the reed's mechanical resonant frequency, the reed will vibrate strongly, acting as an electro-mechanical coupling between the input and output coils. Therefore, the reed can be considered to be a very narrow band-pass filter which passes only the desired tone.

The signal from the "Vibrasponder" unit output coil is then detected and applied as negative bias to the emitter of the audio input stage, allowing it to conduct and unsquelch the audio amplifiers. In dual squelch receivers, the squelch sensitivity is never greater than the tone-coded squelch sensitivity.

MAINTENANCE

1. TEST EQUIPMENT

All the required test equipment needed for aligning and testing the "Handie-Talkie" Radio described in this manual is listed in the following table. The listed items or their equivalents may be used.

TABLE OF RECOMMENDED TEST EQUIPMENT

TYPE OF EQUIPMENT OR TYPE OF MEASUREMENTS	EQUIPMENT CHARACTERISTICS	RECOMMENDED TYPE
All	Select battery operated test equipment where available, for versatility.	See your Motorola sales representative before ordering test equipment. He will analyze your requirements and help you select the latest available equipment to suit your individual needs. He can also advise you of new servicing equipment which becomes available after the printing of this manual.
Power Supply for Bench Testing	Current Ranges 0-200 & 0-400 mA; 0-1 & 0-2 Amps DC volts 1-18 adjustable	Motorola Model TEK-23 Filtered DC Power Supplies, or Current Limiting Power Supply with similar ratings.
Test Jig	Holds boards or radios for service.	Motorola Model ST-455 Service Vice
Transmitter Frequency Measurement	Frequency - 25-500 MHz Accuracy - ±.00005% or better	Any of the following items of Motorola Test Equipment Model S1327A Service Monitor Model S1324A Digital Frequency Meter Model S1325A Digital Frequency and Deviation Meter

TABLE OF RECOMMENDED TEST EQUIPMENT (Cont'd)

TYPE OF EQUIPMENT OR TYPE OF MEASUREMENTS	EQUIPMENT CHARACTERISTICS	RECOMMENDED TYPE
Transmitter Deviation Measurement	Peak reading type for voice or sinusoidal wave; scales for accurate reading of ±5 kHz deviation (and ±1 kHz deviation for "Private-Line" models)	Any of the following items of Motorola Model S1327A Service Monitor Model S1323A Deviation Meter Model S1325A Digital Frequency and Deviation Meter Model S1059A Portable Test Set
Transmitter Power Output Measurement	25-500 MHz; 50 ohms, 0-3, 0-15, 0-50, 0-150 watts 50-ohm dummy load; up to 20 watts	Motorola Model T1024 R.F. Termination Wattmeter Motorola Model T1032A RF Load Resistor Motorola Model S1327A Service Monitor with SLN1009A Wattmeter Plug-In Module
RF Signal Generator for receiver testing	25-500 MHz; FM; high-stability-(±.0002% or better); adjustable output 0 to 1000 microvolts	Motorola Model S1327A Service Monitor Motorola S1318A Series Solid-State FM Signal Generator
Audio Voltage Measurements	High impedance (10 megohm); dBm scale.	Motorola Model S1053C Solid-State AC Voltmeter
Audio Signal Generator for audio circuit testing	Variable amplitude 0 to 1 volt; 100 Hz tone (300 to 3000 Hz preferred); sinusoidal wave	Motorola Model S1067A Solid-State Audio Oscillator Motorola Model TEK-1A Tone Oscillator Motorola S1327A Service Monitor
DC Voltage, Resistance, RF Voltage Measurements	High impedance (11 megohm) dc multimeter	Motorola Model S1063A Solid-State DC Multimeter with SLN6055A RF Probe Motorola Model T1048A Digital Multimeter
Waveform Measurements	Oscilloscope: Audio circuit measurements RF circuit measurements, at least 50 MHz bandwidth	Motorola Model S1331A or S1332A Solid-State Oscilloscope A very high quality instrument is required.
"Private-Line" tone injection for PL decoder circuit measurements	Audio frequency synthesizer or "Private-Line" tone generator using "Vibrasender" Resonant Reed for frequency accuracy	Motorola Model S1333A Audio Synthesizer Motorola Model SLN6221A "Private-Line" Tone Generator
Selective Call tone injection for S.C. Decoder circuit measurements	Audio frequency synthesizer capable of generating two-tone sequential signal; or two-tone sequential generator using "Vibrasender" Resonant Reeds for frequency accuracy.	Motorola Model S1333A Audio Synthesizer Motorola Model TEK-34A Tone Generator

NOTE

When aligning transmitter or receiver, be sure to use specified tune-up cable to simulate actual impedance of antenna.

EPF-1691-A

2. TEST PROCEDURE

When a radio requires servicing, use the following procedures to localize the fault.

a. Fuse Inspection and Replacement

A cartridge fuse is located in the cover of the battery compartment. To inspect or replace the fuse, proceed as follows:

(1) Unsnap the spring snap at each end of the radio.

(2) Pull the bottom section of the radio (battery section) down and away from the upper section.

(3) Remove the battery compartment cover by rotating the captive screw 1/4 turn counter-clockwise and lifting up the cover.

(4) Push the fuse out of its holder with the blade of a screwdriver or similar tool inserted through the hole in the underside of the battery compartment cover.

(5) Press a new fuse into the holder, making sure that each ferrule of the fuse is seated firmly in place.

(6) Reassemble the battery compartment cover to the battery case and rejoin the battery case to the radio section.

b. Check Batteries

The first step in localizing the trouble is to check the battery voltage under load. With the transmitter turned on (keyed), check the battery voltage. A convenient way to do this is to separate the battery compartment and radio compartment. Using the TEKA-40 Extension Cable (or equivalent), connect the batteries to the radio.

CAUTION

Do not key transmitter unless antenna, dummy load, or equivalent is connected to the antenna receptacle.

Place the voltmeter ground lead on a convenient ground and measure the voltage at the transmitter A- input while the transmitter is keyed. The measured loaded voltage should be not less than 11 volts for either the dry or nickel-cadmium batteries. Even though the transmitter may operate at this lower voltage, its operation would be marginal and for only a short additional period. The recommended procedure is to replace, or recharge the batteries if the voltage is below 10 volts under load. Refer to the BATTERY REPLACEMENT AND CHARGING section of this manual for additional information.

NOTE

Only the nickel-cadmium batteries are rechargeable.

c. Check Overall Transmitter Operation

If the battery voltage is sufficient, check the overall performance of the transmitter. A good overall check of the transmitter is the r-f power output measurement. This one check indicates the proper operation of all the transmitter stages (oscillator, frequency multipliers, drivers and final amplifier) with the exception of the modulator and audio circuitry. The transmitter, when properly tuned and operating at 13.5 v d-c, will produce 10.0 w r-f output into a 50-ohm load. It may be necessary to retune the output circuits slightly to match the 50-ohm load. This measurment should be made using a 50-ohm wattmeter connected to one end of the 50-ohm test cable with the other end connected to the antenna receptacle.

For further details, refer to the Transmitter Alignment Procedure. If the power output is less than indicated in the chart, further checking is required. Refer to paragraph 4. TRANSMITTER SERVICE NOTES.

d. Check Overall Receiver Operation

(1) 20 DB Quieting Sensitivity Check

A good overall check of the receiver operation is the 20 db quieting sensitivity measurement. This check will indicate that the receiver has sufficient gain and that all the included circuitry is working properly. The quieting signal is that r-f signal input necessary to reduce the audio output at the speaker by 20 decibels. The measurement should be made in the absence of extraneous signals. Since the receiver squelch circuitry reduces the noise at the speaker, the squelch control should be set for maximum noise while making this measurement.

The actual measurement is made by observing the noise voltage at the microphone connector on an a-c voltmeter with no r-f signal received at the antenna.

NOTE

On handset models not incorporating a speaker, a 120-ohm resistor must

NOTE (Cont'd)

be connected across the a-c voltmeter terminals.

Sufficient carrier signal from a recommended signal generator is then introduced via the antenna receptacle to reduce the noise output voltage to 1/10 of the previous reading. If all circuitry is operating properly, the quieting signal should be 0.5 microvolt or less. Refer to the Alignment Procedure.

(2) Squelch Check

With no r-f input signal, set the squelch control until the speaker noise just cuts out (threshold squelch). Sufficient carrier signal from a recommended signal generator is then introduced until speaker noise is just heard. The signal level at which the squelch begins to open should be less than one-half the 20 db quieting sensitivity voltage measured in subparagraph (1).

(3) Audio Check

The last check to be made is the audio check. This procedure will test the audio circuits exclusive of the squelch circuitry. Refer to the AUDIO AMPLIFIER MEASUREMENTS CHART, which appears later in this manual, for typical measurements and procedures.

NOTE

To aid circuit tracing, the components side of the circuit board is screened in the pattern of the etched circuitry. This paint does not conduct and has no electrical function.

3. RECEIVER STAGE ANALYSIS

The information contained in the following paragraphs will aid the serviceman in localizing the trouble to a particular stage.

a. Test Points

The test points on the printed circuitry are color coded for easy location. The locations of these test points may be seen on the alignment chart, the schematic diagram, and the wiring diagrams at the back of this manual.

b. Stage Measurements Charts

In addition to the 20 db quieting sensitivity measurement, all stage gain measurements can be checked against those shown in the following RF AND IF STAGE MEASUREMENTS CHART and AUDIO AMPLIFIER MEASUREMENTS CHART.

4. TRANSMITTER SERVICE NOTES

The following information will aid the serviceman in troubleshooting the radio transmitter.

CAUTION

Do not key transmitter unless antenna, dummy load or equivalent is connected to the antenna receptacle.

a. Metering Points

The test points on the printed circuit board are supplied for ease in checking. These points are indicated on the schematic diagram, wiring diagrams, and the photograph on the alignment procedure. The chart on the alignment procedure provides nominal voltage readings corresponding to these test points for a fully tuned transmitter with -13.5 volts d-c input.

b. DC Voltage Measurements

If the r-f power output is lower than normal for a fully tuned transmitter, the d-c voltages on the printed circuit board should be checked. These voltages should all be referenced to ground.

CAUTION

When checking a transistor, either in or out of the circuit, do not use an ohmmeter having more than 1.5 volts d-c appearing across test leads or an ohm scale of less than X100.

The transistor is a dependable component and is not subject to replacement as frequently as tubes. Therefore, the serviceman is cautioned not to replace transistors before a thorough check is made. The transistor terminal voltages should be checked first. If these voltages are not reasonably close to those specified, the associated components should be checked. A low impedance meter should not be used for measurement. If all d-c voltages are correct, the signal should be traced through the circuit to show any possibility of breaks in the signal path.

c. RF Signal Tracing

An r-f probe attachment for a d-c multimeter may be used to good advantage in checking the radio transmitter. The presence of r-f can be

RECEIVER RF AND IF STAGE MEASUREMENTS CHART

NOTES

1. Output readings taken with a Motorola Transistorized AC Voltmeter, or equivalent.
2. The carrier frequency is injected at the antenna receptacle using an adapter cable coupled to a Motorola FM Signal Generator, or equivalent.
3. The 1st i-f signal is injected at the points indicated in the chart using a 50-ohm coaxial cable and a series connected .02 uf capacitor.
4. All readings taken with -14.0 volts d-c input.

FREQUENCY	UV INPUT	PROCEDURE	OUTPUT AT	READING (NOTE 1)
-	Noise	-	Base of Q8 (M1)	-58 dbm (0.001 v)
-	Noise	-	Base of Q10 (M2)	-12 dbm (0.19 v)
-	Noise	-	Base of Q11 (M3)	-10 dbm (0.245 v)
-	Noise	- (Short collector of Q1 to collector coil ground with 100 uuf capacitor)	Base of Q8 (M1)	-62 dbm (0.0006 v)
-	Noise	- (Short collector of Q2 to collector coil ground with .02 uf capacitor)	Base of Q8 (M1)	-72 dbm (0.0002 v)
Carrier	6	Connect input to external antenna connector	Base of Q8 (M1)	-29 dbm (0.028 v)
Carrier	6	Connect input to external antenna connector	Input to second section of 455 kHz filter	-20 dbm (0.077 v)
Carrier	100	Connect input to external antenna connector	Output of 1st section of 455 kHz filter	-42 dbm (0.0062 v)
1st i-f	6	Connect input to 1st IF-1 (top of L6)	Base of Q8 (M1)	-29 dbm (0.028 v)
1st i-f	1000	Connect input to 1st IF-5 (top of T2 primary)	Base of Q8 (M1)	-33 dbm (0.017 v)

AUDIO AMPLIFIER MEASUREMENTS CHART

NOTES

1. Remove the GRN-RED lead from test point M4.
2. Connect an audio oscillator capable of generating 1000 Hz to this GRN-RED lead with a 47K-ohm resistor in series.
3. Set the frequency and voltage according to the chart below. The input voltage is measured at the junction of the 47K-ohm resistor and GRN-RED lead.
4. The output readings are referenced to ground unless otherwise indicated and are taken with a Motorola transistorized a-c voltmeter or equivalent.
5. All measurements made with -14.0 volts d-c input.

FREQUENCY	VOLTS INPUT	INPUT TO	OUTPUT AT	READING	REMARKS
1000 Hz	.064 v (-22 dbm)	GRN-RED lead (top of volume control)	Base of Q13	-33 dbm .017 v	Volume control set at maximum
			Collector of Q13	-10 dbm .25 v	
			Base of Q14	-23 dbm .054 v	
			Collector of Q14	+12 dbm 30 v	
			Bases of Q16 & Q17	-5 dbm -.44 v	
			Collectors of Q16 & Q17	+21 dbm 8.8 v	
			Across speaker (pin 8 on rcvr metering jack to gnd) or pin 4 on microphone receptacle	+10 dbm 2.5 v	

checked throughout the r-f circuitry for continuity of signal path. This would include the oscillator, modulator, frequency multipliers, and the driver and final amplifier. It is recommended that the heavy signal flow line (shown on the schematic diagram) be followed through the r-f stages.

d. Frequency Multipliers

Transistor frequency multipliers, or class B amplifiers in general, do not require forward biasing. Without signal drive, a zero-biased, class B frequency multiplier stage will not draw any emitter current. With drive present, the transistor will draw current and this current is monitored best by measuring the d-c voltage developed across the emitter resistor. In the transmitter, these checks are made using test points M1, M2 and M3. The 1st tripler stage operates at a very low signal level. Therefore, a small amount of forward bias is supplied to increase the gain of this stage.

e. Driver and Final Amplifiers

When tuning up the final amplifiers, it may be necessary to retune some previously tuned circuits. This includes coils L108, L109, and capacitors C135, C139, C401, C402, C403 and C404. All these components interact to some extent. By using care in tuning these stages, rated power output will be obtained with minimum current drain.

f. Audio Circuits

If the transmitter does not modulate properly the audio circuits should be checked to make

sure that the audio modulating voltage is reaching the modulator. The audio circuit is a transistorized version of the Motorola audio and IDC circuit. External audio test signals can be coupled into the amplifier-clipper stage, Q108, through a 0.1 microfarad capacitor. In this manner, the audio circuitry can be signal traced.

