SERVICE MANUAL

NUTONE SELECTIVE CALL INTERCOM SYSTEM

MODELS:
I-600
I-614
I-650
M-640

NuTone
Madison & Red Bank Roads, Cincinnati, Ohio 45227

Printed in U.S.A. HI 4/81 LA
NuTone Part No. FS1150

BEFORE ATTEMPTING SERVICE OF THE SELECTIVE CALL INTERCOM SYSTEM, THE TECHNICIAN SHOULD READ AND UNDERSTAND THE TEXT, AND SHOULD BE FAMILIAR WITH THE SCHEMATIC AND WIRING DIAGRAMS IN THIS MANUAL.

THE SYSTEM SHOULD BE CAPABLE OF SUCCESSFULLY COMPLETING THE ENTIRE OPERATIONAL CHECKOUT PROCEDURE, PAGES 4-7.

TABLE OF CONTENTS

ILLUSTRATIONS AND DIAGRAMS

GENERAL

(1) This manual contains service information for the components that are specifically designed for use in the NUTONE SELECTIVE CALL INTERCOM SYSTEM. These components include:

Model I-600 Central Power Supply and Door Speaker Control. (Supplied with NuTone Model 301-N Power Transformer.)

Model I-614 Master Station.

Model I-650 Wiring Terminal Block.

Model M-640 FM/AM Radio Receiver. (Use of the M-640 is optional.)

(2) Products that are used in various NuTone systems; and which are, or may be, incorporated in the Selective Call System include:

Model 301-N (120/16Vac, 30VA) Power Transformer. (Supplied with the I-600 Central Power Supply and Door Speaker Control.)

Model IW-8 4-Twisted-Pair Cable. Supplied in 250 ft. (IW-8-250); and 1,000 ft. (IW-8-1000) lengths.

Model IW-2 Twisted-Pair Cable in 100 ft. (IW-2-100); and 500 ft. (IW-2-500) lengths.

Model RC-91-1 Fold-Away Record Changer.

Model TP-96 Fold-Away 8-Track Tape Player.

NOTE: The Record Changer and/or Tape Player can be used only when the M-640 FM/AM Radio Receiver is included in System.

Various surface-mount and built-in door speakers. Some door speakers are supplied with door chime pushbuttons.

Built-in and surface mounted, inside and outside 8 inch speakers. (Special application)

Model IA-18 Outside FM Antenna.

(2.1) Use of these products will be discussed in the applicable sections of this manual.

(3) The various products should be installed and wired according to the individual installation instructions that are supplied with each NuTone product. (See pages 50 and 55/56.)

(3.1) The wiring connections shown in the schematic diagrams in this manual are not a substitute for the installation wiring instructions, but may be used as a reference when servicing the System.

(4) WIRING SAFETY PRECAUTIONS: When System is initially installed, the 16V AC power leads from the Power Transformer T1 (NuTone Model 301-N) should NOT be connected to the I-600 Terminal Board's "AC" terminals until after all other system wiring — at Terminal Blocks; Master Stations; Central Power Supply; Radio Receiver, etc. — connections are made.

(4.1) When servicing the System, and wires must be removed or connected at the various components (especially the ORN B+ wire connection at a Master Station), the 16Vac wires should be removed from the I-600 terminal board's AC terminals. Insulate these wires so that the secondary of the power transformer is not shorted.

(5) WIRE CONNECTIONS: When making connections at the screw terminals of the various components, make certain that the wire makes good contact with the PC foil pad under the screw head.

(5.1) Wires must not be shorted to one another, nor to other terminals and/or points on the PC boards.

(5.2) PAY PARTICULAR ATTENTION TO THE ORN B+ CONNECTIONS AT THE I-614 MASTER STATION PC BOARD.

(6) EARTH GROUNDING: In a properly installed system, the BLK ground terminal on the I-600 terminal board will be connected to earth ground.

(6.1) Some installation may require termination of multiple wires at this black terminal. In these cases, the wires may be spliced together and then to one wire that is connected to the BLK terminal.

(7) VOLTAGE MEASUREMENTS: The voltages shown in the schematic diagrams and which are noted in the text of this manual are d-c positive, unless otherwise noted. The d-c voltages are measured against PC circuit common ground. This PC circuit common ground is common throughout the system via the BLK terminals and wire.

(7.1) When possible the voltages should be measured with a high-impedance input meter, such as a VTVM or digital readout type.

(7.2) In the field, most voltages may be measured, and satisfactorily interpreted, if a standard 20K ohm per volt multimeter is used.

(7.3) Slight variations (±10-15%) in the various voltages may be noted, but the relationship between the different voltages should be fairly constant.

(8) CMOS devices such as: logic gates; bilateral switches; timers, 4-bit encoders; 4-bit decoders, and Schmitt inverters are used in this system.

(8.1) The System uses standard positive logic.

(8.2) HI = VDD = B+ = Regulated +15Vdc.

(8.3) LO = VSS = PC circuit common ground.

(8.4) When a device's output terminal is HI, its potential may vary between 0.5V and 1.5V less than the full applied VDD.

(8.4.1) When a device's terminal is LO, it may vary slightly from VSS, and may actually measure a potential in the order of 0.5 Vdc.

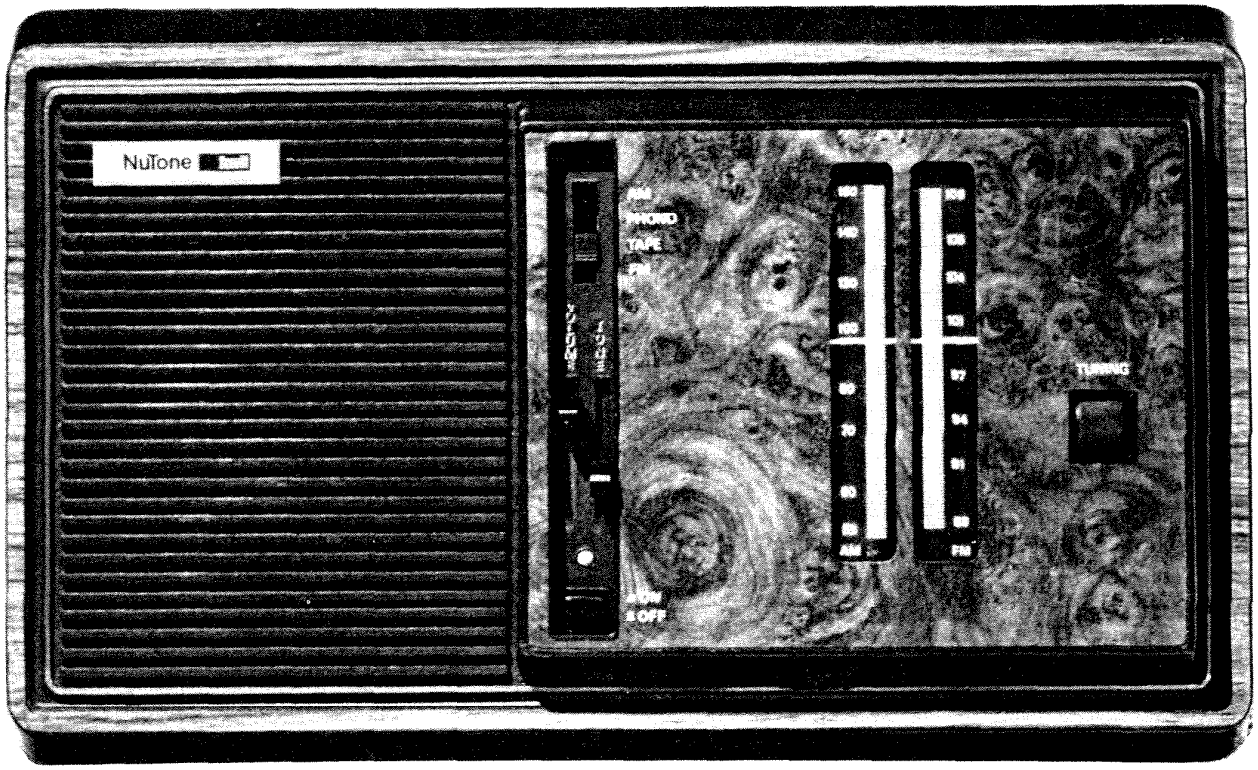
(8.4.2) These variations are well above or below the input voltage that is required at the following state for output transition, and these variations will not effect the circuit's operation.

(9) When a transistor is off, it is non-conducting.

(9.1) When a transistor is on, it is saturated and Ve = Vc.

(10) When repairing, removing, or installing components on the PC boards, use standard PC servicing techniques. Do not mar or break PC paths. Do not over-heat components, board or PC paths.

OPERATIONAL CHECKOUT



MODEL M-640 AM/FM RECEIVER
FIGURE 1

(1) If the optional M-640 Radio Receiver is included in System, complete the instructions in paragraphs (2) through (2.10) below.

(1.1) If the M-640 is not used, skip paragraphs (2) through (2.10), and proceed from paragraph (3) below.

(2) Turn receiver on by pressing-in the ON/OFF SWITCH S401. The RED RECEIVER-ON INDICATOR LIGHT should be illuminated.

(2.1) Throw receiver's PROGRAM SELECTOR SWITCH S402 to FM position.

(2.2) Tune receiver to a familiar FM station.

(2.3) Adjust the receiver's VOLUME CONTROL R411 for the desired audio level at its locale.

(2.3.1) This control effects only the audio level at the receiver's speaker. A flat level is fed to the Master Station(s).

(2.3.2) The receiver's audio program is not fed to the door speaker(s).

(2.4) Adjust receiver's TONE CONTROL R412 to personal preference.

(2.4.1) R412 also controls the base/treble ratio of the entertainment audio signal that is fed to the Master Station(s), and when used, to the background music speakers.

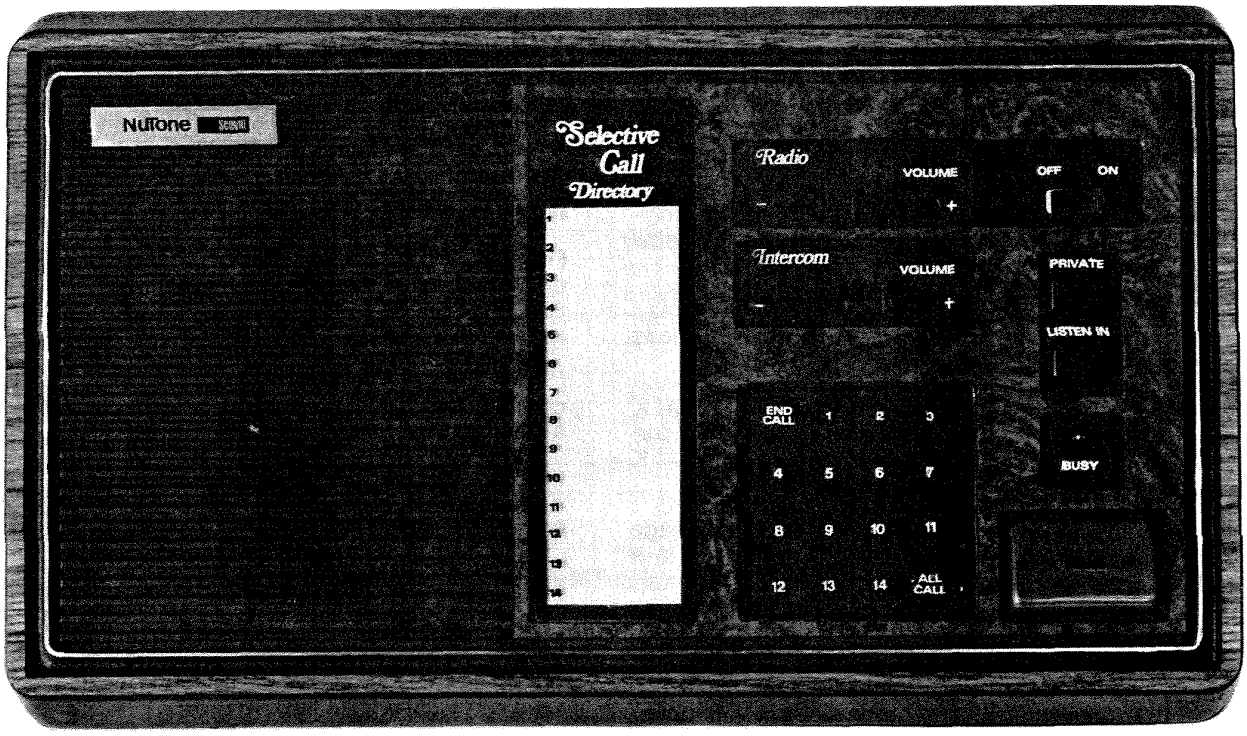
(2.5) Tune across the f-m band, checking reception of the individual stations.

(2.6) Throw SELECTOR SWITCH S402 to AM position, and tune across the a-m band, checking reception of the individual stations.

(2.7) If a record changer is included in System, throw SELECTOR SWITCH to PHONO position and play a record according to the record player's instructions.

(2.8) If a tape player is included in System, throw SELECTOR SWITCH to TAPE position, and play a tape in compliance with tape player's instructions.

(2.9) Check entertainment program at the Master Station(s).



MODEL I-614 MASTER STATION
FIGURE 2

(2.9.1) At each Master Station, throw RADIO ON/OFF SWITCH S1 to ON position, and set RADIO VOLUME CONTROL R154 for the desired audio level of the entertainment program at that station's locale.

(2.10) If the entertainment program of the M-640 is also used to feed a BACKGROUND MUSIC SYSTEM, adjust the level of the background music speakers at the auxiliary background music amplifier, and if used, at the individual background music speaker control.

(3) INTERCOM OPERATION: At every Master Station, make certain that LISTEN SWITCH S2 and PRIVATE SWITCH S3 are OFF — switch's push-button is out.

(3.1) These switches are operated push-in and lock for ON.

(3.2) When ON, push-in to release, button comes out and switch is OFF.

(4) SELECTIVE CALL TO ONE MASTER STATION: At any Master Station an intercom call to any other Master Station may be originated by activating (press-in and release) the keypad's number address button that corresponds to the address number of the station being called. (See SELECTIVE CALL DIRECTORY of front of the originating Master Station.)

(4.1) AT THE ORIGINATING STATION:

(1) An annunciator tone signal — lasting for approximately 0.8 second will be heard.

(2) The RED BUSY INDICATOR LIGHT D123 will be turned ON.

(3) The entertainment program from the Radio Receiver is muted.

(4) The originating station comes on in the LISTEN mode. Audible sounds in the vicinity of the called station will be heard at the originating station.

(4.2) AT THE CALLED STATION:

(1) An annunciator tone signal — lasting for approximately 0.5 second will be heard.

(2) The RED BUSY INDICATOR LIGHT D123 will be turned ON.

(3) The entertainment program from the Radio Receiver is muted.

(4) Sounds in the vicinity of this called station will be heard at the originating station.

(4.3) AT OTHER STATIONS IN SYSTEM:

(1) The annunciator signal is not heard.

(2) The RED BUSY INDICATOR LIGHT D123 WILL be turned ON, and all of these other stations will be locked out, i.e. prevented from initiating an intercom call until the present call is ended by the originating station.

(3) Intercom signals from the originating station and from the called station will not be heard.

(4) The entertainment signal from the Radio Receiver is not interrupted.

(5) At the originating station, activate (push and hold down) the TALK BAR. This will put the originating station in TALK mode, and the called station in LISTEN mode.

(5.1) Speak, in a normal manner, into the I-614 speaker and the intercom message will be heard at the called station.

(6) At the originating station, release the TALK BAR. This will put the originating station in the LISTEN mode, and the called station in the TALK mode.

(7) At the called station, the intercom message can be answered "Hands Free" by speaking, in a normal manner, into the called station's speaker. This answer will be heard at the originating station.

(8) NOTE THAT THE TALK AND LISTEN MODE OF THE ORIGINATING STATION AND OF THE CALLED STATION IS CONTROLLED BY THE ORIGINATING STATION'S TALK BAR.

(9) The intercom signal audio level at each Master Station is controlled by adjusting that station's INTERCOM VOLUME CONTROL (LISTEN VOLUME) R153.

(10) When intercom call is completed, the originating Master Station should terminate the call by activating (press-in and release) its keypad's *END* CALL button.

(11) If the call is not deliberately ended, it will automatically be terminated approximately 1 minute after the last TALK message is sent from the originating station.

(12) When the call is ended, the BUSY light is turned off at all Master Stations; the Receiver's entertainment program will be present at all Master Stations; and an intercom call can be originated at any Master Station.

(13) ALL CALL: At any Master Station an intercom call to all other Master Stations may be originated by activating the keypad ALL CALL address button.

(13.1) AT THE ORIGINATING STATION: Operating conditions are the same as those shown in paragraph (4.1) above, except when the originating station comes on in the LISTEN mode, it will hear audible sounds in the vicinity of ALL other Master stations in System.

(13.2) AT ALL OTHER STATIONS: Operating conditions are the same as those shown for the one called station in paragraph (4.2) above.

(14) When the TALK BAR at the originating station is activated, messages from this station will be heard at all other Master Stations.

(15) When the TALK BAR is released, answer from any or all other station(s) will be heard at the originating Master Station.

(16) CALL ENDED operation is the same as that shown in paragraphs (10) through (13) above.

(17) THE DOOR SPEAKERS ARE NOT INCLUDED IN AN ALL CALL.

(18) DOOR SPEAKER INTERCOM: One or two door speakers may be connected to the DOOR SPKR terminals in the I-600 Central Power Supply and Door Speaker Control.

(18.1) The door speakers are connected in parallel common and both are operated in the same mode at any instant.

(18.2) If it is known that there is a caller at either or both doors, an intercom call to the door speakers can be originated at any Master Station.

(18.3) AT ANY MASTER STATION: Activate the keypad numbered button that addresses the door speaker(s).

(18.3.1) AT THE ORIGINATING STATION: Operation conditions are the same as those shown in paragraph (4.1) above, except when the originating station comes on in the LISTEN mode, it will hear audible sounds from the vicinity of the door speaker(s).

(18.3.2) AT THE DOOR SPEAKER: When called the door speaker(s) come on in the TALK mode.

(18.4) Originating station's TALK BAR operation is the same as for any other intercom operation. When TALK BAR is pressed down, signals from the originating station are heard at the door speaker(s). When the originating station's TALK BAR is released signals from the door speaker(s) will be heard at the originating Master Station.

(18.5) CALL-ENDED *OPERATION:* *Same as that* shown in paragraphs (10) through (12) above.

(19) LISTEN-IN (MONITOR) OPERATION: One or more Master Stations may be monitored by the other Master Stations in the System.

(19.1) At the Master Station(s) that is/are to be monitored, push-in the LISTEN-IN SWITCH S2.

(19.2) At all other Master Stations make certain that the RADIO ON/OFF SWITCH S1 is in the ON position.

(19.2.1) This is necessary because the LISTEN-IN signals from the monitored Station(s) are conducted through the System on the same line (superimposed on the bit D, ORN/W, address line) that carries the Radio Receiver's entertainment program.

(19.2.2) If the System includes the M-640 Radio Receiver, the signals from the LISTEN-IN Station(s) will have a volume head-start, and sounds louder than general background noise at the LISTEN-IN Station(s) should over-ride the entertainment program signals at the other Master Station.

(19.2.3) If a Master Station does not want to hear the signals from the Listen-In Station, it can eliminate these signals by throwing its RADIO ON/OFF SWITCH S1 to the OFF position. This will also turn-off the entertainment signals at this station.

(19.3) The RADIO VOLUME CONTROL R154 also controls the amplitude of the LISTEN-IN signals at the receiving Master Station.

(19.4) When a Master Station is operated LISTEN-IN, it can not hear an annunciator tone if it is called by another Station; it can not originate a call to another Station; it can not hear the entertainment program; and it can not hear intercom signals from another station.

(19.5) LISTEN-IN signals will be turned off at other Stations that are receiving or sending signals while system is operated in an intercom mode.

(20) PRIVATE OPERATION: At a Master Station, intercom operation may be turned OFF by throwing the PRIVATE SWITCH S3 to ON (push-in).

(20.1) When in PRIVATE, the Master Station will receive an annunciator tone if it is called by another Master Station, but it can not receive nor transmit intercom signals.

(20.2) When a Station is in PRIVATE, it will receive entertainment signals from the M-640 Radio Receiver and/or LISTEN-IN signals from any Station that is in the LISTEN-IN mode, so long as its RADIO ON/OFF SWITCH S1 is in the ON position.

(20.3) When a Station that is in the PRIVATE mode is called by another Station and its annunciator tone is activated, it can be put in the intercom mode by taking it out of the Private mode — push-in and release PRIVATE SWITCH BUTTON.

INTER-COMPONENT SYSTEM WIRING AND RANDOM-VOLTAGE PROTECTION

(1) A 4-twisted-pair cable (NuTone IW-8) is connected between the I-600 Central Power Supply/ Door Speaker Control and all I-614 Master Stations in the System.

(2) Each individual-color-coded wire in this cable is common throughout the System, and each individual wire must be terminated at the matching color-coded terminal at these components.

(3) In the schematic diagrams in this manual, the M-640 AM/FM Receiver is shown connected to the Terminal Board of the I-600.

(3.1) The Receiver may be connected as shown, or it may be connected to the terminals in any Master Station, or it may be connected to the System at any I-650 Wiring Terminal Block.

(3.1.1) NOTE: only three (3) wires—ORN, ORN/W, and BLK—should be used for connecting the M-640 to the System. The wires should be connected to the matching color-labelled terminals at the I-600 Terminal Board (preferred); to the I-650 terminals, or to the I-614 terminals.

(4) All wires except the BLK circuit ground wire of the IW-8 cable are protected from random spurious voltages (static, lightning, etc.) by varistors in the I-600 and I-614's. The varistor's operation is as described in paragraphs (9) through (9.1) under MODEL I-600 CENTRAL POWER SUPPLY REGULATED +15VDC (B+), page 13.

(4.1) The Door Speaker's No. 22/2 twisted-pair is protected by varistors at the I-600 Terminal Board.

(5) All wires of the 8-wire cable serve a single function throughout the system EXCEPT the ORN/W "D" address wire.

(5.1) The ORN/W "D" address wire also carries the entertainment program from the M640 Receiver to the Master Stations; and when one or more I-614's is/are operated in the LISTEN-IN mode, it carries the LISTEN-IN signals from these stations to the other Master Stations. The Door Speaker does not receive entertainment nor LISTEN-IN signals.

See para (5)-(5.5.2), pp 36; and Wiring Diagram, pp 55/56.

SPECIAL DEVICES

(1) THE 16-KEY TO 4-BIT ENCODER: National Semiconductor Corp. Type No. MM74C922 (NuTone Part No. 36713-000), used as Z105 in I-614 Master Station: (See Figure 3, and pp 64/65.)

(1.1) The encoder includes a 4-row (Y1-Y4) and 4-column (X1-X4) input which is connected to a 4 x 4 matrix arranged Keyboard. The encoder may be implemented by closing (pressing-in) one of the sixteen SPST Keyboard switches.

(1.1.1) The keyboard scan is supplied by the encoder's on-board oscillator, whose freqency is determined by the oscillator capacitor C106 and is approximately 500 Hz.

(1.2) NOTE: The keyboard is actually a 5Y x 4X matrix array. One Y-row (Y5) is not used. Only 16 of the switches are used and they are visible from the front panel of the I-614.

(1.3) The 4 address data bits A, B, C, and D at pins 17, 16, 15, and 14 respectively are tri-state controlled.

(1.3.1) When the tri-state control is HI, the output data bits are active — either HI or LO.

(1.2.3) When the tri-state control is LO, the output data terminals are inactive, i.e. floating.

(1.4) The logic of level of the tri-state control is determined by the OUTPUT ENABLE pin 13's level.

KEYPAD PUSHBUTTON ADDRESS NUMBER OF STATION CALLED	CONNECTIONS MADE		OUTPUT DATA ENCODER TERMINALS AND ADDRESS BITS*			
	MATRIX ROW/COLUMN	ENCODER TERMINALS	14 D	15 C	16 B	17 A
(0) END CALL	Y1/X1	1/11	LO	LO	LO	LO
1	Y1/X2	1/10	LO	LO	LO	HI
2	Y1/X3	1/8	LO	LO	HI	LO
3	Y1/X4	1/7	LO	LO	HI	HI
4	Y2/X/1	2/11	LO	HI	LO	LO
5	Y2/X2	2/10	LO	HI	LO	HI
6	Y2/X3	2/8	LO	HI	HI	LO
7	Y2/X4	2/7	LO	HI	HI	HI
8	Y3/X1	3/11	HI	LO	LO	LO
9	Y3/X2	3/10	HI	LO	LO	HI
10	Y3/X3	3/8	HI	LO	HI	LO
11	Y3/X4	3/7	HI	LO	HI	HI
12	Y4/X1	4/11	HI	HI	LO	LO
13	Y4/X2	4/10	HI	HI	LO	HI
14	Y4/X3	4/8	HI	HI	HI	LO
(15) ALL CALL	Y4/X4	4/7	HI	HI	HI	HI

NOTE: The "HI" and "LO" logic state notation is used in keeping with the method in this manual:

LO = standard binary logic "0" (=VSS)

HI = standard binary logic "1" (=VDD)

The National MM74C922 0-15/4-Bit Encoder converts the address decimal number of the station being called to a 4-bit binary address.

SEE PAGES 64/65

TRUTH TABLE
MM74C922 0-15/4-BIT ENCODER
(As used in NuTone I-614)

FIGURE 3

(1.5) $\overline{\text{OUTPUT ENABLE}}$ pin 13 is connected to ground (VSS) and is always LO. This locks the tri-state control in a HI state, and the 4 output data bits are always active, i.e. they are either HI or LO.

(1.6) The four output data bits represent binary numbers.

(1.6.1) Bit A is least significant bit.

(1.6.2) Bit D is most significant bit.

(1.6.3) Depending on the logic state of the individual bits, they can represent any one of sixteen numbers (0-15).

(1.6.4) END OF CALL is addressed by zero (Ø).

(1.6.5) Fourteen individual addresses are represented by the individual numbers from 1 to 14.

(1.6.6) ALL CALL (all I-614 Master Stations) is represented by 15.

(1.6.7) When the system is in a quiescent (standby) intercom mode, the encoder output is in an END OF CALL (Ø) state, and all output bits are LO.

(1.7) WHEN THE KEY BOUNCE MASK (KBM) PIN 6 IS LO, CLOSING A KEYBOARD SWITCH WILL NOT IMPLEMENT THE ENCODER.

(1.8) Normally, when the system is in a quiescent mode, KBM is HI and if a valid keyboard entry is made (i.e. one of the switches 1-15 is closed), the encoder will be implemented and the binary equivalent of the keyboard entry (decimal number) will appear on the address data bits, A, B, C, and D at terminals 17, 16, 15, and 14 respectively, (See Table, Figure 3.)

(1.8.1) When the key is released, the KBM will go LO and will remain LO for a period of time as determined by the KBM capacitor C127. In the I-614 the time is approximately 100 mS.

(1.8.2) The encoded binary number will be retained on the output address data bits.

(1.8.3) If after the KBM has returned to its HI state another keyboard switch is activated, the encoder will be implemented and the new number will appear on the binary output bits.

(2) 4-BIT LATCH/4-16 LINE DECODER: Motorola Type No. MC14514B (NuTone Part No. 36715-000) used as Z206 in I-600; and as Z104 in I-614:

(2.1) The binary data input bits A, B, C, and D at terminals 22, 21, 3, and 2 respectively, correspond to the A, B, C, and D binary output bits of the encoder discussed above, i.e. A is the Least Significant Bit, and D is the Most Significant Bit. (See Table, Figure 4, pp 59-61 and 65-67.)

(2.2) The latch/decoder decodes the binary input data to one of sixteen (0-15) outputs.

(2.2.1) END CALL (Ø) at pin 11 is not used as an address in the I-600 nor in the I-614.

DATA IN DECODER TERMINALS AND ADDRESS BITS*				DECODED DATA OUT RECEIVER TERMINAL NORMALLY LO GOES HI	ADDRESS NUMBER OF STATION CALLED NORMALLY LO GOES HI
2	3	21	22		
D	C	B	A		
LO	LO	LO	LO	11	END OF CALL (0)
LO	LO	LO	HI	18	1
LO	LO	HI	LO	7	2
LO	LO	HI	HI	14	3
LO	HI	LO	LO	10	4
LO	HI	LO	HI	20	5
LO	HI	HI	LO	5	6
LO	HI	HI	HI	16	7
HI	LO	LO	LO	9	8
HI	LO	LO	HI	17	9
HI	LO	HI	LO	6	10
HI	LO	HI	HI	13	11
HI	HI	LO	LO	8	12
HI	HI	LO	HI	19	13
HI	HI	HI	LO	4	14
HI	HI	HI	HI	15	ALL CALL (15)

NOTE: In Nutone's I-600/I-614 Selective Call Intercom application, the Input Address Data Bits "A," "B," "C" and "D" and corresponding Integrated Circuit Terminals are reversed from those shown for the MC14514B in the Motorola CMOS Manual. USE THE ABOVE TABLE WHEN SERVICING THE I-600 and I-614.

The "HI" and "LO" logic state notation is used in keeping with the method used in this manual:

LO = standard binary logic "0" (=VSS)

HI = standard binary logic "1" (=VDD)

SEE PAGES 59-61 and 65-67

The MC14514B Receiver/4-Bit Decoder converts the 4-bit binary address to the decimal number of the station that is being called.

TRUTH TABLE
MC14514B RECEIVER/4-BIT DECODER
(As used in NuTone I-600/I-614)

FIGURE 4

(2.2.2) The individual addressed identity terminals are numbered 1-14, and the individual number is selected at each I-614 Master Station and at the I-600 Door Speaker Control.

(2.2.3) ALL CALL (15) at pin 15 is used in each I-614 Master Station, but is not used in the I-600 Door Speaker Control.

(2.3) Each output is normally LO. The output goes HI when the corresponding binary number is fed to the input data bits.

(2.4) When INHIBIT pin 23 is HI, the outputs are locked in an active (LO) state, and outputs will not change regardless of data input and strobe levels.

(2.4.1) In the I-600 and I-614 the INHIBIT pin 23 is held at logic level LO through a 100 Kohm resistor (R221 in I-600; and R133 in I-614) to ground and the outputs can be changed to an active (HI) state depending on the input data and strobe levels.

(2.5) In a quiescent (standby) intercom mode, the STROBE input at pin 1 is LO, and the output is at the state that was set by the last data input before the STROBE transistion from HI to LO.

(2.5.1) So long as the STROBE is LO, the decoder can not be implemented by a change of the input data.

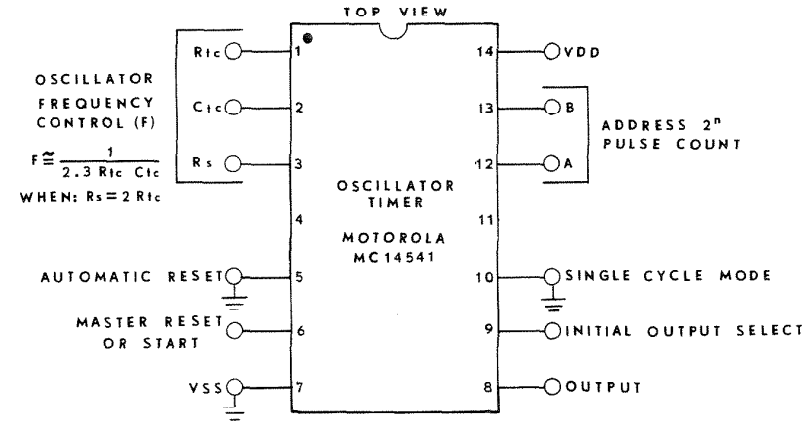
(2.5.1) If there is new data at input and the STROBE input goes HI, the decoder is implemented and the output will correspond to the new input data.

(2.5.2) If there is a change in data input while the STROBE is HI, the output will be changed so as to agree with the new input data.

(3) NOTE: When the System is in the quiescent (Standby) intercom mode:

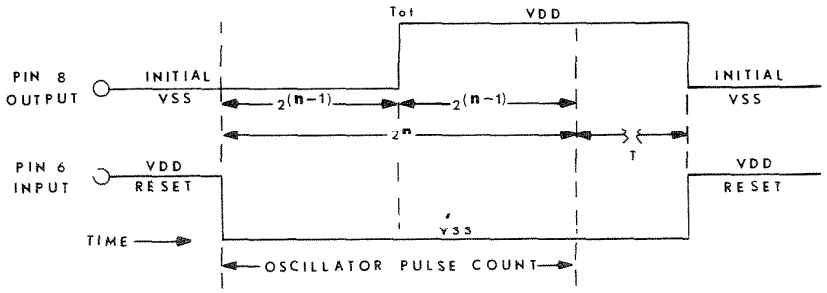
(3.1) The 16-KEY TO 4-BIT ENCODER'S output data bits A, B, C, and D are LO (= Ø = END OF CALL).

(3.2) The 4-BIT LATCH/4-16 LINE DECODER'S input data bits are LO (= Ø = END OF CALL); the Strobe input is LO; and the zero, END OF CALL pin 11 is HI.



PULSE COUNT TABLE

ADDRESS				
PIN 12	PIN 13	COUNTER STAGES	COUNT	COUNT
A	B	n	2^n	$2^{(n-1)}$
HI	LO	8	256	128
LO	HI	10	1024	512
LO	LO	13	8192	4096
HI	HI	16	65536	32768



PIN 9 IS LO: (WHEN PIN 9 IS HIGH, OUTPUT STATES WILL BE INVERTED:)

OUTPUT TRANSITION TIME = $T_{ot} = \frac{2^{(n-1)}}{F} \cong 2^{(n-1)}(2.3\ R_{tc}\ C_{tc})$ SECONDS

FIGURE 5

(4) OSCILLATOR/TIMER: See Figure 5, and I-614 Schematic Diagram; Motorola Type No. MC14541 (NuTone Part No. 36633-000); used as Z103 in I-614.

(4.1) Pin 5, the grounded AUTOMATIC RESET, initializes the Oscillator/Timer to a Reset state when the power is turned on. If pin 6 is HI, it will remain in the Reset State. If pin 6 is LO when power is turned on, it will be initialized, and then go into its active timing mode.

(4.1.1) The circuit can, at any time, be Reset by applying a HI pulse to Input pin 6, and it will remain in the Reset State so long as the HI is maintained on pin 6.

(4.2) The Output State Select pin 9 determines the output state of pin 8, and with pin 9 connected to VSS (LO), the output will be LO when the IC is in its Initial or Reset modes.

(4.3) The on-board oscillator's frequency is determined by R145 and C121 (corresponding to Rtc and Ctc respectively in Figure 5). R146 (Rs) is oscillator feedback resistor.

(4.3.1) The oscillator frequency and time (F/1) formulas in Figure 5 are accurate when RS = 2Rtc (or when R146 = 2 x R145). This is not the condition in the I-614 Master Station. (See Schematic Diagram)

(4.3.1.1) The frequency and time that are calculated when using the formulas will differ from the actual frequency and time that can be measured at Z103. These differences are slight and the nominal time of 60 (± 20%) seconds will suffice as a reference when determining the System's operation.

(4.4) The number of counts that are made by the on-board binary counter is controlled by the Address Bits A (pin 12) and B (pin 13). (See Chart Figure 5)

(4.4.1) Bits A and B are both LO (VSS) and the counter stages n = 13 is addressed.

$$2^n = 2^{13} = 8192$$

$$2^{(n-1)} = 2^{12} = 4096$$

$$\text{or } 2^{(n-1)} = \frac{2^n}{2}$$

(4.4.2) The binary counter is incremented on the positive going pulse of each oscillator cycle.

(4.5) SINGLE-CYCLE TIMING OPERATION:

(4.5.1) The IC's operating mode is determined by the logic state of pin 10. With pin 10 being LO, the device is operating in its single-cycle mode.

(4.5.2) When pin 6 is HI, the device is in the Reset (or initial) mode: the oscillator is off; the binary counter is off (at zero); and the output at pin 8 is LO.

(4.5.3) When pin 6 goes LO, the device is activated in its single-cycle timing mode: the oscillator is turned on; the binary counter is incremented, starting from zero, by each positive going oscillator pulse; and the output at pin 8 remains LO.

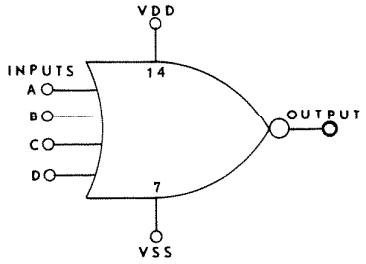
(4.5.4) When the counter has been incremented by $2^{(n-1)}$ (4096) pulses, output transition occurs.

(4.6) At output transition time (Tot), the Output pin 8 goes from LO to HI, and the output will remain HI so long as the Input pin 6 remains LO.

(4.6.1) If a HI is applied to pin 6, the output will return to LO.

(4.7) A HI reset pulse may be applied to Input pin 6 at any time before Tot, and the device will be Reset and will remain Reset (Initial state) so long as the HI is present on pin 6.

(5) DUAL, 4-INPUT NOR GATE: Motorola Type No. MC14002CP; RCA Type No. CD4002AE; (Nu-Tone Part No. 36661-000); used as Z201 in I-600, and as Z108 in I-614.



TRUTH TABLE				
INPUTS				
A	B	C	D	OUTPUT
HI	X	X	X	LO
X	HI	X	X	LO
X	X	HI	X	LO
X	X	X	HI	LO
LO	LO	LO	LO	HI

X=DONT CARE

4-INPUT NOR GATE

FIGURE 6

(5.1) This CMOS IC contains two, independent, 4-input NOR gates, each of which is supplied from a common VDD at pin 14. Both gates are connected to circuit VSS through pin 7.

(5.2) When any one or more inputs is/are HI, the output is LO.

(5.2.1) When all inputs are LO, the output is HI.

(5.3) Input noise immunity: minimum 20% of Vdd, typically 45% of VDD.

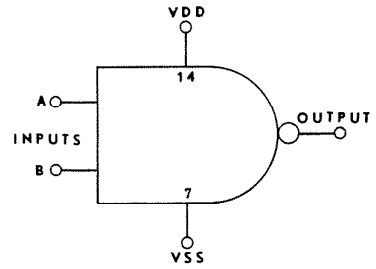
(5.4) There may be slight variations, and a potential in the order of 0.5V may be present on the output when it is in a LO logic state.

(5.4.1) A potential equal to VDD supply minus 0.5V may be noted on the output when it is in a HI logic state.

(5.4.2) These variations from exact VSS or VDD are so minimal that they will have no effect on the circuit's operation.

(5.5) When all inputs of a NOR gate are connected in common, it will act as an inverter, i.e. the output will be at the opposite logic state from that appearing on the input.

(6) QUAD, 2-INPUT NAND GATE: Motorola Type No. MC14011CP; RCA Type No. CD4011AE (Nu-Tone Part No. 36666-000); used as Z107 in the I-614 Master Station.



TRUTH TABLE		
INPUTS		
A	B	OUTPUT
LO	X	HI
X	LO	HI
HI	HI	LO

X=DONT CARE

2-INPUT NAND GATE

FIGURE 7

(6.1) This CMOS IC contains four, independent, 2-input NAND gates, each of which is supplied from a common VDD at pin 14. Both gates are connected to circuit VSS through pin 7.

(6.2) When both inputs are HI, the output is LO.

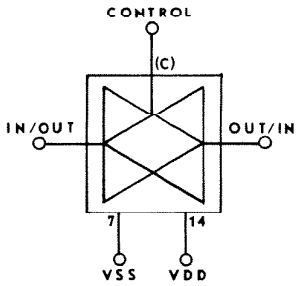
(6.2.1) When either or both inputs is/are LO, the output is HI.

(6.3) Noise immunity specifications and output state variations are the same as those noted in paragraphs (5.3) through (5.4.2) above.

(6.4) When all inputs of a NAND gate are connected in common, it will act as an inverter, i.e. the output will be at the opposite logic state from that appearing on its input.

(7) QUAD BILATERAL SWITCH: Motorola Type No. MC14066BCP; RCA Type No. CD4066AE; (NuTone Part No. 36658-000); used as Z202 in I-600; and as Z106 in I-614.

(7.1) This CMOS IC includes four, independent, bilateral switches with each switch having its own individual control (C).



TRUTH TABLE	
CONTROL	SWITCH
HI	IN=OUT
LO	IN≠OUT

BILATERAL SWITCH

FIGURE 8

(7.2) All switches are powered by a common VDD at pin 14; and all switches are connected to circuit VSS through pin 7.

(7.3) When an individual switch control (C) is HI, the switch is closed and the output state is equal to the input state, i.e. Eout = Ein.

(7.4) When an individual switch control (C) is LO, the switch is open, and the output state does not equal the input state, i.e. Eout ≠ Ein.

(7.5) The IN/OUT terminal and the OUT/IN terminal may serve as either the signal input terminal or as the signal output terminal.

(7.5.1) The circuit's flow direction of the signal being controlled determines whether the IN/OUT terminal is serving as input or output (and conversely whether the OUT/IN terminal is serving as output or input).

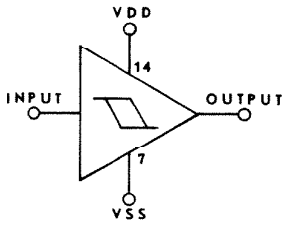
(7.6) Except in the case of Z106C in the I-614 Master Station, the bilateral switches are used to control audio signals in the Selective Call System.

(7.7) When a switch control (C) is LO, the switch is open but some audio may feed through. The level of the audio signal on the output should be −65 db in comparison with the audio signal level on the input.

(7.8) Crosstalk between two switches on the same chip should not exceed −55 db.

(7.9) Z106C is used in the automatic END OF CALL operation of the I-614 Master Station. It is controlled by the output of the Oscillator/Timer Z103.

(8) HEX SCHMITT TRIGGER INVERTER: Motorola Type No. MC14584BCP (NuTone Part No. 36677-000; used as Z109 in the I-614 Master Station.



OUTPUT = $\overline{\text{INPUT}}$

SCHMITT TRIGGER

FIGURE 9

(8.1) CMOS IC includes six, individual inverters, each of whose output is at the opposite logic level from the logic level on its input.

(8.2) All inverters are powered by a common VDD at pin 14, and all are connected to circuit VSS through pin 7.

(8.3) The Schmitt trigger offers high noise immunity and the ability to square up the output waveform with a slowly changing waveform on the input.

(9) For additional information on the CMOS devices that are used in this System, recommend that the manufacturer's (Motorola, RCA, National Semiconductor, etc.) CMOS DATA MANUALS be consulted.

(10) VOLTAGE REGULATOR — 15VDC: Used as Z205 in the I-600 Central Power Supply and Door Speaker Control.

(10.1) Operation of this device — as used in the original and later production versions of the I-600 — is covered under MODEL I-600 CENTRAL POWER SUPPLY, REGULATED +15VDC (B+) paragraphs (3) through (5), page 13.

MODEL I-600 CENTRAL POWER SUPPLY
REGULATED +15 VDC (B+)
(See Schematic Diagram)

(1) The 16Vac secondary of the power transformer T1 (NuTone Model 301-N) is connected through the AC terminals of the Terminal Board and P/J201-1/2 to the full-wave bridge rectifier D201-D204.

(1.1) The transformer is rated at 30VA and is protected by an automatic-reset thermal overload.

(1.2) The secondary voltage of T1 may vary between 16Vac and 18Vac (22-25 Vac peak) depending on the current load of the System.

(1.3) C214-C217 are diode switching noise suppressors for D201-D204 respectively.

(2) The output of the bridge is filtered by C201 and a 22-25 Vdc is fed to the input of the Voltage Regulator Z205.

(3) VOLTAGE REGULATOR Z205, NUTONE PART NO. 36717-000 (FAIRCHILD TYPE NO. A78H15SC) USED IN ORIGINAL PRODUCTION UNITS:

(3.1) With an input voltage of 19-25 Vdc, the output will be 15Vdc (±0.6Vdc) with an output d-c load of up to 2 amps.

(3.2) Two (2), 1000 microfarad output filter capacitors C202 and C203 MUST be used with this regulator.

(3.3) Fairchild has advised that they will discontinue production of this device, and when present stocks are used — in production and as a replacement part — a different device will be used.

(4) VOLTAGE REGULATOR Z205, NUTONE PART NO. 36720-000 (LAMBDA TYPE NO. LAS 1415), USED IN LATER PRODUCTION UNITS AND AS REPLACEMENT PART.

(4.1) With an input voltage of 20-30 Vdc the output will be 15Vdc (±0.75Vdc) with an output d-c load of up to 3 amps.

(4.2) One (1), 100 microfarad output filter capacitor C232 MUST be used with this regulator.

(5) Physically, the two regulators are direct replacement for each other, but because of the output filter capacitor requirements, when one is substituted for the other, the filter capacitors must also be changed so that they are in compliance with paragraphs (3.2) and (4.2) above.

(6) The regulated 15Vdc B+ supplies VDD and VCC to: the door speaker control and amplifier circuits in the I-600; and through J/P201-3, the Terminal Board's ORN B+ terminal, and the IW-8 Cable's ORN wire to the I-614 Master Stations and when used, to the M-640 AM/FM Receiver.

(7) The potential at the ORN B+ terminal in every I-614 must equal or exceed 9Vdc under all operating conditions.

(8) Care must be exercised when making or breaking the connection of this wire at any component.

(8.1) It is recommended that the 16Vac wires from the power transformer T1 be removed from the AC terminals of the I-600 Terminal Board, when making or breaking connections at the terminals throughout the System.

(8.1.1) To prevent shorting the output of T1, insulate the ends of the wires when they are removed from the AC terminals.

(9) The B+ line is protected from lightning strikes; static discharges; and other random voltage spikes by the VARISTOR (voltage sensitive resistor)-RV202.

(9.1) RV202 appears as practically an open circuit under normal 15Vdc operating conditions. If a steady state 38Vdc or 30Vacrms or a transient of 47V is impressed on the B+ line, the varistor will appear practically as an open circuit, and these voltages will be shorted to ground.

(9.1.1) This is one of the reasons for making sure that the ground BLK terminals on the Terminal Board is connected to earth ground.

(9.2) If a negative voltage less than 38Vdc is impressed on the line, the varistor will not short it to ground. To protect the voltage regulator from these negative voltages the reverse connected diode D209 is connected to the B+ line, and should limit negative voltages to approximately −0.8V.

MODEL I-600 DOOR SPEAKER CONTROL

(1) The linear and CMOS devices in this circuit are powered by the Regulated +15VDC (B+) which is supplied by the rectifier D201-D204 and voltage regulator Z205 in this unit.

(2) In the schematic diagrams of this manual, the System is shown in a standby mode (no intercom operation in progress).

(3) The Door Speaker's Identity Wire must be connected to P202 or P203's Numbered Identity Terminal that corresponds to the address number that is assigned to the Door Speaker.

(4) The Door Speaker:

Can not originate an intercom call;

Will not be activated by an ALL CALL that is originated by a Master Station;

Can not hear the entertainment program from the M-640 AM/FM Receiver;

Will not hear intercom signals from a Master Station that is in LISTEN-IN mode.

(5) The Door Speaker may be assigned any address number from 1-14. When that numbered keypad switch is activated at any Master Station, that Station will be able to communicate with the Door Speaker. (In this discussion the address number "10" will be assigned to the Door Speaker.)

(6) At the originating Master Station, the number 10 keypad switch is activated (pushed-in and released); the D and B (binary 10) address data lines throughout the System go HI, and Z206 data input terminals 2 and 23 go HI.

(7) The HI's on lines D and B are also connected to the NOR gate Z201A inputs 5 and 3 respectively, and the gate's output Z201A-1 goes LO.

(7.1) The LO on Z201A-11 is connected through R231 to the base of PNP transistor Q202, and its collector voltage at the high side of R216 goes HI (to approximately VDD) and the decoder's strobe input at Z206-1 goes HI.

(7.2) With strobe input HI, and with address inputs D and B HI; the binary 10 is decoded and Z206-6 goes HI.

(7.2.1) The HI on Z206-6 is connected through terminal P203-10 and the Door Speaker's Identity Wire to (aa) on the PC board.

(8) The HI from (aa) is connected through R230 and R222 to the base of the TALK/LISTEN switching transistor Q201 (NPN). Q201 is turned ON, the coil of TALK/LISTEN RELAY K201 is energized, and the relay contacts are thrown to the TALK position.

(8.1) The HI from the LO side of R230 is also connected to bilateral switch Z202A-13(C); the switch is closed and IN = OUT.

(8.2) The HI from (aa) is also fed to Z202B-5(C) and this bilateral switch is also closed, but since the talk listen relay contacts are in TALK position, no signals will be fed through this section.

(9) The input to inverter connected NOR gate Z201B is normally LO and its output is HI. This HI is blocked by D208.

(9.1) When the TALK/LISTEN BAR in the Master Station is activated (pushed-in to TALK position), the RED/W CONTROL LINE and the input to Z201B goes HI and the inverter output goes LO.

(9.2) The LO from Z201B through D208 shorts the HI to base of Q201, the transistor is turned off, K201's coil is de-energized and its contacts are switched to the LISTEN POSITION.

(9.3) The LO through D208 also opens bilateral switch Z202A.

(10) With the originating Master Station in TALK mode and the Door Speaker in LISTEN mode, intercom audio signals from the Master Station will be fed through the BLK/W OUTPUT wire; P201/J201-4; the PC circuit OUTPUT path and K201-3-4 to the high side of the Door Speaker VOLUME CONTROL R229.

(10.1) The Door Speaker VOLUME CONTROL R229 is on the PC board and the I-600 cover must be removed in order to change its setting.

(11) The audio is fed through R229's adjustable tap; R206; C227; and bilateral switch Z202B to inverting input Z204-6 of the audio power amplifier. (Z202A is open.)

(12) Z204 (National Semiconductor LM380N; Nu-Tone Part No. 36641-000) is an audio power amplifier with its gain internally fixed at 34 db (voltage gain of 50).

(12.1) Its input stage allows the input signal to be ground referenced.

(12.2) The quiescent output voltage at Z204-8 is automatically self entered at one-half the supply voltage, i.e. $E_8 = VCC/2$.

(12.3) The LM380N is a 14DIP with the 3 center pins on either side connected to a copper lead frame in order to supply a heat sink.

(12.4) The output is short circuit proof with internal thermal limiting. The output will supply 2.5 watts at less than 3% harmonic distortion into an 8-ohm load.

(13) The amplifier audio output is fed from Z204-8 through C206; K201-6-7; K201-10-9; J201/P201-11; Door Terminal; and one wire of the IW-2 cable to one side of the Door Speaker.

(13.1) The other side of the Door Speaker is connected to circuit ground through the other wire of the IW-8 cable; the other Door Terminal P201/J201-12; and K201-12-13.

(14) When the party at the originating Master Station has finished speaking, he should release the TALK BAR.

(14.1) When TALK BAR is released, the originating Station is switched to LISTEN mode; and the System's CONTROL (RED/W) line goes LO.

(15) When the CONTROL line goes LO, the input of Z201B goes LO; Z201B-13 goes HI — removing the LO at junction of R230 and anode of D208.

(15.1) The HI from (aa) is connected through R230 and R222 to the base of Q201 — turning it ON. The TALK/LISTEN RELAY K201's coil is energized and its contacts are thrown to the TALK position.

(15.2) The HI from (aa) through R230 is also connected to the bilateral switch Z202A-13(C); the switch is closed and audio signals from the TALK PREAMPLIFIER Z203 will be connected to the inverting input (6−) of Z204.

(16) Audio signals from the Door Speaker will be fed through the IW-2 twisted-pair and the DOOR terminals and P201/J201-11 and P201/J201-12 to the TALK/LISTEN paths on the I-600 PC board.

(16.1) The audio signals on one line of this path are connected through K201-9-11; C222; and R203 to the inverting input (2−) of Z203, the TALK PRE-AMPLIFIER.

(16.2) The audio signals on the other line of this path are connected through K201-12-14; C223; and R204 to the non-inverting input (3+) of Z203.

(17) Z203 (Motorola MC1741CP1; RCA CA741E and CA741G; Fairchild UA741TC; NuTone Part No. 36700-000) is an OpAmp that is operated in the differential mode as a preamplifier of the audio signals from the Door Speaker(s).

(17.1) The differential mode of operation results in high Common Mode Rejection (CMR) of spurious (RFI, etc.) signals that may be introduced into either input line.

(17.2) In a quiescent state the output terminal Z203-6 voltage is equal to VDD/2.

(17.3) Maximum output voltage swing is approximately 14V peak-to-peak.

(18) The audio output at Z203-6 is fed through R205; C226; and Z202A to the ground referenced input Z204-6(−) of the audio amplifier.

(19) The audio signal at Z202A-2 is also fed through the closed bilateral switch Z202B, C227; R206 and the tapped portion of DOOR SPEAKER VOLUME CONTROL R229 to ground. Since K201 is in TALK position the signal is floating at K201-4.

(19.1) The setting of R229 will effect the level of the TALK signal that is fed to the audio amplifier input at Z204-6(−), but the control can not take the signal to zero because of the series resistor R206.

(20) The Door Speaker's amplified TALK signal is fed from Z204-8, through C206; K201-6-8; and R202 to the OUTPUT (Intercom Audio) PC path.

(20.1) From this path, the signal is fed through J201/P201-4 to the BLK/W OUTPUT terminal and BLK/W wire of the IW-8 cable that is connected between the I-600 and I-614's.

(21) At the originating Master Station the Door Speaker's TALK signal is fed through the BLK/W OUTPUT terminal; across the PC OUTPUT (Intercom Audio) path; and K1-3-4 to the LISTEN VOLUME CONTROL R153.

(21.1) From R153's variable tap, the signal is fed through C-123; or 119; and the closed bilateral switch Z106B to the audio amplifier input Z102-6(−).

(21.2) The amplified audio is fed from Z102-8, through C123; K1-6-7; and K1-10-9 to one side of the originating Master Station's speaker.

(21.3) The other side of the speaker is connected through K1-12-13 to ground.

(22) The TALK/LISTEN functions, as described above, between the originating Master Station and the Door Speaker may be repeated indefinately, so long as the originating Station's TALK BAR is activated (i.e. pushed-in to TALK position) before the automatic END OF CALL timer Z103 completes its timing cycle.

(22.1) When the originating Station is in TALK, the CONTROL LINE goes HI, and this HI is connected through R157 and D124 to the Reset terminal Z103-6 of the automatic END OF CALL Timer. The Timer remains in RESET so long as the Station is in the TALK mode.

(22.2) When the TALK BAR is released — originating Station goes to LISTEN mode; and Door Speaker goes to TALK mode — the CONTROL LINE will go LO and the Timer Z103 will commence its timing cycle. If the Master Station remains in the LISTEN mode for the 60 second (approximate) timing cycle, the call will be automatically terminated. (See END OF CALL, pp 28-30.)

(23) If the intercom message between the Master Station and Door Speaker is completed before expiration of the timing cycle, the call can be terminated by activating the END OF CALL (zero) keypad switch at the originating Master Station.

(24) TWO DOOR SPEAKERS:

(24.1) The recommended NuTone Door Speakers for use with the Selective Call Intercom System have a nominal impedance of 16 ohms.

(24.2) Any two of these speakers may be used in the System. They may be installed on individual run of IW-2, maximum length of run is 50 feet with the two speakers connected in parallel common, or the two speakers may be connected on individual runs of IW-2, with each run not exceeding 50 feet, between the I-600 and the individual speakers.

(24.3) These Models include:

IS-61 and IS-65 Built-in

ISA-63 Surface Mount

ISA-64 Surface Mount with Pushbutton

IS-67 Surface Mount with Lighted Push-button

(24.4) When two door speakers are used, they will be in the same mode (TALK or LISTEN) depending on the TALK BAR position in the originating Master Station.

(24.4.1) When in the LISTEN mode, they will both hear the intercom message from the Master Station.

(24.4.2) When in the TALK mode, signals from both door speakers will be heard at the Master Station. Signals from one Door Speaker will not be heard at the other Door Sppeaker.

(25) PAGING AREA SPEAKERS:

(25.1) The Model I-600 may be used to control paging area speakers, which may be used in warehouses, on loading docks, etc. The operation of these speakers is the same as described for the door speakers above.

(25.2) Three (3) of NuTone's 25-ohm, 8-inch speakers may be used inside.

(25.3) Two (2) on NuTone's 16-ohm weatherproof outdoor speakers may be used.

I-600 TERMINAL BOARD INSTALLATION NOTE

(1) Early production units, include an envelope assembly (NuTone Part No. 52550-000) that contains a resistor and a capacitor.

(1.1) Resistor: 560 ohm ± 10%, ½ watt carbon
NuTone Part No. 33101-561
Capacitor: 0.1 microfarad ± 20% Mylar
NuTone Part No. 35066-101

(2) This resistor and capacitor should be connected in series between ORN/W "D" Address Terminal and BLK ground terminal when the Model M-640 AM/FM Radio Receiver is NOT used in the System.

(3) Later production units are shipped with the resistor and capacitor installed in series between the ORN/W and BLK terminals.

(4) When the Model M-640 AM/FM Radio Receiver is included in the System, the capacitor and resistor should be removed. (See page 37.)

I-600 TERMINAL BOARD SERVICE NOTE

(1) In early production units, the I-600 TERMINAL BOARD was drilled, and the varistors RV201-RV209 were installed manually.

(2) During drilling operation, one or more PC paths on the TERMINAL BOARD may have been cut, and the continuity may have been broken between one or more labelled Screw Terminal(s) and its (their) respective J201/P201 terminal(s). (See I-600 Schematic Diagram.)

(3) A break may be determined by visual inspection and/or by running a continuity check between each labeled Screw Terminal and its respective J201/P201 terminal. Resistance between these points should be zero.

(3.1) When making continuity check, suggest that the a-c power be turned off: disconnect the 16 Vac wires of the S-143 cable from the AC Screw Terminals. Make certain that these wires are not shorted, insulate the ends.

(4) When a break in the PC path is found, it may be repaired by making a solder bridge across the break. Make certain that PC paths are not shorted to one another.

(5) The dynamic status may be determined by making voltage measurements. The reading should be the same at the labeled Screw Terminal and its respective J201/P201 terminal. Unless otherwise specified, voltages should be measured in respect to circuit common ground J201/P201-5.

SCREW TERMINAL	J201/P201 TERMINAL	FUNCTION
ORN	3	REGULATED +15 VDC (B+)
BLK/W	4	OUTPUT LINE*
BLU	6	ADDRESS LINE BIT A**
BLU/W	7	ADDRESS LINE BIT B**
RED	8	ADDRESS LINE BIT C**
ORN/W	9	ADDRESS LINE BIT D**
RED/W	10	CONTROL LINE***
DOOR	11	DOOR SPEAKER WIRE
DOOR	12	DOOR SPEAKER WIRE

NOTE: (*) Using an a-c voltmeter (or db meter), the intercom audio signal may be measured between BLK/W Screw Terminal (or J201/P201-4) and circuit ground BLK Screw Terminal (or J201/P201-5).

(**) When Address No. 15 (ALL CALL) is made, all address lines and Terminals should be HI.

(***) When originating Master Station is in a LISTEN mode, the CONTROL LINE is LO.

When originating Master Station is in a TALK mode (TALK-BAR pressed-in), the CONTROL LINE is HI.

MODEL I-600 TERMINAL BOARD CONNECTIONS AND FUNCTIONS
FIGURE 10

MASTER STATION TO MASTER STATION SELECTIVE CALL INTERCOM OPERATING SEQUENCE

EXAMPLE: ORIGINATING STATION ADDRESS NO. 7 CALLED STATION ADDRESS NO. 13

(At start, all Master Stations are in quiescent intercom mode as shown in schematic diagram)

AT ORIGINATING STATION NO. 7	AT CALLED STATION NO. 13	AT NOT-CALLED STATIONS
(1) Activate (press-in and release) the No. 13 Keypad Switch.	**ESTABLISHING THE CALL**	
Z105's output address data bits D, C, and A go HI (binary 13). Address terminals D (ORN/W); C (RED); A (BLU); and the System's matching color-coded wires go HI. Z108A-1 goes LO. Z104-1 STROBE input is latched LO. Z103-6 goes LO; single-cycle timing operation is activated. Timer output Z103-8 remains LO. Z108B-13 goes LO. Z109F-12 goes HI. Q101 is turned on and BUSY indicator light (LED) D123 is turned on. Z104 DATA inputs D, C, and A (binary 13) go HI. Z104 STROBE input is LO and the decoders outputs remain in their quiescent state (S1-S15 are LO, and SØ is HI.)	Address data terminals D (ORN/W); C (RED); and A (BLU) go HI. Z108B-13 goes LO. Z109F-12 goes HI. Q101 is turned on and BUSY indicator light (LED) D123 is turned on. Z107C-8 goes HI; Z107C-10 goes LO; and Encoder Z105 is locked-out. Z104-1 STROBE input goes HI. Z104 DATA inputs D, C, and A (binary 13) go HI. Z104-19, S13 output goes HI. Individual address identity terminal No. 13 goes HI. Identity wire goes HI. Z109E-11 goes HI. Z109E-10 goes LO.	Address data terminals D (ORN/W); C (RED); and A (BLU) go HI. Z108B-13 goes LO. Z109F-12 goes HI. Q101 is turned on, and BUSY indicator light (LED) is turned on. Z107C-8 goes HI; Z107C-10 goes LO; and Encoder Z105 is locked-out. Z104-1 STROBE input goes HI. Z104 DATA inputs D, C, and A (binary 13) go HI. Z104-19, S13 output goes HI. Individual address identity terminal No. 13 goes HI. Identity wire (not connected to identity terminal No. 13) remains LO.
TIMED ANNUNCIATOR TONE AND INTERCOM ENABLE		
The LO from Z108A-1 is connected through D121 to Z106D-12(C) and the bilateral switch is opened. The LO from Z108A-1 is pulsed through C132 to Z109A-1. Z109A-2 is pulsed HI and will remain HI for a pulse width of 680-990 mS. Z109A-2's HI pulse is connected through D119 to Z109C-5 and Z109C-6 will remain LO for 680-990 mS. While (680-990 mS) the HI pulse is on Z109A-2; the annunciator tone generator will be on; the tone is fed from R155, through R151; amplified by Z102; and heard at this Station's speaker. When the LO pulse at Z109A-1 has decayed, Z109A-2 will go LO (680-990 mS). When Z109A-2's HI pulse is terminated, the HI at Z109C-5 will be removed and Z109C-5 will be taken LO by the LO from Z108A-1. Z109C-6 will go HI. Z106B-5(C) goes HI, bilateral switch is closed, and audio signals on the OUTPUT (BLK/W) line will be fed through LISTEN VOLUME control R153; amplified by Z102 and heard at this Station's speaker. The HI at Z109C-6 is connected to the floating segments A and B of the open (LISTEN position) TALK/LISTEN switch S4. NOTE: TALK/LISTEN FUNCTIONS OF THE ORIGINATING AND CALLED STATION IS CONTROLLED BY THE TALK/LISTEN SWITCH (TALK BAR) IN THE ORIGINATING STATION.	The LO from Z109E-10 is connected through D122 to Z106D-12(C) and the bilateral switch is opened. The LO from Z109E-10 is pulsed through C132 to Z109A-1. Z109A-2 is pulsed HI and will remain HI for a pulse width of 321-606 mS. Z109A-2's HI pulse is connected through D118 to Z109B-3 and Z109B-4 will remain LO for 321-606 mS. While (321-606 mS) the HI pulse is on Z109A-2, the annunciator tone generator will be ON; the tone is fed from R155, through R151; amplified by Z102; and heard at this Station's speaker. When the LO pulse at Z109A-1 has decayed, Z109A-2 will go LO (321-606 mS). When Z109A-2's HI pulse is terminated, the HI at Z109B-3 will be removed and Z109B-3 will be taken LO by the LO from Z109E-10. Z109E-4 will go HI. Q102 is turned on; TALK/LISTEN relay K1 is energized and its switches are thrown to the TALK position. Z106B-5(C) goes HI, bilateral switch is closed. Z106A-2(C) goes HI, bilateral switch is closed and audio signals from this Station's speaker will be amplified by Z101 and Z102 and fed to the System's OUTPUT (BLK/W) line. THE CALLED STATION IS INTERCOM ENABLED IN THE TALK MODE WITHIN A PERIOD OF 321-606 mS AFTER CALL IS ORIGINATED.	During intercom operations between the originating Station and the called Station: The NOT-CALLED Stations will not hear the intercom signals; The NOT-CALLED Stations' Encoders will be locked-out; If the System includes the M-640 AM/FM Tuner; and if a NOT-CALLED Station's RADIO switch S1 is on, the radio's audio signals will be amplified by Z102 and heard at this Station's speaker.

→

AT ORIGINATING STATION NO. 7	AT CALLED STATION NO. 13	AT NOT-CALLED STATIONS
THE ORIGINATING STATION IS INTERCOM ENABLED IN THE LISTEN MODE WITHIN A PERIOD OF 600-900 mS AFTER CALL IS ORIGINATED, AND NOISE GENERATED BY THE SWITCHING TALK/LISTEN RELAY IN THE CALLED STATION WILL NOT BE HEARD AT THE ORIGINATING STATION.		
(2) Close TALK/LISTEN switch S4 (Press-in and hold TALK BAR).	**ORIGINATING STATION TO TALK MODE/CALLED STATION TO LISTEN MODE**	
RED/W CONTROL LINE goes HI. (S4A connects the HI from Z109C-6 to the CONTROL LINE. Z107D-12/13 goes HI. Z107D-11 goes LO. The LO from Z107D-11 is pulsed through C131 and Z106B-5(C) goes LO and the bilateral switch is opened during the LO pulse. This prevents key-clicks and relay switching noises from being heard at the originating station. (Pulse time is approximately 400 mS.) At the end of the pulse, Z106B-5(C) goes HI and the bilateral switch is closed. The HI on the CONTROL line is connected through R157 and D124 to Z103-6 and the timer is reset to initial state and remains reset so long as the HI is on Z103-6. Z103-8 remains LO. Section S4B connects the HI from Z109C-6 through R156 to the base of Q102, turning Q102 ON. TALK/LISTEN RELAY coil K1 is energized and its contacts are switched to TALK mode. Z106A-13(C) goes HI and the bilateral switch is closed. Audio signals from this Station's speaker are pre-amplified through Z101; amplified through Z102 and fed from Z102-8 to the BLK/W output line.	CONTROL LINE goes HI. Z107D-12/13 goes HI. Z107D-11 goes LO. Forward bias is removed from Q102 and Q102 is turned off. TALK/LISTEN relay K1's coil is de-energized and its contacts are switched to the LISTEN position. The LO from Z107D-11 is pulsed through C131 and Z106B-5(C) goes LO and the bilateral switch is open during the LO pulse. This prevents key-clicks and relay switching noises from being heard at the called station. (Pulse time is approximately 400 mS.) At the end of the pulse, Z106B-5(C) goes HI and the bilateral switch is closed. Z106A-13(C) goes LO and the bilateral switch is opened. Intercom signals received on the BLK/W OUTPUT line are fed through the LISTEN volume control R153 to input of the AUDIO AMPLIFIER at Z203-6 and from Z102-8 to this Station's speaker.	CONTROL LINE goes HI. Z107D-12/13 goes HI. Z107D-11 goes LO. The operation of these stations does not change. Dilateral switch Z106B is open and noise or signals on the OUTPUT line are not fed to Z102-6.
(3) Release TALK BAR.	**ORIGINATING STATION TO LISTEN MODE/CALLED STATION TO TALK MODE**	
RED/W CONTROL LINE goes LO. Timer input Z103-6 goes LO, timer is activated, timer output Z103-8 stays LO. Q102 is turned off. TALK LISTEN RELAY K1 is de-engized and its contacts are switched to the LISTEN mode. Z106A-13(C) goes LO and the bilateral switch is closed. Intercom signals received on the BLK/W OUTPUT line are fed through the LISTEN volume control R153 to input of the AUDIO AMPLIFIER AT Z203-6 and from Z102-8 to this Station's speaker.	CONTROL LINE goes LO. Q102 is turned on. TALK/LISTEN RELAY K1 is energized and its contacts are switched to TALK mode. Z106A-13(C) goes HI and the bilateral switch is closed. Z106B-5(C) goes LO and the bilateral switch is opened. Audio signals from this Station's speaker are pre-amplified through Z101; amplfied through Z102 and fed from Z102-8 to the BLK/W OUTPUT line.	

→

AT ORIGINATING STATION NO. 7	AT CALLED STATION NO. 13	AT NOT-CALLED STATIONS
(4) Activate (press-in and release) the END OF CALL (O) Keypad Switch.	**TERMINATE INTERCOM CALL**	
ALL Z105's output address data bits go LO. (ALL ADDRESS LINES AND TERMINALS THROUGHOUT SYSTEM GO LO).	All Z104's address data input terminals go LO (binary zero).	All Z104's address data input terminals go LO (binary zero).
Z108A-1 goes HI.	All Data inputs to Z104 go LO.	All Data inputs to Z104 go LO.
Strobe input Z104-1 goes HI.	Z108B-13 goes HI.	Z108B-13 goes HI.
All Data inputs to Z104 go LO.	Z109F-12 goes LO.	Z109F-12 goes LO.
Z108B-13 goes HI.	Q101 is turned off; BUSY indicator (LED) D123 is turned off.	Q101 is turned off; BUSY indicator (LED) D123 is turned off.
Z109F-12 goes LO.	The HI from Z108B-13 is pulsed through R113 and C102 to Strobe input Z104-1.	The HI from Z108B-13 is pulsed through R113 and C102 to Strobe input Z104-1.
Q101 is turned off; BUSY indicator (LED) D123 is turned off.	The Strobe input will be held HI for approximately 200 mS. This assures the decoding of the binary zero that is on the Decoder's data input, and that the outputs S1-S15 will be LO. SØ will be HI.	The Strobe input will be held HI for approximately 200 mS. This assures the decoding of the binary zero that is on the Decoder's data input, and that the outputs S1-S15 will be LO. SØ will be HI.
The HI from Z108B-13 is pulsed through R113 and C102 to strobe input Z104-1.	Station returns to condition shown in Schematic Diagram. (If System includes the M640 AM/FM Receiver, and if RADIO SWITCH S1 is closed, the entertainment program will be heard through this Station's speaker.	Station returns to condition shown in Schematic Diagram. (If System includes the M-640 AM/FM Receiver, and if RADIO SWITCH S1 is closed, the entertainment program will continue to be heard at these Stations.
The Strobe input will be held HI for approximately 200 mS. This assures the decoding of the binary zero that is on the Decoder's data input, and that the outputs S1-S15 will be LO. SØ will be HI.		
Station returns to condition shown in Schematic Diagram. (If System includes the M-640 AM/FM Receiver, and if RADIO SWITCH S1 is closed, the entertainment program will be heard through this Station's speaker.		

NOTE:

The above Sequence of Operation Chart is a condensed version of the various electronic states, fixed and variable, that are present in the Model I-614 Master Stations when a selective intercom call is being made.

When this chart is used with the Schematic Diagrams in this manual and with a standard volt meter (high impedance input meter preferred) the dynamic state at critical points can be determined.

The above Chart should not be considered a substitute for a complete understanding of the MODEL I-614's detailed Theory of Operation which begins on page 20.

(1) All Master Stations in the System are powered by the regulated +15Vdc supply from the I-600 Central Power Supply. B+ is parallel-common-connected through the System's ORN B+ wire to the ORN B+ terminal in every I-614. The potential at every I-614's ORN terminal must be a minimum of 9Vdc under all operating conditions.

(2) USE CARE WHEN CONNECTING OR DISCONNECTING THE B+ ORN WIRE AT THE B+ ORN TERMINAL IN THE I-614. DO NOT SHORT TO OTHER TERMINALS NOR TO THE PC CIRCUIT PATHS.

(2.1) RECOMMEND THAT THE 16VAC WIRES BE DISCONNECTED FROM THE AC TERMINALS ON THE I-600'S TERMINAL BOARD WHEN MAKING OR BREAKING ANY WIRING CONNECTIONS AT THE MASTER STATION(S).

(3) At the Master Station, the regulated +15VDC is fed from the B+ ORN terminal, through the B+; VCC; VDD1; and VDD2 paths to the various devices on the PC board.

(4) In the Schematic Diagram, the Master Station is shown in the quiescent intercom (standby) mode, and the RADIO ON/OFF SWITCH S1 is shown in the OFF position.

(5) When the System includes the Model M-640 AM/FM Receiver, the receiver's audio signals are fed through the ORN/W D bit address line to every Master Station.

(6) When the RADIO ON/OFF SWITCH is in the ON position, the receiver's audio signals are fed through S1; C110; RADIO VOLUME CONTROL R154; and the closed bilateral switch Z106D; to the input of the audio amplifier Z102-2(+).

(6.1) The bilateral switch Z106D is held closed by a HI (VDD1) which is connected through the OFF position of LISTEN-IN SWITCH S2A and R139 — WHEN THE MASTER STATION IS NOT ORIGINATING NOR RECEIVING A SELECTIVE CALL INTERCOM MESSAGE.

(7) The receiver's audio is amplified through Z102 and fed from Z102-8, through C123; K1-6-7; and K1-10-9 to one side of the Master Station's speaker. (TALK/LISTEN RELAY K1 is in the LISTEN position.)

(7.1) The other side of the speaker is connected through K1-12-13 to circuit common ground.

(8) ADDRESS LINES: Each individual color-coded address wire, of the System's IW-8 cable, is common throughout the System. Each color-coded address wire is connected to its matching color-labeled terminal at every Station (Door and Master).

(8.1) When the System is in a quiescent intercom mode, the address lines (and terminals) are at a logic LO state.

(8.2) When an intercom call is originated at any Master Station, one or more of these address wires (and terminals) will be switched to a logic HI level. (See ENCODER TABLE, Figure 3, page 8.)

(8.2.1) The logic level for the various addresses may be checked at the Master Station's and at the I-600 Terminal Board address terminals and compared with those shown in the Table, Figures 3 and 4.

(8.2.2) For HI, the terminal should measure between (VDD1-1V) and VDD1.

(8.2.3) For LO, the terminal should measure between VSS and (VSS+0.5V).

(9) CONTROL LINE: The RED/W CONTROL wire of the System's IW-8 cable, and the RED/W labeled terminals in all Master and Door Stations are common throughout the System.

(9.1) In the quiescent intercom mode, the RED/W CONTROL wires and terminals are LO throughout the System. The line is held LO through R214 in the Model I-600 Central Power Supply and Door Speaker Control.

(9.2) When an intercom call is made, and the originating Station's TALK-BAR is activated, its TALK/LISTEN SWITCH S4 will be held in the TALK position, and the RED/W CONTROL wires and terminals throughout the System will be held in a logic HI level.

(9.3) The voltage on the RED/W CONTROL wires and terminals should be within the ranges shown in paragraphs (8.2.2) and (8.2.3) above.

(10) OUTPUT LINE: The BLK/W OUTPUT wire of the System's IW-8 Cable, and the BLK/W labeled terminals at all Stations are common throughout the System.

(10.1) Sounds, in the vicinity of a Master Station which is in the TALK mode, will be converted to electrical signals by this Station's speaker. Generally these sounds are the result of speaking normally into the speaker.

(10.2) Intercom signals from one side of the speaker's coil will be fed through K1-9-11; C111; and R109 to one input of the differential TALK PREAMPLIFIER at Z101-2(−). (K1 is in TALK mode.)

(10.2.1) Intercom signals from the other side of the speaker's coil will be fed through K1-12-14; C112; and R110 to the other input of the TALK PREAMPLIFIER at Z101-3(+).

(10.3) The TALK intercom signals are preamplified through Z101 and fed from the preamp's output Z101-6, through R118; C105; and the closed bilateral switch Z106A to the audio amplifier input Z102-6(−).

(10.4) NOTE: The audio signals are also fed from the output of the closed bilateral switch Z106A-2, through the closed bilateral switch Z106B; R119; and C103; to the adjustable tap of LISTEN VOLUME CONTROL R153.

(10.4.1) One end of R153 is floating at K1-4 (K1 is in TALK mode); and other end is connected to circuit ground.

(10.4.2) Head start resistor R119 prevents attenuation of this intercom signal if LISTEN VOLUME CONTROL R153 is set at minimum, i.e. ground.

(10.5) Audio amplifier input Z102-2(+) is audio ground referenced through C116.

(10.6) Bilateral switch Z106D is open when a Master Station is in either the TALK or LISTEN intercom mode.

(10.7) The preamplified signal is amplified through Z102, and fed from Z102-8, through C123; K1-6-8; R108; and the OFF section of LISTEN-IN SWITCH S2B, to the BLK/W OUTPUT terminal.

(10.8) From the BLK/W OUTPUT terminal at the sending (TALK mode) Station it is fed through the BLK/W OUTPUT wire of the IW-8 cable, to the BLK/W OUTPUT terminals at all other Stations in the System.

(10.8.1) At all of the intercom not-activated Stations, the intercom signals will be fed from the BLK/W OUTPUT terminal, through OFF position of S2B; K1-3-4; tapped portion of R153; C103; and R119 and will float at the input of the open bilateral switch Z106B-4.

(10.8.2) At the intercom activated station(s) in the LISTEN mode, the intercom signals will be fed from the BLK/W OUTPUT terminal, through OFF position of S2B; K1-3-4; tapped portion of R153; C103; R119; and the closed bilateral switch Z106B; to Z102-6 ( ) input of the audio amplifier. (Note, the bilateral switch Z106A is open.)

(10.8.2.1) The signal is amplified through Z102 and fed from Z102-8, through C123; K1-6-7; and K1-10-9 to one side of the LISTEN mode Station's speaker.

(10.8.2.2) The other side of the speaker is connected through K1-12-13 to circuit ground.

(11) EXCEPTION: THE M-640 RECEIVER'S BLK/W TERMINAL AND WIRE IS NOT COMMON TO THE SYSTEM'S BLK/W CONTROL WIRE, WHICH IS CONNECTED BETWEEN THE DOOR SPEAKER CONTROL AND THE MASTER STATIONS.

(11.1) Original Installation Instructions directed that this wire be connected to the circuit's common ground BLK wire and terminal. Later Installation Instructions direct that the BLK/W wire from the M-640 Receiver NOT be used. (See paragraphs (5.5) through (5.5.2), page 36; and the I-600 Schematic Diagram.)

(12) RANDOM VOLTAGE PROTECTION: The ORN B+ line; BLK/W OUTPUT line; RED/W CONTROL line; and the four (4) color-coded ADDRESS lines are protected by the voltage-sensitive resistors (varistors) RV101-RV107.

(12.1) See paragraph (4) under INTER-COMPONENT SYSTEM WIRING AND RANDOM-VOLTAGE PROTECTION, page 7; and paragraphs (9) and (9.1) under MODEL I-600 CENTRAL POWER SUPPLY REGULATED +15VDC (B+), page 13.

(12.2) All varistors are connected between the line they protect and circuit common ground. This ground is common throughout the System, AND MUST BE CONNECTED TO EARTH GROUND VIA THE BLACK GROUND TERMINAL ON THE I-600'S TERMINAL BOARD.

(13) 4PDT TALK/LISTEN RELAY K1: When, as shown in the Schematic Diagram, the Master Station is in the quiescent (standby) intercom mode, Q102 is turned off; K1's coil is not energized; and the relay's switches are in the LISTEN position.

(13.1) NPN transistor Q102 functions as a control-switch for the TALK/LISTEN RELAY K1.

(13.1.1) When a positive potential of sufficient amplitude is applied to Q102's Base, the transistor will be turned on (saturated), and its collector will essentially be at ground.

(13.2) When Q102 is turned on, K1's coil is energized and its switches are in the TALK position.

(13.3) When an intercom call is made, the originating Station controls its own TALK/LISTEN RELAY; and except for Master Stations that are being operated in the PRIVATE mode (S3 in ON position), the originating Station controls the TALK/LISTEN RELAY in the called Master Station(s).

(13.3.3) When a Master Station is operated in the PRIVATE mode, S3 latches Q102 off, and K1's coil can not be energized. (See PRIVATE MODE OPERATION, below.)

(14) AUDIO AMPLIFIER Z102: The same amplifier IC is used in the Master Station as that used for Z204 in the Model I-600 Central Power Supply and Door Speaker Control. See paragraphs (12) through (12.4), page 14.

(15) TALK PREAMPLIFIER Z101: The same OpAmp IC is used in the Master Station as that used for Z203 in the I-600. See paragraphs (17) through (17.4), page 15.

(16) ANNUNCIATOR TONE GENERATOR: Z107B and Z107A form a standard NAND gate astable-multivibrator, which when on, generates an audible tone at its output Z107A-3.

(16.1) The generator is ON/OFF controlled by the logic level at Z107B-6, which in-turn is controlled by the Schmitt trigger inverter output at Z109A-2.

(16.2) When a Master Station is in the quiescent intercom mode: Z109A-1 is HI; Z109A-2 is LO; Z107B-6 is LO; the generator is OFF and its output at Z107A-3 is LO.

(16.3) When a selective intercom call is made, the input of the Schmitt trigger inverter Z109A-1 is pulsed LO at the originating Station and at the called Master Station(s).

(16.3.1) When Z109A-1 is pulsed LO: Z109A-2 and Z107B-6 are pulsed HI; and the generator is turned ON.

(16.4) The Annunciator Tone Generator will remain ON so long as Z107B-6 is HI.

(16.4.1) When the Annunciator Tone Generator is ON, the tone signal will be fed from the generator output Z107A-3, through C104 and across TONE LEVEL-SET CONTROL R155.

(16.5) The signal will be fed from the tapped portion of R155, through R151, to the input of the Audio Amplifier Z102-2(+).

(16.5.1) When a selective intercom call is made, the bilateral switch Z106D is open in the originating and called Master Stations.

(16.5.2) R151 isolates R155, so that the TONE LEVEL-SET CONTROL has no effect on received radio and/or LISTEN-IN audio signals when a Master Station is in the quiescent intercom mode and RADIO ON/OFF SWITCH S1 is ON.

MASTER STATION TO MASTER STATION SELECTIVE CALL OPERATION

(1) In keeping with the Chart, pages 17-19, the originating station is assigned address number 7; and the called station is assigned address number 13.

(2) All other stations (including the Door Speaker Control) are considered "Not Called Stations."

(3) The system is on (powered) and all stations are considered in the quiescent (standby) intercom mode.

(3.1) No stations are in LISTEN-IN or PRIVATE mode. These modes will be considered in separate sections below.

ESTABLISHING THE CALL—ADDRESSING

(1) AT THE ORIGINATING STATION NO. 7: The keypad switch No. 13 is activated (pushed-in and released): The Encoder Z105's Y4 and X2, input terminals 4 and 10 respectively, are connected together. The decimal address 13 is converted to a binary 13, and the address lines D, C, and A are latched HI.

(1.1) Reference, under SPECIAL DEVICES, see paragraphs (1) through (1.8.3) and Figure 3, pages 7 and 8.

(1.2) Each individual color-coded address wire and terminal is common throughout the system. In this example:

(1.2.1) Every address terminal D and ORN/W wire (of the IW-8 cable) is HI.

(1.2.2) Every address terminal C and RED wire (of the IW-8 cable) is HI.

(1.2.3) Every address terminal A and BLU wire (of the IW-8 cable) is HI.

(1.3) From the Chart, Figure 3, any decimal address (Ø-15) will be converted to a binary number whose active HI bits can be measured at their respective address wires and terminals.

(1.3.1) When an ALL CALL (address No. 15) is activated, all address wires and terminals are HI.

(1.3.2) When the system is in a quiescent intercom mode, which is the same as an END OF CALL (address No. Ø), all address wires and terminals are LO.

(1.4) The HI's on Z105's address output bit terminals D, C, and A are connected to the input terminals 5, 4, and 2, respectively, of NOR gate Z108A, and Z108A-1 goes LO.

(1.4.1) When any address No. 1-No. 15 is called, at least one address line and one input to Z108A goes HI; and its output Z108A-1 goes LO.

(1.5) The LO from Z108A-1 performs the following functions:

(1.5.1) The LO is connected to Z107C-9, where it latches Z107C-10 HI. So long as Z107C-10 is HI, the KBM function of the encoder Z105 allows delayed two-key rollover. (See paragraphs (1.7) through (1.8.3), page 8.)

(1.5.2) The LO is connected through R150 to the master reset Z103-6 of the Automatic END OF CALL TIMER, and initiates the single-cycle timing operation of Z103. (See Oscillator Timer, pages 10 and 11.)

(1.5.2.1) If the automatic timer is allowed to complete its single-cycle timing operation, its output Z103-8 state will change from LO to HI.

(1.5.2.2) The single-cycle timing operation will be interrupted whenever the master reset Z103-6 is switched HI, and will initiate a new single-cycle timing operation when the master reset Z103-6 is again switched LO.

(1.5.3) The LO from Z108A-1 is connected through D121 to Z106D-12(C), and the bilateral switch is open.

(1.5.3.1) When Z106D is open, audio signals from the AM/FM Receiver (and/or audio signals from another Master Station that may be operating LISTEN IN) will not be fed to the input of the

Audio Amplifier at Z102-2(+). Z102-2(+) will be audio ground referenced through C116.

(1.5.4) The HI from Z108A-1 will be pulsed through D117 and C132 to the inverter input Z109A-1 and Z109A-2 will go HI. (This HI pulse will be discussed more completely in the appropriate section below.) (Para. (2.7)-(2.7.2), page 24)

(1.5.5) Z108A-1's LO is connected through R159 to the inverter input Z109C-5.

(1.5.5.1) When the call is first initiated, the HI pulse from Z109A-2 holds Z109C-5 HI, and this HI is isolated from ground (VSS) by R159, and Z109C-5 does not go LO until the HI pulse at Z109A-2 is terminated.

(1.5.5.2) When Z109C-5 is LO, Z109C-6 is HI.

(1.5.5.2.1) The HI from Z109C-6 is connected to floating section A of the TALK LISTEN SWITCH S4, and this HI is used to control the state of the RED/W CONTROL LINE during intercom operation.

(1.5.5.2.2) Z109C-6's HI is also fed through R121 and D114 to Z106B-5(C), closing the bilateral switch and allowing audio signals on the System's BLK/W OUTPUT LINE to be fed to the input Z102-6(−) of the Audio Amplifier when the originating Station is operated in the LISTEN mode.

(1.5.6) The LO from Z108A-1 is connected through D115, and it latches the Strobe input Z104-1 of the Receiver/4-Bit Decoder in a LO state in a matter of nano (10^{-9}) seconds.

(1.5.6.1) When the Receiver/4-Bit Decoder's Strobe input is latched LO, the decoded outputs (SØ-S15) can not change state regardless of any change of state on the Decoder's data inputs.

(1.5.6.2) At the originating Master Station, the Receiver/4-Bit Decoder Z104's outputs S1-S15 will remain LO; and SØ will remain HI during intercom operations.

(1.5.7) With all of the originating Station's Z104 outputs (SØ-S15) LO during selective call intercom operations: Z109E-11 is LO; Z109E-10 is HI; Z109B-3 is HI; and Z109B-4 is LO at this originating Station.

(1.6) When a call is originated, the encoded HI(s) on Z105's output data terminals are connected through blocking diodes; 1K resistors; the labeled (A, B, C, D, as required) terminals; and the color-coded wires of the System's IW-8 cable, to the like labeled terminals at all other (Door and Master) Stations.

(1.7) At the originating Station, the data line(s) HI(s) is/are connected through 100K resistors to the inputs of NOR gate Z108B; and to the binary data input terminals A-D of the Receiver/4-Bit Decoder Z104.

(1.7.1) There is a delay in the NOR gate inputs; and in the data line inputs going HI. The A, B, and C data lines are delayed for approximately 5 milliseconds by their individual 100K resistors in conjunction with their individual .05 microfarad capacitors. Data line D is delayed for approximately 1 millisecond (R131 × C109). The smaller (.01) capacitor is used with the D address line in order to prevent excessive attenuation of the AM/FM Receiver and/or LISTEN IN audio signals that are also carried on this line.

(1.8) With the Strobe input latched LO when the change of Z104's data inputs occurs, the outputs will not change state. AN ORIGINATING STATION CAN NOT ADDRESS A CALL TO ITSELF.

(1.9) When one or more inputs of NOR gate Z108B goes HI; Z108B-13 and Z109F-13 go LO; and Z109F-12 goes HI.

(1.9.1) The HI from Z109F-12 is fed through R114 and D108 to Strobe input Z104-1, but the high is shorted to ground (VSS) through the LO at Z108A-1.

(1.9.2) Z109F-12's HI is also connected through R136 to the base of Q101. The transistor and the BUSY indicator lamp (LED) D123 are turned on.

(2) NOTE: When the System's power is initially turned on (i.e., the 16Vac is connected to the AC terminals of the Model I-600's Terminal Board, a finite period is required in order for the operating logic and voltages to settle into their quiescent intercom state.

(2.1) When power is first turned on, VDD2 is pulsed through R115 and C126 to Z104-1 — the Strobe input of the Receiver/4-Bit Decoder.

(2.2) During the settling-in period, various potentials may appear on the address data lines before they settle into their normal LO state.

(2.2.1) All lines LO = END OF CALL = Ø = Quiescent Intercom State.

(2.2.2) When Z401 decodes a zero (ø), its outputs S1—S15 are LO; and SØ is HI. This is the desired quiescent state.

(2.3) The HI Strobe pulse will assure the encoding of the zero, and when the pulse decays and the Strobe goes LO, the output will be latched in the zero decode state.

(3) AT THE CALLED STATION NO. 13: The address terminals D, C, and A go HI when the No. 13 is addressed at the originating Station.

(3.1) The HI at these terminals is connected through R131, R130, and R128, respectively, to Z108B input terminals 9, 10, and 12; and to the address data bit inputs D, C, and A of the Receiver/4-Bit Decoder Z104.

(3.1.1) Going HI on the C and A bit lines will be delayed for approximately 5 milliseconds, and going HI on the D bit line will be delayed for approximately 1 millisecond. (See paragarph (1.7.1) above.)

(3.2) When one or more of the inputs to Z108B go HI, the output Z108B-13 goes LO; Z109F-13 goes LO and Z109F-12 goes HI.

(3.2.1) Z109F-12's HI is connected through D108 to the Strobe input Z104-1.

(3.3) With its Strobe input HI, Z104 will decode the binary address (HI's on D, C, and A) that is present on its Input Data terminals — S13 (Z104-19) and the ADDRESSED IDENTITY TERMINAL 13 will go HI. All other address (S) terminals are LO.

(3.4) Z109F-12's HI is also connected through R136 to the base of Q101. The transistor is turned on (saturated) and BUSY INDICATOR LIGHT (LED) D123 is turned on.

(3.5) The HI from Z109F-12 is also connected to Z107C-8. Z107C-9 is held HI by the HI from Z108A-1 and the ENCODER LOCKOUT, NAND GATE OUTPUT Z107C-10 is latched LO.

(3.5.1) The LO from Z107C-10 is fed through D116 to the KBM input Z105-6.

(3.5.2) When KBM is latched LO, the encoder Z105's data output terminals can not change state even if the Keypad is activated. This "lockout" provision prevents the activation of an address at a called Station (Paragraph (1.7), page 8).

(3.6) At this Station, the IDENTITY WIRE should be connected to individual addressed identity terminal No. 13, and it will go HI when the terminal goes HI.

(3.6.1) The identity wire HI will be connected through D110 to the inverter input Z109E-11, and Z109E-10 will go LO.

(3.6.2) Z109E-10's LO is connected through D122 to Z106D-12(C) and the bilateral gate is opened.

(3.7) When Z106D is open, audio signals, from the M-640 Receiver and/or from a Master Station that is operating LISTEN-IN will not be fed to the Audio Amplifier input Z102-2(+) at a called station.