The IDC control is a printed circuit potentiometer. Care should be taken when setting this control for the proper deviation.

5. SERVICE AND REPAIR

Complete removal of the printed circuit boards for access to the components is not necessary. Once the bottom plate has been removed, the receiver and transmitter boards can be folded out of the housing. The "Private-Line" squelch deck and second frequency oscillator deck (if used) are mounted on the component side of the receiver and transmitter boards. To gain access to the components, remove the mounting screws and fold the decks away. The ADL board is accessible once the receiver board is folded out of the housing. Remove the screws that mount it to the housing and fold it away from the housing wall for access to components. If board removal is necessary, observe standard servicing practices, such as tagging of leads and identification of connecting points.

a. General Disassembly (Refer to Fig. 2)

To gain access to the transmitter and receiver printed circuit boards, proceed as follows:

(1) Remove the battery compartment as described in the BATTERY REPLACEMENT AND CHARGING SECTION.

(2) Turn the radio upside down and loosen the two captive cover screws.

(3) Lift the radio compartment cover up.

(4) The transmitter and receiver printed circuit boards are now accessible. They may be lifted up and out for access to the component side.

(5) Access to the power amplifier is accomplished by loosening two additional captive mounting screws. See Figure 3.

(6) To remove the shield basket over the Automatic Drive Limiter-Regulator board, remove the power amplifier as previously described, pull the audio-metering deck out, and lift the now-exposed shield basket up and out.

b. Final Power Amplifier Transistors Removal Procedure

The placement of components on this chassis is critical. When replacing power transistors, Q401 and Q402, the disassembly procedure outlined in the following steps should be followed as closely as possible. (Refer to Figure 4.)

(1) Carefully unsolder and remove coils, chokes, and capacitors connected to the transistor terminals.

(2) Cut the leads of the feed-thru terminals projecting through the walls of the bracket. New terminals must be installed at the time of reassembly.

(3) With a spanner wrench remove the insulating nut from the stud of each transistor. Remove the transistors from the module.

(4) When re-installing the transistors, reverse the preceding steps. A new feed-through terminal must be installed in place of the one where the leads were cut when the transistor was removed.

(5) Position all coils, chokes and capacitors exactly as they were prior to their removal. Do not distort the shape or spacing of the coils.

NOTE

When resoldering the transistor emitter lead, keep it as short as possible and solder it on the tab close to the capacitor body.

c. Automatic Drive Limiter (ADL) Check

When repairs or replacement of parts in the automatic drive limiter circuit have been made, check for proper circuit performance in the following manner:

(1) Remove power amplifier, audio metering deck, shield, and two screws holding the ADL board and shield. This will expose the ADL for adjustment.

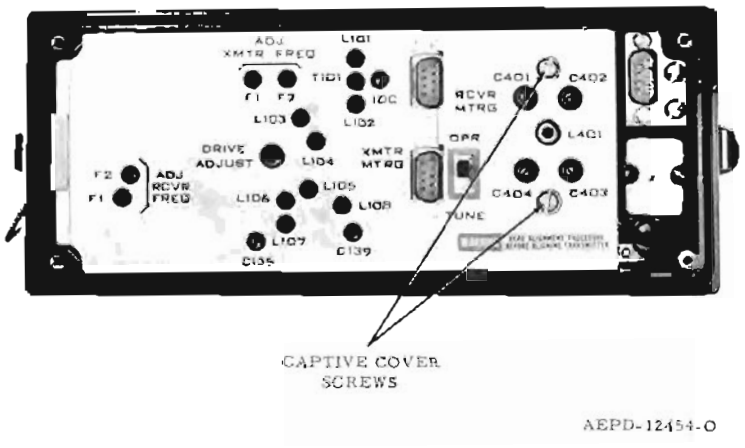


Figure 2.

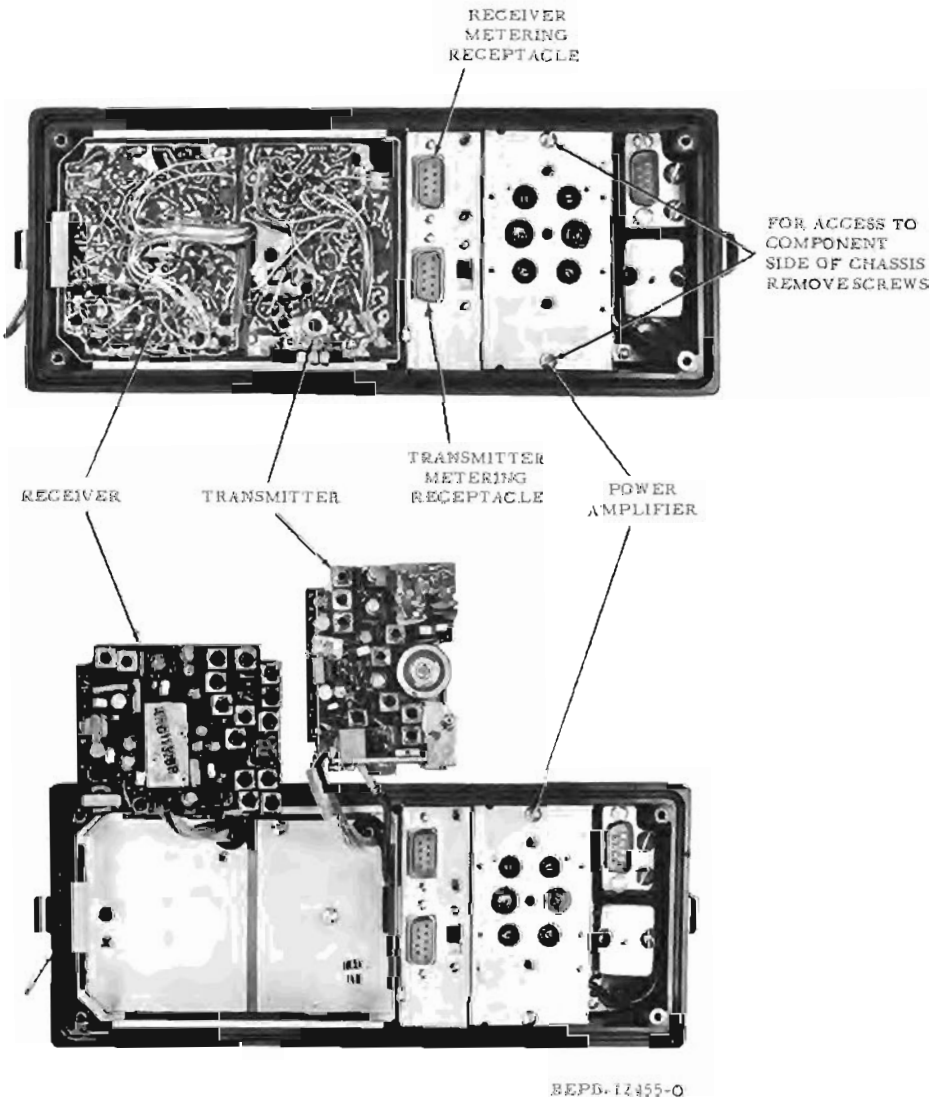


Figure 3.

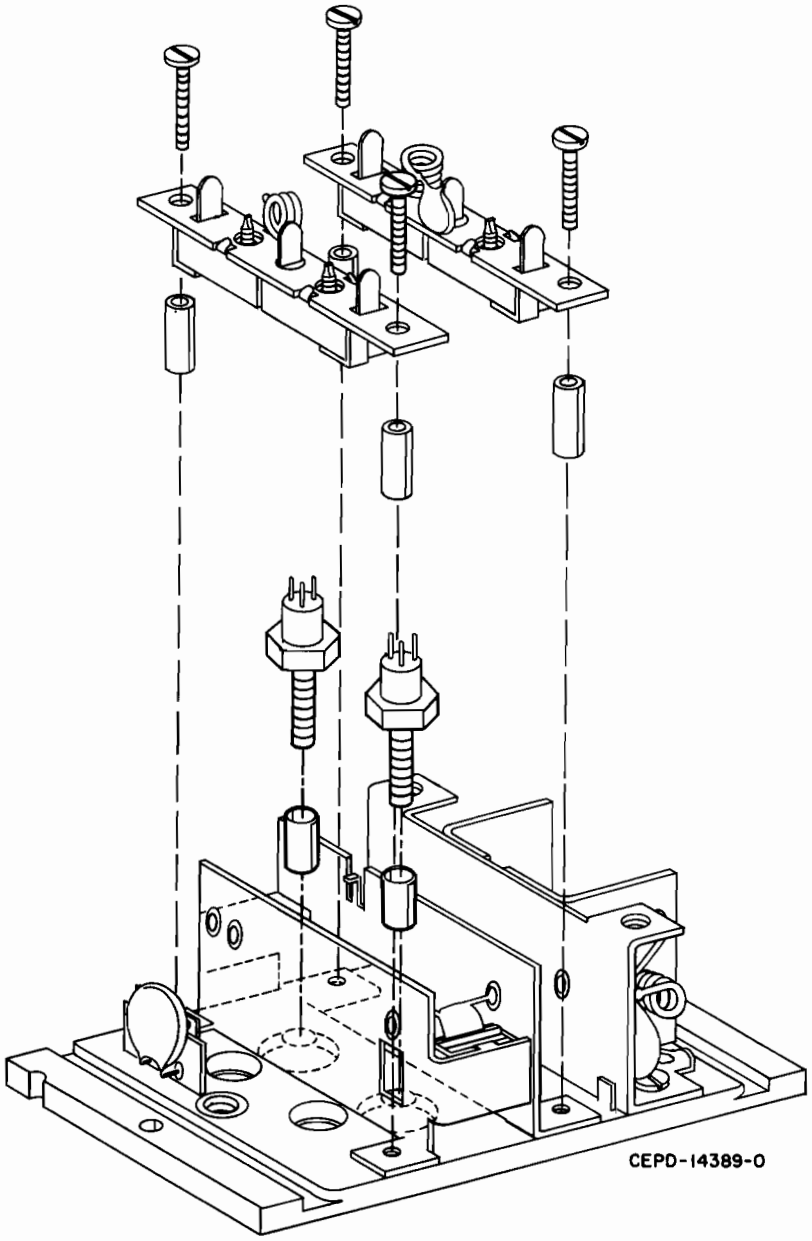


Figure 4.

(2) Set the TUNE-OPERATE switch to the tune position. Connect a 0-20-ohm, 40-watt variable resistor as a dummy load in series with a 0-5 ammeter from the emitter of Q504 to ground.

(3) Turn R512 fully clockwise. Set supply voltage to 13.5 volts. Set dummy load to indicate 2.6 amperes ±.05 ampere. Adjust R507 until voltage across dummy load decreases 0.5 volt.

(4) To check drive limiting to Q106, disconnect violet lead on exciter board and connect a 270 Ω, 1 watt resistor from an equivalent point on the ADL board to the ground plating on the circuit board. This resistor simulates the equivalent d-c load from the driver stage. Monitor the voltage across the high side of the resistor to ground. This voltage should be greater than 11.0 v when the dummy load is set for 1.0 ampere.

(5) Now adjust the dummy load so that the monitored voltage decreases 1 volt. The current should be greater than 1.4 amperes.

(6) Adjust current until the monitored voltage is -5 volts. The current shall be less than 2.3 amperes.

(7) Remove 270-ohm resistor and restore lead when finished with drive limiting check.

(8) To check or adjust the voltage regulator, monitor the voltage across the dummy load connected to the emitter of Q504. Set the dummy load so that 1.4 amperes is drawn at 13.5 volts supply voltage. Increase the supply voltage to 17.0 volts, and adjust R512 so that the voltage across the dummy load measures 14.0-14.2 volts.

(9) Disconnect dummy load and reassemble radio after all checks are completed.

d. Repair Techniques

(1) Construction

The transmitter, receiver, ADL and "Private-Line" squelch decks are mounted on separate printed circuit boards. These boards are the etched copper type with special eyelets in all component mounting holes. This type of board is far superior to the metal foil plated type due to the binding properties of the copper plating to the glass epoxy board. In addition, the special eyelets used in the component mounting holes act as mechanical strain relief members, thereby removing strain from the actual printed circuit.

In the past, servicemen have been led to believe that printed circuits are extremely fragile and that a low wattage soldering iron should be used to prevent damage to the board. This is a misconception. Experience has shown that using a low heat iron has, in many cases, caused the damage the serviceman was trying to prevent. The temperature of the connection must be raised until the solder flows freely around the board eyelet. This usually takes a considerable length of time with a low wattage soldering iron. During this period, heat is conducted away from the eyelet by the printed wiring causing them, in some instances, to break away from the board. Therefore, it is preferable that a high-heat iron be used which will heat the connection rapidly to the point where the solder flows freely. Obviously, an iron this hot should not be held on the connection longer than necessary. The soldering iron supplied with the Motorola ST-639 Printed Circuit Repair Kit is recommended for most work on these boards.

Breaks in the printed circuit wiring can be repaired by bridging the gap with solder. Remove the resin coating covering the printed wiring with solvent before soldering. Areas of damaged circuitry that cannot be practically repaired with a solder bridge can be replaced with a piece of hook-up wire. The hook-up wire should be routed along the original path of the printed circuit to avoid any lead dressing problems in critical areas.

(2) Component Removal

The various components are arranged in "decks" or layers, with those least susceptible to failure on the lower level. At times, however, it may be necessary to remove other components in order to service the faulty one. Special care should be taken during troubleshooting to be as certain as possible that the suspected component is the faulty one. This special care will eliminate unnecessary unsoldering and removal of parts which may weaken or damage the eyelet board.

When removing resistors, capacitors and similar components, heat the connection to be loosened until the solder is molten. Then brush away, or shake off as much of the molten solder as possible. If the leads are bent over, use a soldering aid tool or a knife to straighten them. It may be necessary to apply the soldering iron while doing this. While applying the soldering iron, wiggle the component gently to free it, then lift it from the board. Be sure the component lead is free before trying to remove it or the eyelet circuit board might be damaged. Install the new component and solder it in place. Use solvent to remove excess flux after soldering.

(3) Servicing Aids

Motorola has available several items which can be used to aid in parts replacement and repair of printed circuit boards.

(a) Magnifying Glass

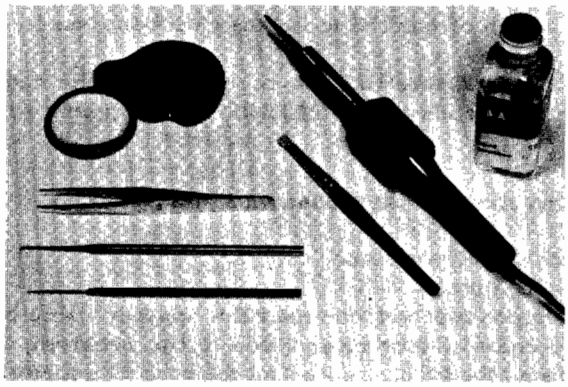
Miniaturization requires precision work both in manufacture and in field service. Adequate concentration of light and magnification are aids to service by enabling a visual examination of connections and miniature parts. The ST-652 Magnifying Glass & Built-In Light Source are most satisfactory devices for use in servicing miniature equipment in the shop. The large illuminated magnifying glass makes it easy to see any portion of the small components found on the printed circuit board. Refer to the accompanying illustration.