(4) AT THE NOT-CALLED STATIONS: The operation at the not-called Master Stations is the same as that shown for the called Master Station in paragraphs (3) through (3.5.1) above.

(4.1) The LO from the ENCODER LOCKOUT Z107C-10 prevents change in the 4-Bit Encoder Z105's data output terminals at the not-called station, even if its Keypad is activated.

(4.2) Since the not-called Stations' identity wire is not connected to address terminal No. 13, no additional functions will be observed at the not-called Stations.

(5) If the System includes the Model M-640 AM/FM Tuner; and if a not-called Station's Radio ON/OFF SWITCH S1 is on, the radio program will be amplified by Z102 and fed through this Station's speaker.

TIMED ANNUNCIATOR-TONE AND INTERCOM-ENABLE

(1) The operation of the Annunciator Tone generator is described in paragraphs (16) through (16.5.2), pages 21 and 22 above.

(2) AT THE ORIGINATING STATION NO. 7: When call is originated, the LO from Z108A-1 is pulsed through C132: Z109A-1 instantaneously goes LO to a potential of approximately 1V; Z109A-2 and Z107B-6 instantaneously go HI; and the tone generator is turned on. (The term "Instantaneously is used in a relative sense.)

(2.1) From the Motorola CMOS Manual: When VDD=15V, the inverter's output transition from LO to HI occurs when its input potential (Vin) drops to 6.75V.

(2.2) After falling to approximately one-volt, Vin immediately starts rising — in an exponential manner — toward VDD1. When Vin has risen to transition (output goes from HI to LO); Z109A-2 and Z107B-6 instantaneously go LO and the tone generator is turned off.

(2.2.1) From the Motorola CMOS Manual: When Vdd=15V, the inverters output transition from HI to LO occurs Vin has risen to 8.25V.

(2.3) At the originating Master Station, the width of the LO pulse at Z109A-1 (and consequently the HI pulse at Z109A-2 and Z107B-6) is determined by the time constant (RC=R148×C132); and by the transition Vin that is required for the individual Schmitt trigger inverter.

(2.4) With the permissible manufacturing tolerances of R148 and C132; and the variations of transition Vin, and HI pulse time at Z109A-2 should be within the following ranges:

(2.4.1) In original production units, i.e. where R148=470 Kohms, the pulse width should be in the range of 680-831 mSeconds.

(2.4.2) In later production units, i.e. where R148=560 K, the pulse width should be in a range of 811-990 mSec.

(2.5) The timed pulse at Z109A-1 is saw-tooth shape (exponential rise), but because of the "Schmitt trigger effect" of the inverter, the HI pulse at Z109A-2 is essentially a square wave.

(2.6) In addition to determining the on-time of the annuncitator tone generator, the HI pulse at Z109A-2 controls additional timed functions in the originating Master Station.

(2.7) The timed HI pulse at Z109A-2 is connected through D119 to the Inverter Input Z109C-5; and Z109C-6 will remain in its quiescent LO state for the duration (680-990 mSec) of the originating Station's timed HI pulse.

(2.7.1) The 100 Kohm resistor R159 isolates the HI pulse on Z109C-5 from the LO (VSS) at Z108A-1.

(2.7.2) After the HI pulse from Z109A-2 is terminated, the LO from Z108A-1 will be connected through R159 to Z109C-5 and Z109C-6 will go HI.

(2.8) The HI at Z109C-6 is connected to the common, open poles of the TALK/LISTEN SWITCH S4.

(2.9) The HI at Z109C-6 is also connected through R121 and D114 to Z106B-5(C) and the bilateral switch is closed.

(2.9.1) When Z106B is closed, incoming intercom signals that are on the BLK/W OUTPUT LINE, will be fed through the LISTEN mode TALK/LISTEN SWITCH K1-3-4; INTERCOM LISTEN VOLUME CONTROL R153; C103; R119 and the closed switch to the input of the Audio Amplifier Z102-6(−), where they are amplified and fed to this originating Station's speaker.

(2.9.2) NOTE Z106B is not closed until after the termination of the HI pulse at Z109A-2 or approximately 680-990 mSec after activation of the Keypad switch.

(2.10) THE ORIGINATING STATION IS INTERCOM-ENABLED IN THE LISTEN MODE WITHIN A PERIOD OF 680-990 mSECONDS AFTER CALL IS ORIGINATED, AND SWITCHING NOISE (KEY-CLICKS, ETC.) THAT MAY BE GENERATED IN THE SYSTEM, IN THIS TIME FRAME, WILL NOT BE HEARD AT THE ORIGINATING STATION.

(3) AT THE CALLED STATION NO. 13: When a call is received at this Station, Z109E-10 goes LO.

(3.1) The LO from Z109E-10 is fed through R158 and pulsed through C132 to Z109A-1.

(3.2) Z109A-1 instantaneously goes LO: to a potential of approximately 5V in original production units; and to a potential of approximately 4V in later production units. In any case, to a potential that is less than 6.75V.

(3.3) In original production units, R148 = 470K, and R158 = 22K.

(3.3.1) In later production units, R148 = 560K, and R158 = 15K.

(3.4) When Vin at Z109A drops to 6.75V, output transition occurs, and Z109A-2/Z107B-6 go HI; and the tone generator is turned on.

(3.5) After going LO, Vin at Z109A-1 starts to rise, at an exponential rate, toward VDD1. When Vin reaches transition (8.25V), Z109Z-2/Z107B-6 go LO and the tone generator is turned off.

(3.6) The pulse width at Z109A-2/Z107B-6 is determined by the RC time constant (RC = (R158 + R148) (C132)), and the individual inverter's transition Vin; and when considering the permissible manufacturing tolerances should be in the range:

(3.6.1) In original production units, 321-392 mSeconds.

(3.6.2) In later production units, 496-606 mSeconds.

(3.7) In any case, Z109A-2 should be HI and the annunciator tone generator should be on for an appreciable shorter period at the called Station than at the originating Station. This should be true whether original or later production units are used exclusively or whether they are mixed.

(3.8) The timed HI pulse at Z109A-2 is fed through D118 to the inverter input Z109B-3, and Z109B-4 is held LO for the duration of the called Station's timed HI pulse — 321-606 mSeconds.

(3.8.1) The 100 Kohm resistor R135 isolates the HI pulse from the LO (VSS) at Z109E-10. (See paragraph (3) above.)

(3.8.2) When the HI pulse from Z109A-2 is terminated, Z109B-3 is connected through R135 to the LO at Z109E-10, and Z109B-4 goes HI.

(3.9) Z109B-4's HI is connected through R117; R144; and in later production units, through R161, to the base of Q102.

(3.9.1) When base of Q102 is HI, TALK/LISTEN RELAY K1 is switched to the TALK position. (See paragraphs (13) through (13.3.3), page 21.)

(3.10) The HI from Z109B-4 is also connected through R117 and D111 to Z106A-13(C) and the bilateral switch is closed. This connects preamplified TALK signals from the output of the Talk Preamplifier Z101-6 to the input of the Audio Amplifier Z102-6(−).

(3.11) Z109B-4's HI is also connected through R147 to Z106B-5(C) and the bilateral switch is closed. This will connect incoming OUTPUT LINE audio signals to the input of the Audio Amplifier Z102-6(−) when the called Station's TALK/LISTEN RELAY K1 is switched to the LISTEN position.

(3.12) It must be remembered that the TALK/LISTEN RELAY is switched to the TALK position; and that the bilateral switches Z106B and Z106A are closed; after the termination of the timed HI pulse at Z109A-2 (321-606 mSeconds).

(3.13) THE CALLED STATION IS INTERCOM-ENABLED, IN THE TALK MODE, WITHIN A PERIOD OF 321-606 mSECONDS AFTER CALL IS INITIATED AT THE ORIGINATING STATION.

(4) AT THE NOT-CALLED STATIONS: During intercom operations between the originating Station and the called Station:

(4.1) The not-called station will not hear the intercom signals.

(4.2) The not-called Stations' Encoders Z105 will be locked-out.

(4.3) If the System includes the M-640 AM/FM Receiver, and if a not-called Station's RADIO ON/OFF SWITCH S1 is ON, the receiver's audio signals will be fed to and amplified by the Audio Amplifier Z102, and heard at these stations' speakers.

(5) WHEN A DOOR SPEAKER IS CALLED: *The* operation and timing of the Annunciator Tone Generator and intercom enable at the originating Master Station is the same as described in paragraphs (1) through (2.10) above.

(5.1) The Door Speaker Control in the I-600 does not include an Annunciator Tone Generator, and a tone will not be heard at the Door Speaker(s) when it/they are called. (See I-600 DOOR SPEAKER CONTROL pages 13-16.)

INTERCOM SWITCHING NOISE SUPPRESSION

(1) Audio switching random noise (key-clicks, etc.) may be generated at the called Station when its RELAY K1 is switched to TALK position and its bilateral switches Z106A and Z106B are closed — within 321-606 mSeconds after initiation of intercom call.

(2) These noises may be amplified by Z101 and Z102 and fed to the Systems BLK/W OUTPUT LINE, but since the originating Station is not intercom-enabled until after 680-990 mSeconds, these noises will not be heard at the originating Station.

(3) At Stations that are not called, bilateral switch Z106B is open and signals on the BLK/W OUTPUT LINE will not be fed to their Audio Amplifiers.

(3.1) Bilateral switch Z106D remains closed in not-called Stations in order to connect receiver (or LISTEN-IN mode) signals to their Audio Amplifiers Z102.

(4) The above represents an idealized condition, and in actual practice some switching or random noise may be heard, but these sounds should be of such low level that they are not objectionable.

SWITCHING TALK LISTEN FUNCTIONS
ORIGINATING STATION TO TALK
CALLED STATION TO LISTEN

(1) The originating Station is intercom enabled in the LISTEN mode, and the called Station is enabled in the TALK mode.

(2) During an intercom call, the TALK/LISTEN functions at the originating Station and at the called Station are controlled by the TALK/LISTEN SWITCH S4 in the originating Station.

(3) CONTROL LINE STATE:

(3.1) When intercom call is initiated, and the originating Station is enabled in the LISTEN mode, the TALK/LISTEN SWITCH S4 in this Station is in its normal LISTEN position.

(3.1.1) S4 is a momentary contact switch. The switch must be held in TALK position by depressing, and holding-in, the TALK BAR. When TALK BAR is released, S4 automatically returns to its normal LISTEN position.

(3.2) When the originating Station's S4 is in LISTEN position, the RED/W CONTROL PATHS, WIRES AND TERMINALS THROUGHOUT THE SYSTEM ARE LO.

(3.2.1) The CONTROL LINE is connected to ground (VSS) through R214 in the Model I-600 Central Power Supply and Door Speaker Control.

(4) AT THE ORIGINATING STATION: *When* TALK/LISTEN SWITCH S4 is switched to TALK position, i.e. the TALK BAR is pressed and held-in:

(4.1) The HI from Z109C-6 is connected through S4A; R112; and this Station's PC CONTROL PATH to the RED/W CONTROL WIRES AND TERMINALS THROUGHOUT THE SYSTEM.

(4.2) The PC Control Path HI is connected through R157 and D124 to the Master Reset Z103-6 of the Automatic End of Call Timer. The Timer's single-cycle operation will be interrupted, and the output at Z103-8 will be held LO so long as the TALK BAR is held in.

(4.2.1) NOTE: When the TALK BAR is released and the CONTROL PATH goes LO, The Timer Z103 will start a new single-cycle operation. (See page 10.)

(4.3) The CONTROL PATH HI will be connected through R137 to the input of Z107D and Z107D-11 will go LO.

(4.4) The LO from Z107D-11 will be pulsed through C131 and D112 to Z106B-5(C) and the bilateral switch will be open during the LO pulse width. The width of the pulse is primarily determined by the RC constant (R121 × C131) and is approximately equal to 100 mSeconds.

(4.4.1) When Z106B is open, noise that may be present on the OUTPUT LINE during switching operation will not be connected to the input of the Audio Amplifier at Z102-6(−).

(4.4.2) At the termination of the 100 mSecond LO pulse, Z106B-5(C) will be held HI by Z109C-6, and the bilateral switch will be closed.

(4.4.3) When Z106B returns to its closed condition, RELAY K1's switching should be completed and any signals on the OUTPUT line will be floating at K1-3-5 and not connected to the Audio Amplifier's input.

(4.5) When S4 is activated as shown in paragraph (4) above, the HI from Z109-6 is connected through S4B and R156 to the base of Q102.

(4.5.1) The switching transistor Q102 is turned on (saturation); the originating Station's TALK/LIS-

TEN RELAY K1 is energized, the Station is switched to the TALK mode. (See paragraphs (13) through (13.3.3), page 21.)

(4.5.2) From the activated S4B, Z109C-6's HI is also connected through R138 and D120 to Z106A-13(C) and the bilateral switch is closed.

(4.6) When Z106A is closed, preamplified signals from the Talk Preamplifier Z101 will be connected to the input Z102-6(−) of the Audio Amplifier, where they are amplified and fed through C123; K1-6-8; and R108 to the System's BLK/W OUTPUT WIRES AND TERMINALS.

(5) AT THE CALLED STATION NO. 13: When the CONTROL LINE PC PATH goes HI (TALK/LISTEN SWITCH S4 in Originating Station is activated), the HI is connected through R137 to the input of Z107D; and output Z107D-11 goes LO.

(5.1) Z107D-11's LO is connected through D113 and it removes the forward bias of Q102; the transistor will be turned off; K1 will be de-energized; and the called Station will be switched to the intercom LISTEN operating mode.

(5.2) The LO through D113 will also remove the HI at the junction of R117 and D111. With this HI removed, Z106A-13(C) will be held LO through R149; and the bilateral switch will be opened.

(5.2.1) When Z106A is open, audio signals from the Talk Preamplifier Z101 can not be fed to the input of the Audio Amplifier Z102.

(5.2.2) The LO at the junction of R117 and D111 is isolated from the HI at Z109B-4 by R117.

(5.3) The LO at Z107D-11 will be pulsed through C131 and D112 to Z106B-5(C). The pulse width is primarily determined by the RC constant (R124 × C131) and is approximately 130 mSeconds. This LO pulse is isolated from the HI on Z109B-4 by R147.

(5.4) The bilateral switch Z106B will be open for approximately 130 mSec. Any audio (signals or noise) on the OUTPUT LINE during the TALK/LISTEN switching will not be fed through the Audio Amplifier in the called Station.

(5.4.1) When the LO pulse is terminated (130 mSeconds), the HI from Z109B-4 is connected through R147 to Z106B-5(C) and the bilateral switch is closed.

(5.5) When Z106B is closed and the called Station is operating in the intercom LISTEN mode, intercom signals on the BLK/W OUTPUT line will be fed to the input of the Audio Amplifier Z102-6(−), where they will be amplified and fed to the called Station(s) speaker.

(6) AT THE NOT-CALLED STATIONS: When the CONTROL LINE PC PATH goes HI (TALK/LISTEN SWITCH S4 in the originating Station is activated), The HI is connected through R137 to the input of Z107D; and output Z107D-11 goes LO.

(6.1) The not-called Stations are not intercom enabled, and Z107D-11's going LO does not effect the not-called Stations' operation.

(7) AT THE I-600 DOOR SPEAKER CONTROL: The HI on the CONTROL LINE is connected through R15 to the input of Z201B and Z201B-13 goes LO.

(7.1) When the Door Speaker is not the addressee, the CONTROL LINE going HI will not effect its operation.

(7.2) For operation when the Door Speaker is the addressee, see under MODEL I-600 DOOR SPEAKER CONTROL, paragraphs (9) through (9.3), page 14.

SWITCHING TALK LISTEN FUNCTIONS ORIGINATING STATION TO LISTEN CALLED STATION TO TALK

(1) AT THE ORIGINATING STATION NO. 7: Release the TALK BAR, the TALK/LISTEN SWITCH S4 will return to its normal LISTEN position, and the HI from Z109C-6 will be removed from the CONTROL LINE.

(1.1) THE CONTROL LINE PC PATH, RED/W WIRES AND TERMINALS THROUGHOUT THE SYSTEM GOES LO. The CONTROL circuit will be held LO through R214 in the Model I-600 Door Speaker Control.

(1.2) The Automatic End of Call Timer's Master Reset Input Z103-6 goes LO, and the timer initiates its single-cycle operation. (If the Timer is allowed to run for its 60-second period, output transition will occur, and Z103-8 will go LO, and an automatic END OF CALL (Ø) will be addressed by Z105.)

(1.3) When the CONTROL LINE goes LO, the input of Z107D goes LO, and Z107D-11 goes HI.

(1.4) When S4B returns to normal LISTEN position, the forward bias to Q102 is removed; the transistor is turned off; K1's coil is de-energized and the originating Station is switched to LISTEN mode.

(1.4.1) S4B in LISTEN position also disconnects the HI, through R138 and D120, from Z106A-13(C) and the bilateral switch is open.

(1.4.2) When Z106A is opened, signals from the Talk Preamplifier Z101, can not be fed to the input of the Audio Amplifier Z102.

(1.5) The HI from Z109C-6 will be connected through R121 and D114 to Z106B-5(C), the bilateral switch will be closed and intercom messages from the called Station will be fed from the BLK/W OUTPUT LINE to the input of the Audio Amplifier, where they will be amplified and fed through the LISTEN contacts of K1 to the originating Station's speaker.

(2) **AT THE CALLED STATION NO. 13:** When the CONTROL LINE goes LO, Z107D's input goes LO; and Z107D-11 goes HI.

(2.1) When Z107D-11 goes HI, the ground (VSS) that is connected through D113 to the high-side (+) of C130 is removed.

(2.2) The potential at the junction of C130(+), R144, R117 and the anode of D111 charges, at an exponential rate, toward the voltage value of the HI at Z109B-4.

(2.2.1) The rate of charge is essentially determined by the RC constant (R117 × C130) and is approximately equal to 100 mSeconds.

(2.3) In approximately 50 mSeconds, the potential at C130(+) will rise to a value that is sufficient to forward bias Q102 to saturation; TALK/LISTEN RELAY K1 will be energized; and the called Master Station is switched to the TALK mode.

(2.3.1) When the voltage at the junction of R117 and D111, approaches Z109B-4's HI, the HI will be connected through D111 to Z106A-13(C); the bilateral switch will be closed; and intercom signals from Z101-6 will be connected to the input of Z102-6(−).

(2.3.2) The HI from Z109B-4 will be connected through R147 to Z106B-5(C); the bilateral switch will be closed, but since K1 is in TALK mode, the signals on the OUTPUT LINE will be floating at K1-3-5 and will not be fed to the Audio Amplifier.

(2.4) When the called Station is in the TALK mode, audio signals in the vicinity of its speaker will be pre-amplified by Z101; fed to, and amplified by Z102; and fed from Z102-8, through c123; K1-6-8 and R108 to the System's BLK/W OUTPUT WIRES AND TERMINALS.

(3) AT THE NOT-CALLED STATIONS: When the CONTROL LINE goes LO (TALK/LISTEN SWITCH in originating Station is released), the input of Z107D goes LO and the output at Z107D-11 goes HI, but the operations at these Stations does not change.

(4) AT THE DOOR SPEAKER: When the CONTROL LINE GOES LO, Z201B's input goes LO and Z201B-13 goes HI.

(4.1) When the Door Speaker is not the called Station, the CONTROL LINE's going LO will not change its operating mode.

(4.2) When the Door Speaker is the called Station, the Door Speaker Control will return to its intercom-enabled TALK mode and the operation is as described in paragraphs (8) through (13.3), page 14.

END OF CALL — MANUAL OR AUTOMATIC

AN INTERCOM CALL CAN BE ENDED ONLY BY THE ORIGINATING STATION.

(1) AT THE ORIGINATING STATION NO. 7:

(1.1) MANUAL END OF CALL: Activate (press-in and release) the END CALL (Ø) keypad switch. Y1 will be connected to X1 (Z105-1 to Z105-11).

(1.2) AUTOMATIC END OF CALL: If the oscillator/timer Z103 is allowed to complete its single-cycle operation, output transition will occur and Z103-8 will go HI. (See para. (4) OSCILLATOR/TIMER, pp 10/11; para. (4.2-(4.2.1), pp 26; and para. (1.2), pp 27.)

(1.2.1) When Z103-8 goes HI, the bilateral switch Z106C is closed and Y1 is connected to X1 (Z105-1 to Z105-11).

(1.3) When Y1 is connected to X1, Z105 encodes the Ø and all four of Z105's data bit output terminals are LO.

(1.3.1) Data bit output terminals D, C, and A are switched to LO. (In this example Station 13 was the Called Station.) While the 13 was encoded, data bit output terminal B was LO and it will remain LO when the Ø is encoded.

(1.4) NOR gate output Z108A-1 goes HI.

(1.4.1) The LO through D115 is cancelled and the HI from Z109F-12 will hold strobe input Z104-1 HI.

(1.4.2) Z108A-1's HI will reset Z103.

(1.4.3) Inverter output Z109C-6 goes LO; CONTROL LINE remains LO and Q102 is OFF regardless of position of T/L SWITCH S4A/B.

(1.4.3.1) Z106B-5(C) goes LO, the bilateral switch is opened and signals on the intercom T/L OUTPUT LINE will not be fed to Audio Amplifier Z102-6(6).

(1.4.4) The LO through D121 is cancelled: Z106D-12(C) goes HI, the bilateral switch is closed; and if RADIO SWITCH S1 is ON, radio and/or listen-in signals will be fed through Z106D to Z102-2(+), where they are amplified and fed to the Originating Station's speaker.

(2) During intercom operation, the binary 13 address data lines D, C, and A are HI throughout the System. The potential of these HI's are determined by VDD1 to the Originating Stations Z105, which may vary between an absolute minimum of 9 volts (during an ALL CALL) and 15 volts.

(2.1) At every I-614: the high-side of C109, C115, and C113; the NOR gate inputs Z108B-9/10/12; and the Receiver/4 Bit Encoder data inputs Z104-2/3/22 are HI.

(2.2) At the Originating Station the strobe input Z104-1 is LO during intercom operation, but goes HI when the Ø is encoded. (See para. (1-4)-1.4.1.) above.)

(2.3) At all other I-614's, the strobe input Z104-1 is HI; and at the I-600, the strobe input Z206-1 is HI.

(3) When, at the Originating Station, an END CALL (Ø) is addressed and its Z105's data outputs go LO, the address lines D, C, and A — throughout

the System — start to go LO in an exponential manner, which is primarily determined by the RC time constants of the various data line circuits.

(4) DATA LINES DISCHARGE PATHS AND TIMES:

(4.1) I-614: "A" address circuit's .05 capacitor C113 discharges through its 100 Kohm resistor R128; the System's Blu wire; and the 22 Kohm resistor R210 in the I-600.

(4.1.1) When used, "B" address circuit's C114 discharges through R129; System's BLU/W wire; and R211 in the I-600.

(4.1.2) "C" address circuit's C115 discharges through R130; the System's RED wire; and R212 in the I-600.

(4.2) I-600; "A" address circuit's .05 capacitor C220 discharges through R217 and R210.

(4.2.1) When used, "B" address circuit's C219 discharges through R218 and R211.

(4.2.2) "C" address circuit's C221 discharges through R219 and R212.

(4.3) In all of the A, B, and C discharge circuits RC = (100K + 22K) (.05 microF) = 6.1 mS. (mS = milliseconds).

(4.3.1) When the CMOS devices operate at 45% (typical) noise immunity, the time of transition (Tot) from HI to LO is .73RC, or 4.53 mS.

(4.3.2) Because of permissible manufacturing tolerances of the R and C components; variations in the noise immunity of individual CMOS devices; and of the difference in voltage to which the capacitors may be charged, the transition from HI to LO of the A, B, and C address circuits may vary between 2 mS and 11 mS.

(4.4) I-614: "D" address circuit's .01 capacitor C109 discharges through 100 Kohm resistor R131; the System's ORN/W wire; and the 470 Kohm resistor R228 in the I-600. (RC = 5.7 mS)

(4.4.1) In the I-614: When the RADIO SWITCH S1 is ON (closed), the .01 capacitor C110 is also charged to the value of the HI on the D line. This capacitor discharges through R160; the ORN/W Wire; R228 in the I-600; and R154. (RC = 5.727 mS)

(4.4.2) I-600: "D" address circuit's 0.1 capacitor discharges through R220 and R228. (RC = 5.7 mS)

(4.4.3) When the System includes the M-640 Radio Receiver, the .1 capacitor C408 and the .560 Kohm resistor R406 in the M-640 are connected between the D ORN/W address line and circuit ground (VSS). This capacitor is charged to the HI on the D line during intercom operation.

(4.4.3.1) When the System DOES NOT include the M-640, the .1 capacitor C299 and the .560 resistor R299 must be connected between the ORN/W D terminal and the BLK ground terminal on the I-600 Terminal Board. During intercom operation C299 will be charged to the D line HI.

(4.5) When the Ø is addressed by the Originating Station, either C408 or C299 will be discharged through a .560 Kohm resistor (R406 or R299); and then through R228 in the I-600. (In either case, RC = 47.06 mS.)

(4.5.1) The Tot from HI to LO of the "D" address circuit is, for all practical purposes, determined by the RC constant (47.06 mS) of this circuit.

(4.5.2) When the CMOS devices operate at 45% (typical) noise immunity, Tot from HI to LO occurs at .73RC, i.e. 34 mS.

(4.6) Because of component tolerances; variations in CMOS noise immunity; and the potential to which the D line is charged during intercom operation, the time of transition from HI to LO of this line may vary between 13 mS and 75 mS.

(5) D BIT TO NO. 8 — SPURIOUS DECODING:

(5.1) When a Station, No. 9 to No. 14 is addressed, the D address circuit and one or more of the other address circuits (A/B/C) go HI. (See Tables, Figures 3/4, pp 8-9.)

(5.2) When this call is ended (Ø addressed), the D address circuit will remain HI for a period of time after the other address circuit(s) have gone LO. This time may vary between 11 and 64 mS. (Compare the times in para. (4.3.2) with those in para. (4.6) above.)

(5.3) At all Stations, the Receiver/4-Bit Decoder's strobe input pin 1 is HI and when only the D data input pin 2 is HI, the D bit will be decoded and S8 at pin 9 will go HI for a period of 11 to 64 mS.

(5.4) At I-614 MASTER STATION WHOSE ADDRESS IS NO. 8: The HI at S8 Z104-9 is fed through Address Identity Terminal P1-8; that Station's Identity Wire; and D110 to inverter input Z109E-11.

(5.4.1) Station No. 8 will, in effect, become a CALLED STATION for a period of 11 to 64 mS.

(5.4.2) Z109E-10 will go LO and the annunciator-tone generator will be activated, and heard through this Station's speaker for 11 to 64 mS. (See TIMED ANNUNCIATOR-TONE AND INTERCOM ENABLE, Para. (3)-(3.13), pp 25.)

(5.4.2.1) The LO from Z109E-10 will be connected through D122, which will open the bilateral switch Z106D, and result in the Radio program being interrupted for 11 to 64 mS at this Station's speaker.

(5.4.2.2) The encoded 8 will probably not last long enough for Station No. 8 to be intercom-enabled, and the T/L relay will remain in its quiescent LISTEN mode.

(5.5) When the address No. 8 Master Station is called (selectively or by an ALL CALL), the possible generation of the spurious D bit to 8 decoding will not effect the Station's operation, i.e. the annunciator tone will not be heard when an END CALL (Ø) is addressed by the Originating Station.

(5.6) When the System includes eight or more Stations, it is recommended that, when possible, address No. 8 be assigned the Door Speaker.

(5.6.1) The Door Speaker Control does not generate nor will it receive an annunciator tone, and it does not contain the timed intercom enabled circuit. Generating the spurious No. 8 address will not be noticed at the Door Speaker.

(5.6.2) If the System includes between 8 and 13 Master Stations, but not a Door Speaker, suggest that address No. 8 not be used.

(5.7) If System requires an address No. 8 Master Station, the annunciator tone can be eliminated by setting the TONE LEVEL-SET CONTROL R155 on the PC board to minimum. This will also cancel the annunciator tone when the No. 8 Station originates or receives a call.

(5.8) If the System requires a No. 8 Master Station with annunciator tone, and the spurious D to 8 decoding is objectionable, the I-614's circuit may be modified as directed on page 53.

(6) At all I-614's, when all address circuits are LO; inputs to Z108B are LO and Z108B-13 goes HI. This HI is fed to inverter input Z109F-13, and coupled through R113 and C102 to strobe input Z104-1.

(7) The inverter output Z109F-12 goes LO; Q101 is biased off; and the BUSY INDICATOR LIGHT (LED) D123 is turned off. This LO is also fed to input Z107C-8; Z107C-10 goes HI and the encoder lockout LO is removed, and Z105 is now capable of encoding an address.

(8) The HI pulse from Z108B-13 keeps the strobe input Z104-1 HI for a period of time that is determined by R132, C102, and R113.

(8.1) In early production units, i.e. where R132 equals 220 Kohms, RC = (220K + 4.7K) (.47 uF) = 105 mS. Transition at .8RC = 84 mS.

(8.2) In later production units, i.e. where R132 equals 470 Kohms, RC = (470K + 4.7K) (.47 uF) = 223 mS. Transition at .8RC = 178 mS.

(8.3) With the strobe HI, and the data inputs to Z104 LO; Z104 will decode the Ø; outputs S1-S15 will be LO; SØ at pin 11 will be HI; and when strobe voltage has decayed from HI to LO, the outputs will remain latched in this state.

(9) The Originating Station has now returned to its quiescent (intercom standby mode), and can originate or receive an intercom call.

(10) AT CALLED STATION NO. 13: When Z104's S1-S15 outputs are latched LO; Z109E-10 goes HI and Z109B-4 goes LO.

(10.1) When Z109E-10 goes HI, the ground through D122 is removed and Z106D-12(C) goes HI. The bilateral switch is closed and the RADIO and/or LISTEN-IN intercom signals are fed to Z102-2(+), where they are amplified and fed to this Station's speaker.

(10.1) The LO from Z109B-4 turns off Q102, which de-energizes the T/L Relay and it returns to its standby LISTEN mode.

(10.1.1) The LO also opens bilateral switches Z106B and Z106A, intercom signals that may appear on the OUTPUT LINE, and the output of the TALK PREAMPLIFIER Z101 is disconnected from the input Z202-6(−).

(10.2) This Called Station has now been returned to its normal quiescent state, and it can now originate or receive an intercom call.

(11) AT NOT CALLED STATIONS: The Busy INDICATOR LIGHT D123 is turned off; and the encoder lockout at Z107C-10 is removed. See para. (6)-(7) above.

(11.1) During the intercom call Z104's S13 at pin 19 was HI but this was not connected to a Not-Called Station's identity wire and the inverter input Z109E-11 remained LO.

(11.2) All of the Not Called Stations are now in their quiescent (intercom standby mode), and any one of them can originate or receive an intercom call.

(12) AT DOOR SPEAKER: When an END CALL (Ø) is made at the Originating Station, all address circuits go LO in the time frames described above. All data inputs to Z206, and all inputs to NOR gate Z201A go LO, and NOR gate output Z201A goes HI.

(12.1) The HI from R231 is connected to the base of Q202, and is pulsed through R231, C208 and R216 to ground. The voltage at the HI side of R216 is held HI for a period of time that is determined by the charging time of C208, and it will keep the strobe Z206-1 HI (above transition) for approximately 22 mS, and the zero input will be decoded and all outputs S1-S15 will go LO.

(12.2) During the intercom call the Door Speaker's Identity Wire remained LO, its status does not change with the END CALL.

(12.3) If the Door Speaker is the Called Station, and the call is ended, its Identity Wire and point (aa) goes from HI to LO; Z202A and Z202B bilateral switches are opened; and its T/L Relay can not be controlled by CONTROL LINE.

(12.4) The Door Speaker is in its quiescent state, and can receive a call from any Master Station.

CHANGING ADDRESS OF CALLED STATION
(Paragraphs (1.8)-(1.8.3), page 8)

(1) If, when the call is addressed at the originating Station, the wrong keypad switch is activated (pressed-in and released), an undesired Station will be called.

(1.1) When this occurs, the call's address can be corrected, at the originating station, by activating a second keypad switch (i.e. the correct address switch for the desired Station) after the KBM time of the Encoder, which in the Model I-614's is approximately 100 mSeconds.

(2) NOTE: Change of address can only be made at the originating Station. The called and not-

called Stations' Encoders are locked out by the LO at Z107C-10 that became present when the first call was made.

(3) When the first call is made, the annunciator tone is heard, and the Radio audio is turned off at the originating Master Station and at the called (undesired) Master Station. Z106D will be opened at both Stations.

(3.1) When the second (correct) call is made, the annunciator tone will NOT be heard at the originating Station because Z108A-1's output remains LO during call roll-over, and the LO has already been pulsed through C132 to Z109A-1. (See TIMED ANNUNCIATOR-TONE AND INTERCOM-ENABLE, above.)

(3.1.1) The Radio audio remains off at the originating Station.

(3.2) When the second (desired) keypad switch is activated, the annunciator tone will be heard, and the Radio audio turned off at this second called Station.

(3.3) When the second call is addressed, the undesired Station that was originally called will be switched to a not-called Station mode, and the Radio audio will be turned on, i.e. Z106D will be closed.

(4) By observing the KBM time, the two-key roll-over can be carried out as often as desired. With each new call, the annunciator tone will not be heard at the originating Station but will be heard at the latest called Master Station. (Annunciator tone is never heard at the Door Speaker(s).)

(5) All subsequent operations will be the same as described above for the originating, called, not-called, and Door Speaker Stations.

ALL CALL (ADDRESS NO. 15) OPERATION

(1) Any Master Station can originate simultaneous intercom call (ALL CALL) to every other Master Station that is operating in the quiescent (standby) intercom mode.

(2) MASTER STATION IN LISTEN-IN MODE will not operate as a called Station during an ALL CALL. (See MASTER STATION LISTEN-IN OPERATION, below.)

(3) MASTER STATION IN PRIVATE MODE will not operate as a called Station during an ALL CALL. (See MASTER STATION PRIVATE OPERATION, below.)

(4) As supplied from the factory, the I-600 Door Speaker(s) will not receive an ALL CALL.

(5) MODIFYING DOOR SPEAKER PC TO RECEIVE ALL CALL: Can be accomplished in Systems containing 13 or less Model I-614 Master Stations. (Reference: I-600 Schematic Diagram and PC Board Layouts.)

(5.1) Install a silicon switching diode (Type No. 1N914; NuTone Part No. 36617-000): Anode end to Z206-15; and cathode end to PC point (aa).

(5.2) Connect the same type diode in series with the Door Speaker's individual identity wire: Anode end to Door Speaker's individual identity terminal at P201 or P202; and cathode end, through identity wire, to PC point (aa).

(5.3) Connect a 220 Kohm, ¼-watt, carbon film resistor (NuTone Part No. 33082-224) between PC point (aa) and printed circuit board ground (VSS).

(6) AT THE ORIGINATING MASTER STATION: Activate (press-in and release) the ALL CALL (15) keypad switch.

(6.1) Y4 (Z105-4) will be momentarily connected to X4 (Z105-7); Z105 will encode the decimal 15; and all of the 4-Bit Encoder's data output terminals A, B, C, and D will go HI. (See Truth Tables, pages 8 and 9.)

(6.1.1) ALL COLOR-CODED ADDRESS WIRES AND LABELED TERMINALS THROUGHOUT THE SYSTEM GO HI.

(6.2) The BUSY INDICATOR LIGHT D123 will be turned on.

(6.2.1) If the System includes the Model M-640 AM/FM Radio Receiver, the radio audio will be turned off. (Z106D will be opened.)

(6.2.2) The annunciator tone will be heard for 680-990 mSeconds.

(6.2.3) Within the time delay parameter (680-990 mSeconds), the originating Station will be intercom-enabled in the LISTEN mode.

(6.3) When a Master Station originates an ALL CALL, its timing, control, and intercom audio TALK/LISTEN operations are the same as when it originates an individually addressed selective call. (See MASTER STATION TO MASTER STATION SELECTIVE CALL OPERATION, page 22.)

(6.4) When the originating Station comes on in the LISTEN mode, it will receive intercom signals from every called Station. (Called Stations come on in the TALK mode.)

(6.5) When the originating Station's TALK BAR is activated (pushed, and held-in) it will be in the TALK mode; and the called Stations will be switched to the LISTEN mode.

(6.5.1) Intercom signals from the TALK mode originating Station will be heard at every LISTEN mode called Station.

(7) AT THE CALLED MASTER STATIONS: When the ALL CALL (decimal 15) is initiated at the originating Station, all binary address bit terminals A, B, C, and D at every Station in the System go HI.

(7.1) Excepting the originating Station, the binary 15 is decoded by Z104 in every Master Station;

and by Z206 in the Door Speaker Control, and output S15 at these Stations' Receiver/4 Bit Decoders will go HI.

(7.1.1) Unless the Door Speaker PC circuit has been modified as shown in paragraphs (5) through (5.3) above, the HI at S15 (Z206-15) will have no effect on the Door Speaker operation.

(7.1.2) S15 (Z104-15) going HI in Master Stations which are operating in the PRIVATE or LISTEN-IN modes will have no effect on these Stations' operation.

(7.2) The BUSY INDICATOR LIGHT D123 will be turned on at all Master Stations.

(7.2.1) If the System includes the Model M640 AM/FM Radio Receiver, the radio audio will be turned off at the stations receiving the ALL CALL.

(7.2.2) The annunciator tone will be heard for 321-606 mSeconds at the called Stations.

(7.2.3) Within the time delay parameter (321-606 mSeconds), the called Stations will be intercom-enabled in the TALK mode.

(7.2.3.1) The time will probably be different for each one of the called Stations, but in any case they should all be enabled before the originating Station is enabled, and relay switching noise, etc. should be silenced or in any case reduced to an acceptable level.

(7.3) When a Master Station receives an ALL CALL, its operation is the same as that described when receiving an individual Selective call. (See MASTER STATION TO MASTER STATION SELECTIVE CALL OPERATION, page 22.)

(7.4) When in the TALK mode, signals from a called Station will be heard at the originating Station, but not at other called Stations.

(7.4.1) When in the LISTEN mode, signals from the originating Station will be heard at every called Station.

(8) END OF CALL operation, manual or automatic operates the same for an ALL CALL as for an individual selective call.

(9) NO ALL CALL: In some Systems, it may be required that a Master Station be excluded from receiving an ALL CALL. This can be accomplished by removing the switching diode D109 from this Station's PC board.

(9.1) A Master Station so modified, will be capable of originating an ALL CALL even though it can not function as a called Station when an ALL CALL is originated by another Master Station.

SELECTIVE ADDRESS FOR MULTIPLE STATIONS

(1) In some Systems, it may be desired that a group (two or more) Master Stations be assigned the same address number — from 1 to 14.

(1.1) At each Master Station in this group, connect the identity wire to the address identity terminal which is assigned to the group.

(2) When, at some other Master Station, an intercom call is originated and the group is addressed, each Master Station in the group will operate as a called Station.

(2.1) At the called Master Stations in the group:

(2.1.1) The BUSY INDICATOR LIGHT D123 is turned on.

(2.1.2) If the System includes the Model M-640 AM/FM Radio Receiver, the radio audio will be turned off (Z106D is opened).

(2.1.3) The annunciator tone will be heard for 321-606 mSeconds.

(2.1.4) Within the time delay parameter (321-606 mSeconds) the called Stations will be intercom-enabled in the TALK mode.

(2.1.4.1) The time will probably be different for each Station of the group, but in any case they should all be enabled before the originating Station is enabled, and relay switching noise, etc. should be reduced to an acceptable level.

(2.2) Each (called) Master Station of the group will operate the same as a Station receiving an individual selective call. (See MASTER STATION TO MASTER STATION SELECTIVE CALL OPERATION, page 22.)

(3) When the called group Stations are operating in the TALK mode, signals from all of the Stations will be heard at the originating Station which will be in the LISTEN mode.

(4) When the originating Station's TALK BAR is held-in, it will be operating in the TALK mode; and the called group Master Stations will be operating in the LISTEN mode.

(4.1) Intercom signals from the originating Station will be heard at all of the group Master Stations.

(5) The originating Station will operate as described under MASTER STATION TO MASTER STATION SELECTIVE CALL OPERATION, page 22.

(6) All other Master Stations (excepting the originating Master Station and the group Stations) will operate as a not-called Station.

(7) One Station of the group can originate a call to the other station(s) in the group:

(7.1) At the originating Station activate (press-in and release) the keypad switch of the group's address.

(7.2) The address will be encoded by the originating Station's Z105, but because the LO from Z108A-1 is connected to the strobe input of its

decoder Z104, the address will not be decoded; and this Master Station's operations will be the same as those described for any other originating Station.

(8) Each of the group's called Station(s) will receive and decode the binary address; and the Receiver/4-Bit Decoder's "S" output and the Addressed Identity that is assigned the group will go HI.

(8.1) The HI from the Identity Terminal will be connected through the Station's Identity Wire to Z109E-11; Z109E-10 will go LO, and the receiving Station(s) will be intercom-enabled in the TALK mode in the same manner as any other called Station.

(9) When the originating Station is in the LISTEN MODE it will hear intercom signals from all of the other group Station's, which are in the TALK MODE.

(9.1) When the originating Station's TALK BAR is activated, it will be in the TALK mode; and the called Stations will be in the LISTEN mode. Intercom signals from the originating Station will be heard at the group's called Station(s).

MASTER STATION IN PRIVATE MODE

(1) To put a Master Station in PRIVATE mode, press PRIVATE pushbutton in. PRIVATE ON/OFF SWITCH S3 will be latched in ON position.

(1.1) To release PRIVATE SWITCH (return to OFF), press-in and release pushbutton.

(2) When S3 is ON, one side of switch grounds the junction of R117 and D111.

(2.1) When S3 is ON, the other side of switch grounds the junction of R147 and D114; and Z106B-5(C).

(2.1.1) With Z106B-5(C) at ground (LO), the bilateral switch Z106B is latched open, and intercom signals on the System's BLK/W OUTPUT circuit will not be fed to the input of the AUDIO AMPLIFIER Z102-6(−), even if the PRIVATE mode Station is in LISTEN mode.

(3) WHEN PRIVATE MODE MASTER STATION IS CALLED:

(3.1) Z109F-12 goes HI; Q101 is turned on; and BUSY INDICATOR LIGHT D123 is turned on.

(3.2) The Receiver/4-Bit Decoder's Strobe input Z104-1 goes HI; Z107C-10 Encoder Lockout goes LO; and its encoders KBM is LO and an address can not be encoded by Z105.

(3.3) The address is decoded by Z104; the PRIVATE Station's Identity Wire goes HI; Z109E-11 goes HI; and Z109E-10 goes LO.

(3.4) Z106D-12(C) goes LO and the Radio audio is turned off; the annunciator tone generator is activated and the tone is heard for 321-606 mSeconds.

(3.5) At the termination of the called PRIVATE mode Station's timing cycle (321-606 mS), Z109B-4 goes HI.

(3.5.1) In a called Station which is not in the PRIVATE mode, Z109B-4's HI is connected through R117; R144; (and in later production units through R161) to the base of Q102; Q102 is turned on and the TALK/LISTEN RELAY K1 is switched to the TALK position.

(3.5.1.1) The HI through R117 is also connected through D111 to Z106A-13(C), turning the bilateral switch on.

(3.5.1.2) But, as noted in paragraph (2) above, the junction of R117 and D111 is grounded through one side of S3 and the relay K1 will not be energized, but will remain in the LISTEN position. The HI to Z106A-13(C) will be shorted and the bilateral switch will remain open.

(3.5.2) In a called Station which is not in the PRIVATE mode, Z109B-4's HI is also connected through R147 to Z106B-5(C) and the bilateral switch is closed.

(3.5.2.1) But as noted in paragraph (2.1) above, the junction of R147 and Z106B-5(C) is grounded through one side of S3, and so the bilateral switch Z106B is latched open, and signals on the System's BLK/W OUTPUT line will not be fed to the input of the Audio Amplifier at Z102-6(−).

(4) From the foregoing it can be seen that a Master Station which is in the PRIVATE mode can neither send nor receive intercom messages when the call is originated at another Master Station.

(5) If it is noted that a PRIVATE mode Station has been called, i.e. its Radio Audio is turned off and the annunciator tone is heard, the PRIVATE mode Station can join the System as a called Station by releasing its PRIVATE pushbutton, allowing S3 to return to its OFF position.

(5.1) The Station will now act like any called Station with its TALK and LISTEN functions controlled by the originating Station's TALK BAR (S4).

(6) ORIGINATING A CALL AT A PRIVATE MODE STATION:

(6.1) When a call is originated at the PRIVATE mode Master Station, it operates the same as any originating Station, except:

(6.1.1) The HI from Z109C-6, which is normally connected through R121 and D114 to Z106B-5(C), is shorted to ground through one side of S3 (see paragraph (2.1) above) and the bilateral switch Z106B is latched open, and signals on the System's BLK/W OUTPUT line can not be fed to the Audio Amplifier.

(6.1.2) If the originating PRIVATE mode Station's TALK/LISTEN SWITCH S4 is activated (TALK BAR held-in), the HI from Z109C-6 will be connected

through S4A to the system's RED/W CONTROL line and the called Station will be switched to the LISTEN mode.

(6.1.2.1) S4B will connect the HI from Z109C-6 through R156 to the base of Q102; the transistor will be turned on; the TALK/LISTEN RELAY COIL K1 will be energized; and the Station switched to TALK mode.

(6.1.2.2) S4B will also connect the HI through R138 and D120 to Z106A-13(C), closing the bilateral switch.

(6.1.2.3) With the Station in TALK mode, and Z106A closed, intercom signals from the speaker will be amplified by Z101 and Z102, and fed from Z102-8 through C123; K1-6-8 and R108 to the System's BLK/W OUTPUT LINE.

(6.2) With the called Station in the LISTEN mode, intercom signals on the System's BLK/W OUTPUT LINE will be fed to, and amplified by the Station's Audio Amplifier and heard at its speaker.

(6.2.1) When the originating PRIVATE mode Station's TALK BAR is released and its T/L RELAY K1 is in LISTEN position, it will not hear an answer from the called Station, because its bilateral switch Z106B is latched open.

MASTER STATION LISTEN-IN MODE

(1) To switch a Master Station to the LISTEN-IN mode, press LISTEN-IN pushbutton and the LISTEN-IN ON/OFF SWITCH S2 will be latched in the ON position.

(1.1) To release LISTEN-IN SWITCH (return to OFF), press-in and release the pushbutton.

(2) When LISTEN-IN SWITCH S2 is in its OFF (intercom standby) position, a HI (VDD1) is connected through S2A and R139 to Z106D-12(C); the bilateral switch is closed; and Radio audio will be fed to the Audio Amplifier input Z102-2(+).

(2.1) When the LISTEN-IN SWITCH S2 is in its ON position, the HI (VDD1) is not fed to the bilateral switch control; Z106D-12(C) is held LO through R139 and R140; Z106D is latched open, Radio audio is turned off; and Audio Amplifier input Z102-2(+) is audio ground referenced through C116.

(2.1.1) The Z102-2(+) input line is isolated from the TONE LEVEL SET CONTROL R155 by R151. R151 is 2.2 Mohm in original production units; and is 3.3 Mohm in later production units.

(3) When S2A is in ON position, the HI (VDD1) is connected through R156 to the base of Q102; the transistor is turned on; T/L RELAY K1's coil is energized and the LISTEN-IN Station is in the TALK mode.

(3.1) The HI through S2A is also connected through R138 and D120 to Z106A-13(C). TALK intercom signals from the speaker will be pre-amplified through Z101; fed from Z101-6, through R118, C105 and closed bilateral switch Z106A to the Audio Amplifier input Z102-6(−).

(3.1.1) The TALK intercom signals will be amplified through Z102; fed from Z102-8, through C123, K1-6-8, and R108 to the OUTPUT LINE's PC path.

(4) When S2B is in the ON position, TALK intercom signals on the LISTEN-IN Station's OUTPUT LINE PC path will be connected to the LISTEN-IN AUDIO PC path, and then through C107 and R111 to the ORN/W D address line.

(4.1) The LISTEN-IN audio signals are superimposed on the D address line (along with Radio audio signals), whether the line is HI or LO.

(4.2) The LISTEN-IN audio signals are isolated from ground by R131 and C109 in every Master Unit; and by R228 in the Door Speaker Control.

(5) At every Master Station the LISTEN-IN intercom signals will be fed from the ORN/W D address terminal, through R160, to one side of the RADIO ON/OFF SWITCH S1.

(5.1) If a Master Station's S1 is in OFF position (open), the LISTEN-IN intercom signals will not be heard at this Station regardless of its operating mode.

(6) When S1 is closed, the LISTEN-IN intercom signals (along with Radio audio) will be fed through C110 to the RADIO VOLUME CONTROL R154.

(6.1) From the VOLUME CONTROL TAP, these signals will be fed to the bilateral switch at Z106D-11.

(6.2) If a Master Station is operating: as an originating Station; as a called Station; or as a LISTEN-IN Station, the bilateral switch is open, and the signals will float at Z106D-11.

(7) If a Master Station is operating in the quiescent (standby) intercom mode; or if it is acting in the PRIVATE mode, Z106D will be closed, and the LISTEN-IN intercom signals (along with the Radio audio) will be fed from Z106D-10 to the input of the Audio Amplifier Z102-2(+).

(7.1) The T/L RELAY K1, in stations operating in either one of these modes, will be in LISTEN mode. Audio Signals to Z102 will be amplified and fed from Z102-8, through C123; K1-6-7; and K1-10-9 to one side of its speaker. The other side of the speaker is connected through K1-12-13 to ground.

(8) NOTE: R111 was originally 2.7 Kohms, but in later production units its value has been changed to 100 ohms in order to give the LISTEN-IN audio a head-start in over-riding the Radio audio level.

(9) Do not originate a call from a Master Station that is operating in the LISTEN-IN position.

(9.1) Press-in and release LISTEN-IN pushbutton — S2A and S2B will return to OFF POSITION.

(9.2) The Master Station will be returned to its regular intercom quiescent (standby) mode.

(9.3) Proceed with origination of call in regular manner.

(9.4) When call is completed, Station can be returned to LISTEN-IN mode by pressing in LISTEN-IN pushbutton — S2A and S2B will again be in the ON position.

(10) A Station which is operating in a LISTEN-IN mode should not be called by another Master Station.

(10.1) The LISTEN-IN Station will not receive intercom signals from the System's BLK/W OUTPUT LINE: the line is open at S2B which is in ON position; and T/L RELAY K1 is latched in the TALK position.

(10.2) Signals from the LISTEN-IN Station are not connected to the System's BLK/W OUTPUT LINE, but instead are fed through the ON position of S2B to the System's ORN/W D address line.

(11) If a LISTEN-IN Station is called by another Master Station, its annunciator tone generator will be activated for 321-606 mSeconds.

(11.1) The tone will be fed from the TONE LEVEL SET CONTROL R155's tap, through R151 to the input Z102-2(+) along with the LISTEN-IN signals that are fed to the other input Z102-6(−) of the Audio Amplifier.

(11.2) Both signals will be amplified by Z102, and fed from Z102-8 to the ORN/W D address line, and thence to the other Master Stations which are in an intercom quiescent (standby) mode or in PRIVATE mode. (See paragraphs (3.1.1) through (7) above.)

(11.3) Note the annunciator tone will be heard at these other Master Stations along with (but overriding) the Radio audio.

(12) When the annunciator tone is heard with the Radio signals, the listener should know that this indicates that a LISTEN-IN mode Master Station is being called.

EXTENSION SPEAKER WITH I-614

(1) NuTone Model IW-2, 22 ga. twisted-pair cable (maximum of 50 feet) may be used to connect an extension speaker to the I-614 Master Station.

(2) Connect the wires of the IW-2 cable between the two terminals on the I-614 speaker and the two terminals on the extension speaker.

(3) Any of NuTone's present production; built-in or surface mount; inside or outside; 8-inch speakers may be used. Such as:

Model SS-48 inside, built-in speaker.

Model IS-78 inside, metal-frame, built-in speaker.

Model ISA-77 outside, surface mount, speaker.

Model IS-79 patio, metal-frame, built-in speaker.

(4) When properly connected, the extension speaker operates in the same mode as the I-614 speaker. All incoming audio signals will be amplified by Z102 and fed to both speakers. When the Station is in intercom TALK mode, signals from both speakers will be amplified by Z101/Z102 and fed to the OUTPUT line.

(5) To prevent extraneous noise pick-up, the twist in the IW-2 cable must be maintained between the Master Station speaker and the extension speaker.

(6) If desired, an on/off switch and/or a level-set control for the extension speaker may be installed in the line between the Master Station speaker and the extension speaker.

(6.1) If the level-set control is used to attenuate the audio to the extension speaker, it will also attenuate the signals from the speaker when it is used as a transmitting transducer (microphone).

MAXIMUM B+ LOAD CURRENT IS REQUIRED WHEN AN "ALL-CALL" IS MADE.

TO ASSURE OPERATION OF THE TALK/LISTEN RELAY K1 IN EVERY CALLED STATION DURING AN "ALL-CALL," THE VOLTAGE, AT EVERY MODEL I-614 MASTER STATION'S ORN B+ TERMINAL, MUST BE A MINIMUM OF 9VDC.

THE I-600 CENTRAL POWER SUPPLY B+ IS NORMALLY A REGULATED +15VDC. A REDUCED B+ AT THE MASTER STATION(S) IS CAUSED BY THE NUMBER OF I-614's ON AN IW-8 RUN, AND THE IR LINE DROP OF THE ORN B+ AND BLK GROUND WIRES. (SEE "SYSTEM REPRESENTATIVE INSTALLATION WIRING DIAGRAM," PAGES 55/56.)

TO REDUCE POSSIBLE CROSSTALK, WHICH MAY RESULT FROM AUDIO COUPLING BETWEEN WIRES OF THE SYSTEM'S IW-8 CABLE, THE TOTAL LENGTH OF THE IW-8 CABLE—BETWEEN THE I-600 CENTRAL POWER SUPPLY/DOOR SPEAKER CONTROL AND ALL OF THE I-614 MASTER STATIONS IN THE SYSTEM — MUST NOT EXCEED 1,000 FEET.

MODEL M-640 AM/FM RECEIVER

AUDIO AMPLIFIER MODULE

(1) ORIGINAL PRODUCTION UNITS

(1.1) PC Board, Part No. 37740-(suffix)

(1.2) Complete Assembly, Part No. 42524-000

(2) LATER PRODUCTION UNITS

(2.1) PC Board, Part No. 37749-(suffix)

(2.2) Complete Assembly, Part No. 42565-000

(3) The original and later production units are interchangeable and either may be used with the original or later production unit of the AM/FM Tuner Module.

(4) The Amplifier Module includes the System's inter-connecting wiring terminals and the AM/FM antenna lead-in terminals.

(4.1) The antenna is connected to the Tuner Module via coax lead from ⓔ and ⓓ on the Amplifier Module.

(5) Originally, it was recommended that the M-640 be connected to the System, via four (4) color-coded wires of an IW-8 cable, at the I-600 Terminal Board (as shown in the schematic diagrams); or to one of the System's Model I-650 Wiring Terminal Blocks.

(5.1) As a third (but not preferred method) the wires may be connected to the System at the color-coded terminals in an I-614 Master Station.

(5.2) The ORN B+ terminals are to be connected, via the ORN wire, to the Regulated +15VDC (B+ supply) at the ORN terminal on the I-600 Terminal Board, or to the ORN terminal in one of the System's Model I-650 Terminal Blocks.

(5.3) The ORN/W Radio (preamplified audio output) terminal is to be connected, via the ORN/W wire, to the ORN/W "D" Address terminal on the I-600 Terminal Board, or to the ORN/W terminal in the I-650.

(5.4) The BLK circuit ground (B−) terminal is to be connected, via the BLK wire, to the System's circuit ground at the BLK ground (VSS) terminal on the I-600 Terminal Board, or to the BLK terminal in the I-650 Wiring Terminal Block.

(5.5) The original Installation Instructions directed that the BLK/W RADIO (audio) ground terminal be connected, via the BLK/W wire to the BLK circuit ground (VSS) terminal on the I-600 Terminal Board, or to the BLK terminal in the I-650 Wiring Terminal Block.

(5.5.1) Subsequent laboratory test and field operating reports have determined that the BLK/W wire, between the M-640's Amplifier Module and the I-600 Terminal Board; or to the I-650, is NOT required.

(5.5.2) Later Installation Instructions direct that the ORN; ORN/W; and BLK wires be connected in accordance with paragraphs (5.2), (5.3) and (5.4) above.

(6) RANDOM VOLTAGE PROTECTION:

(6.1) The ORN B+ line and the ORN/W Radio Audio ("D" Address) line are protected from lightning strikes, static discharges, and other random voltage spikes by the varistors RV101 and RV107 in the Model I-614 Master Stations; and by RV202 and RV204 on the I-600 Terminal Board.

(6.1.1) See paragraphs (9) through (9.2), page 13; and paragraphs (12) through (12.2), page 21.

(6.2) SINCE THESE RANDOM VOLTAGES ARE REFERENCED AGAINST EARTH GROUND, THE CIRCUITS BLK GROUND (VSS) TERMINAL ON THE I-600'S TERMINAL BOARD MUST BE CONNECTED TO EARTH GROUND. (See paragraphs (6) and (6.1), page 3; and the I-600 Schematic Diagram.)

(7) OPERATING POWER:

(7.1) The Regulated +15VDC B+ from the I-600 is fed through the ORN B+ terminal and the RADIO ON/OFF SWITCH S401. (S401 is operated: press-in for ON; and press-in and release for OFF.)

(7.2) When S401 is ON, the 15VDC is fed through the RADIO ON INDICATOR LIGHT D401 (LED) and the voltage dropping resistor R404 to ground.

(7.3) The 15VDC is also fed to the high (+) side of filter capacitor C407 and from there, as VCC to the Audio Amplifier IC at Z401-14.

(7.4) In original production units: From the high-side of C407, the voltage is fed through D402 and R402 to ⓐⓐ, where it is filtered by C410. C401 is an RF bypass.

(7.4.1) In later production units: From the high-side of C407, the voltage is fed through R402 to ⓐⓐ, where it is filtered by C410. C401 is an RF bypass.

(7.5) The potential at ⓐⓐ is approximately +14VDC.

(7.5.1) From ⓐⓐ, the 14Vdc is fed to the PROGRAM SELECTOR SWITCH S402 terminals 5 and 6.

(7.5.2) In original production units: The 14Vdc at ⓐⓐ supplies positive collector voltage to Q402 and through R408 to Q401; and Class A bias through R410 to Q401.

(7.5.2.1) In later production units: The +14VDC at ⓐⓐ is fed through R417 and filtered by C418; then supplies positive collector voltage to Q402 and through R408 to Q401; and Class A bias throught R410 to Q401.

(8) PROGRAM SELECTOR SWITCH S402:

(8.1) AM POSITION: The +14VDC is connected from S402-6, through S402-7 and P401-2, to J1-2 on the AM/FM Tuner Module. The +14VDC is floating at S402-5.

(8.1.1) The AM audio signal is connected from J1-1 and P401-1, through S402-1 and S402-2, to R416.

(8.2) PH (PHONO) POSITION: The +14VDC is floating at S402-6 and S402-5.

(8.2.1) The phonograph audio signal is fed through pin-jack J401; matching network R414/C412; S402-3 and S402-2 to R416.

(8.2.1) The phono input matches the ceramic cartridge that is used in NuTone's Model RC-91-1 Fold-Away Record Changer.

(8.3) TP (TAPE) POSITION: The +14VDC is floating at S402-6 and S402-5.

(8.3.1) The tape player's audio signal is fed through pin-jack J402; matching network R413/C411; S402-8 and S402-9 to R416.

(8.3.1.1) The tape input matches the output of NuTone's Model TP-96 Fold-Away 8-Track Tape Player.

(8.4) FM POSITION: The +14VDC is connected from S402-5, through S402-4 and P401-3, to J1-3 on the AM/FM Tuner Module. The +14VDC is floating at S402-6.

(8.4.1) The FM audio signal is connected from J1-4 and P401-4, through S402-10 and S402-9, to R416.

(9) The selected audio signal is fed from R416 to the TONE CONTROL NETWORK C403/R412.

(9.1) The level balance between the bass audio signals and the treble audio signals is determined by the setting of the TONE CONTROL RHEOSTAT R412.

(10) In original production units the audio signals from R410 are also fed through tapped portion of VOLUME CONTROL R411 and C402 to Z401-6(−) input of the Audio Amplifier IC.

(11) In both original and later production units, the audio from R416 is coupled through C405 to the base of audio voltage amplifier Q401.

(12) The audio signals are amplified by Q401 and direct coupled to the base of Q402. Q401's gain is approximately 5.

(13) In later production units the amplified audio output of Q401 is also coupled through C416; VOLUME CONTROL R411; and C402 to Z401-6(−) input of the Audio Amplifier IC.

(14) The TONE CONTROL R412 controls the tone balance to both the Audio Amplifier IC (and receiver's speaker); and to the ORN/W line.

(14.1) When TONE CONTROL R412 is set to 100 Kohm, a 100 Hz. audio signal and 10 KHz. audio signal will be at essentially the same level (within 0.4 db).

(14.2) When R412 is set to zero ohms, the 100 Hz. tone will be essentially equal to its value at the 100 Kohm setting (within 0.5 db).

(14.2.1) When R412 is set to zero ohms, the 10 KHz. tone level will be down approximately 18 db from that of the 100 Hz. tone.

(15) The VOLUME CONTROL R411 controls only the audio level of the receiver's speaker.

(16) The Audio Amplifier Z401 (National Semiconductor LM380N; NuTone Part No. 36641-000) is the same as that used in the I-600 and I-614. See paragraphs (12) through (12.4), page 14.

(17) The additional gain of Q401 to Z401 is used in later production units in order to permit greater volume at the receiver's own speaker.

(18) (See paragraph 12 above.) The audio signal is amplified through the emitter follower Q402 and at the junction of R406 and R407 has a gain of approximately 0.7.

(18.1) The audio signal is coupled through C408 in original production units; and through C408 and R418 in later production units, to the ORN/W RADIO (audio) terminal.

(18.2) From the ORN/W terminal the radio audio signals are fed through the ORN/W ("D" Address) wire to the I-614 Master Station.

(18.2.1) Each Master Station adjusts its own RADIO VOLUME LEVEL at R154, but the TONE BALANCE is determined by the setting of R412 in the receiver.

(19) RECEIVER INSTALLATION NOTE: (See I-600 TERMINAL BOARD INSTALLATION NOTE, page 16.)

(19.1) When the M-640 AM/FM Radio Receiver is NOT included in the System. A 0.1 microfarad capacitor and 560 ohm resistor should be connected in series between the ORN/W and BLK terminals on the I-600 Terminal Board.

(19.2) When the resistor and capacitor are installed and the AM/FM Receiver is not included in the System, the ORN/W "D" address line's impedance to ground is approximately 1.7 Kohms at 1 KHz.

(19.3) When the M-640 AM/FM Radio Receiver is included in the System, C408 and R406 on the Amplifier Module keeps the ORN/W line at approximately 1.7 Kohms at 1 KHz.

(19.4) Keeping the ORN/W line at 1.7 Kohms at 1 KHz. will help prevent crosstalk.

(19.5) Regardless of whether the resistor and capacitor are used between the ORN/W and BLK terminals, the ORN/W "D" Address Line's d-c resistance to ground will be approximately 470 Kohm (R228 in I-600).

AM/FM TUNER MODULE
ORIGINAL PRODUCTION UNITS

(1) ORIGINAL PRODUCTION UNITS

(1.1) PC Board, Part No. 37655-(suffix)

(1.2) Complete Assembly, Part No. 41881-000

(2) Different features of the later production units of the AM/FM Tuner Module will be shown below, but it should be noted here that the original and later production units of the AM/FM Tuner Modules are interchangeable and each may be used with either the original or later production unit Amplifier Modules.

(3) When the PROGRAM SELECTOR SWITCH S402, on the Amplifier Module, is in the FM position, the regulated 14VDC is connected through P401/J1-3 to the FM Tuner Section. The AM Section is not powered.

(3.1) The FM recovered audio is fed from IC301-6; de-emphasized by R312 and C319; and connected through J1/P401-4 to S402-10.

(4) When S402 is in the AM position, the regulated +14Vdc is fed through P401/J1-2 to the AM Tuner Section. The FM Section is not powered.

(5) The AM recovered audio is fed from IC302-9, through R326 and J1/P401-1 to S402-1. C341 provides high-frequency roll-off.

(6) When S402 is in the PH (phono) or TP (tape) position, neither the AM nor FM section is powered.

(7) When measuring tuner operating voltage at P401-2 (AM) or at P401-3 (FM) make certain that these terminals are not shorted to any other terminal nor to ground.

(8) FM TUNER:

(8.1) The FM signal is fed from the antenna, through the coaxial lead-in to the primary of antenna transformer L301. The transformer is center-tapped to FM RF ground through C301.

(8.2) The FM RF amplifier Q301 (Dual-gate MOSFET) is operated tuned-gate, tuned-drain — resulting in high-gain at low-noise.

(8.3) The FM RF signal is fed through a section of the antenna transformer secondary through C304 to G1 of Q301. The gate tuned circuit is varied by tuning one section of the ganged tuning Capacitor C303A. C303B is the high-frequency trimmer. Tuning slug of L301 is tuned for low-frequency padding.

(8.4) The MOSFET drain is loaded by the tuned RF tank circuit. The tank's resonant frequency is varied by C303F. C303E is high-frequency trimmer and L302 is the low-frequency padder.

(8.5) The output of the tank circuit is coupled through C327 to the base of mixer Q302.

(8.6) The oscillator frequency should be 10.7 MHz. (the IF frequency) higher than that of the FM RF carrier signal to which the receiver is tuned.

(8.7) The output of the oscillator is coupled through C327 to the base of mixer Q302.

(8.8) The mixer Q302 beats the RF and oscillator signals and is loaded by T301A which should be tuned to the 10.7 MHz. IF frequency.

(8.8) For additional selectivity, the output of T301A is coupled through C314 to the 10.7 MHz. tuned T301B.

(8.10) The output of T301B is coupled from the high-side of C315 to the Ceramic Filter CF301.

(8.9) CF301 is rated at 10.7 MHz. with a 3 db bandwidth of 200-280 KHz. — more than sufficient for the FM broadcast band. The filter has a very high rejection of all other RF frequencies, eliminating the need of additional IF transformers for high-selectivity.

(8.11) The output of CF301 is fed to terminal 1 of IC301.

(8.12) IC301 is a monolithic integrated circuit that provides all the functions of a comprehensive FM IF system, including 3-stage FM IF amplifier/limiter with level detection and an audio amplifier that features use of a noise squelch circuit.

(8.12.1) A complete explanation of this device (RCA CA3089E) is available in the linear integrated circuit technical literature that is published by the manufacturer.

(8.13) The quadrature detector is tuned by the outboard coil L304.

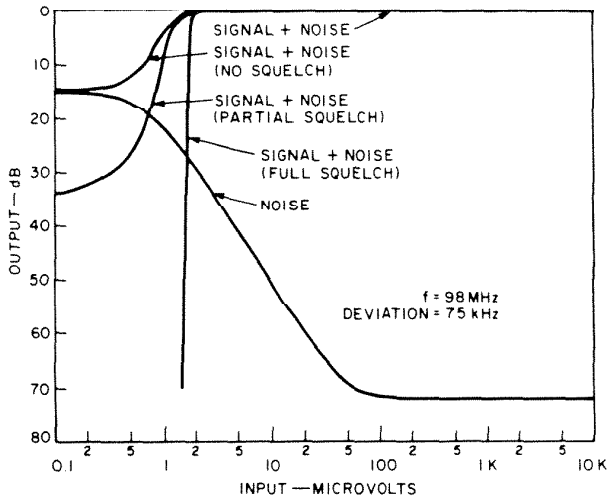
(9) FM SQUELCH CONTROL R315:

(9.1) The Receiver is supplied, from the factory, with SQUELCH CONTROL R315 set at maximum position, i.e. with full squelch.

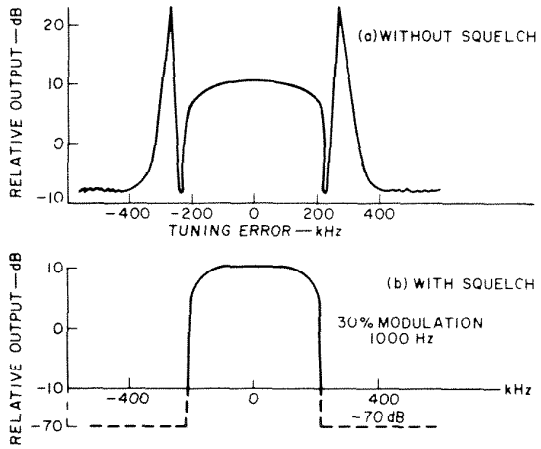
(9.2) When sufficient (normally excess of 5 microvolts) FM broadcast band RF signal is fed to the input of the FM tuner, it will operate with full limiting and the setting of R315 will not effect the quantity nor quality of the recovered audio signal and the signal-to-noise ratio will be in the order of 45 db. As the input increases, the signal-to-noise ratio will rise to the order of 70 db.

(9.3) When there is sufficient RF signal and the squelch can be operated at maximum, the sideband response that is characteristic of limiter-discriminator FM operation will be eliminated. The receiver will be quiet when tuned between stations, and the tuning is as easy and unambiguous as in an AM receiver — without resorting to AFC. This eliminates AFC pull from a strong station when attempting to tune to a weak station.

(9.3.1) The FM oscillator in this system has been designed with quality components and with the use of the regulated voltage supply, should be practically free of drift under normal operating conditions, and AFC is not required.



S+N and N for no squelch, partial squelch, and full squelch, for signal input to a tuner using the CA3089.



Typical tuning characteristic (a) without squelch and (b) with squelch, showing the suppression of the annoying side responses characteristic of limiter-discriminator receivers.

FIGURE 11

(9.4) When the RF input is below 5 microvolts, due to: distance from transmitter (fringe area); poor receiving antenna; shielded RF area; etc., there may not be sufficient signal to drive the set to limiting, and it will require that the squelch control be set to a lower point.

(9.4.1) This may improve listening satisfaction, but conversely, the receiver may be operating at a point where the signal-to-noise ratio has deteriorated and the recovered audio is not acceptable.

(9.5) The magnitude of the squelch control voltage depends only on the signal-to-noise ratio at the tuner input and is essentially independent of the front-end gain because the quadrature signal is fully limited.

(9.6) Adjustment of the SQUELCH CONTROL R315 primarily changes the degree of noise suppression rather than the threshold. Control R315 is generally operated at maximum value, i.e. full clockwise as viewed from the FM side of the AM/FM Tuner Module.

(9.7) *IN THE FIELD ADJUSTMENT OF THE* SQUELCH CONTROL R315: (See paragraphs (12.3) through (12.4.3.1) below.)

(9.7.1) Set the Receiver's VOLUME CONTROL R411 and the TONE CONTROL R412 for normal operation.

(9.7.2) Set SQUELCH CONTROL R315 TO MINIMUM, i.e. no squelch.

(9.7.3) Tune the Receiver to weakest FM station that the homeowner would normally be expected to receive.

(9.7.4) If the weak station's reception is acceptable, advance the SQUELCH CONTROL R315 until it interferes with reception of the station; then back the control until reception is again acceptable.

(9.7.5) When in normal operation, the FM tuner is properly aligned and the received signal is too weak to permit full squelch operation, if possible, the RF signal input to the receiver should be increased.

(9.7.5.1) This may be accomplished by changing the position of the inside antenna that is supplied with the Receiver; installation of an outside antenna, and if required a directional antenna with an antenna rotor. In some cases, increasing the height of existing antenna will increase input sufficiently.

(9.7.6) REMEMBER, WITH A PROPERLY ALIGNED FM TUNER, SUB-PAR OPERATION OF THE SQUELCH CIRCUIT IS GENERALLY DUE TO INSUFFICIENT FM SIGNAL INPUT.

(10) AM TUNER:

(10.1) The AM signal is fed from the center-tap of the antenna transformer L301's primary, through C345 to the tuned AM RF circuit.

(10.2) The RF circuit is tuned by gang capacitor C303D. C303C is high-frequency trimmer and coupling of L309 is adjusted for low-frequency padding.

(10.3) Delayed AGC is supplied from IC302-15 through R329 and D301 to ground.

(10.3.1) The IC302 includes an audio preamplifier on-board, but in this application its output IC302-15 supplies delayed AGC voltage to the RF tuning circuit.

(10.3.2) With an increase in received signal, the delayed AGC voltage at IC302-15 increases in a positive direction, which increases the current through D301 which will tend to swamp the AM signal.

(10.4) The output of the tuned RF circuit is fed through C333 to IC302-2.

(10.5) IC302 is a monolithic integrated circuit (RCA CA3088E) which provides: AM converter; two (2) stages of IF amplifiers; and detector. In

this application it also supplies: internal AGC to the first on-board IF stage; and delayed AGC to the RF tuned circuit.

(10.5.1) Complete specifications of the IC's operation can be found in the RCA LINEAR INTEGRATED CIRCUITS MANUAL NO. SSD-201C (and subsequent publications).

(10.6) IC302-2 is the base of the oscillator/convertor stage on the IC chip.

(10.7) The oscillator tank is tuned by varying C303G. C303H is the oscillator trimmer. L310, the oscillator collector coupling, is adjusted for low-frequency padding.

(10.8) The converter output IC302-3 is fed to, and tuned by, the 455 KHz. IF transformer T302. The output of T302 is fed through the ceramic filter CF302, to the input of the first IF amplifier stage at IC302-4.

(10.9) The output of the first IF amplifier stage is fed from Z302-6 through the ceramic filter CF303 to the input of the second IF amplifier at IC302-8.

(10.10) CF302 and CF303 are ceramic filters, whose center frequency is 455 KHz. $\pm$ 2 KHz. with a 3 db bandwidth of 10 KHz. $\pm$ 3 KHz., whose frequency stability is within 0.4% from $-10°C$ to $+80°C$.

(10.10.1) These ceramic filters provide improved selectivity while requiring small space, with the elimination of the need for additional IF transformers.

(10.11) The internal AGC voltage which is derived from the on-board detector, varies in amplitude with changes in the received RF signal, and is filtered by C337 at IC302-11.

(10.11.1) The AGC voltage is positive at IC302-11, i.e. at the high-side (+) of C337.

(10.12) As the AGC voltage increases, it is inverted on-board and fed to the base of the first IF amplifier — increasing its bias and decreasing its output.

(10.13) The AGC voltage is also fed to another on-board stage, whose "Turn-on" is delayed until the RF signal input to the antenna reaches 100 — 200 microvolts. When "Turned-on" this delayed AGC is fed from IC302-13 to the input of an on-board amplifier at IC302-14.

(10.13.1) This delayed AGC is amplified and fed from IC302-15 to the RF AGC diode D301, resulting in the swamping action noted in paragraph (10.3.2) above.

(11) RANDOM VOLTAGE PROTECTION: The neon lamp VR301 protects the AM and FM front ends from static charges and nearby lightning strikes. It will not protect the set from a direct lightning strike.

(12) ALIGNMENT:

(12.1) The Master Unit is shipped from the factory with the AM/FM tuner completely aligned and the FM SQUELCH CONTROL R315 set at maximum, i.e. fully squelched.

(12.2) Alignment should be checked, and if necessary, realignment attempted by qualified personnel ONLY WHEN ABSOLUTELY NECESSARY.

(12.2.1) The procedure shown for ORIGINAL PRODUCTION UNITS alignment chart is recommended for "In shop" alignment.

(12.3) The surge impedance (Zo) of different antennae and their associated transmission lines may vary.

(12.3.1) The antenna transformer L301 must be relatively broad-band to allow for the variations of Zo, and when the FM is aligned with the 50 ohm dummy antenna according to the instructions in the alignment chart, it may not exactly match the system antenna to the FM RF input.

(12.4) If FM signal appears weak when checking the squelch circuit as described in paragraphs (9.7) through (9.7.6) above, it may be possible to increase the input to the RF amplifier Q301.

(12.4.1) Tune the Receiver to an FM station.

(12.4.2) Using a high-impedance-input volt-meter, measure the voltage at IC301-13.

(12.4.2.1) Pin 13 of the IC supplies a voltage which may be used to drive a tuning meter. Although a tuning meter is not used in this circuit, the voltage at pin 13 will increase with an increase of signal input at Q301.

(12.4.3) While measuring the voltage at pin 13, adjust the tuning slug of L301 for maximum reading on the meter.

(12.4.3.1) Only very slight adjustment should be required. If tuning seems to be too far off, realign "In shop" according to the alignment chart

SEE ORIGINAL PRODUCTION UNIT'S ALIGNMENT CHART, PAGE 46/47.

AM/FM TUNER MODULE
LATER PRODUCTION UNITS

(1) LATER PRODUCTION UNITS:

(1.1) PC Board, Part No. 37751-(suffix)

(1.2) Complete Assembly, Part No. 42567-000

(2) These later production units are direct replacement for the original production units of the AM/FM Tuner Module in the Model M-640. These later production units may be used with either the original or later production units of the M-640's Amplifier Module.

(3) When the PROGRAM SELECTOR SWITCH S402, on the Amplifier Module, is in the FM position, the regulated 14Vdc is connected from S402-4, through P401/J1-3 to the FM Tuner Section. The AM Tuner Section is not powered.

(3.1) The FM recovered audio is fed from IC301-6; de-emphasized by R318 and C321; and fed through J1/P401-4 to S402-10.

(4) When S402 is in the AM position, the regulated +14Vdc is fed from S402-7, through P401/J1-2 to the AM Tuner Section. The FM Tuner Section is not powered.

(4.1) The AM audio is preamplified on-board the chip and fed from IC302-15; through J1/P401-1 to S402-1.

(5) When S402 is in the PH (phono) or TP (tape) position, neither the AM nor FM Sections are powered.

(6) When measuring operating voltages, at J1-2 for AM, or at J1-3 for FM, make certain that these terminals are not shorted to other terminals nor to ground. If shorted, the Voltage Regulator Z205, in the Model I-600 Central Power Supply and Door Speaker Control, could be damaged.

(7) Use the same care when measuring signal levels at J1-2 (AM) or J1-4 (FM) during alignment procedure.

(8) FM TUNER:

(8.1) The FM signal is fed from the antenna, through the coaxial lead-in to the primary of the antenna transformer T301.

(8.1.1) The transformer is center-tapped to FM RF ground through C301, and at FM frequencies (88-108 MHz.), the transformer T301, when properly adjusted, acts as a balanced input, matching the impedance (Zo) of the antenna lead-in.

(8.2) The FM RF amplifier Q301 (Dual-gate MOSFET) is operated tuned-gate, tuned drain — resulting in a high-gain, low-noise stage.

(8.3) The FM RF signal is fed from a tapped section of the FM antenna transformer secondary, through C304 to G1 of Q301. The gate tuned circuit is varied, between 88-108 MHz., by tuning section C303A of the ganged tuning capacitor.

(8.3.1) C303B is the high-frequency trimmer, and tuning slug of T301 is adjusted for transformer coupling and low-frequency padding.

(8.4) The FM RF signal is amplified through Q301 and loaded by the drain's RF tank circuit. The tank's resonant frequency is adjusted between 88 and 108 MHz. by adjusting section C303E of the ganged tuning capacitor. C303F is the high-frequency trimmer.

(8.4.1) The RF transformer T305 supplies inductance for the tank circuit and it is tuned for coupling and low-frequency padding by adjusting its tuning slug.

(8.4.2) The ferrite bead, L302 on Q301's drain lead help to suppress parasitic signals.

(8.5) The tuned RF signal is coupled by the secondary of T305, through C356, to the base of the FM mixer Q302.

(8.6) Q303 and its associated circuit is the FM local oscillator, whose frequency should be 10.7 MHz. (the FM IF frequency) higher than that of the FM RF carrier signal to which the FM RF stage is tuned.

(8.6.1) The oscillator frequency is adjusted by tuning section C303I of the ganged tuning capacitor.

(8.6.2) C330 is adjusted for high-frequency trimming, and the oscillator coil L309's slug is adjusted for low frequency padding.

(8.6.3) The oscillator output is coupled through C331 to the base of the FM Mixer Q302.

(8.7) The mixer Q302 beats the FM RF signal and the local oscillator signal, and its collector is loaded by the 10.7 MHz. IF tank circuit T301A.

(8.8) Q302's output is coupled through C315 to the tuned (10.7 MHz.) circuit T301B and fed to the input of the ceramic filter CF301-1.

(8.9) The ceramic filter CF301 is rated at 10.7 MHz. with a 3 db bandwidth of 200-280 KHz, which is more than sufficient for the FM broadcast band. The filter has a very high rejection of all other RF frequencies, eliminating the need of additional IF transformers for high-selectivity.

(8.10) The output of the ceramic filter CF301-3 is connected to the input pins 1 and 2 of the first (of three) differential IF amplifier/limiters on-board the FM integrated circuit IC301.

(8.11) IC301 is a monolithic integrated circuit that provides all the functions of a comprehensive FM IF system, including 3-stage FM IF amplifier/limiter with level detection; a delayed AGC control voltage (pin 15); an audio amplifier and noise squelch circuit; and when desired an FM tuning voltage (pin 13).

(8.11.1) A complete explanation of this device (RCA Type CA3089E) is available in the linear integrated circuit technical literature that is published by the manufacturer.

(8.12) Pin 3 is DC Feedback from output of the 3rd IF amplifier/limiter.

(8.13) The delayed AGC voltage at pin 15 is constant until the input to the chip is high enough so that the first IF stage approaches limiting.

(8.13.1) When the input to the RF stage Q301 increases to where the first IF stage on the chip is limiting, the AGC voltage to G2 of Q301 changes in a negative direction, decreasing the forward bias on G2, which reduces Q301's output.

(8.13.2) Until the signal voltage to the chip reaches this threshold (approximately 100 mV), no AGC action occurs. The on-board level-set and limiting in conjunction with the AGC will maintain a minimum of 35 db a-m rejection.

(8.14) The quadrature detector is tuned by adjusting the outboard coil L304.

(9) FM SQUELCH CONTROL R315:

(9.1) The Receiver is supplied, from the factory, with the SQUELCH CONTROL R315 set at maximum position, i.e. with full squelch.

(9.2) When sufficient (normally excess of 5 microvolts) FM broadcast band RF signal is fed to the input of the FM tuner, it will operate with full limiting and the setting of R315 will not effect the quantity nor quality of the recovered audio signal, and the signal-to-noise ratio will be in the order of 45 db. As the input increases, the signal-to-noise ratio will rise to the order of 70 db.

(9.3) When there is sufficient RF signal and the squelch can be operated at maximum, the sideband response that is characteristic of limiter-discriminator FM operation will be eliminated. The receiver will be quiet when tuned between stations, and the tuning is as easy and unambiguous as in an AM receiver, and this is without resorting to AFC. This eliminates AFC pull from a strong station when attempting to tune to a weak station.

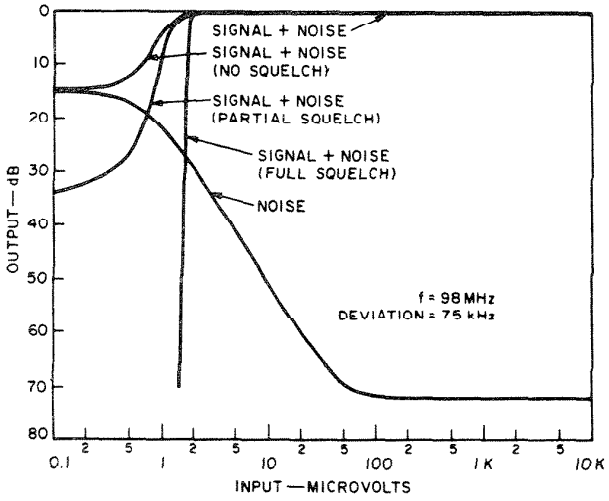
(9.3.1) The FM oscillator in this system has been designed with quality components and with the use of the regulated voltage supply, should be practically free of drift under normal operating conditions, and AFC is not required.

(9.3.2) Since AFC is not required, the on-board AFC transistors' collectors are connected through pin 7 to the quadrature reference at pin 10. This increases stability and will assist in eliminating any distortion that may result if the AFC collectors are allowed to float.

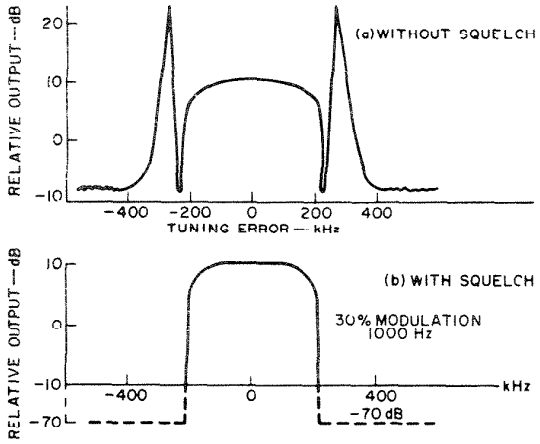
(9.4) When the RF input is below 5 microvolts, due to: distance from transmitter (fringe area); poor receiving antenna; shielded RF area; etc., there may not be sufficient signal to drive the set to limiting, and it will require that the squelch control be set to a lower point.

(9.4.1) This may improve listening satisfaction, but conversely, the receiver may be operating at a point where the signal-to-noise ratio has deteriorated and the recovered audio is not acceptable.

(9.5) The magnitude of the squelch control voltage depends only on the signal-to-noise ratio at the tuner input and is essentially independent of the front-end gain because the quadrature signal is fully limited.



S+N and N for no squelch, partial squelch, and full squelch, for signal input to a tuner using the CA3089.



Typical tuning characteristic (a) without squelch and (b) with squelch, showing the suppression of the annoying side responses characteristic of limiter-discriminator receivers.

FIGURE 12

(9.6) Adjustment of the SQUELCH CONTROL R315 primarily changes the degree of noise suppression, rather than the threshold. Control R315 is generally operated at maximum value, i.e. full clockwise as viewed from the FM side of the AM/FM Tuner Module.

(9.7) IN THE FIELD ADJUSTMENT OF THE SQUELCH CONTROL R315: (See paragraphs (12.3) through (12.4.3.1) below.)

(9.7.1) Set the Receiver's VOLUME CONTROL R411 and the TONE CONTROL R412 for normal operation.

(9.7.2) Set SQUELCH CONTROL R315 to MINIMUM, i.e. no squelch.

(9.7.3) Tune the Receiver to the weakest FM station that the homeowner would normally be expected to receive.

(9.7.4) If the weak station's reception is acceptable, advance the SQUELCH CONTROL R315 until it interferes with reception of the station, then, back the control until reception is again acceptable.

(9.7.5) When in normal operation the FM tuner is properly aligned and the received signal is too weak to permit full squelch operation, if possible the RF signal input to the receiver should be increased.

(9.7.5.1) This may be accomplished by changing the position of the inside antenna that is supplied with the Receiver; installation of an outside antenna, and if required, a directional antenna with an antenna rotor. In some cases, increasing the height of the existing antenna will increase the input sufficiently.

(9.7.6) REMEMBER, WITH A PROPERLY ALIGNED FM TUNER, SUB-PAR OPERATION OF THE SQUELCH CIRCUIT IS GENERALLY DUE TO INSUFFICIENT FM SIGNAL INPUT.

(10) AM TUNER:

(10.1) The AM signal is fed from the center-tap of T301, through C354, to the primary of the AM antenna RF transformer T302, where it is coupled to the AM RF amplifier Q304's tuned-gate (G1) circuit.

(10.2) G1's tuned circuit is adjusted by tuning section C303C of the ganged tuning capacitor. C303D is the high-frequency trimmer, and the tuning slug of T302 is adjusted for transformer coupling and low-frequency padding.

(10.3) The AM signal is amplified by Q304 and fed through C339 to the input (pin 2) of the AM integrated circuit IC302. Pin 2 is to the base of the on-board oscillator/converter.

(10.3.1) The ferrite bead L311, on Q304's drain lead, helps to suppress parasitic signals.

(10.4) IC302 is a monolithic integrated circuit (RCA CA3088E) which provides: AM conversion; and two (2) stages of IF amplification and detection. In this application it also supplies internal AGC to the first on-board IF stage and delayed AGC to the RF amplifier. The detector's recovered audio is preamplified.

(10.4.1) Complete specifications of the IC's operation can be found in the RCA LINEAR INTEGRATED CIRCUITS MANUAL NO. SSD-201C (and subsequent publications).

(10.5) The AM local oscillator is operated at 455 KHz. (the AM IF frequency) above the frequency of the signal to which the RF amplifier Q304's gate (G1) circuit is tuned.

(10.6) The local oscillator's frequency is adjusted by tuning section C303G of the ganged tuning capacitor.

(10.6.1) C303H is the high-frequency trimmer, and the tuning slug of T303 is adjusted for low-frequency padding and oscillator feedback coupling.

(10.6.2) The oscillator signal is fed through C348 and IC302-1 where it is injected to the emitter of the AM converter.

(10.7) The converter's 455 KHz. difference frequency is fed from IC302-3 and R339 to the IF transformer T304.

(10.8) Both primary and secondary of T304 should be adjusted to 455 KHz. There are two tuning slugs in the coil form, and both are reached from the top. Go through the top slug to the bottom slug when tuning.

(10.9) The output of the secondary of T304 is fed through C353 to IC302-4, the base of the first IF amplifier.

(10.9.1) The output of the first IF amplifier is fed from IC302-6 to the input of the ceramic filter CF302-1.

(10.10) CF302 is a ceramic filter, whose center frequency is 455 KHz. $\pm$ 2 KHz. with a 3 db bandwidth of 10 KHz. $\pm$ 3 KHz., whose frequency stability is within 0.4% from $-10°C$ to $+80°C$.

(10.11) The output of the filter CF302-2 is fed to the base of the second IF amplifier at IC302-8. The second IF amplifiers feedback connects IC302-7, through R332 to the amplifiers base at IC302-8.

(10.12) The detector's output at pin 9 is fed to its AM filter, and the recovered audio is coupled through R334 and C345 to the on-board audio amplifier's base at pin 14.

(10.13) The audio signal is amplified through one stage and coupled from an emitter follower to the audio output pin 15.

(10.14) The detector's output controls the on-board first IF's AGC, and the AGC output at pin 13, to G2 of the RF amplifier Q304.

(10.14.1) As the detector conducts, pin 13 goes toward ground, the forward bias to G2 of Q304 decreases, and Q304's output decreases.

(10.15) The detector controlled AGC bus on-board the chip also controls the voltage to pin 12, which may be used to drive a tuning meter.

(10.16) Positive operating voltages (Vc) is fed to various terminals of IC302:

(10.16.1) Vcc to pin 16 is connected through on-board resistors in order to supply Vc to the audio amplifier transistors.

(10.16.2) Vcc is connected through R338 and pin 6 to the collector of the first IF amplifier.

(10.16.3) Vcc is connected through R340; the primary of T304; R339 and pin 3 to the AM mixer's collector.

(10.16.4) The RF amplifier Q304's G2 forward bias at junction of R327, R326, and R325 is connected to pin 13. This voltage at pin 13 decreases as the RF AGC is activated.

(10.16.5) Vcc is connected through R344 to pin 10. On-board, the voltage at pin 10 is regulated to 5.6V by a Zener diode. This regulated voltage (5.6V)

supplies the mixer's bias level-set network, the AGC level to the first IF; and metering voltage (through a control transistor) to pin 12.

(10.16.5.1) The regulated 5.6V also supplies the second IF amplifier and the detector.

(11) RANDOM VOLTAGE PROTECTION: The 220 microhenry coil L301 has minimal d-c resistance and will drain static charges, on the antenna and lead-in, to ground.