(b) Printed Circuit Repair Kit

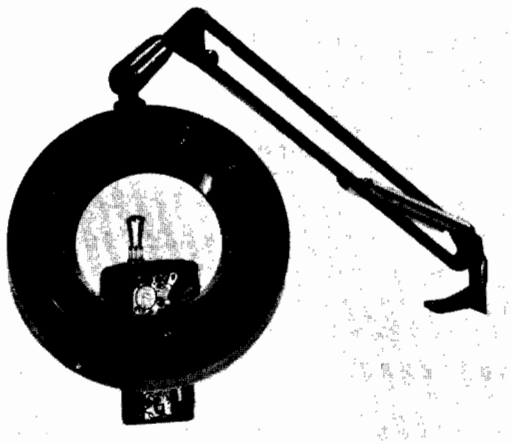
The ST-639 Printed Circuit Repair Kit supplies the basic tools needed for work on printed circuitry and miniature components. Refer to the accompanying illustration.

(4) Alignment Notes

When replacing crystals, realign the radio as described in the alignment procedures in this manual. Also, if any component in a tunable stage is replaced, realign the associated, the preceding, and the following stages.



ST-639 Printed Circuit Repair Kit



ST-652 Magnifying Glass & Built-In Light Source

RECEIVER ALIGNMENT

TEST EQUIPMENT REQUIRED

1. Motorola DC Multimeter.
2. Motorola Transistorized AC Voltmeter or equivalent.
3. Motorola FM Signal Generator or equivalent.
4. Motorola S1056A-9A Series Test Set with 455 kHz crystal or equivalent crystal-controlled oscillator. (Requires NKN6099A Adapter Cable.)
5. Motorola NLN6429A Alignment Tool (supplied).
6. Motorola TEKA-53 Cable Kit (for connecting power supply to radio).
7. Motorola TEK-23 Power Supply (or equivalent, capable of supplying 14 V dc at 2.0 A).

PRELIMINARY SETUP

1. Remove the back cover plate and the internal plate.
2. The dc multimeter ground lead should be connected to a convenient ground on the receiver board.
3. Back out all coil slugs until the top of each slug is flush with the surface of the printed circuit board.
4. Plug the connector on the TEKA-53 Cable into the receptacle on the radio housing. Connect the red (positive) and black (negative) leads to the TEK-23 Power Supply terminals.

HOW TO SET UP THE S1056A-9A SERIES TEST SET

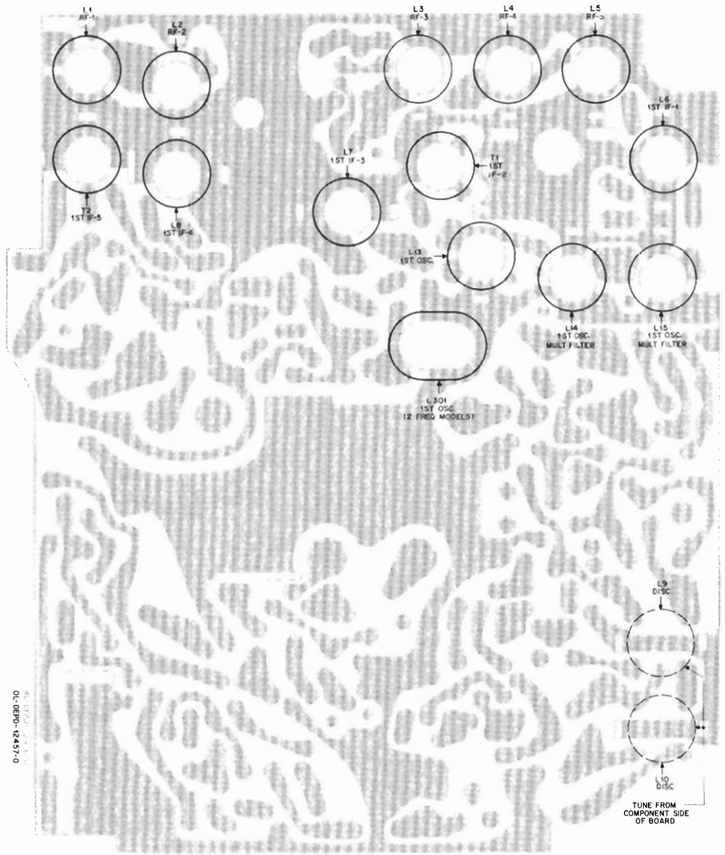
1. Set function selector switch to RCVR position.
2. Switch on 455 kHz crystal oscillator.
3. Connect 20-pin meter cable plug to test set; connect the adapter cable to the cable coming from the test set; connect the other end of the adapter cable to the receiver metering socket. When the test set is not in use; disconnect the 20-pin metering cable to conserve internal battery life. The plug on the cable acts as an on-off switch completing the battery circuit.
4. Connect the rf extension cable to the test set; connect the rf probe cable to the rf extension cable.

FREQUENCY CALCULATIONS

$$f_{o1} = \frac{f_c - 11.7\ \text{MHz}}{3}$$ where f_{o1} = 1st oscillator frequency and f_c = carrier frequency

CAUTION

TO PROTECT TEST EQUIPMENT: MAKE SURE ALL TEST EQUIPMENT SETTINGS ARE PROPERLY MADE BEFORE APPLYING POWER TO THE RADIO. Turn off power to the radio before changing test set function selector switch settings. The transmitter will be keyed if the test set cable is connected to the XMTR METERING receptacle and the test set function selector switch is moved from the XMTR to the RCVR positions.



METERING AND ALIGNMENT POINTS

ALIGNMENT PROCEDURE

NOTES

1. All slugs should be tuned to the peak nearest the printed circuit board end of the coil.
2. Set the squelch control for maximum noise.

STEP	TEST EQUIPMENT	METER POINT & COLOR CODE, TEST SET SELECTOR SWITCH POSITION	ADJUSTMENT	PROCEDURE
1	DC Multimeter	Pin #5 of Rec. Metering Receptacle	B- Supply Voltage	Adjust Power Supply for -14.0 v d-c or 26 ua on test set meter. Test set meter reads 22 ua at -12.0 v d-c and 32 ua at -17.0 v d-c.
	Test Set	5		
2	DC Multimeter	M-6 (BLU)	L13 1st Osc. (F1) L14 Mult. Filter L15 Mult. Filter	Tune L13, L14 and L15 for min. d-c reading on the meter.
	Test Set	6		
3	DC Multimeter & 455 kHz crystal oscillator	M-7 (VIO)	L9 Limiter	Couple a 455 kHz signal into the 455 kHz filter input terminals. Tune L9 for a maximum positive d-c reading.
4	DC Multimeter & 455 kHz crystal oscillator	M-4 (YEL)	L10 Discriminator	Tune L10 for a zero d-c meter reading. NOTE: As the slug is moved into the discriminator coil, the meter reading may move slowly through zero and then sharply return through zero again. Tune the slug to the latter point. When using the test set, turn receiver off and note the deviation from zero. Turn receiver on and adjust L10 to this reference.
	Test Set	4		
5	FM Signal Generator and DC Multimeter	M-4 (YEL)	Signal Generator to carrier frequency	Connect the signal generator to the receiver input. Set the attenuator for 5,000 microvolts and adjust the signal frequency for a zero d-c reading on the meter or reference reading on test set per Step 4. *Do not set the frequency to the 2nd i-f image 910 kHz below the carrier.
	Test Set	4		
6	FM Signal Generator and AC Voltmeter	M-1 (TAN)	T2, L8, L7, T1, L6, L5, L4, L3, L2, L1	Tune these slugs successively for a maximum meter reading. Keep the meter reading below -20 dbm on the a-c voltmeter, and below 15 microamperes on test set meter.
	Test Set	1		
7	DC Multimeter	M-4 (YEL)	L13 1st Osc.	Use the base station transmitter or a frequency standard as a signal source and adjust L13 for a zero d-c reading or reference reading on the test set per Step 4.
	Test Set	4		
8	FM Signal Generator and AC Voltmeter	Pin #8 of Rec. Metering Receptacle or Pin #4 of Microphone Receptacle	Signal Generator	Set squelch control for maximum noise. Adjust the volume control for an output voltage of 0.4 v a-c (noise only - no signal input). Zero the signal generator on the discriminator. Increase the signal intensity until the noise reading is reduced to one-tenth of the reading with no signal (maximum noise). Read the attenuator scale in microvolts (should be less than 0.5 microvolt). This is the 20 db quieting sensitivity.
8A	FM Signal Generator and Test Set			1. Set the position selector to position 4. 2. Turn up the generator output and rotate the generator dial back and forth near the assigned r-f carrier frequency. The test set meter pointer should swing above and below the zero mark as the generator dial is rotated. Set the dial for exact reference reading from Step 4. 3. Reduce the signal generator output to zero (i.e., no signal input). Set the position selector switch to position 11 (AUDIO). 4. Unsquelch the receiver by turning the control head SQUELCH control fully counterclockwise. 5. Adjust the VOLUME control, located on the control head, for a .4 volt reading on the test set meter. Now, turn up the signal generator output until the test set meter reading drops to .04 volt. Note the setting of the signal generator output control. This value in microvolts is the 20 db quieting sensitivity for the receiver.

EPD-13565-B

*CAUTION: After adjusting the signal generator to the carrier, look for the image frequency at 910 kc below this setting. This is a check on the accuracy of the setting. Upon locating the image, return to the proper setting for the carrier frequency.

"IDC" ADJUSTMENT

1. INTRODUCTION

An accurate means of measuring transmitter deviation is to use the Motorola S1327AA Service Monitor. This unit, properly used, permits accurate measurement and setting of transmitter deviation via a peak-reading meter that is unaffected by waveform. An oscilloscope, while not required, is recommended to check for a symmetrical waveform.

The following procedure will insure that the transmitter complies with FCC requirements for maximum deviation.

The importance of correct deviation cannot be overemphasized. Optimum system performance demands accurate deviation setting since overdeviation will interfere with the user on the adjacent channel, and underdeviation may reduce system range.

2. RECOMMENDED TEST EQUIPMENT

a. Motorola S1327A Series FM Station Monitor or equivalent.

b. Motorola Transistorized AC Voltmeter or equivalent.

c. Motorola Model S1067 Solid State Audio Oscillator or equivalent.

d. A general purpose oscilloscope (or Motorola SLN6351A Scope Option) used with the S1327A Service Monitor.

3. MEASUREMENT AND SETTING OF TRANSMITTER DEVIATION

a. Carrier Squelch Models

NOTE

For 2-frequency models, adjust deviation for the F1 channel first. Then check the deviation for the F2 channel and if necessary, adjust R204 for the proper level.

(1) Adjust the 1000 Hz input signal to 1.5 volts. This should drive the IDC circuit into full clip.

(2) With this input signal level, adjust the IDC control on the transmitter to provide a peak-to-peak recovered signal of ±5 kHz deviation. A wide-band system should be adjusted for ±15 kHz. If the waveform under the above conditions is not symmetrical, adjust L101 until a symmetrical waveform is obtained. Readjust the IDC control.

(3) Reduce 1000 Hz input to 0.3 volt. Essentially full deviation should still be observed. Less than 2/3 full deviation will indicate a weak audio transistor or other lack of audio gain.

b. "Private-Line" Models

(1) Remove "Vibrasponder" resonant reed from its socket.

(2) Adjust the 1000 Hz input signal to 1.5 volts. This should drive the IDC circuit into full clip.

(3) With this input signal level, adjust the IDC control on the transmitter to provide a peak-to-peak recovered signal of ±5 kHz deviation. If the waveform under the above conditions is not symmetrical, adjust L101 until a symmetrical waveform is obtained. Readjust the IDC control.

(4) Reduce the 1000 Hz input to 0.3 volt. Essentially full deviation should still be observed. Less than full deviation may indicate a weak audio transistor or other lack of audio gain.

(5) Remove the 1000 Hz tone signal. Insert the "Vibrasponder" unit in its socket.

(6) Check the "Private-Line" tone deviation. The tone deviation should be 0.5 to 1 kHz.

NOTE

If the tone deviation is not within the limits specified in the preceding step, adjust R711 (on the "Private-Line" Squelch Deck) for proper deviation.

(7) Apply a 1000 Hz test tone to pin 2 of the microphone input jack, (base of the amplifier-clipper stage Q111). Place a 0.33 uF capacitor in series with the tone generator output.

(8) Adjust the 1000 Hz input signal level for 1 volt and note the resultant combined deviation of the 1000 Hz modulation and tone signal modulation.

(9) The IDC control on the transmitter should be adjusted to provide a peak-to-peak combined signal of ±5 kHz.

(10) Reduce the 1000 Hz input to 0.25 volt. Essentially full combined 1000 Hz tone and "Private-Line" tone deviation should still be observed. Less than full combined deviation may indicate a defective transistor or other lack of audio gain.

4. MICROPHONE LEVELS

If the modulation level in the system still appears to be too low after setting deviation as indicated above, check the microphone and audio amplifier.

TRANSMITTER ALIGNMENT

EXCERPTS FROM FCC REGULATIONS

FCC regulations state that:

1. Radio transmitters may be tuned or adjusted only by persons holding a 1st or 2nd class commercial radiotelephone operator's license or by personnel working under their immediate supervision.
2. The r-f power output of a radio transmitter shall be no more than that required for satisfactory technical operation considering the area to be covered and the local conditions.
3. Frequency and deviation of a transmitter must be checked before it is placed in service and rechecked once each year thereafter.

TEST EQUIPMENT REQUIRED

This transmitter may be aligned using either of two methods. The test equipment required is as follows:

1. Motorola Test Set and Wattmeter Method

a. Motorola Portable Test Set S1059A. When using the test set to align this transmitter, the Motorola Model NKN6099A Adapter Cable (available on separate order) must be used.
b. Motorola NLN6429A Alignment Tool Kit (supplied).
c. Motorola TEK-23 Power Supply (or equivalent), capable of supplying 14 V d-c at 2.0 amperes.
d. 0-20 watt RF Wattmeter
e. Motorola TEKA-53 Cable Kit (for connecting power supply to radio).

2. DC Multimeter and Wattmeter Method

a. The test equipment required for this method is the same as described for the previous method except substitute a Motorola DC Multimeter (or equivalent) for the Motorola portable test set and adapter cable.
b. Place the multimeter ground lead on pin 11 of the metering socket. Place the positive lead on the pin corresponding to the test set selector switch position for the various steps of the procedure. Example: In step 3 of the procedure, the test set selector switch is placed in position 1. If using a d-c multimeter, the positive lead would be placed on pin 1 of the metering socket.
c. When making the adjustments noted in steps 7, 8, 10 and 11 of the procedure, place the dc multimeter ground lead on pin 6 and the positive lead on pin 11 of the metering socket.