(12) ALIGNMENT:

(12.1) The Master Unit is shipped from the factory with the AM/FM tuner completely aligned and the FM SQUELCH CONTROL R315 is set at maximum, i.e. at full squelch.

(12.2) Alignment should be checked, and if necessary, realignment attempted by qualified personnel ONLY WHEN ABSOLUTELY NECESSARY.

(12.2.1) The procedure shown for LATER PRODUCTION UNITS alignment chart is recommended for "In shop" alignment.

(12.3) The surge impedance (Zo) of different antennae and their associated transmission lines may vary.

(12.3.1) The antenna transformer L301 must be relatively broad-band to allow for the variations of Zo, and when the FM is aligned with the 50 ohm dummy antenna according to the instructions in the alignment chart, it may not exactly match the system antenna to the FM RF input.

(12.4) If FM signal appears weak when checking the squelch circuit as described in paragraphs (9.7) through (9.7.6) above, it may be possible to increase the input to the RF amplifier Q301.

(12.4.1) Tune the Receiver to an FM station.

(12.4.2) Using a high-impedance-input voltmeter, measure the voltage at IC301-13.

(12.4.2.1) Pin 13 of the IC supplies a voltage which may be used to drive a tuning meter. Although a tuning meter is not used in this circuit, the voltage at pin 13 will increase with an increase of signal input to the RF amplifier Q301.

(12.4.3) While measuring the voltage at pin 13, adjust the tuning slug of L301 for maximum reading on the meter.

(12.4.3.1) Only very slight adjustment should be required. If tuning seems to be too far off, realign "In shop" according to the alignment chart.

SEE LATER PRODUCTION UNIT'S ALIGNMENT CHART, PAGE 48/49.

EXTENSION SPEAKER(S) WITH M-640 RECEIVER

(1) One (1) or two (2) extension speakers may be used with the M-640.

(2) NuTone's regular 8-inch inside and/or outside speakers may be used. (See under EXTENSION SPEAKER WITH I-614, paragraph (3), page 35.)

(3) These extension speakers should be connected in parallel at the terminals of the M-640's speaker.

(4) Up to 100 feet of twisted-pair cable (NuTone IW-2) may be connected between the M-640 speaker terminals and each extension speaker.

(5) The Receiver's TONE CONTROL R412 will control the Bass/Treble balance at the M-640 speaker and at the extension speaker(s). (Will also control the Bass/Treble balance of the audio fed to the I-614 Master Stations.)

(6) The Receiver's VOLUME CONTROL R411 will control the audio level at the M-640 speaker and at the extension speaker(s). (But will not effect the audio level at the I-614 Master Stations.)

(7) When individual level-control at the Receiver's speaker and at the extension speaker(s) is desired, and/or when more than two extension speakers are required, it is recommended that the "Background Music" feature with an external amplifier be utilized. (See below)

BACKGROUND MUSIC

(1) The NuTone Model IMA-516 amplifier is supplied with provisions for a "Background Music" system.

(2) When the IMA-516 is located within 25 feet (length of wire run) of the M-640, NuTone's twisted-pair cable IW-2 may be used for audio connection.

(2.1) With M-640 Receiver original production unit:

(2.1.1) Connect the white wire of the IW-2 cable to the high-side of the VOLUME CONTROL R411, i.e. at the junction of R416/C403/R411, on the M-640 Audio PC board.

(2.1.2) Connect the grey wire of the IW-2 cable to ground. The AUDIO GROUND BLK/W TERMINAL on the Audio PC board is a convenient point for this connection.

(2.2) With M-640 Receiver later production unit:

(2.2.1) Connect the white wire of the IW-2 cable to the blue wire of the short, labelled, twisted-pair on the M-640 Audio PC board.

(2.2.2) Connect the grey wire of the IW-2 cable to the black wire of the short, labelled, twisted-pair on the M-640 Audio PC board.

(2.3) At the IMA-516:

(2.3.1) Connect the white wire of the IW-2 cable to the blue wire of the short, labelled, twisted-pair.

(2.3.2) Connect the grey wire of the IW-2 cable to the black wire of the short, labelled, twisted-pair.

(2.4) MAINTAIN TWIST IN WIRES OF THE IW-2 CABLE AS CLOSE TO CONNECTION POINTS AS POSSIBLE. CONSISTENT WITH GOOD MECHANICAL INSTALLATION, IW-2 RUN BETWEEN M-640 AND IMA-516 SHOULD BE AS SHORT AS POSSIBLE. KEEP IW-2 CABLE AS FAR AWAY FROM 120VAC, 60 HZ. POWER WIRING AS POSSIBLE, ESPECIALLY WHEN CABLE IS RUN PARALLEL TO POWER WIRING.

(2.5) The VOLUME CONTROL R411 in the M-640 Receiver will not effect the level of the audio signal that is fed to the IMA-516 amplifier (but will control the level of the M-640 speaker).

(2.6) The TONE CONTROL R412 in the M-640 Receiver will control the bass/treble balance of the audio signal that is fed to the IMA-516 amplifier (and to the M-640 speaker).

(2.7) At the IMA-516 amplifier, the MUSIC LEVEL SET CONTROL R126 should be adjusted to the desired level for the background music speaker(s).

(2.7.1) If individual level-set controls for each background music speaker is used, these controls should be set for maximum volume, and the MUSIC LEVEL SET CONTROL R126 in the IMA-516 should be set so that there is sufficient volume at the speaker in the area requiring the greatest level.

(2.7.2) The level-set controls at the other speakers may then be adjusted for the desired level at each location.

(3) When the run of audio cable between the M-640 and the IMA-516 exceeds 25 feet, a shielded audio cable may be used. Recommend shielded cable maximum run of 50 feet.

(3.1) With M-640 original production unit:

(3.1.1) Connect the center conductor of the shielded cable to the high-side of the VOLUME CONTROL R411, i.e. at the junction of R416/C403/R411, on the M-640 Audio PC board.

(3.1.2) Connect the shield of the shielded cable to ground. The AUDIO GROUND BLK/W TERMINAL on the Audio PC board is a convenient point for this connection.

(3.2) With M-640 later production unit:

(3.2.1) Connect the center conductor of the shielded cable to the blue wire of the short, labelled, twisted-pair on the M-640 Audio PC board.

(3.2.2) Connect the shield of the shielded cable to the black wire of the short, labelled, twisted-pair.

(3.3) AT THE IMA-516:

(3.3.1) Connect the center conductor of the shielded cable to the blue wire of the short, labelled, twisted-pair.

(3.3.2) Connect the shield of the shielded cable to the black wire of the short, labelled, twisted-pair.

(3.4) When the shielded cable is used between the M-640 and the IMA-516, the VOLUME CONTROL; TONE CONTROL; and SPEAKER LEVEL SET will operate as described in paragraphs (2.5) through (2.7.2) above.

(4) OTHER BACKGROUND MUSIC AMPLIFIERS:

(4.1) When desired the audio signal from the M-640 may be used to drive an audio amplifier other than the IMA-516.

(4.2) With original production units of the M-640, connect the shielded cable at the receiver as described in paragraphs (3.1) through (3.1.2) above.

(4.3) With other production units of the M-640, connect the shielded cable at the receiver as described in paragraphs (3.2) through (3.2.2) above.

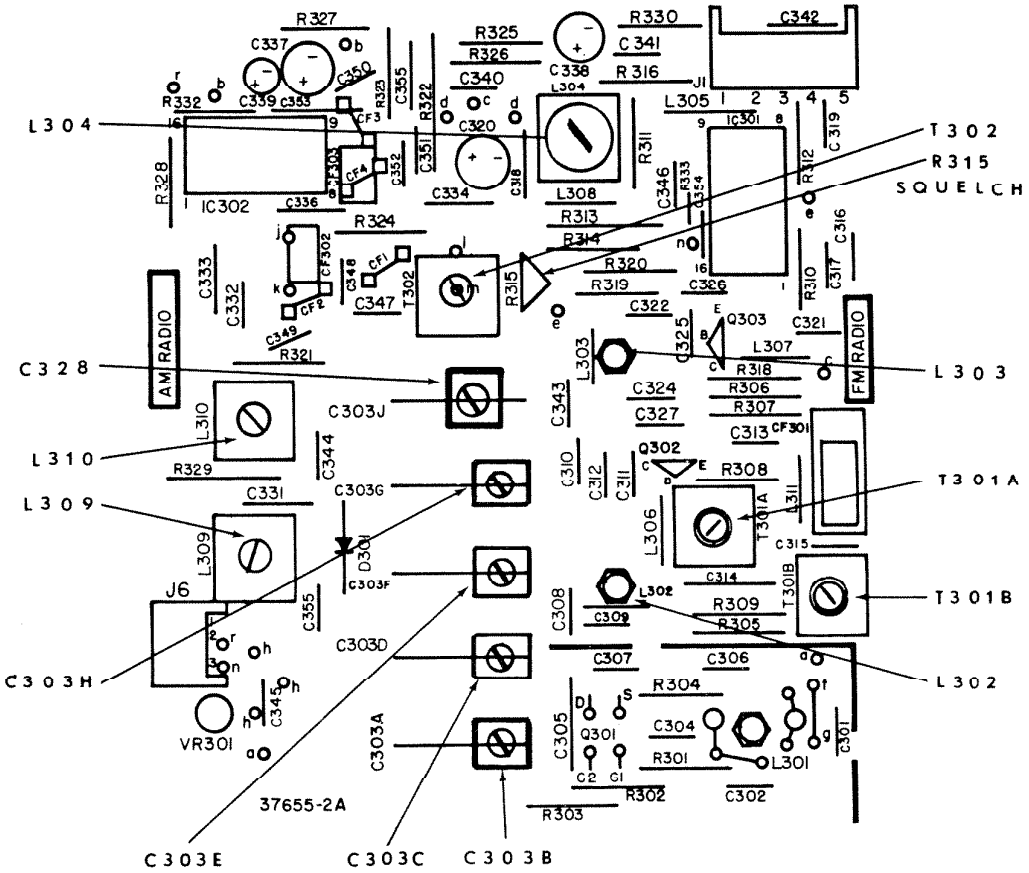
(4.4) Connect an RCA audio pin plug (or such other connector that may be required by the music amplifier being used) to other end of shielded cable, and plug into AUXILIARY — or other high-level input — to the music amplifier. DO NOT USE A MAGNETIC PHONO NOR TAPE HEAD INPUT AS THIS COULD OVERLOAD THE AMPLIFIER'S INPUT.

(4.4.1) If connected to a stereo amplifier, connect the pin plug through a "Y" connector to the high-level input in both the left and right channels.

(5) Reference IMA-516 Installation Instructions (NuTone Part No. 48163-000) and/or IMA-516 Service Manual (NuTone Part No. FS1075). Both publications are available from NuTone Customer Service Department.

AM ALIGNMENT

THIS RECEIVER SHOULD BE ALIGNED ONLY WHEN ABSOLUTELY NECESSARY AND ONLY BY QUALIFIED PERSONNEL. USE NON-INDUCTIVE, LOW-CAPACITY ALIGNMENT TOOL WHEN MAKING ADJUSTMENTS.



MODEL M-640 TUNER (TOP OF BOARD) (ORIGINAL PRODUCTION UNITS)

SET RECEIVER CONTROLS:

1. SELECTOR SWITCH S402 in AM position.
2. VOLUME CONTROL R411 to desired level.
3. TONE CONTROL R412 as desired.

INSTRUMENTS REQUIRED:

1. CATHODE RAY OSCILLOSCOPE:
   - 1.1 High-side of vertical input connected through a 15K, ½-watt resistor to tuner's AM audio output at J1/P1-1.
   - 1.2 Low-side (ground) of vertical input connected to receiver's circuit ground at J1/P1-5.
   - 1.3 VTVM (or other high-impedance input meter) may be used, but recommend oscilloscope so that linearity as well as amplitude of the recovered audio signal may be observed.
2. AM SIGNAL GENERATOR:
   - 2.1 Modulate RF output with 400 Hz. @ 30%.
   - 2.2 Connect high-side of generator output through a 200 pf (ceramic or mica) capacitor to shield (braid) of the coax antenna lead-in.
   - 2.3 Connect low-side (ground) of generator output to tuner module ground at RF shield.

SIGNAL GENERATOR OUTPUT LEVEL SHOULD BE KEPT AT MINIMUM CONSISTENT WITH GOOD TRACE ON SCOPE

STEP	SIGNAL GENERATOR SETTING	RECEIVER SETTING	ADJUST	TUNE FOR
1.	537 KHz. Use signal level required. Do not overdrive.	AM Tuning Dial to 537 KHz. (Ganged tuning capacitor C303 full close.)	L310 Oscillator padder coil.	Maximum sine wave trace on scope (or maxi voltage on meter).
2.	1620 KHz.	AM tuning dial to 1620 KHz. (Ganged tuning capacitor C303 full open).	C303H Oscillator trimmer.	do
3.	Repeat steps 1 and 2 until oscillator tunes at both ends and no further improvement in trace can be made.			
4.	600 KHz.	AM tuning dial to 600 KHz.	L309 AM antenna transformer.	do
5.	1500 KHz.	AM tuning dial to 1500 KHz.	C303C Antenna tuning trimmer	do
6.	Repeat steps 4 and 5 until no further improvement in trace is made, and tuner tracks across AM band.			
7.	1500 KHz.	AM tuning dial set to 1500 KHz.	T302 AM 455 KHz. IF transformer.	do

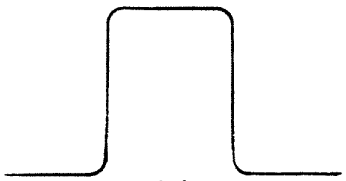
FM ALIGNMENT

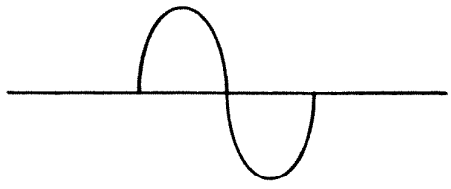
SET RECEIVER CONTROLS:

1. SELECTOR SWITCH S402 in FM position.
2. VOLUME CONTROL R411 to desired level.
3. TONE CONTROL R412 to choice.
4. SQUELCH CONTROL R315 (on tuner PC board) to minimum.

INSTRUMENTS REQUIRED:

1. CATHODE RAY OSCILLOSOPE:
   - 1.1 High-side of vertical input connected through a 15K, ½-watt resistor to tuner's FM audio output at J1/P1-4.
   - 1.2 Low-side (ground) of vertical input connected to receiver's circuit ground at J1/P1-5.
   - 1.3 Use 60 Hz. horizontal sweep. If scope does not have own 60 Hz. horizontal sweep, use exterior source.
2. FM SIGNAL GENERATOR:
   - 2.1 Modulate RF output with 60 Hz. at 400 KHz. sweep width.
   - 2.2 Connect a 50-ohm resistor across RF output of signal generator.
   - 2.3 Connect high-side of generator's output to center conductor of coax antenna lead-in.
   - 2.4 Connect low-side (ground) of signal generator's output to shield (braid) of coax lead-in.

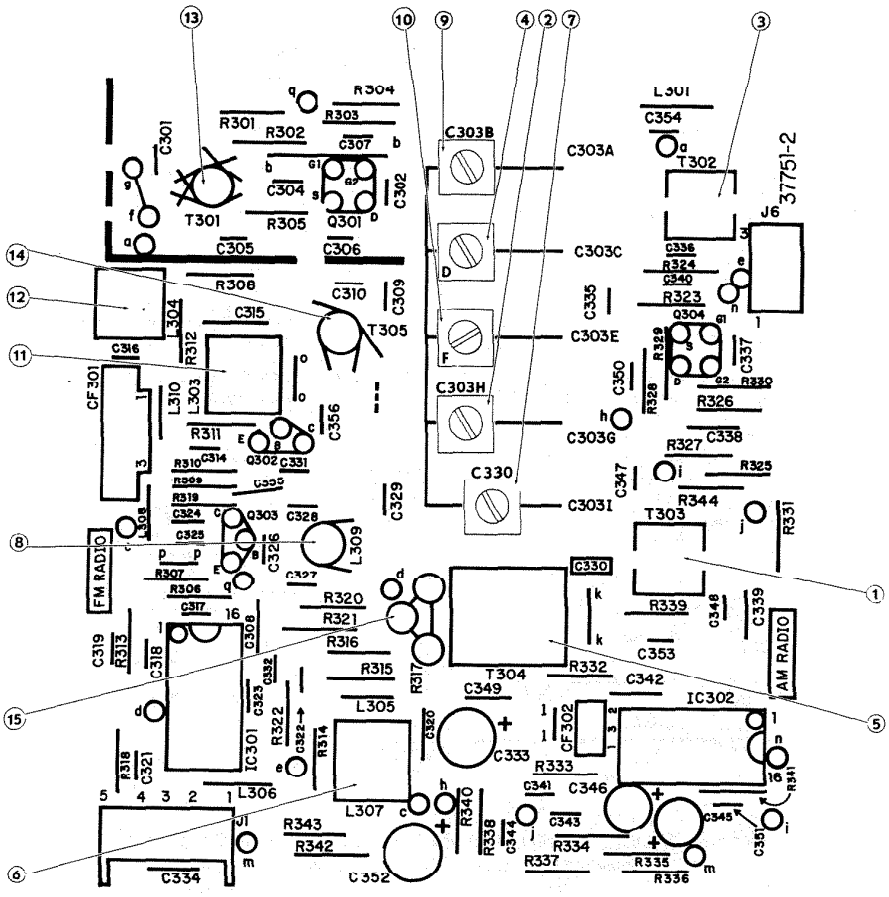




TO PREVENT LIMITING, SIGNAL GENERATOR OUTPUT LEVEL SHOULD BE AS LOW AS POSSIBLE CONSISTENT WITH GOOD TRACE ON SCOPE

STEP	SIGNAL GENERATOR SETTING	RECEIVER SETTING	ADJUST	TUNE FOR
1.	106 MHz. @ 2-5 microvolts. (If generator does not have calibrated output, use lowest level sistent with good trace on scope.)	Tune receiver (ganged tuning capacitor C303 to pick up signal generator.	L304 quadrature coil. Detune to get wave form in "A" above. If wave is negative, reverse direction of slug detuning.	Maximum trace on scope as shown in "A" above. Sacrifice amplitude for linearity and flat top. If necessary, reduce output from signal generator to prevent tuner limiting.
2.	108.5 MHz.	FM tuning dial to 108.5 MHz. (Ganged tuning capacitor C303 full open.)	C328 oscillator trimmer.	do
3.	87.5 MHz.	FM tuning dial to 87.5 MHz. (Ganged tuning capacitor C303 full close.)	L303 oscillator coil. Use extreme care, adjust in small increments.	do
4.	Repeat steps 2 and 3. Oscillator should be "Rocked-in" at both ends of dial.			
5.	106 MHz.	FM tuning dial to 106 MHz.	C303B RF input trimmer. C303E RF output trimmer. T301A Mixer tank — 10.7 MHz. T301B FM mixer 10.7 MHz. IF coupler.	do
6.	90 MHz.	FM tuning dial to 90 MHz.	L301 Antenna input transformer: Two peaks may be noted while adjusting the slug. USE THE PEAK WITH SLUG POSITIONED NEAR BOTTOM OF COIL. L302 RF amplifier tank coil.	do
7.	Repeat steps 5 and 6 until no further improvement in scope trace is noted at any setting. As the set is aligned, it may be necessary to reduce the output of the signal generator in order to prevent tuner limiting.			
8.	90 MHz. (Check level. Do not drive tuner to limiting.)	FM tuning dial to 90 MHz.	L304 quadrature coil.	Maximum symmetrical "S" curve, see "B" above. Curve should be linear and equal distance above and below the scope's horizontal reference line.
9.	90 MHz.	FM tuning dial to 90 MHz.	Increase signal generator output until tuner goes into limiting. Should occur before signal generator output reaches 10 microvolts.	Maximum symmetrical "S" curve that does not increase in amplitude after tuner limiting is reached.
10.	Check limiting action across band: With output set at 10 microvolts, tune signal generator to various frequencies across the FM broadcast band (88-108 MHz.). Adjust tuning dial to receive these frequencies. Linear "S" curve should remain constant in amplitude at every frequency.			
11.	Disconnect signal generator and, if used, external sweep to scope. Scope should use regular horizontal sweep. Tune receiver between stations and note noise at J1/P1-4 as seen on scope. Turn FM SQUELCH CONTROL R315 clockwise to full squelch. Noise should disappear from scope and horizontal trace should be a straight line.			

AM ALIGNMENT



MODEL M-640 TUNER (TOP OF BOARD) (LATER PRODUCTION UNITS)

SET RECEIVER CONTROLS:

1. SELECTOR SWITCH S402 in AM position.
2. VOLUME CONTROL R411 to desired volume.
3. TONE CONTROL R412 as desired.

INSTRUMENTS REQUIRED:

1. CATHODE RAY OSCILLOSCOPE:

   1.1 High-side of vertical input connected through a 15K, ½-watt resistor to tuner's AM audio output at J1/P1-1.

   1.2 Low-side (ground) of vertical input connected to receiver's circuit ground at J1/P1-5.

   1.3 VTVM (or other high-impedance input meter) may be used, but recommend oscilloscope so that linearity as well as amplitude of the recovered audio signal may be observed.

2. AM SIGNAL GENERATOR:

   2.1 Modulate RF output with 400 Hz. @ 30%.

   2.2 Connect high-side of generator output through a 200 pf (ceramic or mica) capacitor to shield (braid) of the coax antenna lead-in.

   2.3 Connect low-side (ground) of generator output to tuner module ground at RF shield.

TO PREVENT ACTIVATION OF AGC, KEEP RF SIGNAL GENERATOR OUTPUT AT MINIMUM LEVEL THROUGHOUT ALIGNMENT PROCEDURE

STEP	SIGNAL GENERATOR SETTING	RECEIVER SETTING	ADJUST	TUNE FOR
1.	537 KHz. use minimum signal level required. Do not drive tuner to AGC.	AM Tuning Dial to 537 KHz. (Ganged tuning capacitor C303 fully closed.)	① T302, oscillator low-frequency padder; and mixer to oscillator feedback coupling.	Maximum linear sine wave trace on scope; or maximum voltage on meter.
2.	1620 KHz. (Check level)	AM Tuning Dial to 1620 KHz. (Ganged tuning capacitor C303 fully open).	② C303H oscillator high frequency trimmer.	do
3.	Reducing signal generator as required: Repeat steps 1 and 2 until no further improvement can be made and oscillator tunes at both ends of AM band.			
4.	600 KHz. (Check level)	AM Tuning Dial to 600 KHz.	③ T302 AM Antenna to RF Amplifier input Transformer.	do
5.	1500 KHz. (Check level)	AM Tuning Dial to 1500 KHz.	④ C303D AM antenna to RF Amplifier input trimmer.	do
6.	Reducing signal generator as required. Repeat steps 3 and 4 until no further improvement can be made and RF tuning tracks across the band.			
7.	1500 KHz. (Check level)	AM Tuning Dial to 1500 KHz.	⑤ T304 AM IF (455 KHz.) Transformer: primary and secondary (top and bottom slug).	do

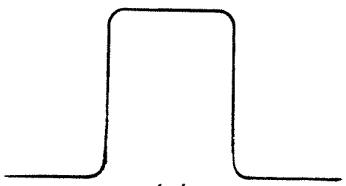
FM ALIGNMENT

SET RECEIVER CONTROLS:

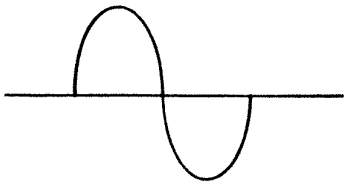
1. SELECTOR SWITCH S402 in AM position.
2. VOLUME CONTROL R411 to desired level.
3. TONE CONTROL R412 to choice.
4. SQUELCH CONTROL R317 (15) (on tuner PC board) to minimum.

INSTRUMENTS REQUIRED:

1. CATHODE RAY OSCILLOSCOPE:
   - 1.1 High-side of vertical input connected through a 15K, ½-watt resistor to tuner's FM audio output at J1/P1-4.
   - 1.2 Low-side (ground) of vertical input connected to receiver's circuit ground at J1/P1-5.
   - 1.3 Use 60 Hz. horizontal sweep. If scope does not have own 60 Hz. horizontal sweep, use exterior source.
2. FM SIGNAL GENERATOR:
   - 2.1 Modulate RF output with 60 Hz. at 400 KHz. sweep width.
   - 2.2 Connect a 50-ohm resistor across RF output of signal generator.
   - 2.3 Connect high-side of generator's output to center conductor of coax antenna lead-in.
   - 2.4 Connect low-side (ground) of signal generator's output to shield (braid) of coax lead-in.



'A'



'B'

TO PREVENT LIMITING, SIGNAL GENERATOR OUTPUT LEVEL SHOULD BE AS LOW AS POSSIBLE CONSISTENT WITH GOOD TRACE ON SCOPE

STEP	SIGNAL GENERATOR SETTING	TUNER SETTING	ADJUST	TUNE FOR
1.	106 MHz. @ 2 to 5 micro-volts. (If generator does not have a calibrated output, use lowest level consistent with good trace on scope.)	Tune receiver (ganged tuning capacitor C303 to pick up signal generator.	(6) L307 quadrature coil. Detune coil to get wave-form "A" above. If wave is negative, reverse direction of slug detuning.	Maximum trace on scope as shown in "A" above. Sacrifice gain for linearity and flat-top. If necessary, reduce signal generator output to prevent limiting.
2.	108.5 MHz. (Check level)	FM tuning dial to 108.5 MHz. (ganged tuning capacitor C303 full open.)	(7) C330 oscillator trimmer.	do
3.	87.5 MHz. (Check level)	FM tuning dial to 87.5 MHz. (Ganged tuning capacitor C303 full close.)	(8) L309 oscillator coil. Use extreme care, adjust in small increments.	do
4.	Repeat steps 2 and 3. Oscillator should be "Rocked-in" at both ends of dial.			
5.	106 MHz. (Check level)	FM tuning dial to 106 MHz.	(9) C303B RF input trimmer. (10) C303F RF amplifier output trimmer. (11) L303 FM Mixer tank to 10.7 MHz. IF. (12) L304 FM mixer 10.7 MHz. IF coupler.	do
6.	90 MHz. (Check level)	FM tuning dial to 90 MHz.	(13) T301 antenna input transformer. Two peaks may be noted when adjusting this slug. USE THE PEAK WITH THE SLUG POSITIONED NEAR THE BOTTOM OF THE COIL. (14) T305 RF amplifier drain tank and mixer coupler.	do
7.	Repeat steps 5 and 6 until no further improvement in scope trace is noted at either setting. As the set is aligned, it may be necessary to reduce signal generator output in order to prevent FM tuner limiting.			
8.	90 MHz. (Check level, do not drive tuner to limiting.)	FM tuning dial to 90 MHz.	(6) L307 quadrature coil.	Maximum symmetrical "S" curve. See "B" above. Curve should be linear and equal distance above and below the scope's horizontal reference line.
9.	90 MHz.	FM tuning dial to 90 MHz.	Increase signal generator output until tuner goes into limiting. Should occur before signal generator output reaches 10 microvolts.	Maximum symmetrical "S" curve that does not increase in amplitude after tuner limiting is reached.
10.	Check limiting action across band. With output set at 10 microvolts tune signal generator to various frequencies across the FM broadcast band (88-108 MHz.). Adjust FM tuning dial to receive these frequencies. Linear "S" curve should remain constant in amplitude at every frequency.			
11.	Disconnect signal generator and, if used, external sweep to scope. Scope should use regular horizontal sweep. Tune receiver between stations and note noise at J1/P1-4 as seen on scope. Turn FM SQUELCH CONTROL R317 (15) clockwise to full squelch. Noise should disappear from scope and horizontal trace should be a straight line.			

MODEL I-650 WIRING TERMINAL BLOCK AND INSTALLATION WIRING

(See Representative System Wiring Diagram, pages 55/56.)

(1) The Model I-650 has been designed for use as a convenient connecting and distribution point for a maximum of four (4) IW-8 cables.

(2) The original production unit I-650 includes two (2) color-coded barrel terminals for each of the color-coded wires in the IW-8 cable. Two matching color-coded wires may be connected to each barrel terminal. (Figure 13)

(2.1) Wire does not require stripping when connected to the barrel terminal. Use push-on cap when making connection, and remove cap when connection is completed.

(2.2) To prevent improper connection, push cap straight-on. Guard against hidden breaks in the wires.

(3) The later production unit I-650 Wiring Terminal Block includes eight (8) individually color-coded stand-off screw terminals. Connect each color-coded wire — from all of the IW-8 cables in the Terminal Block — to its matching color-coded terminal.

(4) In the Wiring Diagram, I-650(X) and I-650(Y) serve as central distribution points, and they should be installed as close to the I-600 as practicable.

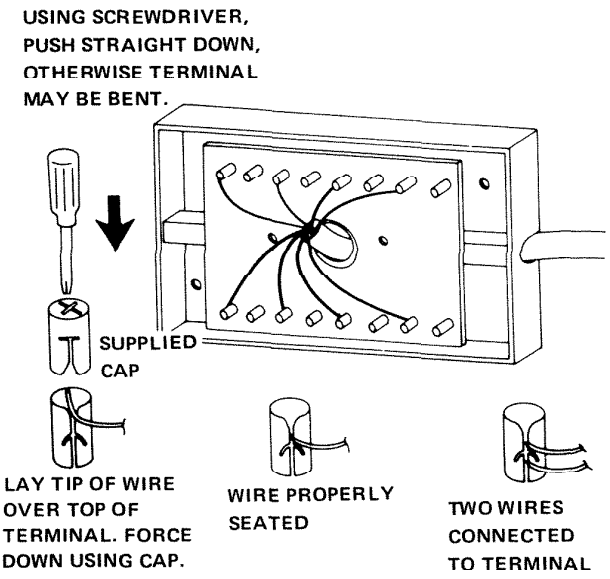
(4.1) Note that the load current for the Master Stations "1" — "7" and "9" flows from I-650(X) to the I-600. By installing I-650(X) within a couple of feet of the I-600, the IR drop through IW-8(X) will be negligible.

(4.2) The load current for the Master Stations "10" — "14" flows through I-650(Y), and by keeping the Terminal Block within a couple of feet of I-600, the IR drop through IW-8(Y) will be negligible.

(5) In the representative System, the I-600 is connected to the electrical center (approximately) of the intercom system. This gives a more or less balanced load through the various branches of the IW-8 trunk line, and this method of installation is advised.

(6) The IW-8 trunk line is looped through Master Stations "4" and through "6" and "7." It is recommended that looping of the IW-8 cable be done only at built-in Master Stations which are installed in the Model I-614R Rough-in Frames.

(7) When the I-614 Master Station is surface-mounted or is set on a desk (or table), it should be installed in the I-614B Master Station Base.



I-650
FIGURE 13

(7.1) It should be connected to the IW-8 trunkline through an I-650 Wiring Terminal Block.

(8) When the Model M-640 AM/FM Receiver is surface-mounted, or set on a desk (or table), it should be installed in the I-614B Master Station Base.

(8.1) For on-the-desk installation, suggest that the M-640 Receiver be connected through an I-650 Wiring Terminal Block.

(8.2) When the M-640 is built-in, it should be installed in the Model M-640R Rough-in Frame.

(8.3) When the M-640 is connected into the System at the I-600 Central Power Supply and Door Speaker Control's Terminal Board, the maximum run of IW-8 Cable between the M-640 and the I-600 should not exceed 1,000 feet.

(8.4) In the Wiring Diagram, page 55/56, an optional method of installing the M-640 is shown, i.e. it is connected through the IW-8 cable to I-650(g).

(8.4.1) When connected in this manner, the total length of IW-8 cable, between the M-640 Receiver and the I-600's Terminal Board, should not exceed 50 feet.

SYSTEM'S TERMINAL RESISTANCE MEASUREMENTS AND WIRING CONTINUITY CHECK

(1) The System's interconnecting IW-8 color-coded wiring continuity can be determined by measuring the resistance at the matching color-coded terminals in the I-600; and at all I-614's and I-650's.

(1.1) The resistance measured at these points may vary slightly (± 10%), but in general will be very close to those shown in the Chart, Figure 14.

(1.2) The ORN and ORN/W wires and terminals can also be checked at the M-640 AM/FM Receiver when it is included in the System.

(2) Turn power off: Disconnect both wires of the 16Vac cable from the AC terminals on the I-600 Terminal Board. Insulate bare wire ends.

(3) The resistance values shown in Figure 14(A) are measured from the terminal indicated to the circuit common ground (VSS).

(3.1) Connect the common (negative) lead of the ohmmeter to the BLK ground (VSS) terminal in the component at which the resistance is being measured.

(3.2) Connect the positive lead of the ohmmeter to the color-labelled terminal at which the resistance is being measured.

(4) Figure 14(B): The resistance values shown are measured between the two wires so indicated.

(4.1) Polarity of ohmmeter leads is not critical except as indicated for the ORN terminal/wire measurements.

TERMINAL	FUNCTION	RESISTANCE IN OHMS (K=1000)
ORN*	B+	1.5K — 8K*
BLK/W	OUTPUT (T/L INTERCOM AUDIO SIGNALS)	560 (R207)**
RED/W	CONTROL LINE	100K (R214)**
BLU	"A" DATA LINE	22K (R210)**
BLU/W	"B" DATA LINE	22K (R211)**
RED	"C" DATA LINE	22K (R212)**
ORN/W	"D" DATA LINE ALSO CARRIES RADIO AND "LISTEN-IN" AUDIO SIGNALS	470K (R228)**

NOTE: (*) Will charge to this resistance as power supply filter capacitors are charged. Greatest resistance will be measured at I-600 with no I-614's connected. Resistance will be less with each I-614 that is connected into System.

IF ohmmeter leads are reversed, resistance will measure but a few ohms, line will be shorted to ground through D209 on I-600 Terminal Board.

(**) Indicates line resistors to ground that are located on the I-600 PC Board.

SYSTEM WIRE/TERMINALS RESISTANCE TO GROUND
FIGURE 14(A)

WIRES MUST BE CONNECTED TO CORRECT TERMINALS IN I-614'S AND IN I-650'S.

(K=1000)

	ORN/W					
RED	492K	**RED**				
BLU/W	492K	44K	**BLU/W**			
BLU	492K	44K	44K	**BLU**		
RED/W	570K	122K	122K	122K	**RED/W**	
BLK/W	470.56K	22.56K	22.56K	22.56K	100.56K	**BLK/W**
ORN*	471.5K*	23.5K*	23.5K*	23.5K*	101.5K*	2.06K*

NOTE: (*) Connect positive lead of ohmmeter to ORN TERMINAL. Resistance shown is minimum. Resistance will rise to a greater value as the power supply filter capacitors are charged.

WIRE/TERMINAL TO WIRE/TERMINAL RESISTANCE IN OHMS
FIGURE 14(B)

MAKING SYSTEM'S TERMINAL VOLTAGE MEASUREMENTS

(1) The System's operating voltages can be determined at the individual color-coded terminals in the I-600; and at all I-614's and I-650's.

(1.1) The potential on the ORN and ORN/W wires and terminals can be measured at the M-640 AM/FM Receiver when it is included in the System.

(2) Recommend that, when available, a high-impedance-input voltmeter (analog or digital) be used.

(2.1) If necessary, a standard 20 kohm/volt multimeter may be used, and for general servicing the readings will be within practical field service requirements.

(3) Connect the common (negative) lead of the voltmeter to the BLK ground (VSS) terminal in the component at which the voltage is being measured.

(4) Set the voltmeter to the scale that is capable of measuring the maximum voltage that can be expected at the terminal under measurement.

(5) Connect the positive lead of the voltmeter to the color-coded terminal at which the potential is being measured.

(6) ALL VOLTAGES ARE DC POSITIVE IN RESPECT TO CIRCUIT GROUND (VSS) EXCEPT WHERE NOTED IN THE CHART.

(7) CARE MUST BE EXERCISED TO MAKE CERTAIN THAT THE VOLTMETER PROBES DO NOT SHORT THE TERMINAL BEING MEASURED TO ANY OTHER TERMINAL: COMPONENT: NOR PC PATH.

TERMINAL	FUNCTION	VOLTAGE* (LOGIC STATE)	REMARKS
ORN	B+	REGULATED +15VDC	Must measure a minimum of 9Vdc at every I-614, when an ALL CALL is addressed by the originating station.
ALSO AT M-640		(14.25-15.75V at I-600)	Must measure a minimum of 12Vdc at the M-640.
BLK/W	OUTPUT (T/L INTERCOM AUDIO SIGNALS)	0VDC	During intercom operation, Audio AC may be measured with a low-scale AC voltmeter; a db meter, or an oscilloscope.
RED/W	CONTROL LINE	LO (VSS)	Will go HI (to originating Station's VDD) when the T/L Relay in the originating Station is in the TALK mode.
BLU	"A" DATA LINE	LO (VSS)	DATA LINE(S) go HI (to originating Station's VDD) when addressed. See Encoder Chart, pages 8; and 62-64.
BLU/W	"B" DATA LINE	LO (VSS)	
RED	"C" DATA LINE	LO (VSS)	
ORN/W ALSO AT M-640	"D" DATA LINE (ALSO CARRIES RADIO AND "LISTEN-IN" AUDIO SIGNALS)	LO (VSS)	At END OF CALL, DATA LINES return to a LO state in an exponential (RC time) manner.
AC TO AC	POWER SUPPLY	16VAC TO 18VAC	MEASURE AT I-600 ONLY.
DOOR TO DOOR	DOOR SPEAKERS	AUDIO AC	MEASURE AT I-600 ONLY. Intercom Audio AC voltage to/from DOOR SPEAKER(S) when these Speaker(s) is/are addressed. Voltages may be read with a low-scale voltmeter, a db meter or an oscilloscope.

NOTE: (*) All voltages (logic states) d-c positive unless otherwise noted.

(**) LO (VSS) is nominally circuit ground, actual potential may measure a small positive voltage, depending on IR line losses and/or voltage at the output of the various CMOS devices.

TERMINAL VOLTAGE MEASUREMENTS
FIGURE 15

OBJECTIONABLE SPURIOUS D DATA TO "8" DECODING I-614 MODIFICATION

(1) When a No. 8 address Master Station with annunciator tone is required, and the spurious D data bit to "8" decoding is objectionable, the I-614 should be modified. This may be accomplished in the field, or on the bench, without removing the I-614's PC board from the chassis. (See END OF CALL, para. (5)-(5.8), pp 29.)

(2) In the field, at the I-600 Terminal Board, disconnect the 16 Vac power wires from the AC terminals. Insulate the wire ends.

(2.1) Remove the I-614 from its built-in mounting frame, or from its surface (desk) mounting base.

(3) Remove the Station Identity Wire from its Address Identity Terminal P1-8.

(4) Cut the wire and connect, in-series with the wire, a 10 Kohm ± 5%, 1/4 watt, carbon film, resistor. (NuTone Part No. 33082-103) Make certain that the resistor connections are insulated.

(5) Install — on bottom of PC board — a 22 microF, 50 WVDC, tubular, electrolytic capacitor. Make certain that the capacitor and leads are insulated from the PC board. (NuTone Part No. 35068-116)

(5.1) See I-614 PC Board, Bottom View, pp 62-64; and Schematic Diagram, pp 65-67.

(5.2) Connect (solder) the positive (+) lead of the capacitor to the junction of D110/D109/R134 at PC point (ii) or (hh).

(5.3) Connect the negative (−) lead of the capacitor to PC circuit ground path.

(6) Install I-614 in its rough-in frame, or in its surface-mount (desk) base.

(7) Connect the 16 Vac power wires to the AC terminals on the I-600 Terminal Board.

(8) With the resistor and capacitor in the circuit, the voltage at Z109E-11 will rise to transition in approximately 220 mSec. Because of permissible tolerances, this time may vary between 188 and 400 mS.

(8.1) In any case, the rise time is much greater than the duration (11-64 mS) of the spurious encoded "8," and P1-8 will go LO before Z109E's transition occurs and the Station's annunciator tone will not be activated.

SYSTEM SERVICING — GENERAL

BEFORE ATTEMPTING SERVICE OF THE SELECTIVE CALL INTERCOM SYSTEM, THE TECHNICIAN SHOULD READ AND UNDERSTAND THE TEXT, AND SHOULD BE FAMILIAR WITH THE SCHEMATIC AND WIRING DIAGRAMS IN THIS MANUAL.

THE SYSTEM SHOULD BE CAPABLE OF SUCCESSFULLY COMPLETING THE ENTIRE OPERATIONAL CHECKOUT PROCEDURE, PAGES 4-7.

TO ASSURE OPERATION OF THE TALK/LISTEN RELAY K1 IN EVERY STATION DURING AN "ALL CALL," THE VOLTAGE AT THE ORN B+ TERMINAL IN EVERY MODEL I-614 MASTER STATION MUST BE A MINIMUM OF 9 VDC WHEN THE "ALL CALL" IS IN PROGRESS. SEE PAGE 35.

WHEN CONNECTING WIRE(S) AT A SCREW TERMINAL IN THE SYSTEM, THE SCREWS MUST BE TIGHTENED DOWN IN ORDER TO ASSURE ELECTRICAL CONTACT BETWEEN THE PC COPPER PAD AND THE WIRE(S).

WHEN MAKING RESISTANCE AND VOLTAGE MEASUREMENTS AT THE TERMINALS, THE METER PROBE MUST MAKE ELECTRICAL CONTACT WITH THE PC COPPER PAD. IF A SCREW IS LOOSE AT A TERMINAL, IT WILL NOT BE IN ELECTRICAL CONTACT WITH THE COPPER PAD, AND READINGS CAN NOT BE MADE BY CONNECTING THE PROBE TO THE SCREW.

(1) In some of the trouble shooting instructions below, the REPRESENTATIVE SYSTEM WIRING DIAGRAM, pages 55/56, is used as an example.

(1.1) The actual System being serviced will probably differ in some detail(s) from the Representative System, but the basic service technique is, in general, applicable to all Systems.

(2) The 16 Vac power wires (from the Power Transformer, Model 301-N) should be disconnected from the AC terminals on the I-600 Terminal Board when making resistance measurements. (See pages 57-61.)

(2.1) When measuring resistance of an individual component on one of the unit's PC boards, it may be necessary to disconnect one end of the component in order to prevent "sneak" paths. (See Pages 57-61; 62-66; and 68-72 or 73-77.)

(2.2) When making resistance (continuity) check of the System's interconnecting IW-8 cable(s), follow the instructions on page 51, and compare the readings with those listed in the Charts, Figures 14(A) and 14(B) — within tolerance, they should agree.

(2.2.1) NEW SYSTEM: Suggest that the resistance

(continuity) check of the IW-8 wires be made before making the initial connection of the 16 Vac power wires to the AC Terminals on the I-600 Terminal Board.

(2.3) The condition of the I-600 Terminal board may be determined by making a PC continuity check as instructed by I-600 TERMINAL BOARD SERVICE NOTE, and the Chart, Figure 10, page 16.

(3) The 16 Vac power wiring should be disconnected from the AC terminals on the Terminal Board when repairing and/or replacing individual components; System wiring, etc.

(4) The 16 Vac wires must be connected to the AC terminals on the I-600 Terminal Board when making quiescent and dynamic voltage and logic state measurements.

(4.1) When measurements are made with the power on, use extreme care in the vicinity of the ORN B+ terminal in all components.

(4.2) This terminal must not be shorted to other terminals, components, and PC paths. An overload on the B+ supply may damage the Voltage Regulator Z205 in the Model I-600 Central Power Supply/Door Speaker Control.

(5) QUIESCENT (INTERCOM STANDBY) VOLTAGE MEASUREMENTS: should be made when no intercom call is in progress, and should be compared with those shown under column heading "VOLTAGE * (LOGIC STATE)" in the Chart, Figure 15, page 52.

(6) DYNAMIC VOLTAGE MEASUREMENTS: should be made when an intercom call is originated by any I-614 Master Station, and should be compared with those shown under column heading "REMARKS" in the Chart.

(6.1) Any I-614 may originate a selective call to any other Master Station when making these dynamic voltage measurements, but it is recommended that an ALL CALL be made. This will allow voltage measurements to be made with a maximum load on the d-c supply (B+) in the I-600.

(6.1.1) EXAMPLE: In the Representative System, pages 55/56, an ALL CALL is made by Master Station No. 1. The readings at Stations 1, 9, 10, 13, and 14 will be the minimum that should be expected in this System when there is a maximum load on the I-600's d-c supply (B+).

(6.2) THE B+ MEASUREMENT AT EVERY I-614's ORN TERMINAL MUST NOT BE LESS THAN THE MINIMUM OF 9 VDC. (See page 35.)

(6.2.1) When, because of IR line losses, the B+ at a Station is less than the regulated 15 Vdc, VDD1 at this Station will also be less than 15 Vdc.

(6.2.1.1) When this Station originates a call, and its Z105's output data bit(s) go HI, the potential on these HI output data bits will be less than the normal 13.5-15 Vdc.

(6.2.1.2) In order for the address to be decoded at the other Stations, the HI on the address data lines must exceed 55% of VDD1 at each of the other Stations. (This is equal to 8.75V when VDD1 is 15V.)

(6.3) The B+ voltage on the ORN terminal in the M-640 Radio Receiver should be a minimum of 12VDC.

(7) Recommend that when making System wiring resistance (continuity) measurements, and/or voltage measurements, that these measurements be made first at the I-600 Terminal Board.

(7.1) These measurements should also be made at the I-614 Master Stations, especially those on the end of each IW-8 branch.

(7.1.1) EXAMPLE: In the Representative System, pages 55/56, at I-614 Master Stations No. 1; 9; 10; 13; and 14.

TROUBLE SHOOTING — IN THE FIELD

(1) When making resistance (continuity) check at the I-600 Terminal Board. The BLU A and the BLU/W B data terminals each measures 11 Kohm to ground. (Normally each should measure 22 Kohm to ground. All other resistance measurements agree with those in the Chart, Figure 14(A).)

(1.1) This indicates a short between the BLU and BLU/W wires, and that both terminals are connected through a parallel combination of the 22 Kohm resistors R210 and R211.