HOW TO SET UP THE S1059A TEST SET

1. Set function selector switch to XMTR position.
2. Place the oscillator and meter reversing switch in the OFF position.
3. Connect the 20-pin meter cable plug to the test set; connect the adapter cable to the cable coming from the test set; connect the other end of the adapter cable to the transmitter metering socket. When the test set is not being used, disconnect the 20-pin metering cable to conserve internal battery life. The plug on the cable acts as an on-off switch completing the battery circuit in the test set.

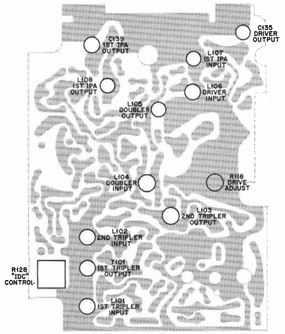
PRELIMINARY SETUP FOR TRANSMITTER ALIGNMENT

1. Plug the connector on the NKN6099A Cable into the receptacle on the radio housing. Connect the r-f cable to the wattmeter. Connect the red (positive) and black (negative) leads from the cable to the TEK-23 Power Supply (or equivalent).
2. If the Motorola portable test set is used for alignment, connect it to the transmitter metering socket as described previously.
3. Turn all coil slugs until end of slug is flush with top of coil form. Turn L105 four full turns clockwise. Set C401 to maximum capacitance (fully clockwise). Set C402 to minimum capacitance (3 turns counterclockwise). Set C403 and C404 to maximum capacitance (fully clockwise), then turn one full turn counterclockwise. If bottom plate has been removed, be sure it is replaced before alignment.

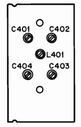
CAUTION

TO PROTECT TEST EQUIPMENT: MAKE SURE ALL TEST EQUIPMENT SETTINGS ARE PROPERLY MADE BEFORE APPLYING POWER TO THE RADIO. Turn off power to the radio before changing test set function selector switch settings. The transmitter will be keyed if the test set cable is connected to the XMTR METERING receptacle and the test set function selector switch is moved from the XMTR to the RCVR positions.

Metering and Alignment Points



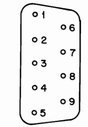
IL-0870-17944-0



CAUTION
DO NOT USE METAL SCREWDRIVER FOR ADJUSTMENT.

AEPD-17932-0

POWER AMPLIFIER



Meter Socket Detail
Pin Side

AEPF-1719-0

$$f_o = \frac{f_c}{18}$$

FREQUENCY CALCULATIONS

Where f_o = oscillator frequency

and F_c = carrier frequency

NOMINAL VOLTAGE READINGS

NOTE

The following readings apply to a fully tuned transmitter with -13.5 v d-c input.

Function Metered		2nd Tripler Q104	Doubler Q105	Driver Q106 Note 3	Regulated Supply Voltage	Unregulated Supply Voltage	P.A. (R.F. Drive) Note 1	P.A. Coll. Current Notes 2, 3
Test Set Switch Position and DC Multimeter Monitoring Points	Test Set Switch Position	1	2	3	4	5	6	7
Readings	Test Set Indication	20 ua	32 ua	41 ua	25 ua (10 ua TEK-5B)	12.0v=22 ua 14.0v=26 ua 17.0v=32 ua	20 ua	9 ua

NOTES:
1. P.A. Metering switch in TUNE position and meter in reverse position.
2. P.A. Metering switch in OPERATE position (transmitter must be keyed by the XMTR ON button mounted on test set).
3. This reading will vary depending on the position of the DRIVE CONTROL (R118) and operation of the "ADL" circuit.

ALIGNMENT PROCEDURE

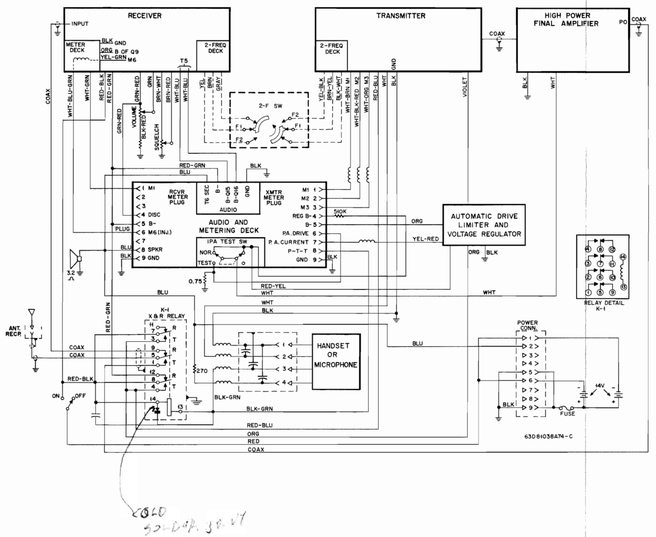
STEP	TEST EQUIPMENT	TEST SET SELECTOR SWITCH POSITIONS (Or pin no. of metering receptacle when using DC Multimeter. See socket detail.)	ADJUSTMENT	PROCEDURE Make adjustments in order given.
1	Test Set	--	--	Place the PA metering switch in the TUNE position.
2	Power Supply	--	R118	Adjust the power supply voltage to -13.5 v dc with transmitter keyed. Adjust R118 for minimum resistance (fully clockwise). CAUTION: To prevent damaging the unit, use a plastic screwdriver blade when adjusting R118.
3	Test Set or DC Multimeter	1	T101, L102	Adjust T101 and L102 for maximum reading.
4	Test Set or DC Multimeter	2	L103, L104	Tune L103 and L104 for a dip.
5	Test Set or DC Multimeter	1	L103	Tune L103 for maximum dip.
6	Test Set or DC Multimeter	3	L106, L105	Tune L106, then L105 for maximum dip.
*7	Test Set or DC Multimeter	6	C135, L107	Tune C135 and L107 for peak meter reading. If a peak cannot be noted on the meter, tune for maximum power supply current drain.
*8	Test Set or DC Multimeter	6	C139, L108	Tune C139 and L108 for peak meter reading. If a peak cannot be noted on the meter, tune for maximum current drain. When tuning L108 do not turn slug past top of coil form, but proceed with next step.
9	Test Set or DC Multimeter	3	L106	Tune L106 for minimum meter reading.
*10	Test Set or DC Multimeter	6	L107, C135	Set L107 at top of coil form, or for 5 ua meter reading. Tune C135 for maximum reading. Repeak L107 and C135 for maximum meter reading in position 6.
*11	Test Set or DC Multimeter	6	L108, C139	Repeak L108 and C139 for maximum meter reading.
12	Wattmeter	--	C403, C404	Move the TUNE-OPERATE switch to the OPERATE position. With a non-metallic tuning tool, tune C403 and C404 for maximum power output.
13	Wattmeter	--	L401, C402	Adjust L401 and C402 for maximum power output on wattmeter
14	Wattmeter	--	C401, C402	Readjust C401 and C402 for maximum power output.

* When multimeter is used, place ground lead on pin 6 and positive lead on pin 11 of metering socket.

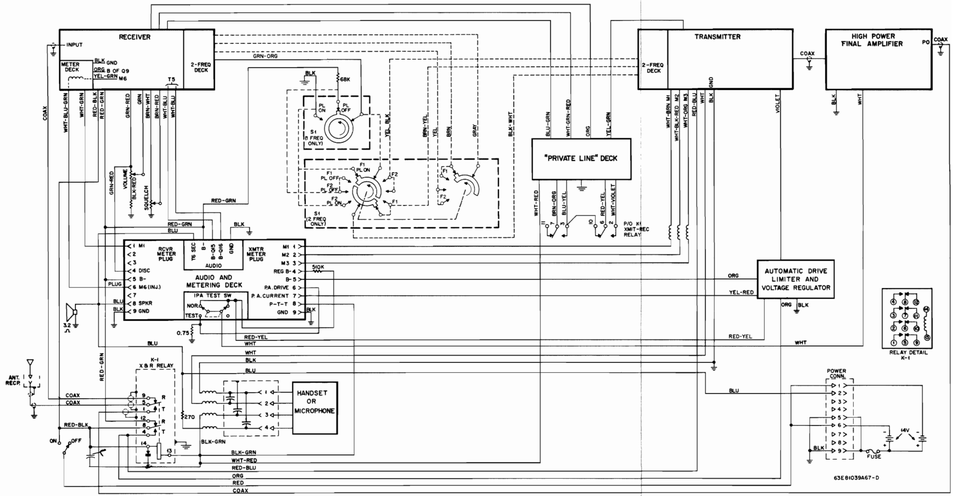
ALIGNMENT PROCEDURE (Cont'd)

STEP	TEST EQUIPMENT	TEST SET SELECTOR SWITCH POSITIONS (Or pin no. of metering receptacle when using DC Multimeter. See socket detail.)	ADJUSTMENT	PROCEDURE
15	Wattmeter	--	L108, C139	Repeak L108 and C139 for maximum meter reading. CAUTION: Do not readjust any exciter tuning adjustments except L108, C139 and R118 (drive control) after switching to the OPERATE position.
16	Wattmeter	--	C401, C402, L401, C403, C404	Retune C401, C402, L401, C403 and C404 for maximum power output.
17	Wattmeter	--	C401, C402, L401, C403, R118	If current drain is no greater than 2.3 amps, adjust C404 and L401 clockwise to reduce current to 2.0 amps. If current is greater than 2.3 amps, adjust R118 counterclockwise to reduce current to 2.3 amps, then adjust to 2.0 amps with C404 and L401
18	Power Supply	--	Input Voltage	Reduce voltage input to 8.0 v dc. Power output should decrease smoothly.
19	--	--	--	DEVIATION CHECK: See "IDC" ADJUSTMENT procedure for proper setting of the IDC control.
20	--	--	--	OSCILLATOR: C101 is preset to the frequency at the factory. Do not readjust C101 unless the crystal is replaced or the setting was accidentally changed. If it is necessary to readjust C101, set up the frequency monitor for frequency measurement, and adjust C101 for zero reading on the monitor CARRIER FREQUENCY meter. Place the bottom plate on the transmitter unit and tighten securely. IMPORTANT - When the bottom plate is attached, the frequency may shift, therefore, recheck the carrier frequency on the frequency monitor. If necessary, repeat this adjustment and recheck procedure compensating for the variations until a zero meter reading is obtained with the bottom plate securely attached to unit. TWO-FREQUENCY TRANSMITTER ONLY OSCILLATOR NO. 2: Use the same procedure as above, substituting C201 for C101.

CARRIER SQUELCH MODELS

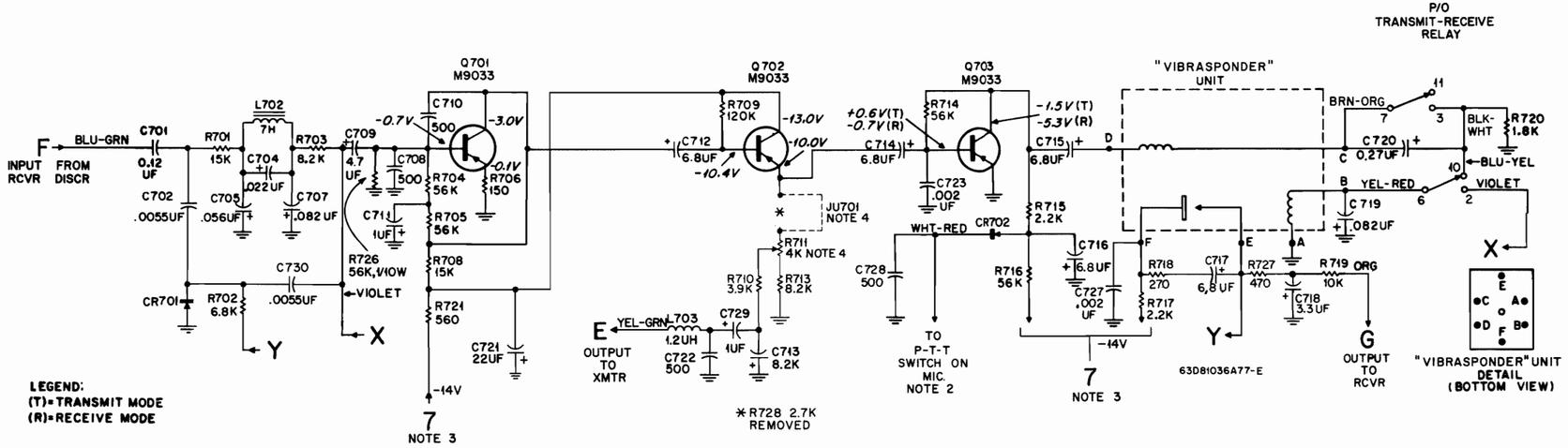


TONE CODED MODELS



NAD6181A Antenna, Flexible (132-150.8 MHz)
NAD6182A Antenna, Flexible (150.8-162 MHz)
NAD6183A Antenna, Flexible (162-174 MHz) EPD-20204-A

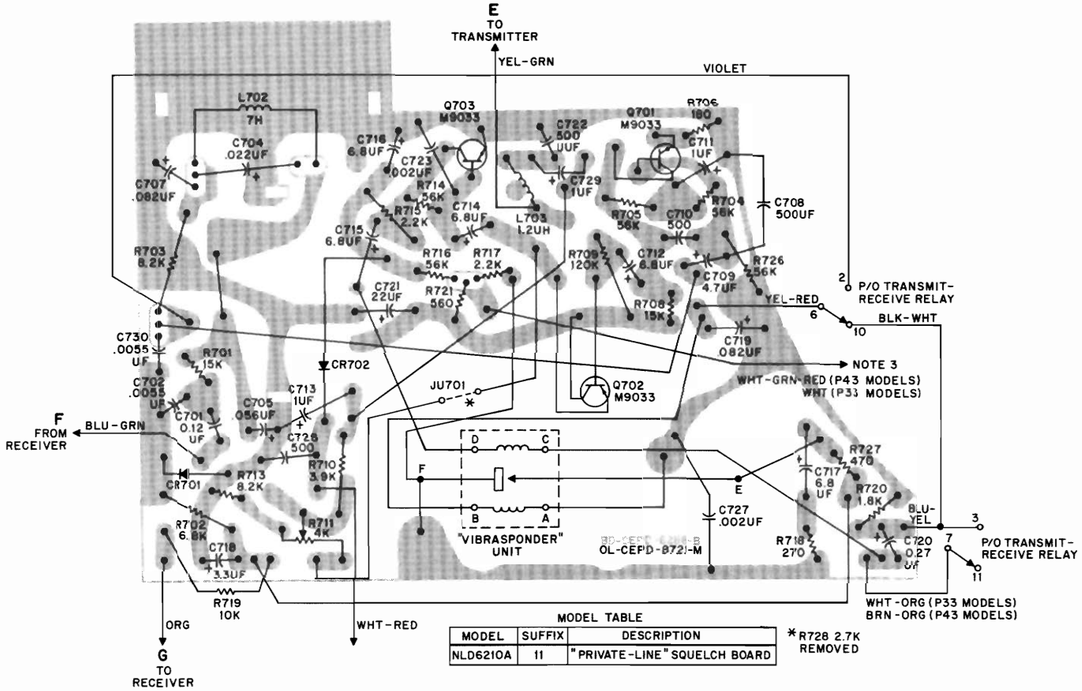
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	1V807174A10	ANTENNA ROD AND BALL (19-1/2") 136-150.8 MHz
	1V858453	ANTENNA ROD AND BALL (18-1/2") 150.8-162 MHz
	1V858454	ANTENNA ROD AND BALL (17-1/4") 162-174 MHz
	14A844065	INSULATOR, Antenna: threaded
	14A844245	INSULATOR, Antenna: nylon
	41A844061	SPRING, Antenna
	28A844066	CONNECTOR, Plug
	42A462075	"O" Ring
	4A322404	WASHER
	4B490516	FLAT WASHER, 1/4"-.106-.030
	3B3174C04	SETSCREW, No. 4-40 x 1/8"
	11B132626	TUBING, Heat shrink: No. 18 clear
	11B132026	TUBING, Heat shrink: No. 10 clear



NOTES

1. UNLESS OTHERWISE SPECIFIED: RESISTOR VALUES ARE IN OHMS; K=1000. CAPACITOR VALUES ARE IN MICROMICROFARADS.
2. REFER TO INTERCABLING DIAGRAM FOR "PRIVATE-LINE" TONE-CODED SQUELCH MODELS.
3. REFER TO B- NETWORK ON "PRIVATE-LINE" RECEIVER SCHEMATIC DIAGRAM.
4. REFER TO "IDC" ADJUSTMENT PROCEDURE FOR PROPER SETTING OF THIS CONTROL. JUMPER JU701 MAY BE REMOVED IF GREATER ADJUSTMENT RANGE IS NEEDED.

EPD-12694-B



MODEL	SUFFIX	DESCRIPTION
NLD6210A	11	"PRIVATE-LINE" SQUELCH BOARD

REVISIONS

BOARD AND SUFFIX NO.	REF. SYMBOL	CHANGE
NLD6210A-7		"VIBRASPONDER" WAS "VIBRASENDER-SPONDER"
NLD6210A-8	C716	WAS 23D82397D16 22 uf
NLD6210A-9	R710	WAS 6S127803 10K; 1/4 W
	R728	ADDED
NLD6210A-9		JU701 REFERENCE ADDED TO NOTE 4.
NLD6210A-9		RELOCATED WAS CONNECTED BETWEEN GROUND AND JUNCTION OF R721, -14 V.
NLD6210A-9		REMOVE NMN6017A HANDSET
NLD6210A-10	C702, 730	WAS 21C82724H01
NLD6210A-11	R728	DELETED

PARTS LIST SHOWN ON BACK OF THIS DIAGRAM

"Private-Line" Squelch Deck Schematic Diagram and Printed Circuit Board Detail
Motorola No. PEPD-12685-H
5/31/74 - AP

PARTS LIST

NLD6210A "Private-Line" Squelch Deck EPD-12688-F

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed: uf; ±10%; unl stated
C701	23D82397D20	0.12 ±20%; 35 v; non-polarized
C702, 730	21C82213E03	.0055; +100-0%; 75 v
C704	23D82397D13	.022; 6 v
C705	23D82397D10	.056; 35 v
C707, 719	23D82397D14	.082; 20 v
C708, 722	21K861441	500 uuf ±10%; 75 v; N4700
C709	23D82397D05	4.7 +40-20%; 3 v
C710, 728	21K847065	500 uuf; GMV; 250 v
C711, 713, 729	23D82397D07	1 +40-20%; 15 v
C712, 714, 716	23D82397D23	6.8 ±20%; 20 v
C715, 717	23D82397D09	6.8 +40-20%; 10 v
C718	23D82397D28	3.3; 20 v
C720	23D82397D25	0.27; 20 v
C721	23D82397D16	22 ±20%; 15 v
C723	21K861442	.002 +100-20%; 75 v
C727	21K831126	.002 GMV; 300 v
		SEMICONDUCTOR DEVICE, diode: SEE NOTE
CR701	48C82392B03	silicon
CR702	48C82178A01	germanium
		REACTOR: AF choke:
L702	25C82750D02	7 h
		COIL, RF: choke:
L703	24D82723H01	1.2 uh
		TRANSISTOR: SEE NOTE
Q701, 702, 703	48R869033	P-N-P; type M9033
		RESISTOR, fixed: ±10%; 1/8 w; unl stated
R701, 708	6S185B93	15K
R702	6K128687	6.8K; 1/4 w
R703, 713	6S185B90	8.2K
R704, 705, 714, 716, 726	6S185C01	56K
R706	6S185B70	180
R709	6S185C05	120K
R710	6S129232	3.9K; 1/4 w
R711	18C82876B01	var; 4K ±20%; 1/20 w
R715, 717	6S185B83	2.2K
R718	6S129752	270; 1/4 w
R719	6K129225	10K; 1/4 w
R720	6S129269	1.8K 1/4 w
R721	6S185B76	560
R727	6K127801	470; 1/4 w
NONREFERENCED ITEM		
	1V80724A84	PRINTED CIRCUIT BD. ASSY.

NOTE:

Replacement transistors and diodes must be ordered by Motorola part number only for optimum performance.

PARTS LIST

LEGEND
L = 132-150.8 MC
H = 150.8-174 MC

NRD6151AA Receiver Circuit Board (132-150.8 MHz Carrier Squelch)
NRD6152AA Receiver Circuit Board (150.8-174 MHz Carrier Squelch)
NRD6151AF Receiver Circuit Board (132-150.8 MHz Tone-Coded Squelch)
NRD6152AF Receiver Circuit Board (150.8-174 MHz Tone-Coded Squelch)

EPD-15158-D

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed: uuf; ±10%; 75 v;
C1L	21K861462	15; N150
C1H, 4L, 9L, 19L	21K861431	12; N150
C2L	21K861434	40; N150
C2H, 5L	21D82877B06	30; N150
C3	21C82450B22	0.75; 500 v
C4H, 9H, 19H	21K867807	8 ±5%; N080
C5H, 16	21D82877B01	24; N150
C6, 12, 18, 83	21K861437	100; N2200
C7, 8	21C82450B26	0.3; 500 v
C10L, 11L	21K861430	10; N150
C10H, 11H	21D82877B13	7 ±5%; N150
C14, 36, 38, 75	21K861442	.002 uf +100-20%
C15L	21D82877B17	5 ±5%; N150
C15H	21K861427	4
C17L, 88H	21K861603	3.3; NP0
C17H	21D82450B28	1
C20L, 40	21K865197	25; NP0
C20H	21K861432	20; N150
C21	21K864522	90; N080
C22, 39	21D82877B02	150; N1400
C23, 24	21K861442	.002 uf +100-20%; 75 v
C25	21D82877B09	3.8 ±0.25; NP0
C26, 34, 89	21K864521	30; N750
C27	21K861436	100; N750
C28, 37, 42, 44, 45, 46, 48, 49, 51, 56, 61, 86	21K861443	.01 uf +100 -20%
C29	21D82450B42	0.75 pf; 500 v
C30, 31	21D82450B43	0.47; 500 v
C32, 33	21K864067	80; N150
C35, 50	21K861444	.02 uf +100-20%
C41	21K861429	8; N150
C43, 47, 54	21K847065	500 GMV; 250 v
C52	21D82239E02	800 ±5%; 200 v
C53	23C82397D06	0.22 uf +40-20%; 35 v
C55	23C82397D16	22 uf ±20%; 15 v
C57	21K864457	.002 uf +100-20%
C58, 62	8C82317B03	.03 uf; 50 v
C59	21D82877B05	150
C60	21K859943	250 ±5%; 500 v
C63, 79	23D82397D19	2 uf +40-20%; 8 v
C64	23C82397D05	4.7 uf +40-20%; 3 v
C65	23D82397D32	2 uf +40-20%; 8 v
C66, 67, 71	23C82397D17	15 uf ±20%; 20 v
C68, 76	8C82317B06	.0082 uf; 100 v
C72	23C82397D31	10 uf ±20%; 20 v
C73	23C82397D15	10 uf ±20%; 20 v
C74	23C82397D08	0.15 uf +40-20%; 35 v
C82	21K868829	220
C88L	21D82877B07	2.2; N150
C92, 93, 94	21K831126	.002 uf GMV; 300 v
		SEMICONDUCTOR DEVICE, diode: NOTE I
CR1	48C82363E03	silicon
CR2	48C859464	germanium
CR3	48C82363E05	silicon
CR4, 6, 7, 13	48C82178A01	germanium
CR8, 9, 10, 12	48C82392B03	silicon
CR14	48C82178A10	germanium
		COIL ASSEMBLY, RF:
L1L	24V80903A02	incl C1L, C3 and 24C82710H01 COIL, RF: VIO-BRN; does not incl 76B82451B04 CORE, tuning
L1H	24V80903A01	incl C1H, C3 and 24C82710H01 COIL, RF: VIO-BRN; does not incl 76B82451B04 CORE, tuning
L3L	24V80903A68	incl C7, C9L and 24C82711H09 COIL, RF; ORG-ORG does not incl 76B82451B04 CORE, tuning
L3H	24V80903A03	incl C7, C9H and 24C82711H01 COIL, RF: VIO-RED; does not incl 76B82451B04 CORE, tuning
L5L	24V80903A06	incl C8, C11L, CR2 and 24C82711H03 COIL, RF: VIO-ORG; does not incl 76B82451B04 CORE, tuning
L5H	24V80903A05	incl C8, C11H, CR2 and 24C82711H03 COIL, RF: VIO-ORG; does not incl 76B82451B04 CORE, tuning
L14L	24V80903A08	incl C17L, C83L, CR3 and 24C82710H02 COIL, RF: VIO-GRN; does not incl 76B82451B04 CORE, tuning
L14H	24V80903A07	incl C17H, C83H, CR3 and 24C82710H07 COIL, RF: does not incl 76B82451B04 CORE, tuning
L15L	24V80903A10	incl C19L and 24C82710H02 COIL, RF: VIO-GRN; does not incl 76B82451B04 CORE, tuning
L15H	24V80903A09	incl C19H and 24C82710H02 COIL, RF: VIO-GRN; does not incl 76B82451B04 CORE, tuning
		COIL, RF: adjustable:
L2, 4	24C82710H01	VIO-BRN; does not incl 76B82451B04 CORE, tuning
L6	24C82711H02	VIO-BLU; does not incl 76K847160 CORE, tuning, nor 76A82686D01 SLEEVE, iron (long)
L7, 8	24C82710H03	VIO-GRAY; does not incl 76K847160 CORE, tuning, nor 76A82686D01 SLEEVE, iron (long)
L9	24C82695D01	pri: 1, 2 w/center tap (5) sec: 3, 4 (tuning core incl)
L10	24C82696D01	bifilar winding (incl tuning core)
L13L	24C82711H05	VIO-BLK; does not incl 76B82451B02 CORE, tuning nor 76A82686D01 SLEEVE, iron (long)
L13H	24C82711H04	VIO-YEL; does not incl 76B82451B02 CORE, tuning, nor 76A82686D01 SLEEVE, iron (long)
		COIL, RF: choke;
L16	24D82723H01	1.2 uh
		REACTOR:
L12	25B82751D01	AF choke; 1.5 h
		TRANSISTOR: NOTE I
Q1	48K869794	P-N-P; type M9794
Q2, 5	48R869168	P-N-P; type M9168
Q3	48R869169	P-N-P; type M9169
Q4	48R869062	N-P-N; type M9062
Q6, 7, 8, 9, 10, 11	48R869057	P-N-P; type M9057
Q12	48R869148	P-N-P; type M9148
Q13	48R869441	P-N-P; type M9441
Q14, 15	48R869248	N-P-N; type M9248
		RESISTOR, fixed: ±10%; 1/4 w; unl stated
R1	6K127805	15 k
R2	6S185B89	6.8 k; 1/8 W
R3, 4	6K129432	820
R5, 21, 23, 27, 29	6K127807	33K
R6	6S185B89	6.8K; 1/8 w
R7, 52	6K128599	680
R8	6S185B79	1K; 1/8 w
R9	6S129230	12K
R10	6K129863	390
R11, 38	6K127806	27K
R12, 65, 53	6K129433	5.6K
R13	6K129818	820 ±5%
R14, 57	6K127801	470
R15	6K128902	47K
R16, 66	6K128687	6.8K
R18	6K129775	330
R19, 76	6K129225	10K
R20, 39, 44	6K128688	2.7K
R22, 24, 26, 28, 30, 45, 47,	6K127804	4.7K
R25	6S185B97	33K; 1/8 w
R31	6K128685	22K
R32	6S185B84	2.7K; 1/8 w
R33, 50	6K128689	2.2K
R34, 69	6K127802	1K
R37	6S185B96	27K; 1/8 w
R43	6K128904	18K
R46	6K129144	68K
R49	6R129984	680 ±5% ("Private-Line" Models)
	or6S129681	1.5K ±5% (Standard Squelch Models)
R51	6K129233	47
R53	6K129433	5.6K
R54, 60	6K128686	8.2K
R55	6S129681	1.5K ±5%
R58	6K129862	150
R59	6S185B73	330; 1/8 w
R62	6K129269	1.8K
R70	6S131523	27 ±5%
R73	6S185B87	4.7K; 1/8 w
R75	6S185B86	3.9K; 1/8 w
		THERMISTOR:
RT1	6B82357G01	100 ohms ±10% @ 25°C
		TRANSFORMER, RF:
T1	24C82712H02	VIO-WHT; does not incl 76K861425 CORE, tuning nor 76A82686D01 SLEEVE, iron (long)
T2	24C82712H01	VIO-VIO; does not incl 76K847160 CORE, tuning, nor 76A82686D01 SLEEVE, iron (long)
		TRANSFORMER, AF:
T3	1V80784A95	pri: res 1000 ohms sec: res 200 ohms; coded GRN ("PL")
	or25B82699D01	pri: res 1340 ohms sec: res 348 ohms; coded BLU (Standard Squelch)
T4	25B82893E02	pri: res 120 ohms ±10% sec: tapped; res 12 ohms ±10%
		CRYSTAL UNIT, quartz: NOTE II
Y1	YMW-35	receiver control
Y2	YNW	11.245 mc
	NON-REFERENCED ITEMS	
	1V80725A08	PRINTED CIRCUIT BD. ASSY. (2-freq. Osc.)
	26B82671D01	SHIELD, coil; 13 req'd

FILTER EPD-12005-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		FILTER, IF:
Z1	NFN6007BS	bandpass; 30 kHz

NLN6234A Resistor-Capacitor Kit (60 kHz) EPD-10772-C

R35, 36	6S185B93	RESISTOR, fixed: 15K ±10%; 1/8 w
C81, 90, 91	21K865197	CAPACITOR, fixed: uuf; 25 ±10%; 75 v; N150
C87	21K847065	500 GMV; 250 v