(1.2) Disconnect the BLU/W wire(s) of the IW-8 cable(s) from the BLU/W terminal. Separate these BLU/W wires.

(1.3) Measure the resistance between the BLU terminal and ground; and between the BLU/W terminal and ground. Each should be 22 Kohm. If so, it indicates that the short is between the BLU and BKU/W wires in the remote branches.

(1.3.1) If 11 Kohm is still measured, it means that there is a short on the I-600 Terminal Board, or on its PC Board.

(1.4) If resistance is normal with BLU/W wire(s) removed from BLU/W terminal, the branch IW-8 cable(s) with the shorted wires must be located. (Example, see Representative System, pages 55/56.)

(1.4.1) Connect one lead of ohmmeter to the BLU terminal.

(1.4.2) Connect other lead of ohmmeter to the BLU/W wire in IW-8(X) cable. Resistance should be infinate (open). If there is a short in this branch it will probably measure between zero and 20 ohms, depending on the length of the wires between the I-600 and the short circuit.

(1.4.3) If this branch is shorted, the short may be further isolated by disconnecting the BLU and BLU/W wires of the three IW-8 cables at I-650(X) Terminal Block, and measuring the resistance between this pair in each one of the cables.

(1.4.3.1) When the short is located in a particular run of IW-8 cable, check between each unit, at the I-614's, and at the I-650's. Pay particular attention to the connections at all components. Make certain that the wires are not transposed.

(1.5) If the short is not located in the IW-8(X) branch circuit, the IW-8(Y) branch may be checked in the same general manner.

(1.6) Regardless, the short must be located and cleared, whether it is in one or both branches.

(2) If shorts between the ORN; ORN/W; BLK; and BLK/W wires is/are noted, the IW-8 cable between the M-640 and the I-600 must also be checked.

(2.1) DO NOT CONNECT THE BLK/W WIRE IN THIS CABLE. (See paragraphs (5) through (5.5.2), page 36.)

(3) (See Representative System, pages 55/56.) At I-614 Master Station No. 9, the RED/W control wire appears open, and does not go HI when originating station's TALK BAR is activated (should be in a HI logic state). The RED/W terminal resistance and logic state are both normal at Stations 1; 10; 13; and 14.

(3.1) Check RED/W connections at the I-614's and I-650's in the IW-8 branch between IW-8(X) and I-614 No. 9. Pay particular attention to the connections at the Terminal Blocks and Master Stations.

(3.1.1) NOTE: Use particular care around the push-on terminals in the original production I-650 Terminal Blocks. Look for hidden breaks in the RED/W wire(s) near these terminals (See paragraphs (2)-(3), page 50.)

(4) If when the System is turned-on, i.e. the 16 Vac power wires are connected to the AC terminals on the I-600 Terminal Board:

The BUSY indicator light D123 is turned on at all Master Stations;

One Master Station (No. 4 in example) is silent (like a Called Station);

One Master Station (No. 6 in example) hears sounds from the area of the silent Station (acts as an Originating Station);

At all other Master Stations, the Radio program is heard (operating as Not-Called Stations).

(4.1) When the power is turned-on, the various d-c voltages require a finite period before reaching their operating state, and while these voltages are changing, a spurious address may be originated by one of the Stations (in this example Station No. 6). The C address data bit line (RED) was addressed, and Station No. 4 was called.

(4.2) An END CALL (Ø) may be manually addressed at the originating Station, or the originating Station's Timer Z103 may be allowed to complete its single-cycle timing operation (in approximately 60 seconds ±20%) in order to end the call and return all Stations to their normal quiescent (intercom standby) mode. (See END OF CALL — MANUALLY OR AUTOMATIC, pages 28-30.)

(5) When the 16 Vac is initially connected, the BUSY indicator light D123 is turned on at all I-614 Master Stations.

One Station (No. 2 in Representative System) is silenced (acting like a Called Station), indicating that the BLU/W B data line is HI.

At all other Master Stations, the Radio program is heard. (Acting like Not-Called Stations)

This condition persists well beyond any Timer's single-cycle operation period.

(5.1) Measure logic state (voltage) at the BLU/W terminal on the I-600 Terminal Board, and at J201/P201-7. If HI at the BLU/W terminal but not at J201/P201-7, it is an indication that the PC path between these two points on the I-600 Terminal Board is open. Repair as necessary. See I-600 TERMINAL BOARD SERVICE NOTE, page 16.

(6) M-640 Radio's audio can not be heard at any Master Station, but is heard at the Radio's speaker.

(6.1) Check Radio's IW-8 cable wire connections at the I-600 Terminal Board, and at the M-640.

(6.1.1) Measure audio signal at ORN/W terminal in the M-640. Use low a-c or db scale on volt meter, if present at this Terminal, check at ORN/W terminal on the I-600 Terminal Board. Signal must be present at both terminals.

(6.1.2) If not present at either terminal, ORN/W wire may be shorted to BLK wire, or the Radio's audio voltage amplifier stage(s) may be faulty: Q401 and Q402 in original production units; Q402 in later production units.

(7) Master Station No. 4 originates a selective call to Station No. 2. All System functions are normal, except: Station No. 2 operates as a Not Called Station; and Station No. 3 operates as a Called Station.

(7.1) At the I-600 Terminal Board, check logic state on the BLU and BLU/W terminals. BLU should be LO and BLU/W should be HI.

(7.1.1) If both terminals are HI, it is an indication that the BLU and BLU/W wires have been shorted at some point in the System, and that the A data line has been added to the B data bit and Station No. 3 appears as the Called Station.

(7.1.1.1) Check resistance (continuity) of the BLU and BLU/W wires/terminals. See Figures 14(A) and 14(B), page 51. Clear short when located.

(7.1.2) If the correct terminal (BLU/W) is HI, and BLU is LO, as they should be. Check for transposition of these wires at the terminals of Master Station No. 2 and No. 3.

(7.1.2.1) Check Stations 2 and 3 identity wires, they must be connected to terminals 2 and 3 respectively of P1.

(8) An ALL CALL is made at Station No. 1 and this Station is intercom enabled as an Originating Station. (Its Z105's data outputs should go HI, i.e. it encodes the decimal 15 to a binary 15.)

Station No. 11 is intercom enabled as a Called Station.

All other Stations in the System are intercom enabled as Not Called Stations.

(8.1) When Station No. 11 is intercom enabled in the Called Station mode, its data line terminals D, B, and A (ORN/W; BLU/W; and BLU respectively) go HI.

(8.2) At Station No. 1, measure the logic state on the RED (C data line) terminal. Should be HI.

(8.2.1) If not HI, check C address data output at Z105-15.

(8.2.1.1) Z105-15 should be HI. If not HI, it is an indication that Z105 is faulty and needs replacement.

(8.2.1.2) If Z105-15 is HI, check continuity through Z103 and R105 to the RED terminal.

(8.2.2) If the RED terminal is HI, check the RED wire for opens. (In the Representative System, the open is between Stations 1, and 2.

(9) When a selective call is made, the Originating Station and the Called Station are intercom enabled in their regular manner. The other Stations are intercom enabled as Not Called Stations.

At the Originating Station, before the TALK BAR is activated, both intercom signals from the Called Station and the Radio audio are heard.

When the Talk Bar is activated at the Originating Station, intercom signals from the Originating Station and the Radio Audio are heard at the Called Station.

(9.1) This indicates a short between the ORN/W D data line (which also carries the Radio audio signals) and the BLK/W control line. Clear the short.

(10) When an intercom call is made, the intercom enable appears normal, i.e. the annunciator tone is heard at the Originating Station and at the Called Station; and the Radio audio continues at the Not Called Stations, but the intercom audio can not be heard at the Originating and Called Stations.

(10.1) This is generally an indication of a short between the BLK/W output line and the BLK circuit ground (VSS) line.

(10.1.1) When the M-640 Radio Receiver is installed in accordance with the original wiring instructions, the BLK/W wire from the M-640 should be connected to the BLK wire/terminal on the I-600 Terminal Board. In many cases, the BLK/W wire from the M-640 is connected to the BLK/W

terminal at the I-600. Since the M-640 BLK/W terminal is grounded, this will ground the System's BLK/W output line. (See paragraphs (5) through (5.5.2), page 36; and the I-600 Schematic Diagram, pages 59-61.)

(10.1.1.1) When the M-640 has been installed with the original 4-wire method, recommend that the Radio be connected through 3-wires, disconnect the BLK/W wire of the IW-8 cable between the I-600 and the M-640.

(10.2) If the BLK and BLK/W wires are actually shorted, the short should be located using the resistance (continuity) check and then cleared.

(11) When an intercom call is made, all Stations are intercom enabled in the regular manner. Audio signals from the Called Station are heard at the Originating Station. When at the Originating Station, the TALK BAR is activated, intercom signals from the Originating Station can not be heard at the Called Station.

(11.1) This is an example of a RED/W control line short to the BLK ground line. Locate and clear short. NOTE: Check the nut on the mounting screw at the lower right hand corner of the I-600 Terminal Board — make certain that the RED/W foil path is not shorted through the letter W and nut to chassis ground.

(12) When the Door Speaker is the Called Station, and it is in the TALK mode (Originating Station is in the LISTEN mode), intercom signals from the Door Speaker are accompanied by spurious noise (hum, buzz, etc.).

SEE REPRESENTATIVE SYSTEM: I-614 Master Station No. 10 is intercom enabled and intercom signals from this station are accompanied by spurious noise.

(12.1) Check the wiring to the Door Speaker (and/or to the external speaker with Station No. 10). These speakers must be connected to the System through the 22 ga. twisted-pair (NuTone IW-2), and the twist must be maintained throughout its length and as close to its connections as possible.

(13) If the integrity of the interconnecting wiring is proven, and mal-function(s) is/are present in the System, the fault probably lies in one or more of the individual products (I-600; I-614; I-650; M-640; 301-N) that make up the System.

(14) The System cycles off and on.

(14.1) Indicates an overload on the 120/16Vac 301-N Power Transformer. The heat sensitive automatic reset overload protector in the 301-N will open with a rise in transformer temperature, that is the result of an excessive current drain. The overload protector will close, turning the set on, when the transformer temperature falls.

(14.2) Excessive current will be drawn if there is a dead short in the ORN B+ circuit, or if there is a resistive short such as a leaking filter capacitor.

(14.3) Determine whether the mal-function is in the I-600, or in the ORN B+ circuit elsewhere in the System.

(14.3.1) Disconnect the ORN B+ wire(s) from the ORN terminal on the I-600 Terminal Board.

(14.3.2) With the 16Vac connected to the AC terminals at the I-600, measure B+ at the ORN terminal, should read and maintain the regulated 15Vdc.

(14.3.3) If transformer cycles with only the I-600 connected, check the bridge rectifier; voltage regulator; filter capacitor(s); D209; RV202; etc.

(14.3.3.1) When checking the voltage regulator Z205, make certain that the correct filter capacitor(s) is/are used. See MODEL I-600 CENTRAL POWER SUPPLY REGULATED +15VDC (B+), paragraphs (3) through (5), page 13.

(14.4) If the I-600 operates correctly, look for shorts, etc. in the ORN B+ branches.

(14.4.1) EXAMPLE, use Representative System, pages 55/56.

(14.4.2) Connect the ORN wire, of the IW-8 cable to the M-640 Radio Receiver, to the ORN terminal on the I-600 Terminal Board. The voltage on this terminal should be maintained at the regulated +15Vdc. If voltage is low and/or the 301-N cycles, check the M-640 for shorts; filter capacitors, etc.

(14.4.3) Connect the ORN wire, of the IW-8(X) cable, to the ORN terminal on the I-600 Terminal Board. The voltage on this terminal should be maintained at +15 Vdc. If the voltage decreases, and/or if the 301-N cycles, check the wiring and products in this branch. Paying particular attention to the connections at the ORN terminals in the I-614's, check the filter capacitors C122, C124, C125 in suspected I-614's.

(14.4.4) Connect the ORN wire, of the IW-8(Y) cable, to the ORN terminal on the I-600 Terminal Board, and check through as instructed above.

(15) When a mal-functioning I-614 Master Station is suspected, the Station can be checked for Originating; Called; and Not Called operation with the MASTER STATION TO MASTER STATION CHART, pages 17-19.

(15.1) This check should be made in conjunction with the I-614 PC Layout and Schematic Diagram, pages 62-67.

(15.2) The operation of the individual integrated circuits (CMOS and Linear) can be determined by checking the SPECIAL DEVICES section, pages 7-12.

BENCH SERVICING

MODEL I-600 CENTRAL POWER SUPPLY/DOOR SPEAKER CONTROL (Reference Pages 13-16)

(See PC Layout and Schematic Diagram, Pages 57-61.)

(1) Remove cover.

(2) On the PC Board, connect the Door Speaker identity wire to a single-bit Address Terminal, i.e., either No. 1, 2, 4, or 8.

(2.1) Address Terminal No. 1 is on P202.

(2.2) Address Terminals 2, 4, and 8 are on P203.

(3) Connect a NuTone Door Speaker — via 22 ga. twisted-pair (NuTone IW-2), to the DOOR TERMINALS on the I-600 Terminal Board. (Paragraph (24.3), page 15)

(3.1) If a NuTone speaker is not available, use any 8-16-ohm permanent-magnet speaker.

(4) Check the color-coded resistance, compare with the Charts, Figures 14(A) and 14(B), page 51.

(5) If resistance measurements are as specified, connect the 16Vac output of a NuTone Model 301-N Transformer to the AC terminals on the

I-600 Terminal Board. Connect primary of Transformer to 120Vac, 60 Hz.

(6) Make quiescent (intercom standby) voltage measurements at the terminals. Readings should agree with those shown under column heading "VOLTAGE* (LOGIC STATE)" in Figure 15, page 52.

(7) CHECK DYNAMIC OPERATION: Connect a wire between the ORN B+ terminal and the data bit terminal that corresponds to the assigned address number of this Door Speaker's identity terminal. (See paragraph (2) above and the Decoder's Chart with Schematic Diagram.)

(7.1) The T/L Relay Q201 should be energized and switched to the TALK position (Called Station operation).

(7.2) Connect a low-range a-c voltmeter, db meter, or oscilloscope across the DOOR terminals and speak into the Door Speaker (paragraph (3) above). Meter or scope should show level of the TALK intercom audio signal.

(7.3) Connect the meter or scope between the BLK/W OUTPUT and BLK VSS terminals — use a higher range than that used in paragraph (7.2) above. Talk into the speaker and note the audio level in comparison with that read across DOOR terminals. Should be much greater. At maximum audio level, will read approximately 14 Vpp.

(7.4) Connect a wire between the ORN B+ and RED/W CONTROL terminals. The Control line should go HI; Z201B-13 should go LO; Q201 turned off; and the T/L Relay Q201 will be deenergized and switched to the LISTEN mode.

(7.5) Insert an audio signal (audio oscillator, etc.) between the BLK/W OUTPUT and BLK VSS terminals. Signal should be heard at the Door Speaker and its volume can be controlled by DOOR SPKR VOLUME CONTROL R229.

(8) Remove the wire between the ORN B+ and RED/W CONTROL terminals. Control Line goes LO, Z201B-13 goes HI; Q201 is turned on; and the T/L Relay is energized and switched to the TALK mode.

(8.1) Remove the jumper between the ORN B+ and data bit terminal (paragraph (7) above). All data inputs to Z206 should be LO; all Z206 outputs S1-S15 should be LO; Z206-11 (SØ) should go HI; Q201 is turned off; and K201 is deenergized and switched to its quiescent LISTEN position.

MODEL I-614 MASTER STATION
(Reference Pages 17-19 and Pages 20-35)

(See PC Layout and Schematic Diagram, Page 62-67)

(1) If an I-600 is available when an I-614 requires "Bench Service," connect a run of IW-8 cable between the I-614 and the I-600 Terminal Board. Observe color-code.

(2) At the I-600, connect the Door Speaker Identity wire to a single-bit Address Terminal at P202 or P203, i.e. to Address No. 1, 2, 4, or 8.

(3) At the I-614 connect the Master Station Identity wire to a single-bit Address Terminal at PI. Do not use the same Address No. that is used for the Door Speaker Identity.

(4) Connect a NuTone Door Speaker — via 22 ga. twisted-pair cable (NuTone IW-2) — to the DOOR TERMINALS on the I-600 Terminal Board.

(4.1) If a NuTone speaker is not available, use any 8-16-ohm permanent magnet speaker.

(5) Make Terminal/Wire resistance measurements as directed on page 51, and compare with the Charts, Figures 14(A) and 14(B).

(6) If resistance measurements are as specified, connect the 16Vac output of a NuTone Model 301-N Transformer to the AC terminals on the I-600 Terminal Board. Connect primary of Transformer to 120Vac, 60 Hz.

(7) Make quiescent (intercom standby) voltage measurements at the terminals on the I-600 Terminal Board and at the I-614 terminals. Readings at both units should agree with those shown under column heading "VOLTAGE* (LOGIC STATE)" in Figure 15, page 52.

(8) CHECK DYNAMIC OPERATING VOLTAGE AND LOGIC STATES: At the I-614 Master Station, originate a call to the Door Speaker and complete TALK/LISTEN functions while checking the dynamic measurements against those shown under column heading "REMARKS" in Figure 15.

(9) When the I-614 requires "Bench Service" and a Model I-600 is not available:

(9.1) Connect its Identity Wire to one of the single-bit Address Terminals on PI. (1, 2, 4, or 8)

(9.2) Connect a 470 Kohm resistor between the ORN/W D (RADIO) screw-terminal and the common ground screw-terminal.

(9.3) Connect a 22 Kohm resistor between each of the other data screw-terminals (RED C; BLU/W B; and BLU A) and the common ground screw-terminal. (Three 22 Kohm resistors required.)

(9.4) Connect a 100 Kohm resistor between the CONTROL screw-terminal and the common ground screw-terminal.

(9.5) Connect a 560 ohm resistor between the OUTPUT screw-terminal and the common ground screw-terminal.

(9.6) NOTE: The ground side of each of these resistors may be spliced together and then connected to the common ground screw-terminal through one-wire.

(9.7) The resistors (paragraphs (9.2) through (9.5) above) simulate the grounding resistors for these lines that are normally located in the I-600.

(9.8) Complete terminal resistance (continuity) check, and compare readings with the Charts, Figures 14(A) and 14(B), page 51.

(9.9) Connect a regulated +15Vdc supply to the ORN B+ screw-terminal. Connect the ground (common) of the 15V supply to the common ground screw-terminal.

(9.9.1) Connect a 10"-12" OPTEST wire to the ORN B+ screw-terminal. This wire will be used during operational testing of the unit.

(9.10) Make quiescent (intercom standby) voltage measurements and compare values with those under column heading "VOLTAGE* (LOGIC STATE)" in the Chart, Figure 15, page 52.

(9.11) DYNAMIC TESTING — ORIGINATING STATION:

(9.11.1) CHECK ADDRESS ENCODING OF Z105: Originate an ALL CALL — press-in and release ALL (No. 15) on the address switch pad. All address data screw-terminals should go HI; measure with voltmeter. Annunciator tone should be heard and the BUSY indicator light D123 should be turned on. CONTROL LINE terminal should be LO.

(9.11.2) END CALL: Allow unit to remain in originating mode until automatic timer completes its single-cycle operation (60 seconds ± 20%), or activate END (Ø) address button. All data terminals should go LO; BUSY light should be turned off; and CONTROL LINE terminal should remain LO.

(9.11.3) Originate a call to any other address, its corresponding data line terminal(s) should go HI. See the TRUTH TABLE, page 64. Annunciator tone is heard; BUSY light comes ON, and CONTROL LINE terminal remains LO.

(9.11.4) Activate TALK/LISTEN switch (Press-in and hold TALK BAR), T/L Relay should be switched to TALK mode; CONTROL LINE terminal should go HI.

(9.11.4.1) Talk into the Station's speaker, intercom audio signal may be measured with low-range ac meter; db meter; or oscilloscope connected between the OUTPUT terminal and the common ground terminal.

(9.11.5) Release the TALK BAR, T/L Relay should return to its LISTEN position; CONTROL LINE terminal should go LO.

(9.11.6) Insert an audio signal (from audio oscillator, signal generator, etc.) between the BLK/W OUTPUT terminal and the BLK common ground terminal. The signal should be heard through Station's speaker.

(9.11.7) END CALL: See paragraph (9.11.2) above.

(9.12) DYNAMIC TESTING — CALLED STATION:

(9.12.1) Connect the OPTEST wire from the ORN terminal to the data terminal that corresponds to the Address No. that is assigned this Station. (See paragraph (9.1) above.)

(9.12.1.1) The annunciator tone should be heard; the BUSY indicator light should be turned on; the T/L Relay should be energized and switched to the TALK mode.

(9.12.2) Talk into the speaker, and measure the audio signal between the OUTPUT and common ground terminals. (See paragraph (9.11.4.1) above.)

(9.12.3) Connect a jumper between the ORN B+ terminal and the RED/W CONTROL terminal. The Relay should be deenergized and switched to the TALK mode.

(9.12.4) Remove the jumper at the CONTROL terminal, and the OP TEST wire from the data terminal. The BUSY indicator light should be turned off; the T/L Relay deenergized and switched to its normal quiescent LISTEN mode.

(10) When making any one of the tests above, the level of every GATE, Switch, etc. can be checked against the operating chart, pages 17-19.

(11) LOW VOLTAGE OPERATION: When possible, reduce the B+ to 9Vdc and carry out the complete dynamic operating checkout as directed above.

MODEL M-640 AM/FM RADIO RECEIVER
(Reference Pages 36-49)

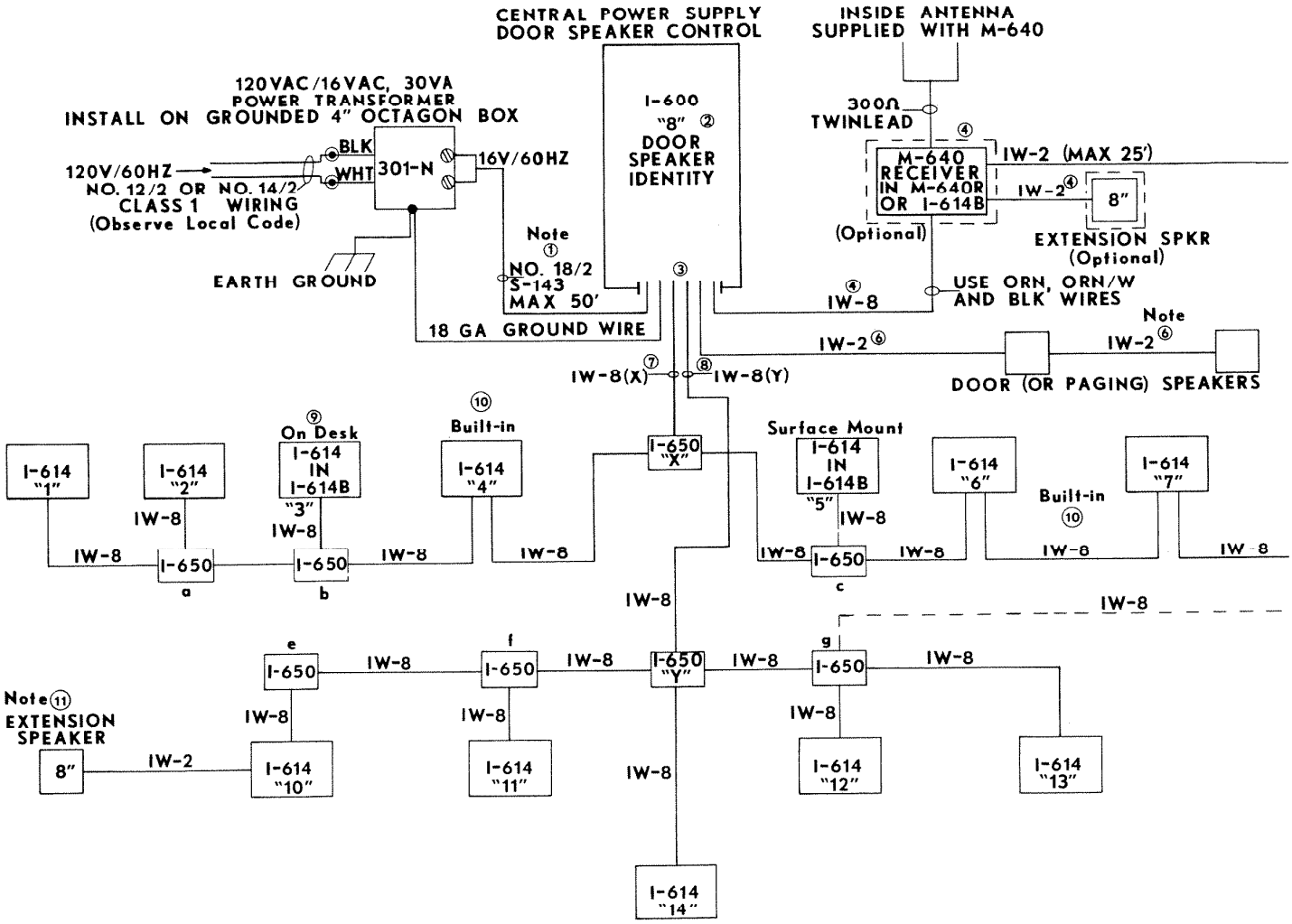
(ORIGINAL PRODUCTION: PC Layout and Schematic Diagram, Pages 68-72)
(NEW PRODUCTION: PC Layout and Schematic Diagram, Pages 73-77)

(1) Connect a 12-15 Vdc regulated supply to the ORN B+ terminal. Connect the common (ground) from the supply to the BLK ground terminal.

(2) Connect an antenna to the antenna terminals on the amplifier PC board.

(3) Check operation. Measure output signal between the ORN/W and BLK terminals. Use low range ac meter; db meter; or oscilloscope.

(4) If alignment is required, use the correct instruction: Pages 46/47 for original production unit; pages 48/49 for later production units.



SELECTIVE CALL REPRESENTATIVE SYSTEM WIRING DIAGRAM

INSTALLATION NOTES:

① When the 16V/60Hz power cable between the 301-N Power Transformer's secondary and the I-600's Terminal Board exceeds 50 feet, a larger wire should be used. For runs up to 125 feet, use No. 14/2 cable.

② When System includes eight (8) or more Stations (including Door or Paging Speaker(s), suggest that Identity Number "8" be used for the Door Speaker Control.

③ Interconnecting wires and cables to the I-600 should enter unit through the grommet in bottom of chassis cover.

④ When the M-640 Receiver is connected to the System at the I-600, the IW-8 cable should not exceed 1,000 feet. (See paragraphs (11)-(11.1), page 21, and paragraphs (4) through (5.5.2), page 36.)

For extension speaker(s) and Background Music Speaker connections, see pages 44 and 45.

⑤ When IMA-516 is used as Background Music Amplifier, it must be powered by its own individual Model 301-N Power Transformer. (See IMA-516 Installation Instructions.)

⑥ MAINTAIN TIGHT TWIST IN DOOR SPEAKER WIRING. KEEP WIRE RUN AS SHORT AS POSSIBLE.

⑥ A maximum of 250 feet of cable (NuTone IW-2) may be used to one Door (or Paging) Speaker.

When two speakers are parallel-common connected on one run of cable, a maximum of 125 feet of cable may be used.

If an individual run of IW-2 is used to each of two speakers, each run may be a maximum of 125 feet.

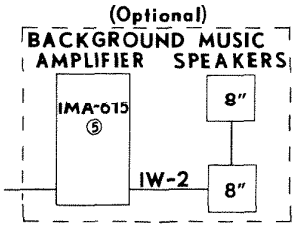
⑦ ⑧ The IW-8(X) run of cable between the I-600 and I-650(X), and the IW-8(Y) run of cable between the I-600 and I-650(Y) should be as short as possible. (See paragraphs (4) through (4.2), page 50.)

⑨ When the I-614 and the M-640 are set on a desk or table, they should be installed in the Model I-614B Base. (See paragraphs (7) through (8.1), page 50.)

⑩ The IW-8 should be loop connected only at built-in I-614 Master Stations which are installed in the Model I-614R Rough-in Frames.

⑪ For extension speakers used with the I-614 Master Station, see page 35.

⑫ When the M-640 Receiver is connected to the System at a Model I-650 Terminal Block, the maximum cable (IW-8) between the M-640 and the I-600 should not exceed 50 ft.

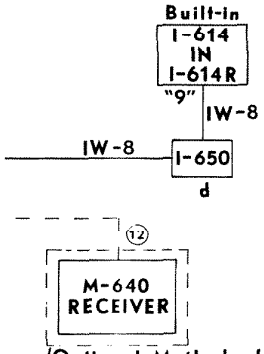


NOTICE

TO AID IN REDUCING HUM AND BUZZ PICKUP FROM A.C. POWER CIRCUIT — LIGHT DIMMERS, ETC., THE SYSTEMS IW-8 AND IW-2 CABLES SHOULD, WHEN POSSIBLE, BE RUN AT LEAST 12 INCHES FROM ANY A.C. POWER WIRING, ESPECIALLY WHEN CABLES ARE RUN PARALLEL WITH THE A.C. POWER WIRING.

CONSISTENT WITH SUFFICIENT WIRING FOR MAKING CONNECTIONS AT THE VARIOUS COMPONENTS, ALL CABLE RUNS SHOULD BE AS SHORT AS POSSIBLE.

THE SYSTEM'S TOTAL IW-8 CABLE — BETWEEN THE I-600; ALL I-650'S AND ALL I-614'S — SHOULD NOT EXCEED 1,000 FEET.



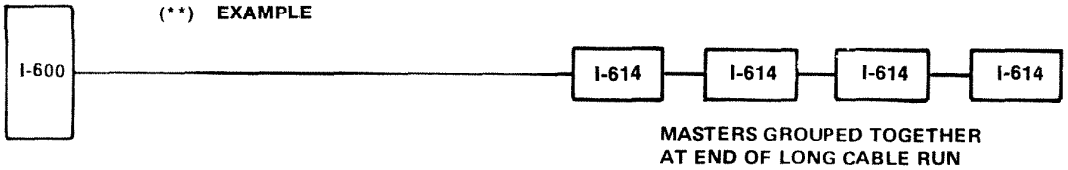
(Optional Method of Installation. Antenna; Extension Speaker; and Backgrond Music Components should be installed as shown above.)

MAXIMUM LENGTH IN FEET OF IW-8 CABLE RUNS BETWEEN I-600 AND I-614'S

NO. OF MASTERS ON CABLE RUN	MASTER STATIONS RANDOM SPACED OR CLUSTER INSTALLED	I-600 and I-614'S EVENLY SPACED ON IW-8 CABLE RUN	
	MAXIMUM LENGTH OF IW-8 CABLE RUN	MAXIMUM LENGTH OF IW-8 CABLE RUN I-600 TO ALL I-614'S	MAXIMUM LENGTH OF IW-8 CABLE LINE BETWEEN I-600 AND I-614'S
2	835	1000	500*
3	625	858	286
4	470**	684***	171
5	374	575	115
6	312	600	84
7	266	497	71

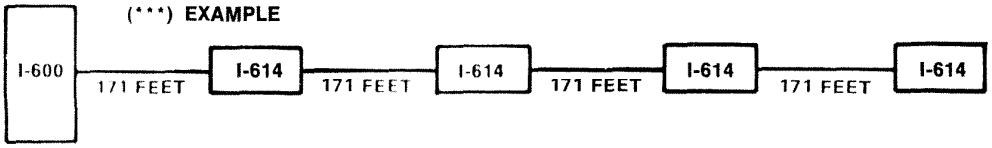
NOTE: (*) The lengths shown here are maximums: Any length under the maximum may be used but the cable saved in one link cannot be added to another link.

470 FEET MAXIMUM

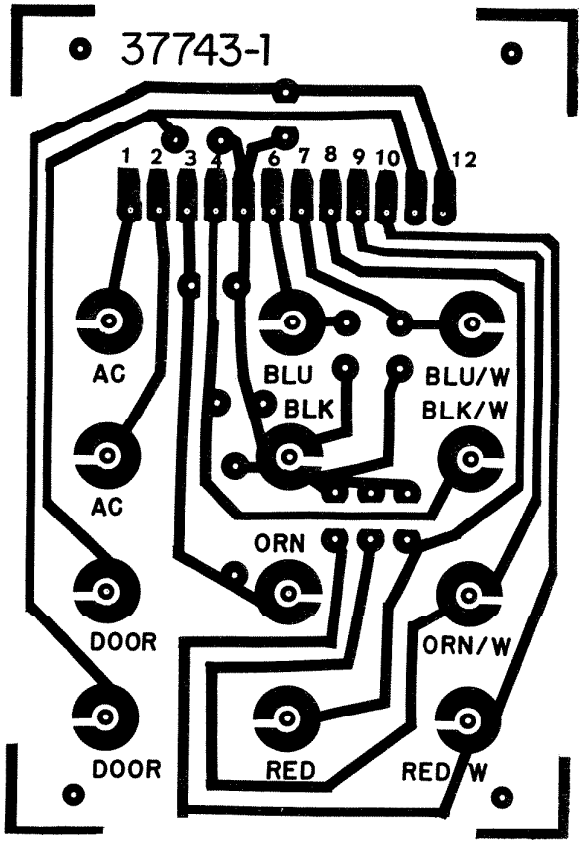


MASTERS GROUPED TOGETHER AT END OF LONG CABLE RUN

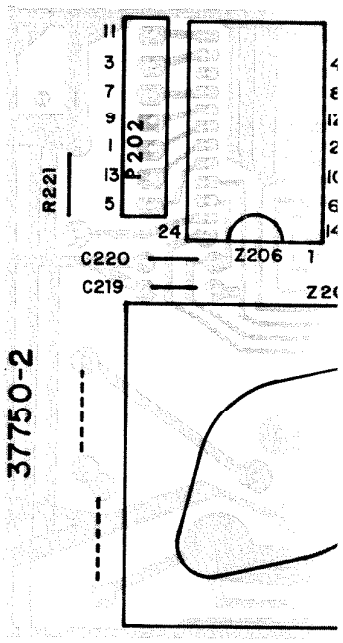
684 FEET MAXIMUM

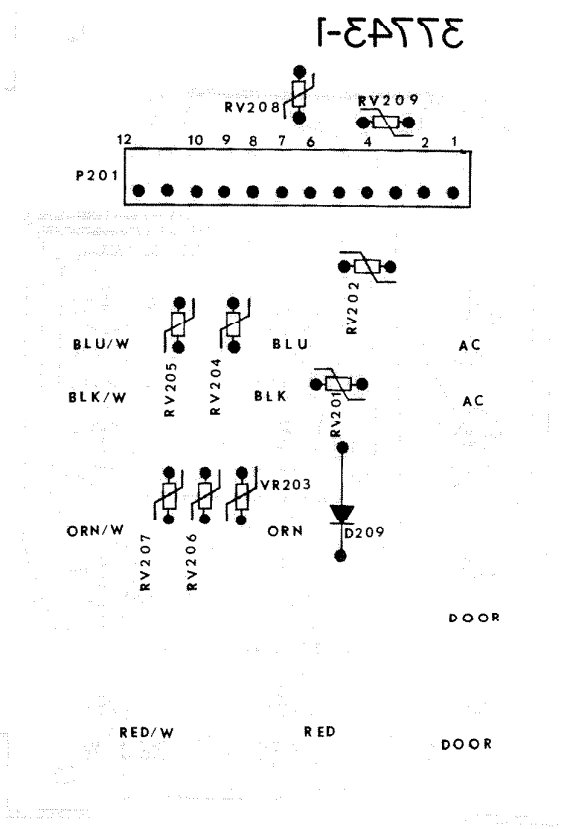


MASTERS EQUALLY SPACED ALONG THE CABLE RUN

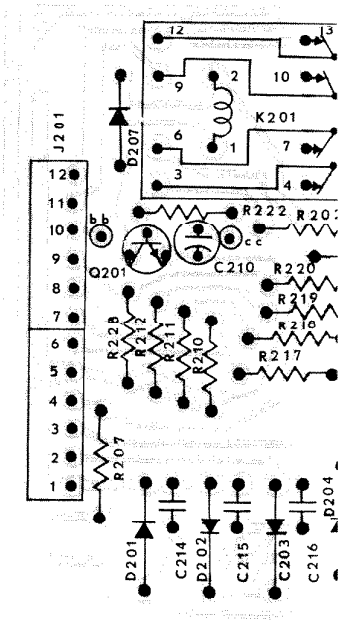


(TOP VIEW)

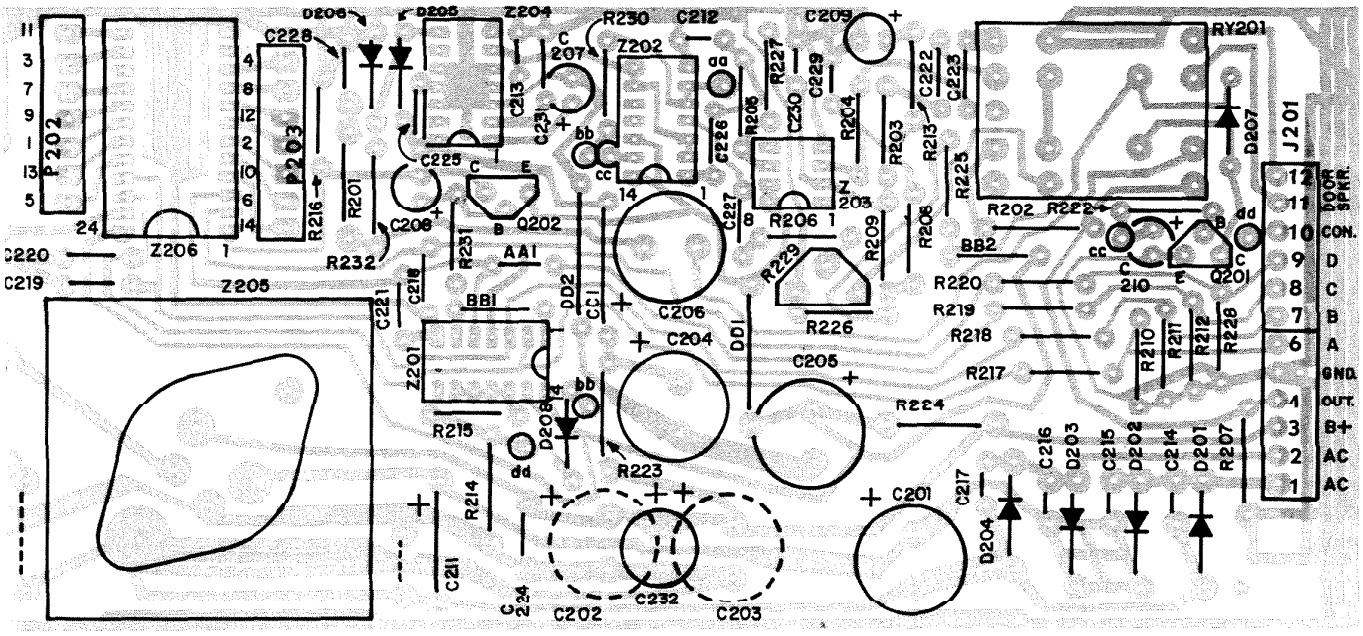


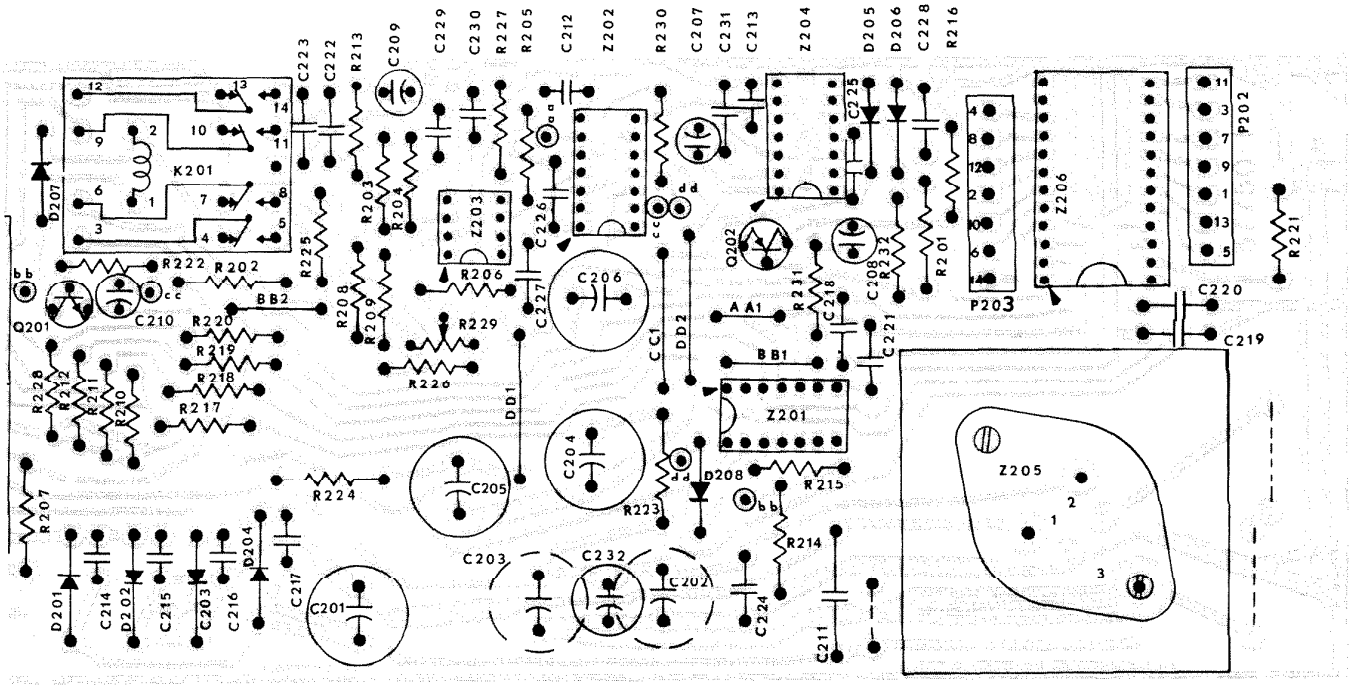


(BOTTOM VIEW)



MODEL I-600 CENTRAL POWER SUPPLY AND DOOR SPEA





Y AND DOOR SPEAKER CONTROL

DATA IN DECODER TERMINALS AND ADDRESS BITS*				DECODED DATA OUT RECEIVER TERMINAL NORMALLY LO GOES HI	ADDRESS NUMBER OF STATION CALLED NORMALLY LO GOES HI
2	3	21	22		
D	C	B	A		
LO	LO	LO	LO	11	END OF CALL (0)
LO	LO	LO	HI	18	1
LO	LO	HI	LO	7	2
LO	LO	HI	HI	14	3
LO	HI	LO	LO	10	4
LO	HI	LO	HI	20	5
LO	HI	HI	LO	5	6
LO	HI	HI	HI	16	7
HI	LO	LO	L0	9	8
HI	LO	LO	HI	17	9
HI	LO	HI	LO	6	10
HI	LO	HI	HI	13	11
HI	HI	LO	LO	8	12
HI	HI	LO	HI	19	13
HI	HI	HI	LO	4	14
HI	HI	HI	HI	15	ALL CALL (15)

NOTE: In Nutone's I-600/I-614 Selective Call Intercom application, the Input Address Data Bits "A," "B," "C" and "D" and corresponding Integrated Circuit Terminals are reversed from those shown for the MC14514B in the Motorola CMOS Manual. USE THE ABOVE TABLE WHEN SERVICING THE I-600 and I-614.

The "HI" and "LO" logic state notation is used in keeping with the method used in this manual:

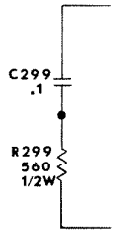
LO = standard binary logic "0" (=VSS)

HI = standard binary logic "1" (=VDD)

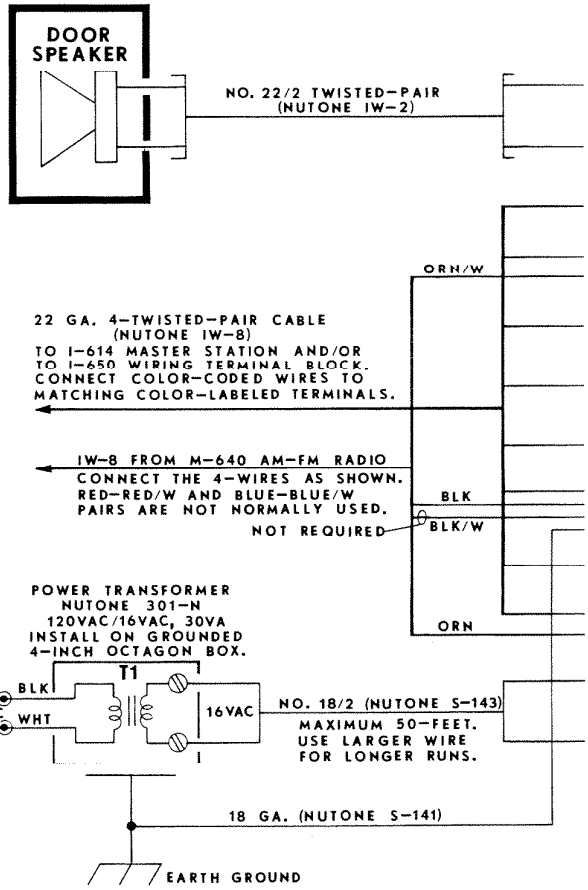
The MC14514B Receiver/4-Bit Decoder converts the 4-bit binary address to the decimal number of the station that is being called.

TRUTH TABLE
MC14514B RECEIVER/4-BIT DECODER
(As used in NuTone I-600/I-614)

When M-640 Receiver is NOT used in System, C299 and R299 must be connected between ORN/W and BLK screws on TERMINAL BOARD. (See pages 16 and 37.)