P/O NCN6068A Control Panel (C1-R1 Spkr.-Mic.)
P/O NCN6070A Control Panel (C1-R2 Spkr.-Mic.)
P/O NCN6072A Control Panel (C1-R1 Spkr. Handset)
P/O NCN6074A Control Panel (C1-R2 Spkr. Handset) EPD-15178-C

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C69	8K868591	CAPACITOR, fixed: 0.39 uf ±10%; 100 v
J1	9C82847E02	CONNECTOR, receptacle: female; 9 contact
LS1	50D83205B02	LOUDSPEAKER, permanent magnet: 3"; square; 3.2 ohms imped
Q16, 17	48R869582	TRANSISTOR: (SEE NOTE I) P-N-P; type M9582
R66	6S129144	RESISTOR, fixed: 68K ±10%; 1/4 w
R74	6S6432	270 ±10%; 1/2 w
R77, 78	17C82350A07	1.5 Ω 1 w
S1	40C82891E01 or 40C82843E01	SWITCH: rotary; 3 pole; 4 position ("PL") rotary; 2 pole; 2 position (2 freq.)
T5	25C83212B01	TRANSFORMER, AF: pri: BRN, BLU w/RED center tap; total res 10 ohms ±20% sec: BLK, GRN; res 0.3 ohms ±20%
K1	80C83202B01	RELAY: 13.6 v; 160 ohms

NLD6221A 2nd Freq. Oscillator (132-150.8 MHz)
NLD6222A 2nd Freq. Oscillator (150.8-174 MHz) EPD-10774-O

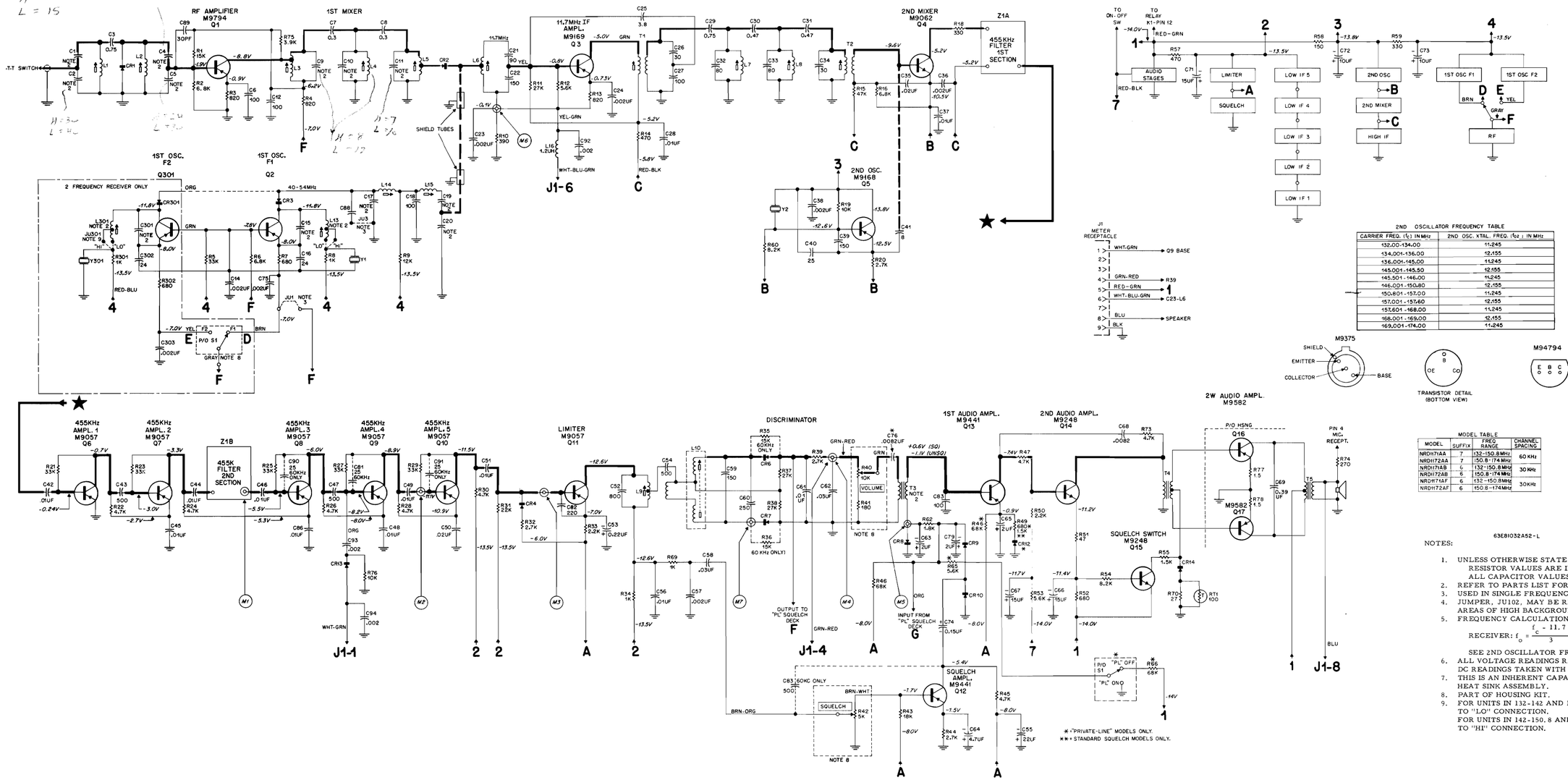
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C301L	21D82877B17	CAPACITOR, Fixed 75 V: 5 uF ±5%; N150
C301H	21K861427	4 uF ±10%; N150
C302	21D82877B01	24 uF ±10%; N150
C303	21K861442	.002 uF +100-20%
CR301	48C82363E01	SEMICONDUCTOR DEVICE, Diode: NOTE I silicon
L301L	24C82766D08	COIL, RF: VIO-BLK; does not incl 76B82451B02 CORE, tuning
L301H	24C82766D05	VIO-YEL; does not incl 76B82451B02 CORE, tuning
Q301	48R869168	TRANSISTOR: NOTE I PNP; type M9168
R301	6K127802	RESISTOR, Fixed: ±10%, 1/4 W: 1 k
R302	6K128599	680
Y301	YMW-35	CRYSTAL UNIT, Quartz: NOTE II

NOTES:
I. Replacement diodes and transistors must be ordered by Motorola part number only for optimum performance.
II. Crystals are part of the complete radio model (not part of the receiver model). When ordering crystal units, specify carrier frequency, crystal frequency and crystal part (type) number.

REVISIONS

CHASSIS AND SUFFIX NO.	REF. SYMBOL	CHANGE
NRD6151AA-1 NRD6152AA-1	Q13	WAS 48R869148; P-N-P; TYPE M9148
NRD6151AA-2 NRD6152AA-2 NRD6151AF-1 NRD6152AF-1	Q1	WAS 48R869243 P-N-P; TYPE M9243
NRD1171AA-1 NRD1172AA-1 NRD1171AB-1 NRD1172AB-1	C25	WAS 2.8 uuf
	T3	ADDED: OR 25B82699D01 PRI: RES 1000 OHMS SEC: 200 OHMS, CODED GRN; (STANDARD SQUELCH)
	R49	ADDED: 1.5K (STANDARD SQUELCH MODELS)
NRD1171AA-2	Q16, 17	WERE 48R869249
NRD1172AA-2	R70	WAS 6S124A13, 33
NRD1171AB-2 NRD1172AB-2 NRD1171AF-1 NRD1172AF-1	RT1	WAS 6B861477, 100 ohms
	R77	ADDED 1.5 OHMS
	R78	
	CR14	ADDED 48C82178A10
	R72	REMOVED 17K851523, 1.5 ±10%; 1 w
NRD1171AA-3 NRD1172AA-3 NRD1171AB-3 NRD1172AB-3 NRD1171AF-2 NRD1172AF-2		CIRCUIT BOARD REVISED
NRD1171AA-4 NRD1172AA-4 NRD1171AB-4 NRD1172AB-4 NRD1171AF-3 NRD1172AF-3	C23, 24	WERE 21K831126, .002 uf
	C59	WAS 21D82877B02
NCN6070A-3 NCN6068A-3 NCN6072A-3	S1	ADDED
NRD1171AA-5 NRD1172AA-5 NRD1171AB-5 NRD1172AB-5 NRD1171AF-4 NRD1172AF-4	CR3	WAS 48C82363E01
NRD1171AA-6 NRD1171AB-6 NRD1171AF-5 NRD1172AA-6 NRD1172AB-6 NRD1172AF-5	C29	WAS 21C82450B22
	C30, 31	WAS 21D82450B24
NFN6007BS		WAS NFN6007AS
NRD1171AA-7 NRD1171AF-6 NRD1172AA-7 NRD1172AF-6	Q1	WAS 48K869375
	R1	WAS 6K128904 18K
	R2	WAS 6S185B87 4.7K; 1/8 w

RECEIVER



2ND OSCILLATOR FREQUENCY TABLE

CARRIER FREQ. (f_c) IN MHz	2ND OSC. XTAL. FREQ. (f_{02}) IN MHz
132.00-134.00	11.245
134.001-136.00	12.155
136.001-145.00	11.245
145.001-145.50	12.155
145.501-146.00	11.245
146.001-150.80	12.155
150.801-157.00	11.245
157.001-157.60	12.155
157.601-168.00	11.245
168.001-169.00	12.155
169.001-174.00	11.245

MODEL TABLE

MODEL	SUFFIX	FREQ RANGE	CHANNEL SPACING
NRDH71AA	7	132-150.8MHz	60 KHz
NRDH72AA	7	150.8-174MHz	
NRDH71AB	6	132-150.8MHz	30 KHz
NRDH72AB	6	150.8-174MHz	
NRDH71AF	6	132-150.8MHz	30KHz
NRDH72AF	6	150.8-174MHz	

63E81032A52-L

NOTES:

1. UNLESS OTHERWISE STATED:
   RESISTOR VALUES ARE IN OHMS, ±10%; 1/4 W. K=1000.
   ALL CAPACITOR VALUES ARE IN MICROMICROFARADS.
2. REFER TO PARTS LIST FOR COMPONENT VALUE.
3. USED IN SINGLE FREQUENCY MODELS ONLY.
4. JUMPER, JU102, MAY BE REMOVED FOR OPERATION IN AREAS OF HIGH BACKGROUND NOISE.
5. FREQUENCY CALCULATIONS:

   RECEIVER: $f_o = \frac{f_c - 11.7\ \text{MHz}}{3}$

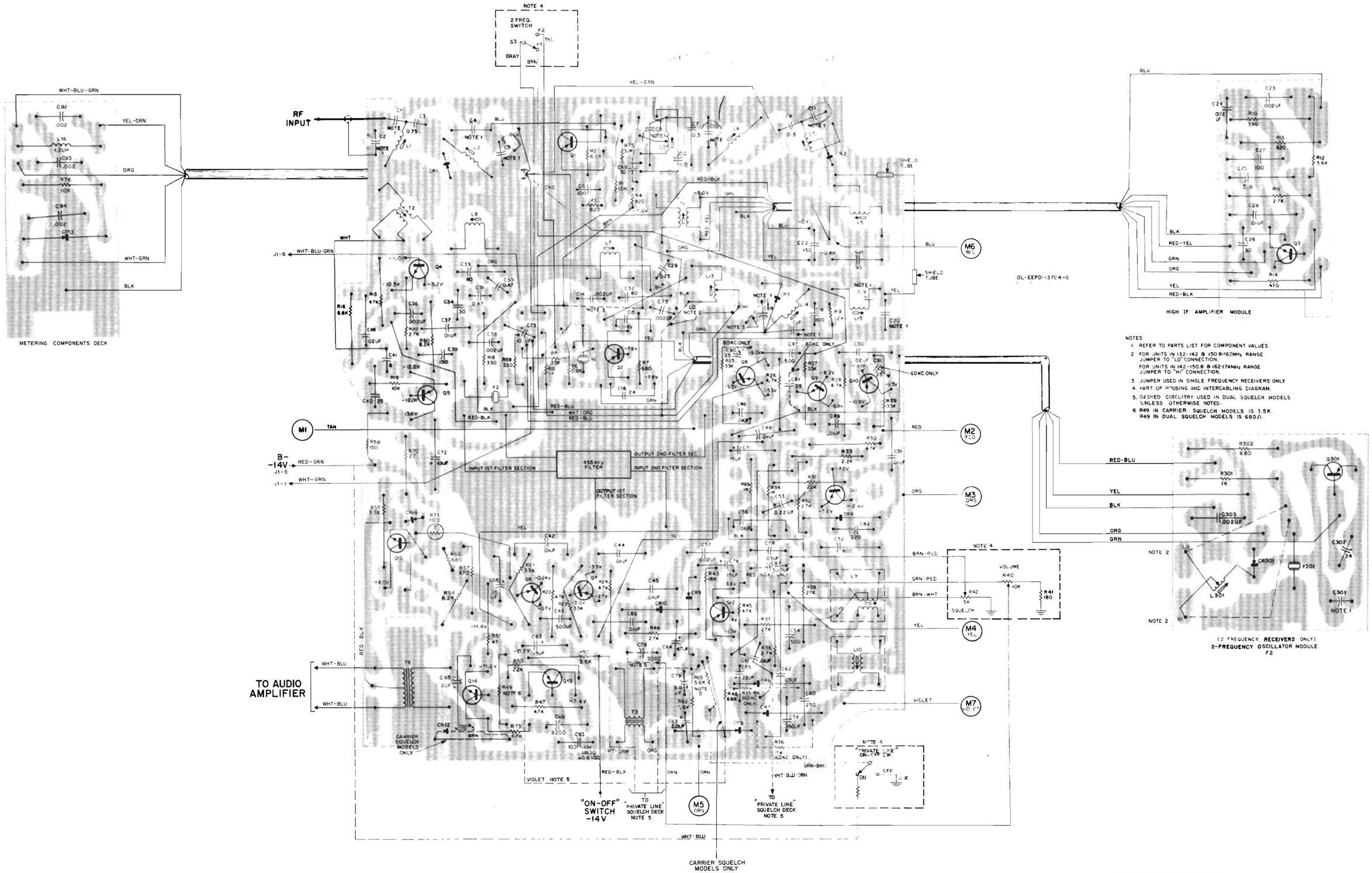
   SEE 2ND OSCILLATOR FREQUENCY TABLE.
6. ALL VOLTAGE READINGS REFERENCED TO CHASSIS GROUND. DC READINGS TAKEN WITH A MOTOROLA DC MULTIMETER.
7. THIS IS AN INHERENT CAPACITY WHICH IS PART OF THE HEAT SINK ASSEMBLY.
8. PART OF HOUSING KIT.
9. FOR UNITS IN 132-142 AND 150.8-162 MC RANGE JUMPER TO "LO" CONNECTION.
   FOR UNITS IN 142-150.8 AND 162-174 MC RANGE JUMPER TO "HI" CONNECTION.