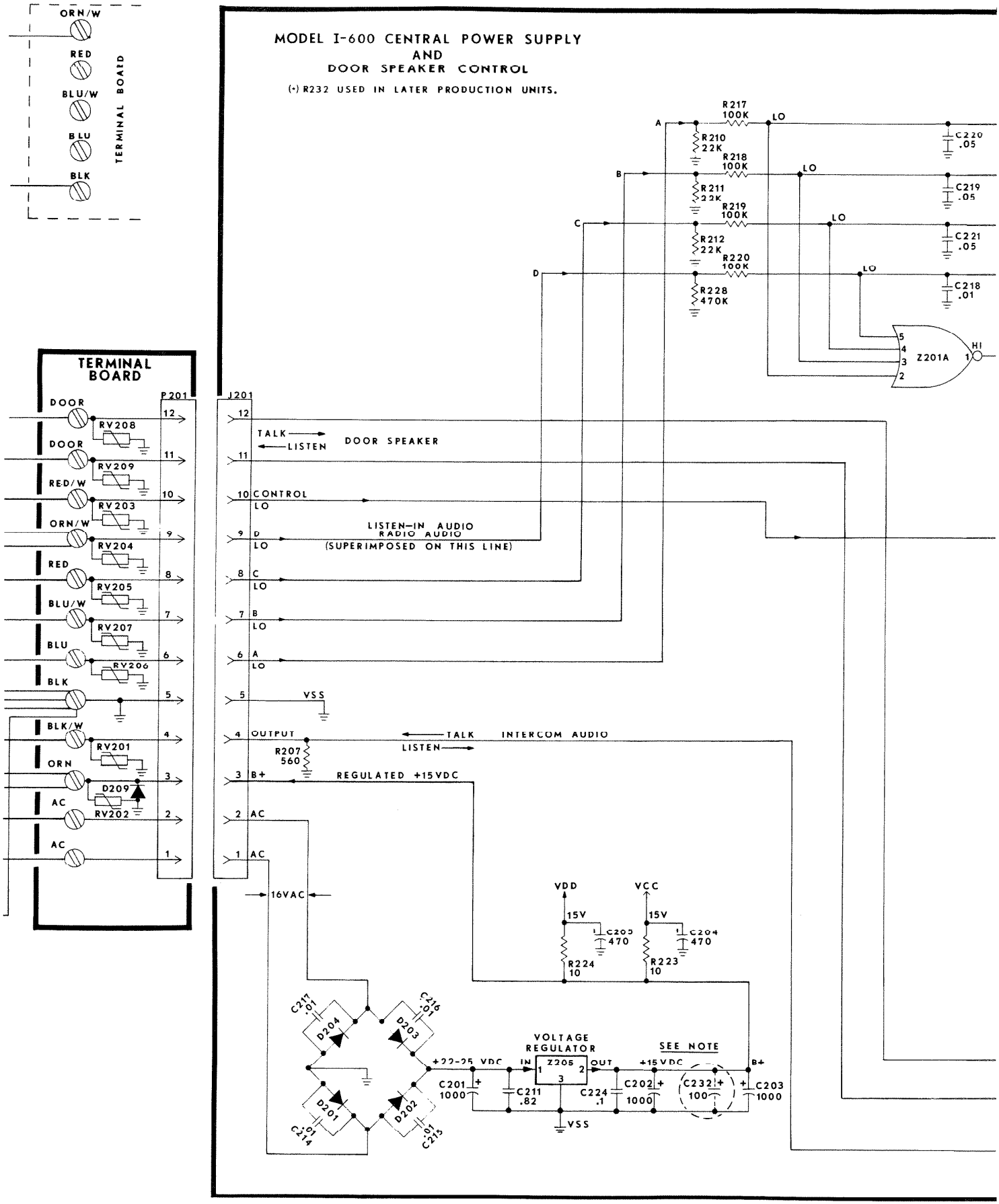
NOTE:
Latest Installation Instructions direct that the BLK/W wire of the IW-8 Cable from the M-640 to the BLK terminal on the TERMINAL BOARD is NOT required. (See page 36.)



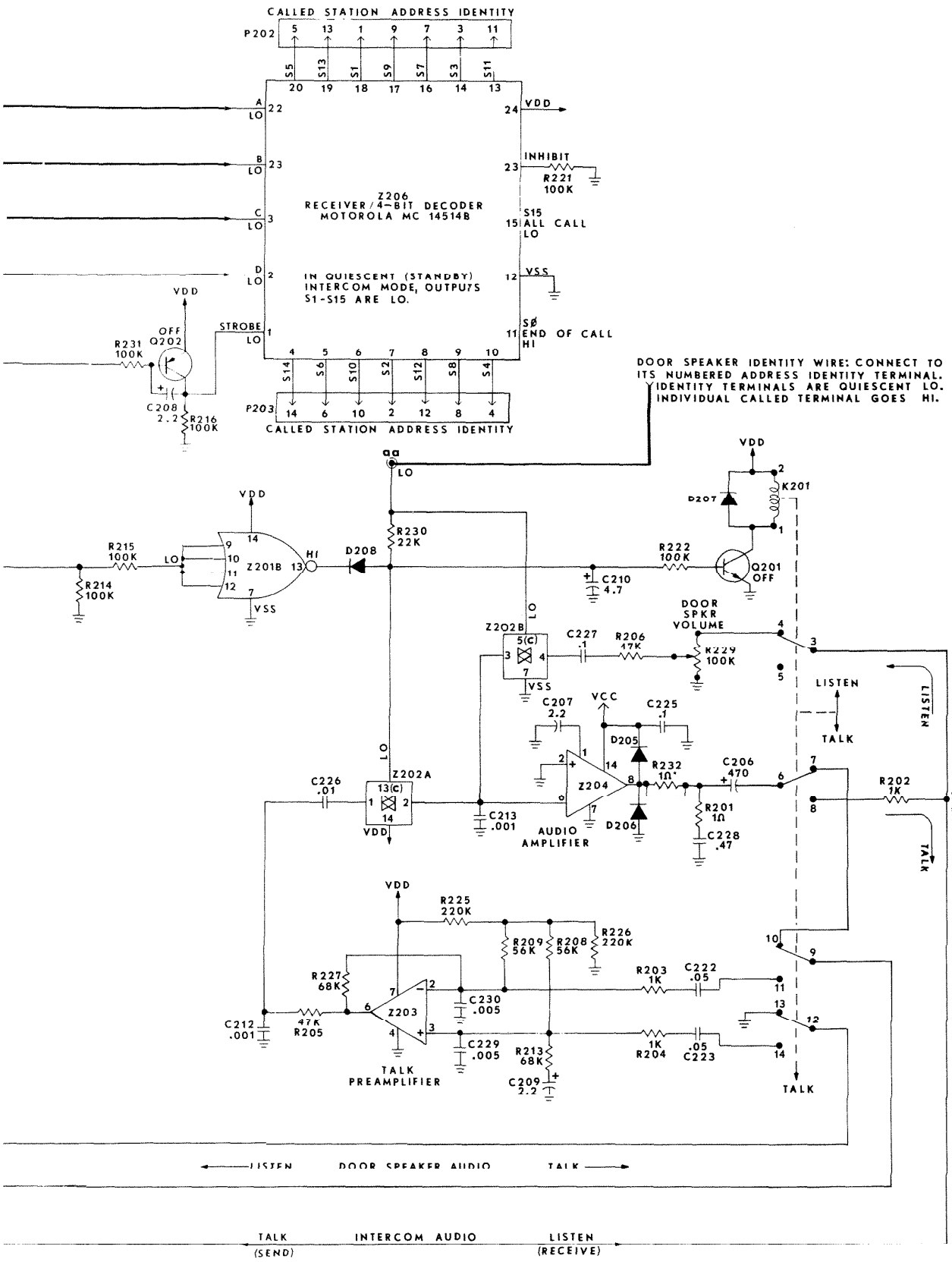
NOTE: VOLTAGE REGULATOR Z205

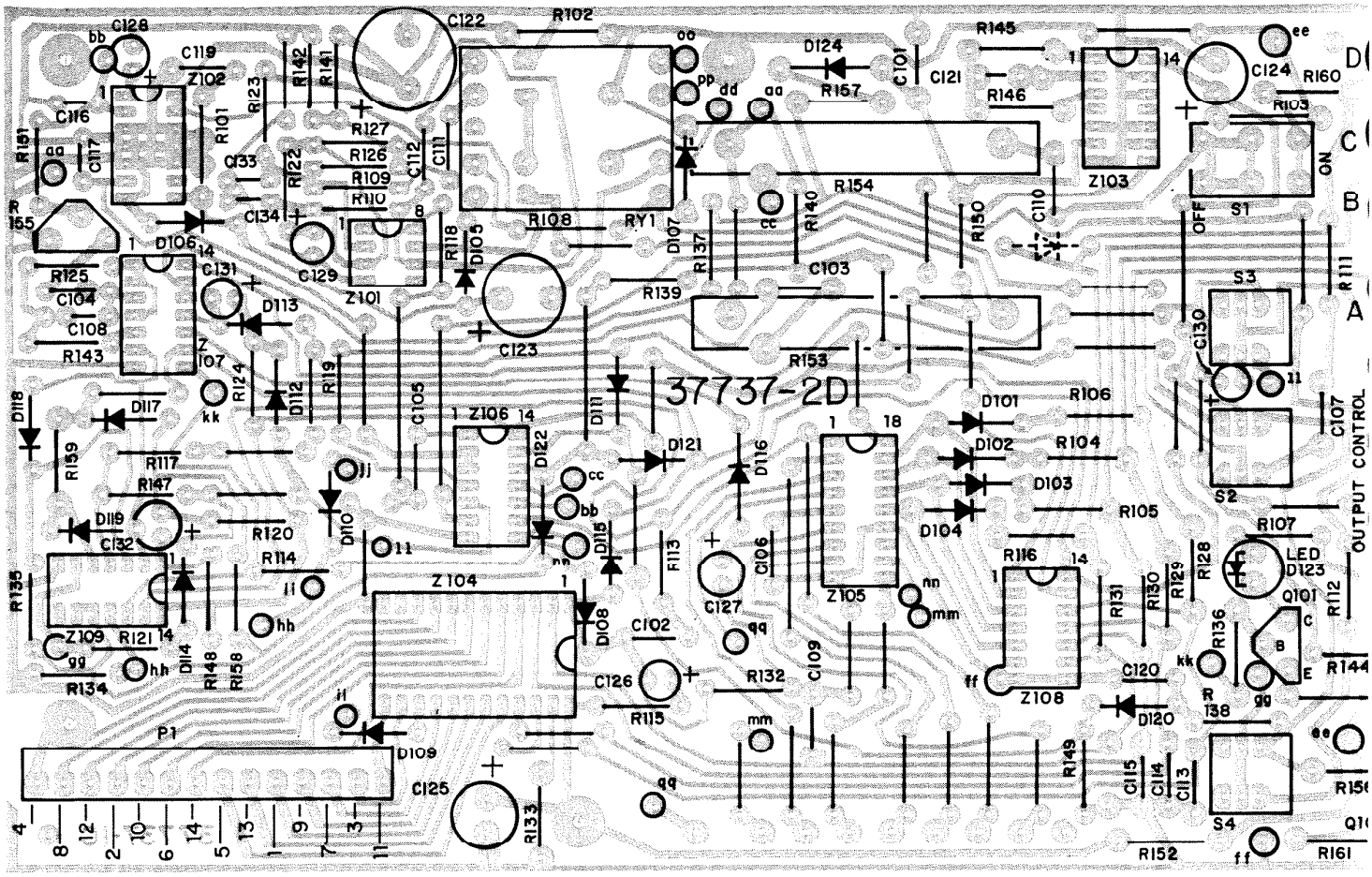
EARLY PRODUCTION – WITH NUTONE PART NO. 36717-000 (FAIRCHILD TYPE A78H15SC) THE 1000 µf FILTER CAPACITORS C202 AND C203 MUST BE USED.

LATER PRODUCTION – WITH NUTONE PART NO. 36720-000 (LAMBDA TYPE LAS 1415) THE 100µf FILTER CAPACITOR C232 MUST BE USED.



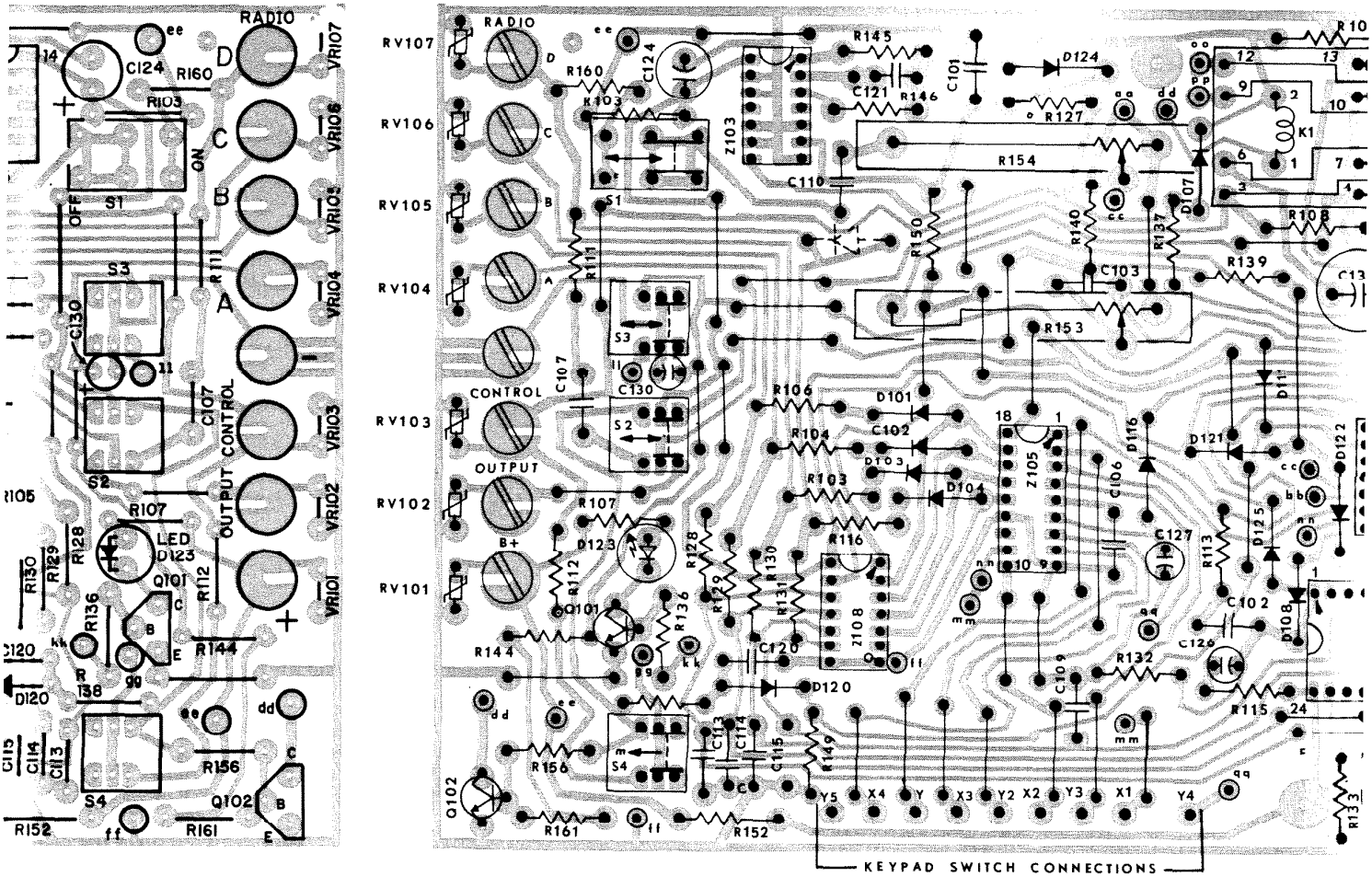
MODEL I-600 CENTRAL POWER SUPPLY AND DOOR SPEAKER CONTROL


CALLED STATION ADDRESS IDENTITY
P202
Z206
RECEIVER/4-BIT DECODER
MOTOROLA MC 14514B
IN QUIESCENT (STANDBY) INTERCOM MODE, OUTPUTS S1-S15 ARE LO.
INHIBIT
R221 100K
S15 ALL CALL LO
S∅ END OF CALL HI
VDD
VSS
OFF Q202
R231 100K
C208 2.2
R216 100K
STROBE
P203
CALLED STATION ADDRESS IDENTITY
DOOR SPEAKER IDENTITY WIRE: CONNECT TO ITS NUMBERED ADDRESS IDENTITY TERMINAL. IDENTITY TERMINALS ARE QUIESCENT LO. INDIVIDUAL CALLED TERMINAL GOES HI.
R215 100K
R214 100K
Z201B
D208
R230 22K
C210 4.7
R222 100K
Q201 OFF
D207
K201
Z202B
C227 .1
R206 47K
DOOR SPKR VOLUME
R229 100K
LISTEN
TALK
C207 2.2
VCC
C225 .1
D205
Z204
R232 1Ω
C206 470
R201 1Ω
C228 .47
D206
AUDIO AMPLIFIER
Z202A
C226 .01
C213 .001
R202 1K
OUTPUT LINE
R225 220K
R209 56K
R208 56K
R226 220K
R227 68K
R203 1K
C222 .05
Z203
C230 .005
C212 .001
47K R205
C229 .005
R213 68K
C209 2.2
R204 1K
C223 .05
TALK PREAMPLIFIER
DOOR SPEAKER AUDIO
INTERCOM AUDIO
TALK (SEND)
LISTEN (RECEIVE)



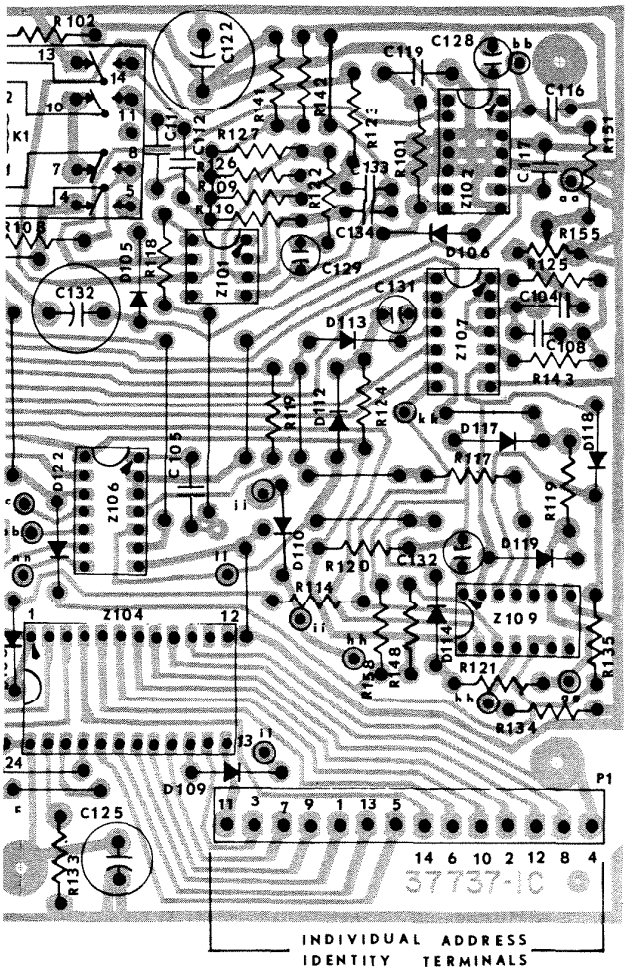
TOP (FRONT) VIEW

MODEL I-614



BOTTOM (REAR) VIEW

MODEL I-614 MASTER STATION PC BOARD LAYOUT



KEYPAD PUSHBUTTON ADDRESS NUMBER OF STATION CALLED	CONNECTIONS MADE		OUTPUT DATA ENCODER TERMINALS AND ADDRESS BITS*			
	MATRIX ROW/COLUMN	ENCODER TERMINALS	14 D	15 C	16 B	17 A
(0) END CALL	Y1/X1	1/11	LO	LO	LO	LO
1	Y1/X2	1/10	LO	LO	LO	HI
2	Y1/X3	1/8	LO	LO	HI	LO
3	Y1/X4	1/7	LO	LO	HI	HI
4	Y2/X/1	2/11	LO	HI	LO	LO
5	Y2/X2	2/10	LO	HI	LO	HI
6	Y2/X3	2/8	LO	HI	HI	LO
7	Y2/X4	2/7	LO	HI	HI	HI
8	Y3/X1	3/11	HI	LO	LO	LO
9	Y3/X2	3/10	HI	LO	LO	HI
10	Y3/X3	3/8	HI	LO	HI	LO
11	Y3/X4	3/7	HI	LO	HI	HI
12	Y4/X1	4/11	HI	HI	LO	LO
13	Y4/X2	4/10	HI	HI	LO	HI
14	Y4/X3	4/8	HI	HI	HI	LO
(15) ALL CALL	Y4/X4	4/7	HI	HI	HI	HI

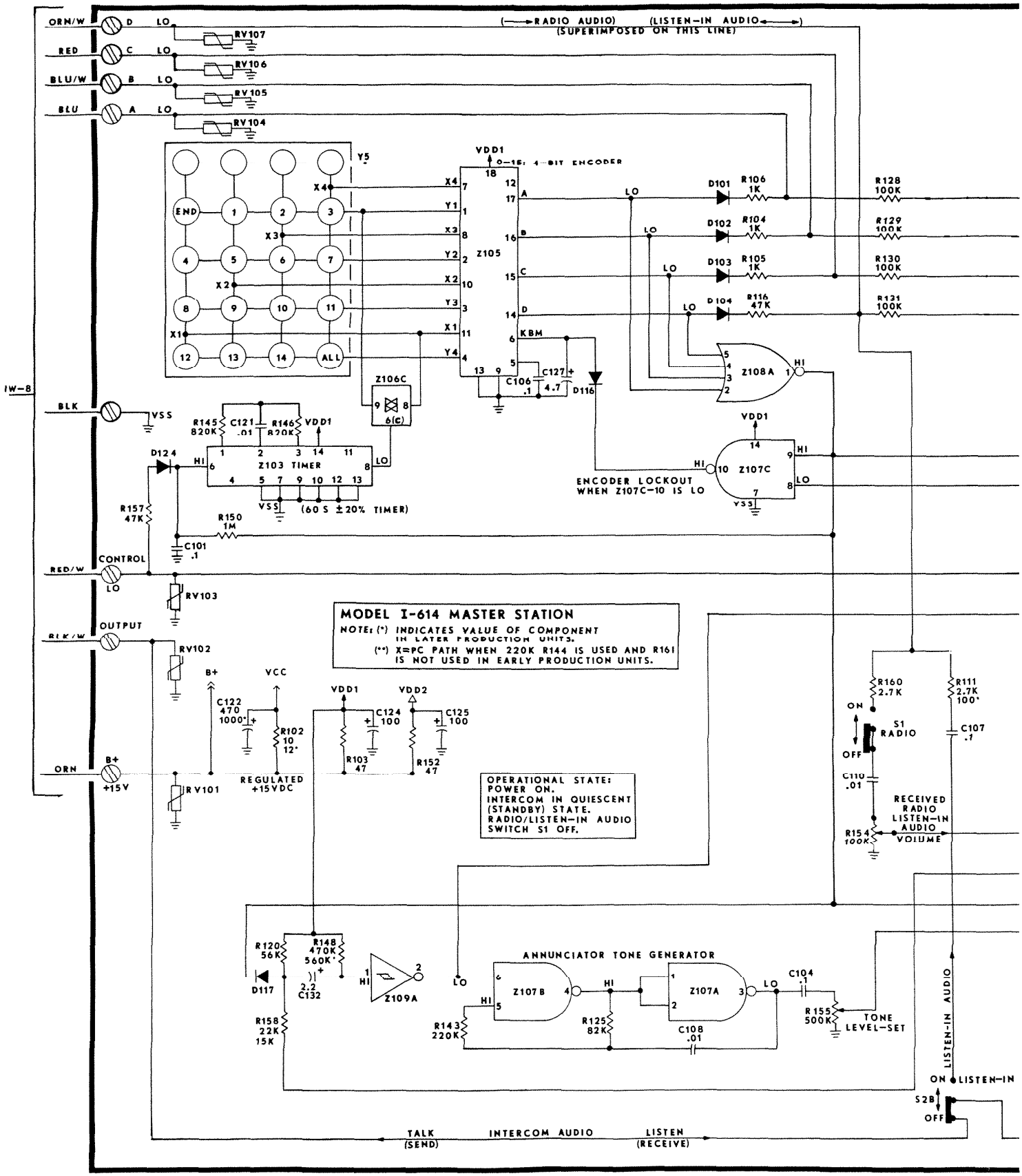
NOTE: The "HI" and "LO" logic state notation is used in keeping with the method in this manual:

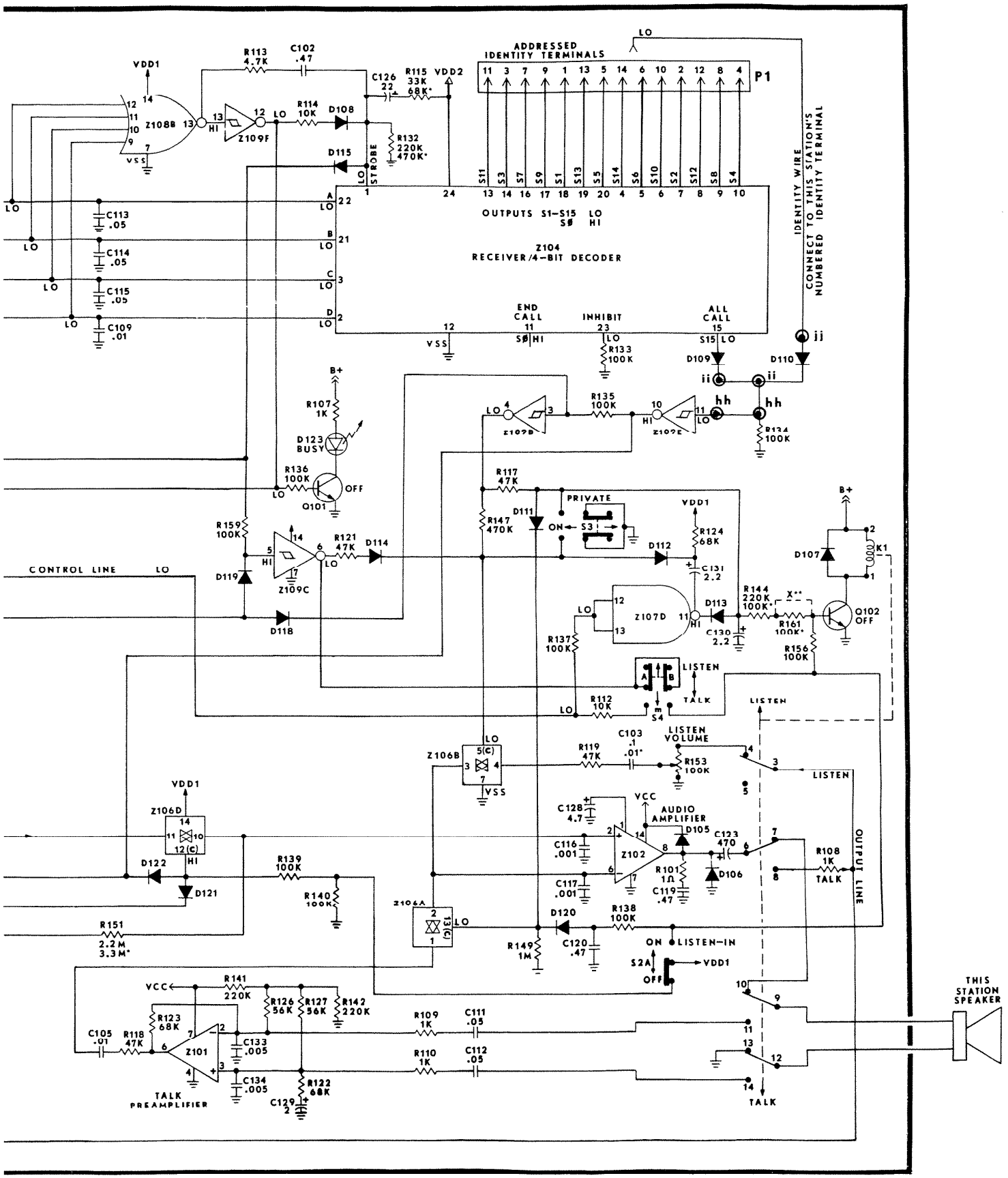
LO = standard binary logic "0" (=VSS)

HI = standard binary logic "1" (=VDD)

The National MM74C922 0-15/4-Bit Encoder converts the address decimal number of the station being called to a 4-bit binary address.

TRUTH TABLE
MM74C922 0-15/4-BIT ENCODER
(As used in NuTone I-614)


ORN/W
RED
BLU/W
BLU
BLK
RED/W
BLK/W
ORN
RV107
RV106
RV105
RV104
(RADIO AUDIO) (LISTEN-IN AUDIO)
(SUPERIMPOSED ON THIS LINE)
Y5
END
X4
X3
X2
X1
VDD1
0-15: 4-BIT ENCODER
Z105
KBM
Z106C
D101
D102
D103
D104
R106 1K
R104 1K
R105 1K
R116 47K
R128 100K
R129 100K
R130 100K
R131 100K
Z108A
C106 .1
C127 4.7
D116
ENCODER LOCKOUT WHEN Z107C-10 IS LO
Z107C
R145 820K
C121 .01
R146 820K
Z103 TIMER
(60 S ±20% TIMER)
D124
R157 47K
R150 1M
C101 .1
CONTROL
RV103
OUTPUT
RV102
RV101
B+
+15V
VCC
VDD2
C122 470 1000*
R102 10 12*
C124 100
C125 100
R103 47
R152 47
REGULATED +15VDC
MODEL I-614 MASTER STATION
NOTE: (*) INDICATES VALUE OF COMPONENT IN LATER PRODUCTION UNITS.
(**) X=PC PATH WHEN 220K R144 IS USED AND R161 IS NOT USED IN EARLY PRODUCTION UNITS.
OPERATIONAL STATE: POWER ON. INTERCOM IN QUIESCENT (STANDBY) STATE. RADIO/LISTEN-IN AUDIO SWITCH S1 OFF.
R160 2.7K
R111 2.7K 100*
S1 RADIO
ON
OFF
C107 .1
C110 .01
RECEIVED RADIO LISTEN-IN AUDIO VOLUME
R154 100K
R120 56K
R148 470K 560K*
D117
C132 2.2
Z109A
ANNUNCIATOR TONE GENERATOR
Z107B
Z107A
R143 220K
R125 82K
C108 .01
C104 .1
R155 500K
TONE LEVEL-SET
R158 22K 15K
LISTEN-IN AUDIO
ON LISTEN-IN
S2B
OFF
TALK (SEND)
INTERCOM AUDIO
LISTEN (RECEIVE)


ADDRESSED IDENTITY TERMINALS
P1
IDENTITY WIRE
CONNECT TO THIS STATION'S NUMBERED IDENTITY TERMINAL
OUTPUTS S1–S15 LO
S0 HI
Z104
RECEIVER/4-BIT DECODER
END CALL
INHIBIT
ALL CALL
STROBE
Z108B
Z109F
Z109B
Z109E
Z109C
Z107D
Z106D
Z106B
Z106A
Z102
Z101
AUDIO AMPLIFIER
PRIVATE
LISTEN
TALK
LISTEN VOLUME
CONTROL LINE
OUTPUT LINE
THIS STATION SPEAKER
TALK PREAMPLIFIER
ON LISTEN-IN
OFF
VDD1
VDD2
VCC
VSS
B+

DATA IN DECODER TERMINALS AND ADDRESS BITS*				DECODED DATA OUT RECEIVER TERMINAL NORMALLY LO GOES HI	ADDRESS NUMBER OF STATION CALLED NORMALLY LO GOES HI
2	3	21	22		
D	C	B	A		
LO	LO	LO	LO	11	END OF CALL (0)
LO	LO	LO	HI	18	1
LO	LO	HI	LO	7	2
LO	LO	HI	HI	14	3
LO	HI	LO	LO	10	4
LO	HI	LO	HI	20	5
LO	HI	HI	LO	5	6
LO	HI	HI	HI	16	7
HI	LO	LO	L0	9	8
HI	LO	LO	HI	17	9
HI	LO	HI	LO	6	10
HI	LO	HI	HI	13	11
HI	HI	LO	LO	8	12
HI	HI	LO	HI	19	13
HI	HI	HI	LO	4	14
HI	HI	HI	HI	15	ALL CALL (15)

NOTE: In Nutone's I-600/I-614 Selective Call Intercom application, the Input Address Data Bits "A," "B," "C" and "D" and corresponding Integrated Circuit Terminals are reversed from those shown for the MC14514B in the Motorola CMOS Manual. USE THE ABOVE TABLE WHEN SERVICING THE I-600 and I-614.

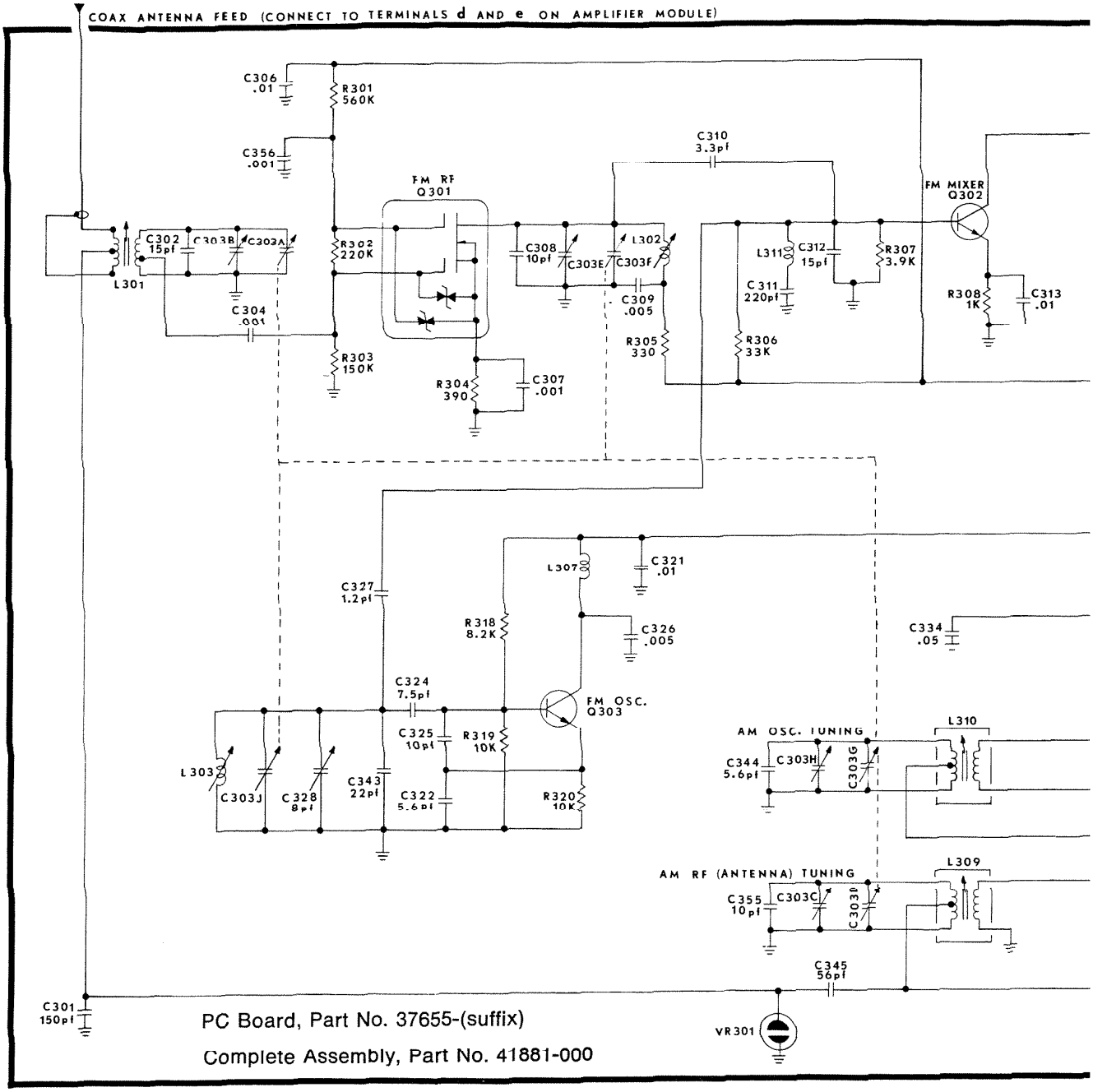
The "HI" and "LO" logic state notation is used in keeping with the method used in this manual:

LO = standard binary logic "0" (=VSS)

HI = standard binary logic "1" (=VDD)

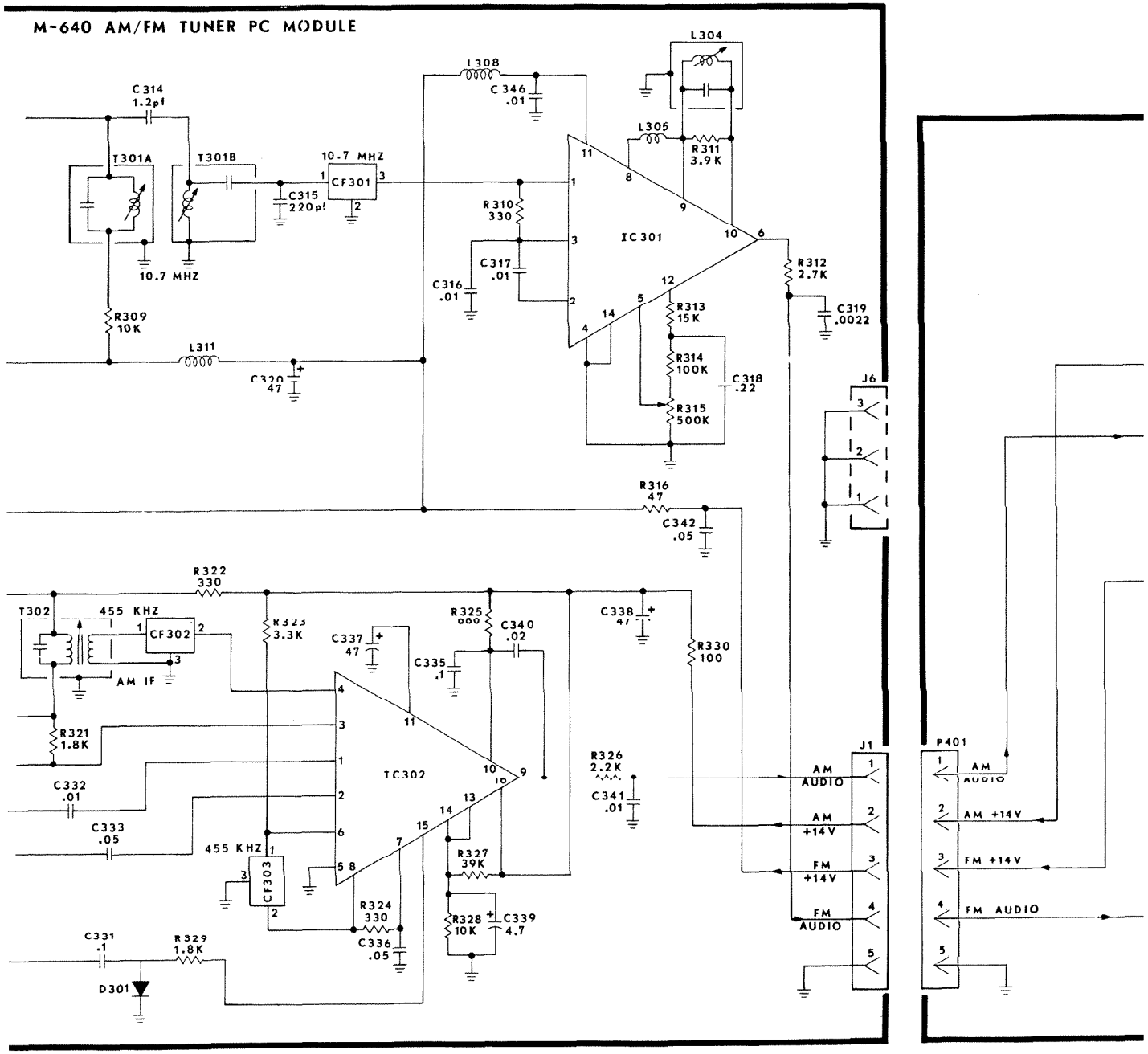
The MC14514B Receiver/4-Bit Decoder converts the 4-bit binary address to the decimal number of the station that is being called.