EPD-14459-A

* = "PRIVATE-LINE" MODELS ONLY.
** = STANDARD SQUELCH MODELS ONLY.

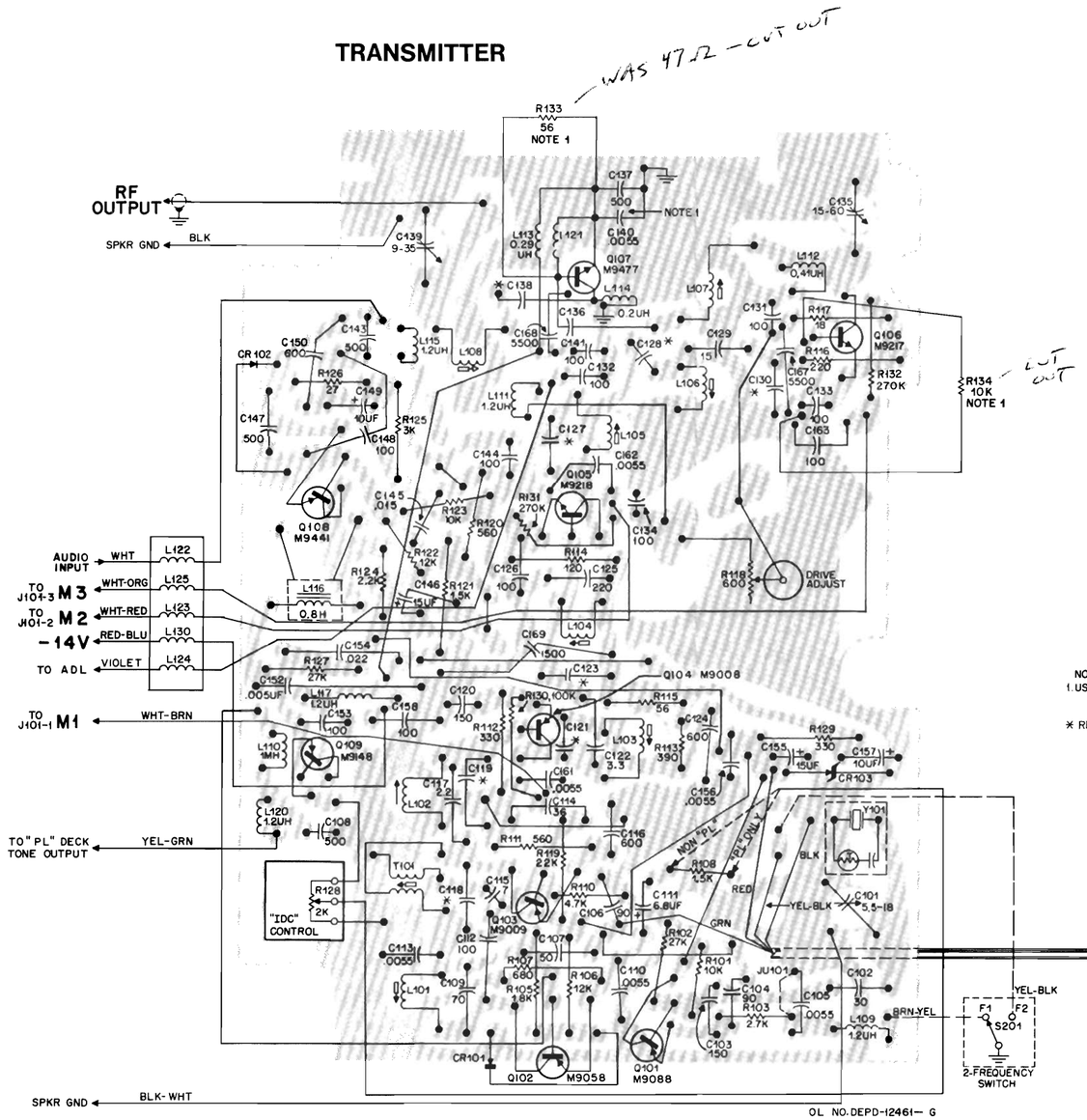
PREVIOUS REVISIONS AND PARTS LISTS SHOWN ON FRONT OF THIS DIAGRAM

Receiver Schematic Diagram
Motorola No. 63E81032A52-L
5/31/74 - AP



Receiver Printed Circuit Board
and Wiring Diagram
Motorola No. PEPD-13564-G
5/31/74 - AP

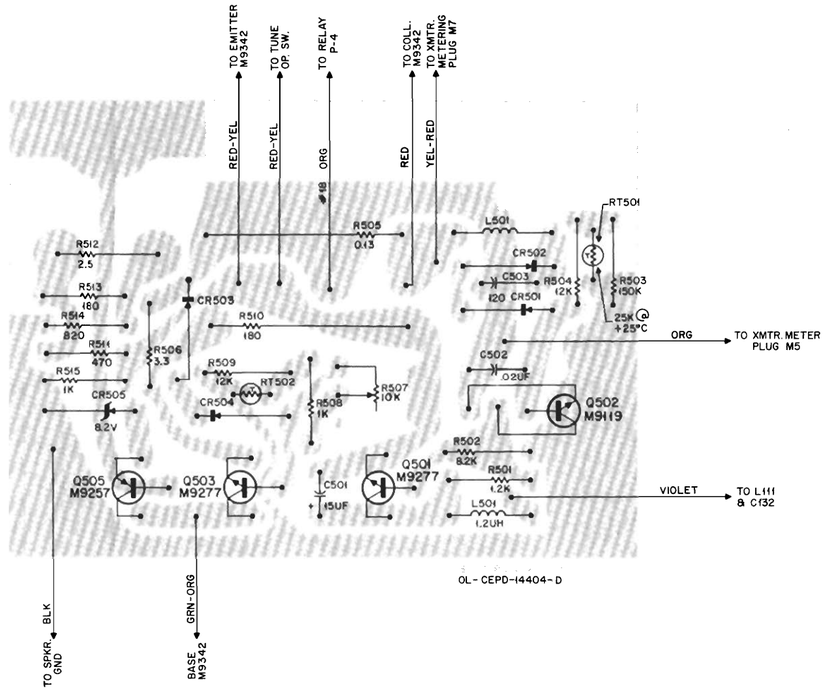
TRANSMITTER

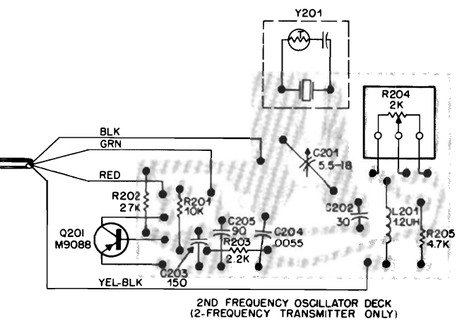


NOTE:
1. USED ON 150.8-174 MHz MODELS ONLY

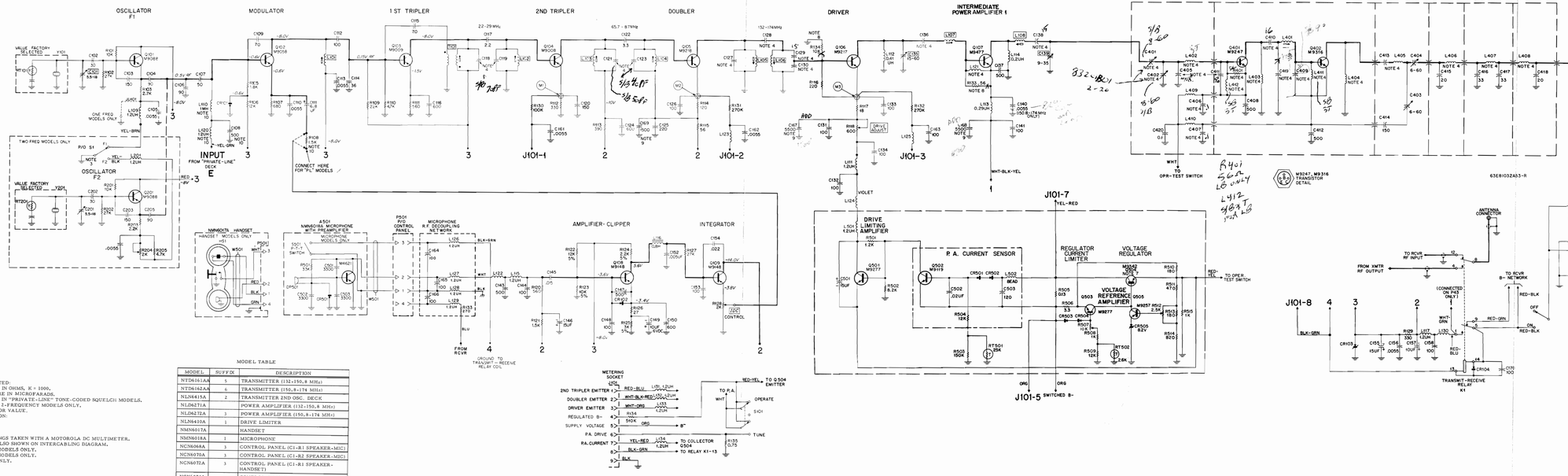
* REFER TO PARTS LIST FOR VALUE.

AUTOMATIC DRIVE LIMITER





Transmitter Printed Circuit Board
and Automatic Driver Limiter
Board Detail
Motorola No. PEPD-14398-G
5/31/74 - AP



NOTES:

1. UNLESS OTHERWISE STATED:
   RESISTOR VALUES ARE IN OHMS, K = 1000,
   CAPACITOR VALUES ARE IN MICROFARADS.
2. JUMPER J0102 REMOVED IN "PRIVATE-LINE" TONE-CODED SQUELCH MODELS.
3. PART OF HOUSING KIT IN 2-FREQUENCY MODELS ONLY.
4. REFER TO PARTS LIST FOR VALUE.
5. FREQUENCY CALCULATION:
   $f_o = \frac{f_c}{19}$
6. ALL DC VOLTAGE READINGS TAKEN WITH A MOTOROLA DC MULTIMETER.
7. PART OF HOUSING AND ALSO SHOWN ON INTERCABLING DIAGRAM.
8. USED ON 150, 8-174 MHz MODELS ONLY.
9. USED ON 132-150, 8 MHz MODELS ONLY.
10. USED ON "PL" MODELS ONLY.

MODEL TABLE

MODEL	SUFFIX	DESCRIPTION
NTD6161AA	5	TRANSMITTER (132-150.8 MHz)
NTD6162AA	6	TRANSMITTER (150.8-174 MHz)
NLN6415A	2	TRANSMITTER 2ND OSC. DECK
NLD6271A		POWER AMPLIFIER (132-150.8 MHz)
NLD6272A	3	POWER AMPLIFIER (150.8-174 MHz)
NLN6410A	1	DRIVE LIMITER
NMN6017A		HANDSET
NMN6038A	1	MICROPHONE
NCN6068A	3	CONTROL PANEL (CI-R1 SPEAKER-MIC)
NCN6070A	3	CONTROL PANEL (CI-R2 SPEAKER-MIC)
NCN6072A	3	CONTROL PANEL (CI-R1 SPEAKER-HANDSET)
NCN6074A		CONTROL PANEL (CI-R2 SPEAKER-HANDSET)

MODEL	SUFFIX	SUB-MODEL	SUFFIX	DESCRIPTION
NPN1004A		NPN6036A		POWER SUPPLY
		NLN6406A		BATTERY KIT
NPN1005A		NPN6037A		POWER SUPPLY
		NLN6407A		BATTERY KIT
NPN1006A		NPN6038A		POWER SUPPLY
		NLN6408A		BATTERY KIT

EPD-18203-D

PREVIOUS REVISIONS AND PARTS LISTS SHOWN ON BACK OF THIS DIAGRAM
Transmitter Schematic Diagram
Motorola No. 63E81032A53-R
5/31/74 - AP

REVISIONS

BOARD AND SUFFIX NO.	REF. SYMBOL	CHANGE
NTD6161AA	L122	WAS L130
NTD6162AA	L116	WAS 25B82872B01
NTD6161AA-1	L130	ADDED TO KI-1
NTD6162AA-1	C601	ADDED 3000 pF
NLD6272A	C410	WAS 21K8478T4 8 pF (132-150.8 MHz) or 21K840846 15 (150.8-174 MHz)
NLD6272A-1	R515	ADDED
NTD6161AA-3		PLATING CHANGE
NTD6162AA-3		
NCN6067A-1	CR104	ADDED
NCN6068A-1		
NCN6070A-1		
NCN6072A-1		
NCN6068A-1	C164	WAS 21K861436
NCN6070A-1		
NCN6072A-1		
NTD6162A-3	L401	WAS 24D83222B12
NLD6272A-2		
NCN6070A-3	SI	ADDED
NCN6068A-3	C170	ADDED
NCN6072A-3		
NTD6161AA-3	R130	WAS 6S185B91
NTD6162AA-4		
NLN6410A	R507	WAS 18C82876B01, 4 k
NTD6161AA-4	C101	WAS 20C82399D08
NTD6162AA-5	C201	WAS 3-10 pF
NLN6415A-1		
NPN6038A	CR601	WAS 48C82466H03

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION

PARTS LIST

NTD6161AA Xmtr. Chassis 132-150.8 MHz
NTD6162AA Xmtr. Chassis 150.8-174 MHz EPD-15216-D

		CAPACITOR, fixed: pF; unl stated
C101	20C82399D04	var; 5.5-18 NP0
C102	21D82877B06	30 ±10%; N150
C103	21D82877B34	150 ±10%; NP0
C104, 106	21D82877B33	90 ±10%; NP0
C105, 110, 113, 156, 161, 162	21C82213E03	.0055 uF +100-0%; 75 v
C107	21D82877B31	50 ±10%; NP0
C143, 147	21K847065	500 +100-0%; 25 v
C109	21K861435	70 ±10%; N150
C111	23C82397D09	6.8 uf +40-20%; 10 v
C112, 126, 133, 144, 153, 158, 163	21K861436	100 ±10%; N750
C114	21K861433	36 ±10%; N150
C115	21D82877B13	7 ±5%; N150
C116, 124, 150	21K851299	600 ±10%; 600 v
C117	21K861425	2.2 ±10%; N150
C118, 119	21K861435 or21K864012	70 ±10% N150 (132-150.8 MHz) 60 ±10%; N150 (150.8-174 MHz)
C120	21D82877B05	150 ±10%; N750
C121	21K864013 or21K861433	50 ±10% N150 (132-150.8 MHz) 36 ±10%; N150 (150.8-174 MHz)
C122	21K861603	3.3 ±.25; NP0
C123	21K861434 or21K865197	40 ±10%; N150 (132-150.8 MHz) 25 ±10%; N150 (150.8-174 MHz)
C125	21K861438	220 ±10%; N1400
C127	21K861427 or21D82877B13	18 ±10%; N150 (132-150.8 MHz) 7 ±10%; N150 (150.8-174 MHz)
C128	21K861426 or21D82450B30	2.2 ±10%;N150 (132-150.8 MHz) 1.8 ±10%;500 v (150.8-174 MHz)
C129	21K861462	15 ±10%; N150
C130	21K861435 or21D82877B06	70 ±10%; N150 (132-150.8 MHz) 30 ±10%; N150 (150.8-174 MHz)
C131, 132, 134, 141, 148	21K861437	100 ±10%; N2200
C135	20C82399D07	15-60; N1500
C136	21K861462	15 ±10%; N150
C137	21C82880E22	500 ±10%; 350 v
C138	21K861462 or21K861429	15 ±10%; N150 (132-150.8 MHz) 8 ±0.5%; N150 (150.8-174 MHz)
C139	20C82399D05	var; 9-35; N650
C140	21C82213E03	.0055 uf +100-0%; 75 v (150.8-174 MHz only)
C145	8C82548E02	.015 uf ±10%; 100 v
C146, 155	23C82397D17	15 uf ±20%; 20 v
C149	23C82397D03	10 uf ±20%; 6 v
C152	8C82548E03	.005 uf ±10%; 100 v
C154	8C82548E04	.022 uf ±10%; 100 v
C157	23D82397D15	150 uf ±20%; 20 v
C167, 168	21C82213E03	.0055 uf +100-0%; 75 v (132-150.8 MHz only) 1500 ±25%; 250 v (132-150.8 MHz only)
C169	21K858107	
		SEMICONDUCTOR DEVICE, diode: (SEE NOTE)
CR101	48C82392B03	silicon
CR102	48C82178A01	germanium
CR103	48D82256C08	zener; (7.79-8.61)
L101	24V80904A41	COIL, RF: 7.0 uh; coded BLK-YEL
L102	24V80904A37	coded; BLK-BLK; 11 turns
L103, 104	24V80904A39	coded; BLK-RED; 5 turns
L105, 106	24V80904A72	coded; BLK-YEL; 4 turns
L107	24V80904A39 or24V80904A72	coded; BLK-RED; 5 turns (132-150.8 MHz) coded; BLK-YEL; 4 turns (150.8-174 MHz)
L108	24V80904A73	coded; BLK-GRN; 6 turns
L109, 111, 117, 115	24D82723H01	choke; 1.2 uh
L110	24D82549D03	choke; 1 mh
L112	24D82723H05	choke; 0.41 uh
L113	24D82723H04	choke; 0.29 uh
L114	24D82723H11	choke; 0.2 uh
L116	25B82872B02	choke; audio; 0.8 h
L121	24C83961B01	choke; BRN
L122, 123, 124, 125, 130	24C83961B01	choke; bead type
		TRANSISTOR: (SEE NOTE)
Q101	48R869088	P-N-P; type M9988
Q102	48R869058	P-N-P; type M9358
Q103	48R869099	P-N-P; type M9909
Q104	48R869008	P-N-P; type M9908
Q105	48R869218	N-P-N; type M9218
Q106	48R869217	N-P-N; type M9217
Q107	48R869477	N-P-N; type M9477
Q108, 109	48R869148	P-N-P; type M9148
		RESISTOR, fixed: ±10%; 1/4 w
R101	6S185B91	10K; 1/8 w
R102, 127	6S185B96	27K; 1/8 w
R103	6S185B84	2.7K; 1/8 w
R105	6S129269	1.8K
R106	6S129230	12K
R107	6S128599	680
R109	6S128685	22K
R110	6S185B87	4.7K; 1/8 w
R111, 120	6S129620	560
R112, 129	6S129775	330
R113	6S185B74	390; 1/8 w
R114	6S129617	220
R115	6S185B64	56; 1/8 w
R116	6S127800	220
R117	6S131650	1.5K
R118	18C82035B15	var; 600
R121	6S127803	1.5K
R122	6S185A75	12K ±5%; 1/8 w
R123	6S185A73	10K ±5%; 1/8 w
R124	6S185A57	2.2K ±5%; 1/8 w
R125	6S124A60	3K ±5%
R126	6S185B60	27; 1/8 w
R128	18C82876B04	var; 2K
R130	6S129226	100K; 1/4 w
R131, 132	6S131858	270K
R133	6S185B64	56 (150.8-174 MC)
R134	6S185B91	10K; 1/8 w (150.8-174)
T101	24V80904A42	TRANSFORMER: 1st Tripler; coded BLK; does not incl 76K861425 CORE, tuning
Z101	1V80752A87	FILTER, harmonic: incl ref parts C159, 160, L118, 119
	NON-REFERENCED ITEMS	
	26B82671D07	SHIELD, coil; 9 req'd
	2A83251B01	NUT, transistor mtg.
	76A82686D02	SLEEVE, iron

NLN6415A Xmtr. Osc. (F2) EPD-12134-C

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, Fixed: pF
C201	20C82399D04	var; 5.5-18; 200 V; NPO
C202	21D82877B06	30 ±10% 75 V N150
C203	21D82877B34	150; ±10%; 50 V; NPO
C204	21C82213E03	.0055 uF +100-0%; 75 V
C205	21D82877B33	90 ±10%; 50 V; NPO
L201	24C82000E21	COIL, RF: Choke; (sleeved); 1.2 uH
Q201	48R869088	TRANSISTOR: SEE NOTE P-N-P; type M9988
		RESISTOR, Fixed: ±10%; 1/8 W
R201	6S185B91	10 k
R202	6S185B96	27 k
R203	6S185B83	2.2 k
R204	18C82876B04	var. 2 k ±15%; 1'20 W
R205	6S185B87	4.7 k

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION

NMN6017A Handset (Plug-In, Carbon) EPD-12135-A

		HANDSET, carbon:
HS501	50D82433G01	incl, P501, W501 & 55P82446G01 HANDLE, 15P82446G02 CAP, transmitter, 15P82446G03 CAP, receiver, 15P82446G04 SWITCH, spst; normally open 59P82446G05 CARTRIDGE, receiver, 59P82446G06 CARTRIDGE, transmitter, 4K84985 WASHER, strain relief, 37A82445 SLEEVE, strain relief
P501		CONNECTOR, plug: p/o W501
W501	30D82565B19	CORD, handset: coiled; 4-conductor; incl ref part P501

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION

NMN6018A Microphone (Plug-In; Transistorized) EPD-12136-A

		AMPLIFIER, AF:
A501	1V80727A19	incl. C501, 502, 503, CR501, Q501, R501, and 1V80727A20 BOARD, circuit
C501	21K861442	CAPACITOR, fixed: .002 uf +100-20%; 75 v
C502, 503	21D82428B10	.0033 uf
		SEMICONDUCTOR DEVICE, diode: NOTE
CR501	48C82178A01	germanium
DP501	59C82857E02 or59C82864E01	CARTRIDGE, microphone: reluctance type
P501		CONNECTOR, plug: p/o W501
Q501	48R134621	TRANSISTOR: NOTE P-N-P; type M4621
R501	6K127807	RESISTOR, fixed: 33K ±10%; 1/4 w
S501	40C82863E01	SWITCH, push: single pole normally open
W501	30D82565B04	CORD, microphone: incl ref part P501 and a coiled 4 conductor; str. cord

NLD6271A RF Power Amplifier (132-150.8 MHz)
NLD6272A RF Power Amplifier (150.8-174 MHz) EPD-15207-D

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, Fixed: pF; unl stated
C401, 402	20C83201B02 or 20C83201B01	variable; 8-60; 100 V; coded RED (132-150.8) variable; 1.5-20; 100 V; coded BRN (150.8-174)
C403, 404	20C83201B02	variable; 8-60; 100 V; coded RED
C405	21K847088	10 ±5%; 300 V (150.8-174 MHz only)
C406	21C82372C03	0.1 uF +80-20%; 25 V (132-150.8 MHz only)
C407	21C82372C03 or 21D82428B04	0.1 uF +80-20%; 25 V (132-150.8 MHz) .01 uF +70-30%; 100 V (150.8-174)
C408, 412	21D82880E22	500 ±10%; 350 V
C409, 411	21K859202 or 21K864067	90 ±5%; 75 V; N750 (132-150.8 MHz) 80 ±10%; 75 V; N150 (150.8-174 MHz)
C410	21K848525 or 21K847874	16 ±5%; 500 V; NPO (132-150.8 MHz) 12 ±5%; 500 V; NPO (150.8-174 MHz)
C413	21D82610C06 or 21D82610C07	39 ±5%; 450 V; NPO (132-150.8 MHz) 51 ±5%; 200 V; N150 (150.8-174 MHz)
C414	21K861347	150 ±10%; 100 V
C415, 418	21K859698	20 ±5%; 500 V; P100
C416, 417	21D82355B09	33 ±5%; 500 V; NPO
C419	21K848525	16 ±5%; 500 V; NPO (132-150.8 MHz only)
C420	21C82372C03	0.1 uF +80-20%; 25 V
L401	24D83222B18	COIL, RF: does not incl 76B82451B04 CORE, tuning
L402	24C83203B12	3 turns
L403	24C82000E04 or 24C82000E21	choke; 0.31 uH; sleeved choke; 1.2 uH; sleeved
L404	24C83203B05	2 turns
L405	24C83203B14 or 24C83203B13	4-1/2 turns (132-150.8 MHz) 3-1/2 turns (150.8-174 MHz)
L406, 408	24C83203B06	4 turns
L407	24C83202B07	4-1/2 turns
L409, 410	24C83961B01	3 turns
L411, 412	24C83961B03 or 24C83961B01	1 turn (132-150.8 MHz) 3 turns (150.8-174 MHz)
Q401	48R869247	TRANSISTOR: NPN: type M9247
Q402	48R869316	type M9316
R401	6S129860	RESISTOR, Fixed: 56 ±10%; 1/4 W (132-150.8 MHz only)
	NONREFERENCED ITEMS	
	29A82872E01	TERMINAL, feed-thru; 5 req'd

NLN6410A Regulator and Drive Limiter Kit EPD-15208-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, Fixed:
C501	23D82397D17	15 uF
C502	21C82213E02	.02 uF
C503	21D82877B15	120 pF
		SEMICONDUCTOR DEVICE, Diode (Note)
CR501	48C82178A10	germanium
CR502		same as CR501
CR503		same as CR501
CR504	48C82392B11	silicon
CR505	48D82256C08	silicon; zener type
L501	24D82723H01	COIL, RF: Choke; 1.2 uH
L502	24C83961B01	bead type (BRN)
Q501	48R869277	TRANSISTOR, (NOTE) NPN; type M9277
Q502	48R869119	NPN; type M9119
Q503		Same as Q501
Q505	48R869257	PNP; type M9257
R501	6S129708	RESISTOR, Fixed: ±5%; 1/4 W; unl stated 1.2 k
R502	6S129983	8.2 k
R503	6S129146	150 k ±10%
R504	6S129220	12 k ±10%
R505	17C82036G24	0.13; 2 W
R506	6S124B57	9.3
R507	18C82876B06	variable; 10 k ±20%; 1/20 W
R508	6K127802	1 k ±10%
R509		same as R504
R510	17C82036G23	180; 2 W
R511	6S129709	470
R512	18C82193H04	variable; 2.5 k ±20%
R513	6S129431	180
R514	6S129818	820
R515		same as R508
RT501	6B82321A01	THERMISTOR: 25 k ±10% @ 25°C
RT502	6K864426	2.65 k ±10% @ 25°C

NCN6068A Control Panel (C1-R1 Spkr.-Mic.)
NCN6070A Control Panel (C1-R2 Spkr.-Mic.)
NCN6072A Control Panel (C1-R1 Spkr.-Handset)
NCN6074A Control Panel (C1-R2 Spkr.-Handset) EPD-15209-B

		CAPACITOR, fixed:
C164	21K831125	100 uuf ±10%; 300 v; N750
C165, 166, 170	21K861436	100 uuf ±10%; 75 v; N750
		SEMICONDUCTOR DEVICE, diode: (SEE NOTE)
CR104	48C82392B03	silicon
J101	9C82847E02	CONNECTOR, receptacle: female; 9 contact
L126, 127, 128, 129	24D82723H01	COIL, RF: choke; 1.2 uh
L131, 132, 133, 134	24C82000E21	1.2 uh; sleeved
Q504	48R869342	TRANSISTOR: P-N-P; type M9342
R134	6S2052	RESISTOR, fixed: 510K ±5%; 1/2 w
R135	17C82036G13	0.75 ±5%; 2 w
S101	40B83204B01	SWITCH, slide: dpdt

NPN6036A Power Supply (less batteries) EPD-15210-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C701	21C82187B16	CAPACITOR, Fixed: 3000 pF ±10%; 100 V
C702		same as C701
C703		same as C701
C704		same as C701
C705		same as C701
C706		same as C701
C707		same as C701
C708		same as C701
C709		same as C701
C710		same as C701
F701	65S52293	FUSE, Cartridge: 1-1/4" x 1/4" 5 A; 250 V
J701	9C82847E01	CONNECTOR, Receptacle: female; 9 contact

NLN6424A "Private-Line" Squelch Hardware PLF-7783-D

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C108	21K847065	CAPACITOR, Fixed: 500 pF; 25 V
L110	24D82549D03	COIL, RF: choke, 1 mH
L120	24V82000E21	choke, 1.2 uH
R108	6S185B81	RESISTOR, Fixed: 1.5 k ±10%; 1/8 W

NLN6406A Battery Kit EPD-15211-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	60B82455G01	BATTERY: 1-1/2 V; (industrial "D"); 22 req'd

NPN6037A Power Supply (less batteries) EPD-15212-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C801	21D82187B16	CAPACITOR, Fixed: 3000 pF ±10%; 100 V
C802	21K858108	3000 pF ±25%; 250 V
C803		same as C802
C804		same as C802
C805		same as C802
C806		same as C801
F801	65S52293	FUSE, Cartridge: 1-1/4" x 1/4" 5 A, 250 V
J801	9C82847E01	CONNECTOR, Receptacle: female; 9 contact

NLN6407A Battery Kit EPD-15213-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	60B83520B01	BATTERY: 1-1/2" volt (E93 alkaline); 24 req'd

NPN6038A Power Supply (less battery) EPD-15214-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C601	21C82187B16 or 21K850446	CAPACITOR, Fixed: 3000 pF ±10%; 100 V 3000 pF ±25%, 250 V
CR601	48C82466H13	SEMICONDUCTOR DEVICE, Diode: (Note) silicon
F601	65S122345	FUSE, Cartridge: 5/8" x 1/4" 5 A, 32 V
J601	9C82847E01	CONNECTOR, Receptacle: female; 9 contact
J602	28A83078D01	male; 4 contact
P601	28A83424D01	CONNECTOR, Plug: male; 4 contact
XF601	1V80759A99	FUSEHOLDER: For 5/8" x 1/4" fuse

NLN6408A Battery Kit EPD-15215-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	60D83420D01	BATTERY: 15 V; (nickel-cadmium)

NOTE:
Replacement diodes and transistors must be ordered by Motorola part number only for optimum performance.

TR 146.52 = 3140.00 KHz Y/N W-19
RR 146.52 = 46940.00 Y/N W-35

END OF DOCUMENT