TRUTH TABLE
MC14514B RECEIVER/4-BIT DECODER
(As used in NuTone I-600/I-614)



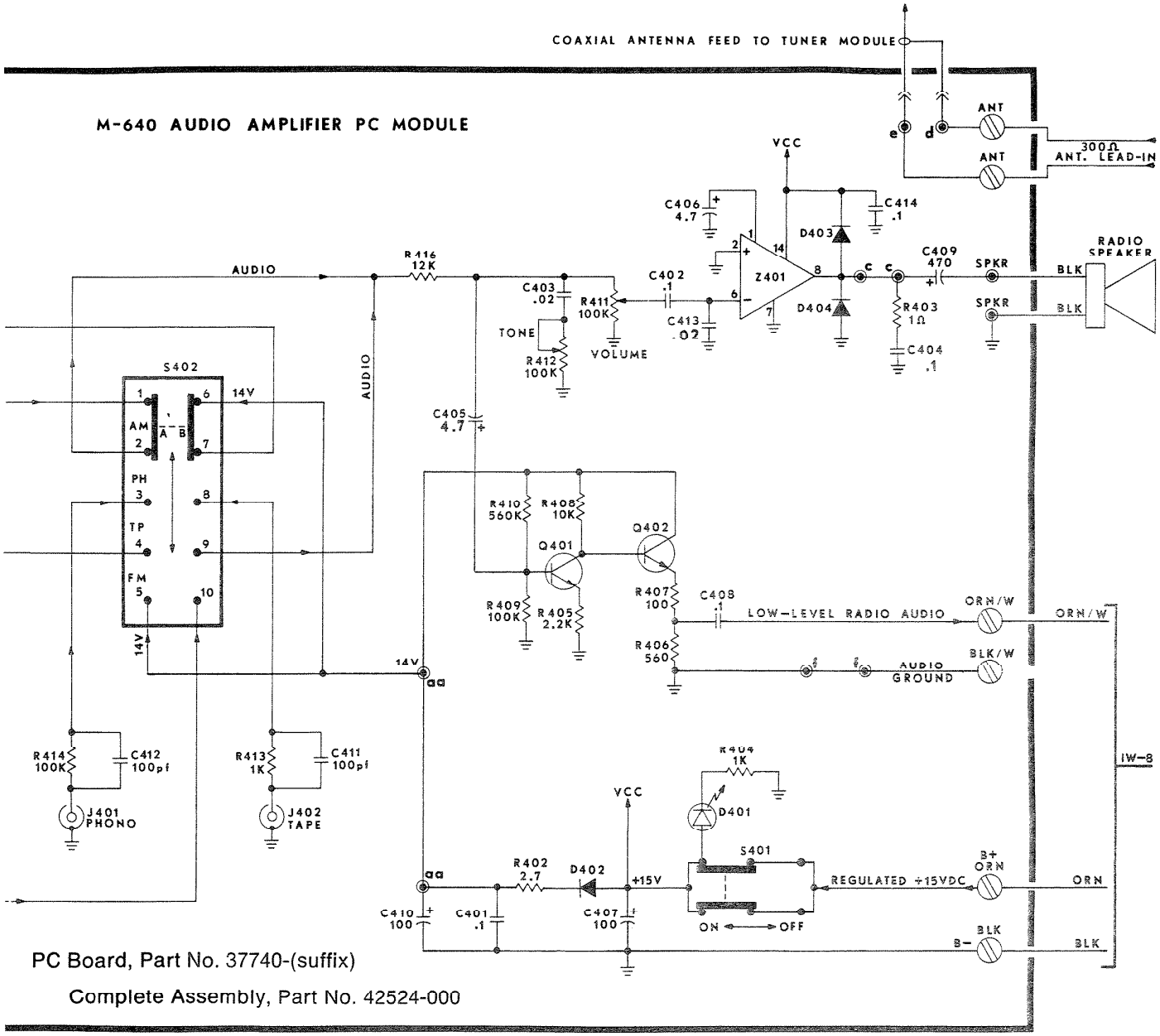
PC Board, Part No. 37655-(suffix)

Complete Assembly, Part No. 41881-000



MODEL M-640 AM/FM RADIO RECEIVER (ORIGINAL

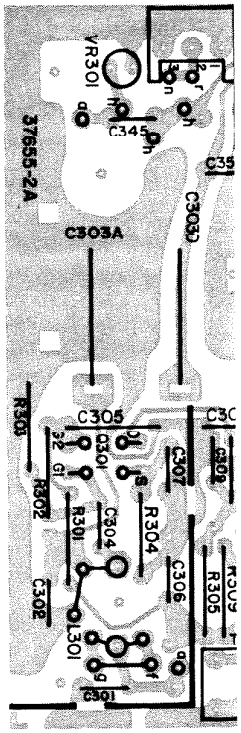
M-640 AUDIO AMPLIFIER PC MODULE



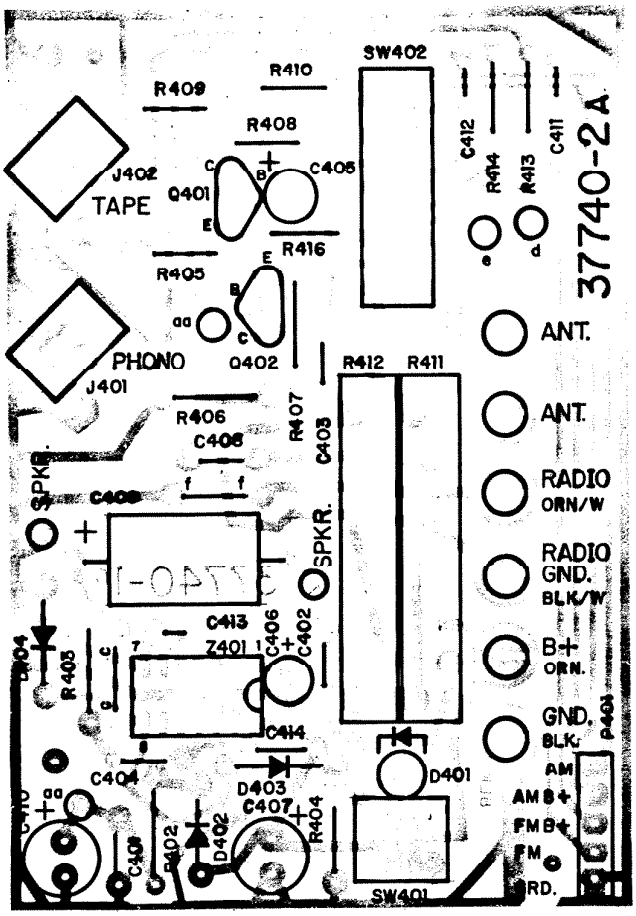
PC Board, Part No. 37740-(suffix)

Complete Assembly, Part No. 42524-000

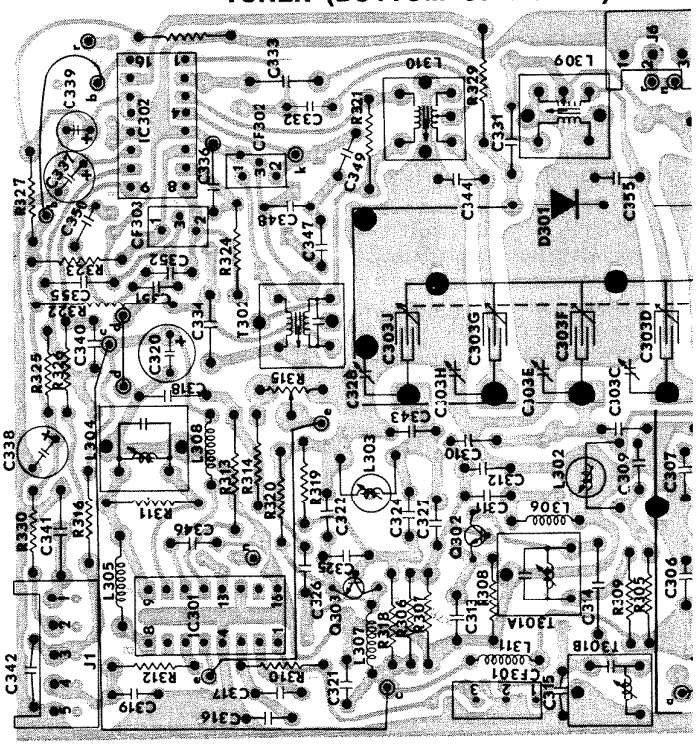
PRODUCTION UNITS)



AMPLIFIER (TOP OF BOARD)



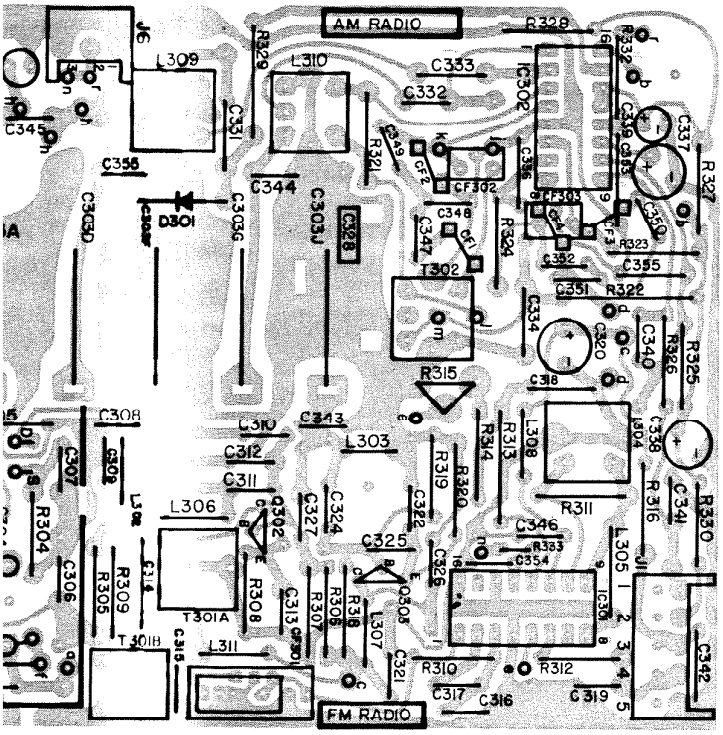
TUNER (BOTTOM OF BOARD)

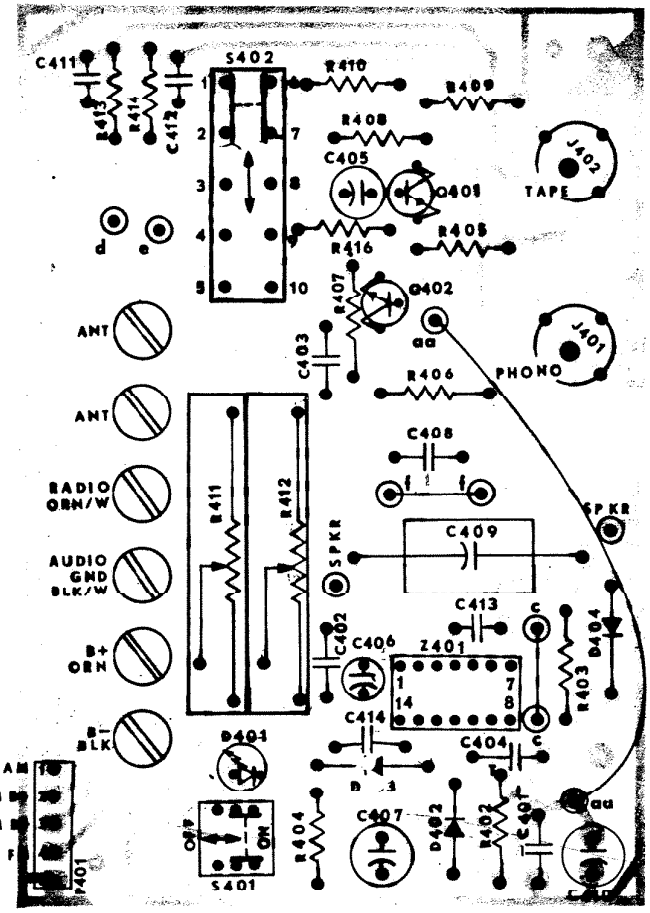


ORIGINAL PRODUCTION M-640 FM/AM RADIO RECEIVER (FRONT VIEW)

AMPLIFIER (BOTTOM OF BOARD)

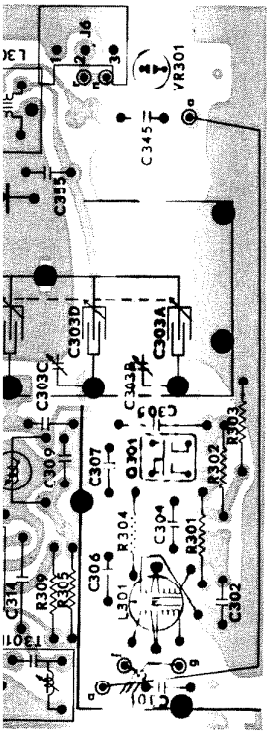
TUNER (TOP OF BOARD)





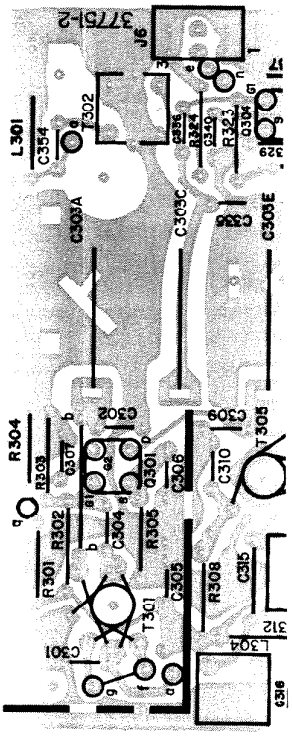
ORIGINAL PRODUCTION M-640 FM/AM RADIO RECEIVER (REAR VIEW)

RD)



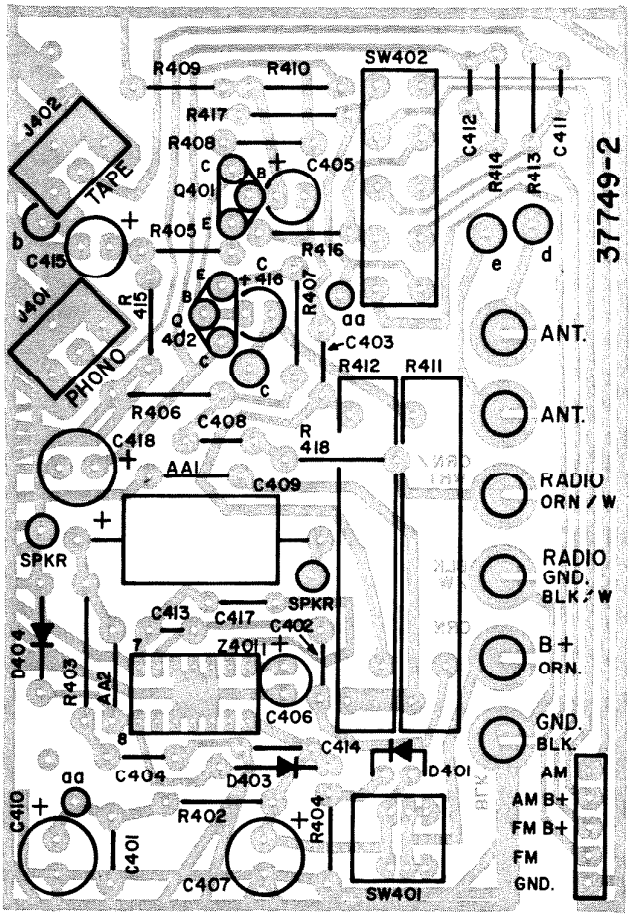
AMPLIFIER COMPLETE ASSEMBLY PART NO. 42524-000

TUNER COMPLETE ASSEMBLY PART NO. 41881-000

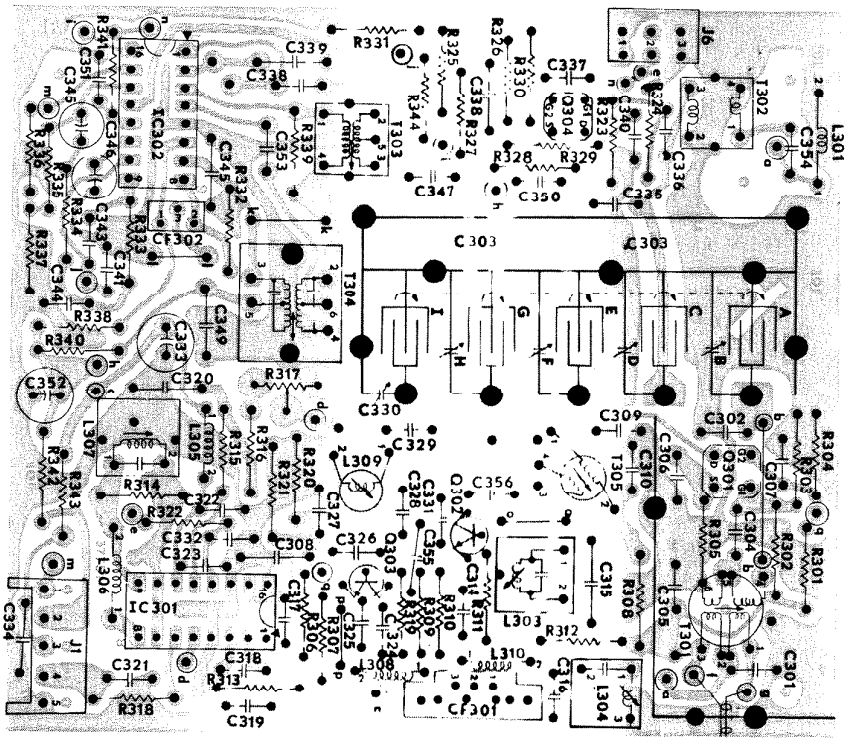


NOT USED:
C332
C351
R322
R341
J6

AMPLIFIER (TOP OF BOARD)



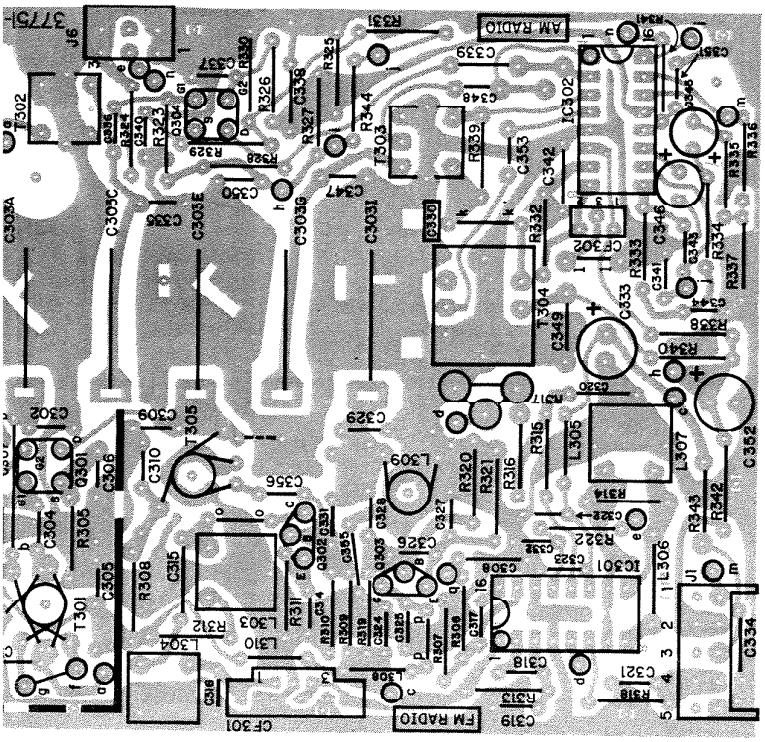
TUNER (BOTTOM OF BOARD)

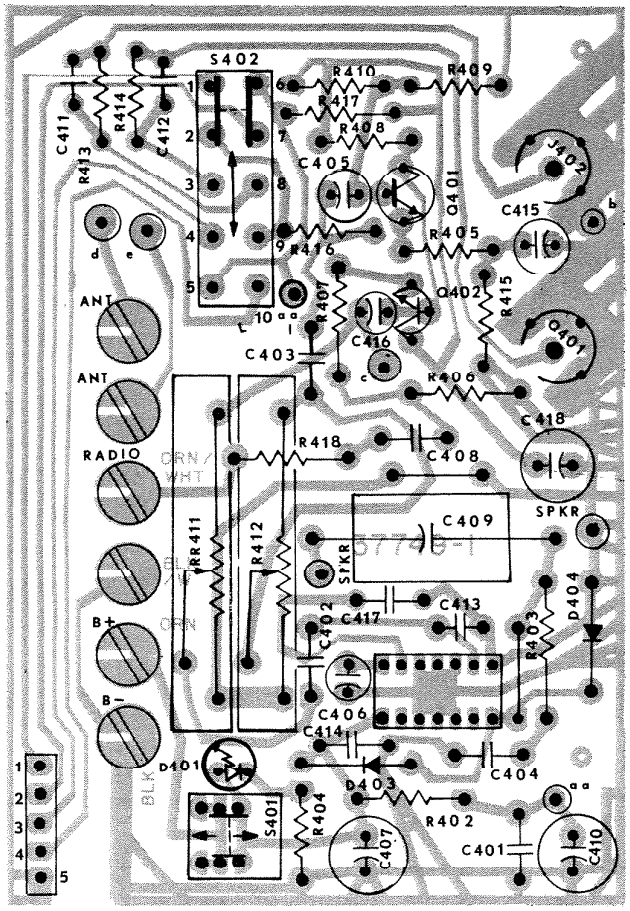


LATER PRODUCTION M-640 AM/FM RADIO RECEIVER (FRONT VIEW)

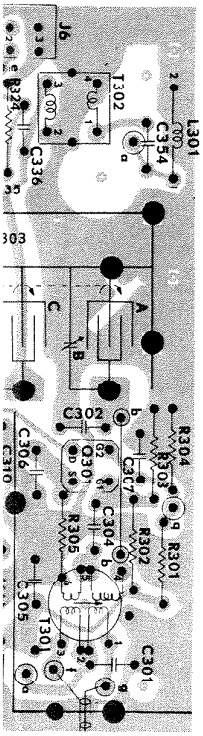
AMPLIFIER (BOTTOM OF BOARD)

TUNER (TOP OF BOARD)



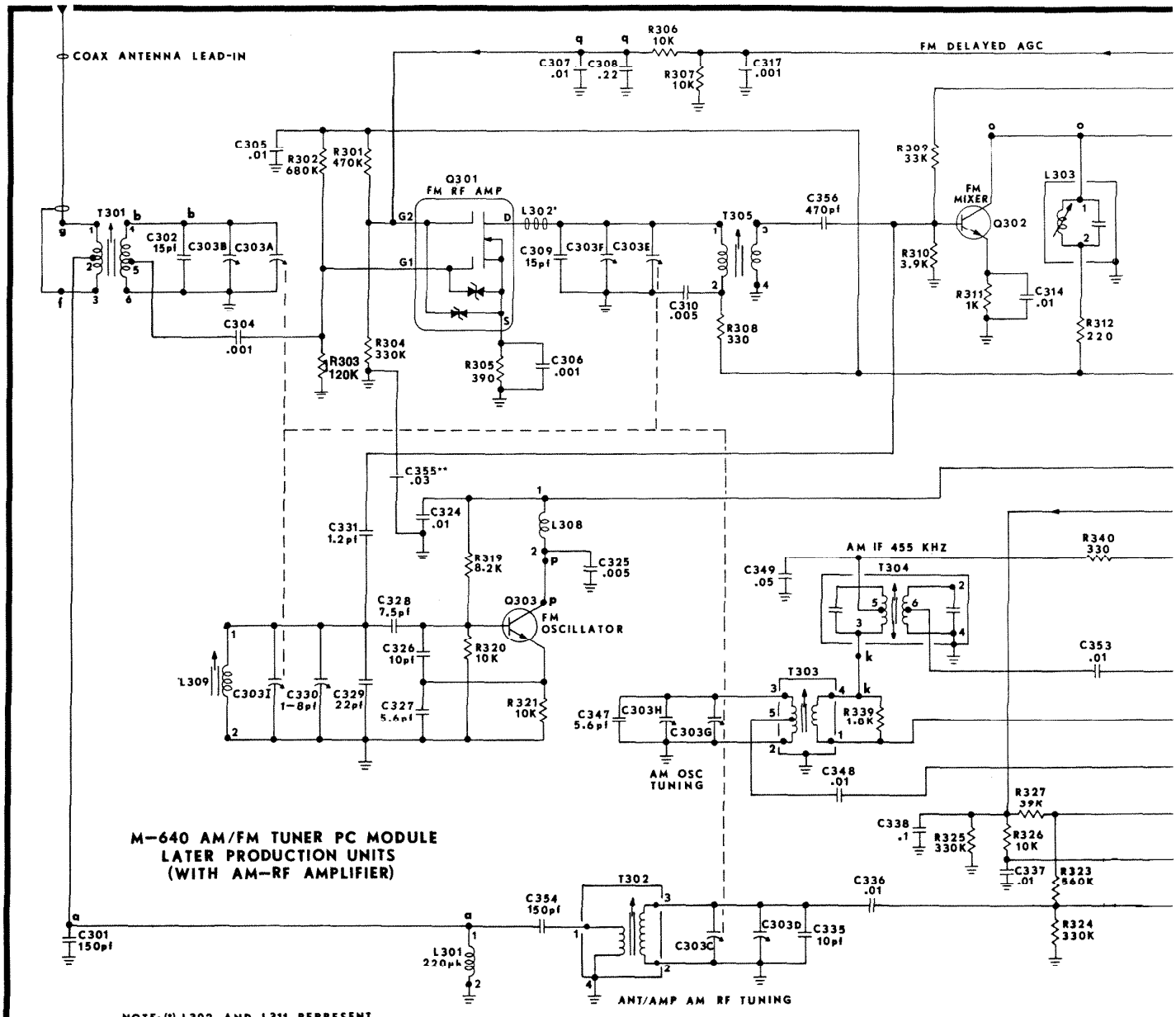


LATER PRODUCTION M-640 AM/FM RADIO RECEIVER (REAR VIEW)



AMPLIFIER COMPLETE ASSEMBLY PART NO. 42565-000

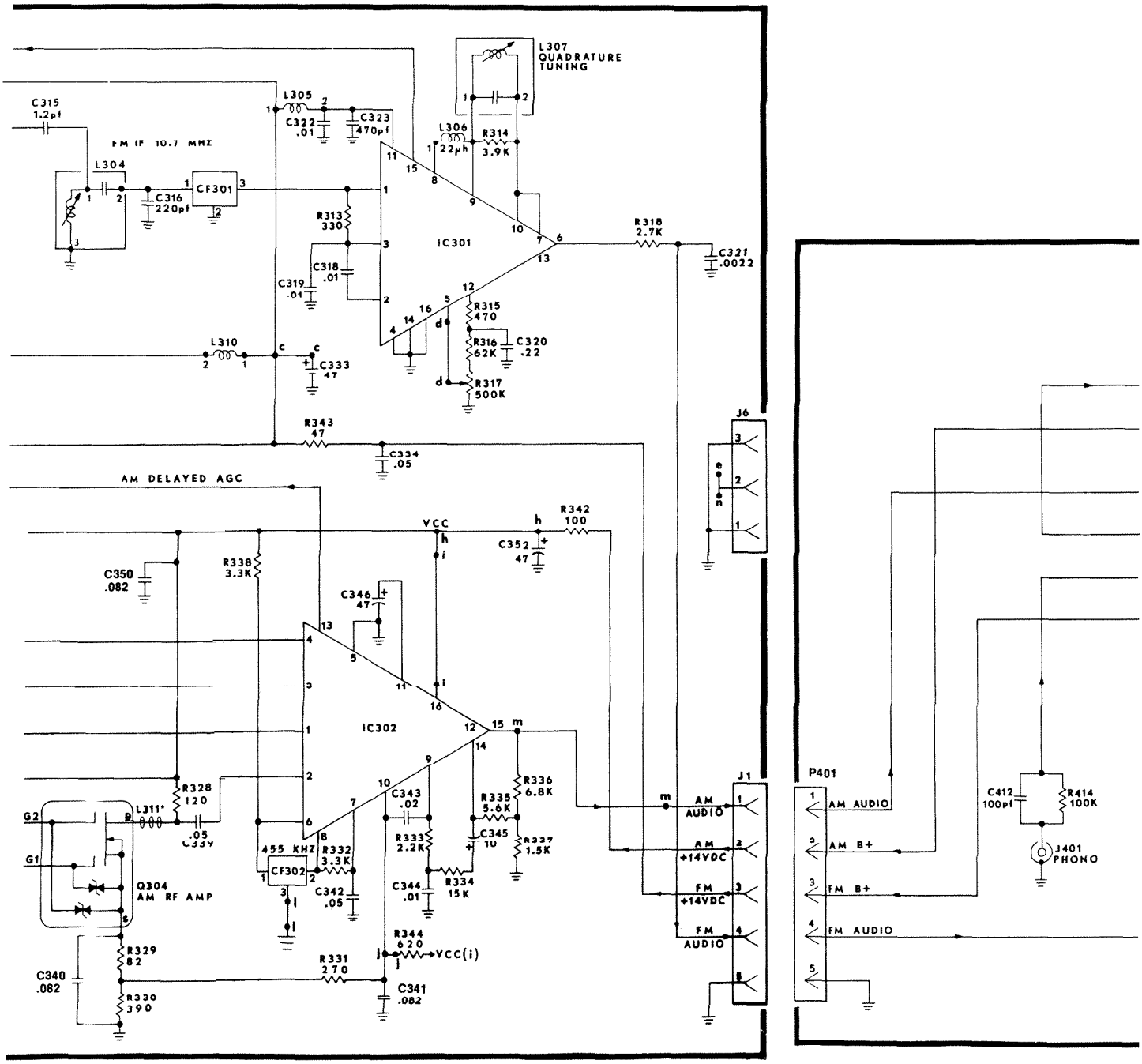
TUNER COMPLETE ASSEMBLY PART NO. 42567-000



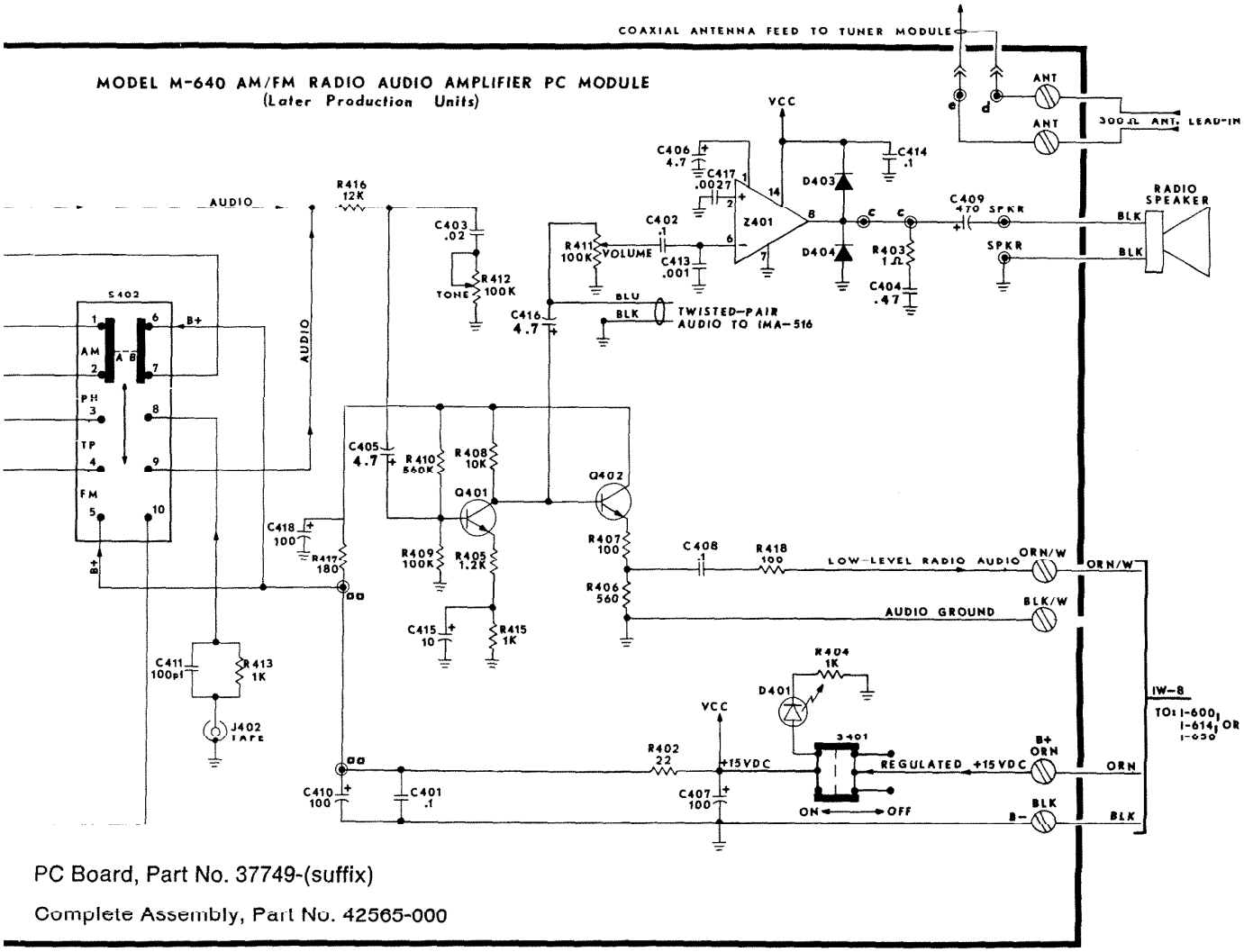
NOTE: (*) L302 AND L311 REPRESENT FERRITE BEAD ON THE RESPECTIVE FET'S DRAIN LEAD.

(**) C355 SERVES AS GROUND-PATH RF CURRENT BYPASS.

42567-000 Complete Assembly
37751-000 PC Board



MODEL M-640 AM/FM RADIO RECEIVER (LATER PRODUCTION UNITS)



PC Board, Part No. 37749-(suffix)

Complete Assembly, Part No. 42565-000

REPLACEMENT PARTS LIST

RESISTORS: Value in Ohms ± 5%, ¼-watt, Carbon Film, unless otherwise noted.
K = Kilo = 10^3 M = Mega = 10^6

CAPACITORS: Value in micro farads (10^{-6}) ± 10%, 500Vdc, Ceramic Disc, unless otherwise noted.
p = pico = 10^{-12}

Schematic Symbol	NuTone Part No.	Description
		MODEL I-600
		POWER SUPPLY/DOOR SPKR. CONTROL
	38881-000	Base Housing (Original Production)
	39823-000	Base Housing (Later Production)
	48524-000	Label, Door Station Identity
	38882-000	Cover (Original Production)
	39824-000	Cover (Later Production)
	39705-000	Grommet
T1	8700-900	NuTone Model X301N 120/16 Vac, 30VA, Automatic-reset overload
		CONTROL CIRCUIT MODULE
	42513-000	Complete Assembly (Original Production)
	42561-000	Complete Assembly (Later Production)
	37738-000	PC Board (Original Production)
	37750-000	PC Board (Later Production)
		CAPACITORS
C201	35091-107	1000 +100%, −10%, 35WVDC, Electrolytic
C202, C203	35091-118	1000 +50%, −10%, 25WVDC, Electrolytic (Early Production Units, and must be used when Fairchild Type A78H15SC is used as Voltage Regulator Z205.)
C202, C203	Not Used	(In later production units, i.e. when LAMBDA Type LAS 1415 is used as Voltage Regulator Z205.)
C204-C206	35091-105	470 +100%, −10%, 25WVDC, Electrolytic
C207	35091-106	2.2 ±20%, 25WVDC, Electrolytic (Original Production)
C207	Not Used	(Later Production)
C208, C209	35091-106	2.2 ±20%, 25WVDC, Electrolytic
C210	35091-103	4.7 +100%, −10%, 25WVDC, Electrolytic
C211	35125-104	.82 ±5%, 35WVDC, Tantalum
C212, C213	35100-145	.001
C214-C217	35100-139	.01 +80%, −20%, 50V
C218	35100-159	.01
C219-C223	35100-146	.05 ±20%, 50V
C224, C225	35100-127	.1 +80%, −20%, 50V
C226	35100-159	.01
C227	35100-127	.1 +80%, −20%, 50V
C228	35100-127	.1 +80%, −20%, 50V (Original Production)
C228	35055-101	.47 ±20%, 100V, Polyester Film (Later Production)
C229, C230	35100-187	.005
C231	35100-155	.0027 +80%, −20%
C232	Not Used	(In original production units, i.e. when Fairchild Type A78H15SC is used as Voltage Regulator Z205.)
C232	35091-108	100, +100%, −10%, 25WVDC, Electrolytic (Used in later production units, i.e. when LAMBDA Type LAS 1415 is used as Voltage Regulator Z205.)
		DIODES
D201-D204	36608-000	Silicon Rectifier, 3 Adc, 100 PIV Power Supply Bridge Rectifier Motorola MR-502 Gen. Inst. 1N540Z
D205-D208	36549-000	Silican Rectifier, 1 Adc, 100 PIV 1N4002

Schematic Symbol	NuTone Part No.	Description
		RELAYS
K201	39775-000	TALK/LISTEN: 4PDT; normally in listen, momentary talk; contact rating 60W, 100VA, 220V, 2 Aac/dc; coil voltage nominal 12V, minimum pull-in 8.4V, maximum 21V. ARROW M NF412V
		CONNECTORS
J201	39339-110	Receptacle, 12-pin; to Terminal Board
P202, P203	39338-102	Connector, 7-post, Station Identity
	32687-W7	Wire Assy, Station Identity connect
		TRANSISTORS
Q201	36590-000	NPN Planar Silicon Darlington Motorola MPS-A13
Q202	36509-000	PNP Planar Silicon Darlington Motorola MPS-A65 Fairchild TWN0264
		RESISTORS
R201	33039-010	1 ±10%, 1-watt, wirewound
R202	33039-102	1K ±10%, 1-watt, wirewound
R203, R204	33082-102	1K
R205, R206	33082-473	47K
R207	33039-561	560 ±10%, 1-watt, wirewound
R208, R209	33082-563	56K
R210-R212	33082-223	22K
R213	33082-683	68K
R214-R222	33082-104	100K
R223, R224	33039-100	10 ±10%, 1-watt, wirewound
R225, R226	33082-224	220K
R227	33082-683	68K
R228	33082-474	470K
R229	34042-000	0-100K ±30%, 0.1-watt, potentiometer, 225° minimum rotation. C.T.S. Corp. Type X-201 Stackpole Carbon Co. #1556
R230	33082-223	22K
R231	33082-104	100K
R232	Not Used	(Original Production)
R232	33039-010	1 ±10%, 1-watt, wirewound (Later Production)
		INTEGRATED CIRCUITS
Z201	36661-000	NOR Gate, Duel, 4-input Motorola MC14002CP RCA CD4002AE
Z202	36658-000	Quad Bilateral Switch Motorola MC14066CP RCA CD4066BE
Z203	36700-000	Operational Amplifier (OpAmp), Talk Preamplifier Motorola MC1741CP1
Z204	36641-000	Audio Amplifier National Semiconductor LM380N
Z205	36717-000	Original Production, (use with C202 and C203). 15Vdc Voltage Regulator Fairchild A78H15SC
Z205	36720-000	Later Production, (use with C232). 15Vdc Voltage Regulator LAMBDA LAS1415
Z206	36715-000	4-Bit Latch/4-16 Line Decoder Motorola 14514BP
		I.C. SOCKETS (DIP)
	39810-000	8-Pin
	39811-000	14-Pin
	39791-000	24-Pin

Schematic Symbol	NuTone Part No.	Description
		HEAT SINK
	38994-000	For Z205 Voltage Regulator Wakefield Eng. #689.100B2 Thermalloy #6003B-2
	64973-003	Screw, #6 x 3/8 Sltd. Pan Hd. #25 for Heat Sink Mounting
	11077-003	Hex Nut #6-32, for Heat Sink mounting screws
	10333-000	Washer, fibre insulating, for Heat Sink mounting
		TERMINAL BOARD
	42515-000	Complete Assembly
	37743-000	Printed Circuit Board
	39209-003	Screw, #6 x 3/8 Sltd. Pan Hd. Terminal Board Connecting
	20257-003	Screw, #8-32 x 2¼" Sltd. Rd. Hd. Terminal Board mounting retainer
	18028-015	Nut, #8-32 Hex for Terminal Board mounting screws
	39683-000	Standoffs, plastic Terminal Board Mounting
C299	35066-101	Capacitor, .1 ±20%, 150V, Mylar tubular
D209	36549-000	Diode, Silicon Rectifier 1 Adc, 100 PIV 1N4002
P201	39338-106 (Two Used)	6-Pin male connector post Assy. (12-pin in-line, connect Terminal Board to Control PC Board)
R299	33101-561	Resistor, 560, ½-watt Carbon Film
	39818-000	Insulating tubing, for C299 and R299
	42550-000	(Original Production) Envelope Assembly, contains C299, R299 and insulating tubing.
RV201-RV209	36719-102	Varistor, 47V GE V47ZA-1
		MISCELLANEOUS
	48538-000	Homeowners Manual
	48525-000	Installation Instructions
	48584-000	Installation Instructions (Supplement)
	42572-000	Envelope Assembly, including two, #6 x ¼ Slt. Rd. Hd. Cover Mounting Screws
	16269-003	Screw, #6 x ½, Slt. Rd. Hd. Unit installation mounting

MODEL I-614 MASTER STATION

	42500-000	Front Panel, complete assembly
	38996-000	Pushbutton, TALK BAR, for TALK/LISTEN switch S4
	39331-000	Nameplate
		PRINTED CIRCUIT
	42501-000	Complete Assembly
	37737-000	PC Board
		CAPACITORS
C101	35100-127	.1 +80%, −20%, 50V
C102	35055-101	.47 ±20%, 100V, Polyester Film
C103	35100-127	(Original Production) .1, +80%, −20%, 50V
C103	35100-159	(Later Production) .01
C104	35100-127	.1 +80%, −20%, 50V
C105	35100-159	.01
C106, C107	35100-127	.1 +80%, −20%, 50V
C108	35100-166	.01, ±20%, 25V
C109, C110	35100-159	.01
C111-C115	35100-146	.05 ±20%, 50V
C116, C117	35100-145	.005
C118	Not Used	
C119, C120	35055-101	.47 ±20%, 100V, Polyester Film
C121	35100-159	.01
C122	35091-105	(Original Production) 470 +100%, −10%, 25WVDC, Electrolytic
C122	35091-117	(Later Production) 1000 +100%, −10%, 35WVDC, Electrolytic
C123	35091-105	470 +100%, −10%, 25WVDC, Electrolytic
C124, C125	35091-108	100 +100%, −10%, 25WVDC, Electrolytic
C126	35091-110	22 +100%, −10%, 16WVDC, Electrolytic
C127, C128	35091-103	4.7 +100%, −10%, 25WVDC, Electrolytic
C129-C132	35091-106	2.2 ±20%, 25WVDC, Electrolytic
C133, C134	35100-138	.005 ±20%, 100V
		DIODES
D101-D107	36549-000	Silicon Rectifier, 1 Adc, 100 PIV 1N4002
D108-D122	36617-000	Silicon Switching, 50 mAdc, 75 PIV 1N914
D123	36676-000	LED, Red, BUSY INDICATOR, 50 mA, 5 PIV Xcitor #XC556-2
	0008-S08	Insulating Sleeving for D123 leads
D124	36549-000	Silicon Rectifier, 1 Adc, 100 PIV 1N4002
		RELAYS
K1	39775-000	TALK/LISTEN: 4PDT; normally in LISTEN, momentary TALK; contact rating 60W, 100VA, 220V, 2 Aac/dc: coil voltage nominal 12V, minimum pull-in 8.4V, maximum 21V. ARROW M NF412V
		CONNECTORS
P1	39776-000	Post Connector Assy. including 14 station identity terminals
		TRANSISTORS
Q101, Q102	36590-000	NPN Silicon, Planar, Darlington, Motorola MPS-A13
		RESISTORS
R101	33039-010	1 ±10%, 1-watt, wirewound
R102	33039-100	(Original Production) 10 ±10%, 1-watt, wirewound
R102	33039-120	(Later Production) 12 ±10%, 1-watt, wirewound
R103	33039-470	47 ±10%, 1-watt, wirewound
R104-R110	33082-102	1K
R111	33082-272	2.7K (Original Production)
R111	33082-101	100
R112	33082-103	10K
R113	33082-472	4.7K
R114	33082-103	10K
R115	33082-333	33K (Original Production)
R115	33082-683	68K (Later Production)
R116-R119	33082-473	47K
R120	33082-563	56K
R121	33082-473	47K
R122-R124	33082-683	68K
R125	33082-823	82K
R126, R127	33082-563	56K
R128-R131	33082-104	100K
R132	33082-224	220K (Original Production)
R132	33082-474	470K (Later Production)
R133-R140	33082-104	100K
R141-R143	33082-224	220K
R144	33082-224	220K (Original Production)
R144	33082-104	100K (Later Production)
R145-R146	33082-824	820K
R147	33082-474	470K
R148	33082-474	470K (Original Production)
R148	33082-564	560K (Later Production)
R149, R150	33082-105	1M
R151	33082-225	2.2M (Original Production)
R151	33082-335	3.3M (Later Production)
R152	33039-470	47 ±10%, 1-watt, wirewound
R153-R154	34679-000	0-100K ±20%, ¼-watt, Potentiometer, slide type. INTERCOM LISTEN VOLUME; RADIO VOLUME, modified log taper Stackpole type 5020
	39773-000	Knob, for slide pots R153 and R154

Schematic Symbol	NuTone Part No.	Description
R155	34043-000	0-500K +30%, linear taper, 0.1-watt, 255° rotation. ANNUNCIATOR TONE LEVEL SET CONTROL CTS Corp. Type X-201
R156	33082-104	100K
R157	33082-473	47K
R158	33082-223	22K (Original Production)
R158	33082-153	15K (Later Production)
R159	33082-104	100K
R160	33082-272	2.7K
R161	Not Used	(Original Production)
R161	33082-104	100K (Later Production)
		VARISTORS
RV101-RV107	36719-102	Varistor, 47V GE V47ZA-1
		SWITCHES
S1	39514-000	DPDT, double-wipe, break before make (SPST in this operation) RADIO ON/OFF Switchcraft 11A-1352
S2	34676-000	DPDT LISTEN-IN ON/OFF, normally OFF, interlock in ON position. Push to activate. Centralab Electronics
S3	34676-000	DPDT, PRIVATE ON/OFF, normally OFF, interlocking in ON position. Push to activate (same as S2)
S4	34677-000	DPDT, TALK/LISTEN, normally in LISTEN; momentary in TALK
	35202-000	Knob, pushbutton for S2 and S3
		INTEGRATED CIRCUITS
Z101	36700-000	Operational Amplifier (OpAmp) TALK PREAMPLIFIER MOTOROLA MC1741CP1
Z102	36641-000	Audio Amplifier National Semiconductor LM380N
Z103	36633-000	Oscillator/Timer Motorola MC14541CP
Z104	36715-000	4-Bit Latch/4-16 Line Decoder Motorola 14514BP
Z105	36713-000	16-Key to 4-Bit Encoder National Semiconductor MM74C922
Z106	36658-000	Quad Bilateral Switch Motorola MC14066CP RCA CD4066AE
Z107	36666-000	NAND Gate, Quad, 2-Input Motorola MC14011CP RCA CD4011AE
Z108	36661-000	NOR Gate, Dual, 4-Input Motorola MC14002CP RCA CD4002AE
Z109	36677-000	Hex Schmidt Trigger Inverter Motorola MC14584BCP
		I.C. SOCKETS (DIP)
	39810-000	8-Pin
	39811-000	14-Pin
	39790-000	18-Pin
	39791-000	24-Pin
		KEYBOARD
	39774-000	4 x 5 Matrix Switch Pad (4 x 4 switches used in this unit) Texas Inst. #11KS121R
	48502-000	Keyboard Front Label
	38997-000	Bezel, Keyboard mounting
	92635-004	Screw, 6-9 x 3/8" PH for Keyboard Bezel mounting
		SPEAKER
	36119-000	3" x 5" Oval, 16-ohm voice coil Pioneer #A132BP45
	32556-W57	Black Speaker wire with terminals
	32558-W3	Blue Speaker wire with terminals
	39789-003	Screw, 6-20 x 5/16" PH/Slt, Speaker mounting

Schematic Symbol	NuTone Part No.	Description
		MISCELLANEOUS
	48464-000	Label Card, Call Directory
	35204-000	Lens, Engraved, Call Directory
	42490-000	Bag Assembly, Installation Hardware
	48589-000	Installation Instructions
	39708-003	Screw, 6-20 x 3/8" PH/Slt, Wiring terminal connectors and PC Board mounting
	48637-000	Protective Card with station selection and wiring diagram

I-614R ROUGH IN HOUSING

42488-005	"A" Housing Assy. Complete
42490-000	Hardware Bag Assy.
25511-015	Screw #6 x ¼ Slt. Pan Hd. #23
35210-000	Spring
64823-000	Spring Clamp
31986-000	Strap
31987-000	"S" Hook
48478-000	Instruction Sheet

I-614B MASTER STATION BASE ASSEMBLY

35203-000	Base
42480-000	Envelope Assy.
7220-000	Screw #4 x ⅜ Slt. Pan Hd. Type "A"
39680-000	Foot Bumper
39247-000	*Cable Clamp*
48455-000	Instruction Sheet

MODEL M-640 AM/FM RADIO RECEIVER (Original Production Units)

42522-000	*Front Panel Assembly*
39331-000	Nameplate
35231-000	Tuning Wheel
42523-000	Dial Cord Assembly
39786-000	Pointer, AM/FM Dial
39262-000	Spring, AM/FM Dial Pointer
39327-000	Pulley, Dial Cord
39135-000	*Cap, Pulley*
39465-015	Screw, #6 x 1/4", Slotted Hex Pulley retention
31396-000	Washer, #6
35220-000	Friction Band, tuning drive
42491-000	Cable, Coaxial Assembly Complete, Antenna Lead-in
39598-003	*Shield, RF*
36119-000	Speaker, 3" x 5" Oval, 16-Ohm voice coil Pioneer #A132BP45
39789-003	Screw, 6-20 x 5/16" PH/Slt, Speaker mounting, amplifier PC Board mounting, and wiring terminal connectors
	AM/FM TUNER MODULE
41881-000	Complete Assembly
37655-000	PC Board
	CAPACITORS

C301	*35100-174*	*150 pf*
C302	35101-142	15 pf, temperature compensated
C303A-J	35092-000	Variable AM/FM Tuning Gang
C304	35100-120	.001
C305	Not Used	
C306	35100-139	.01 +80%, −20%, 50V
C307	35100-120	.001
C308	*35101-140*	*10 pf, temperature compensated*
C309	35100-138	.005 ±20%, 100V
C310	35101-134	3.3 pf, temperature compensated
C311	35100-125	220 pf
C312	35101-142	15 pf, temperature compensated
C313	35100-139	.01 +80%, −20%, 50V
C314	35101-147	1.2 pf ±0.25 pf, temperature compensated
C315	35100-125	220 pf
C316, C317	35100-139	.01 +80%, −20%, 50V

Schematic Symbol	NuTone Part No.	Description
C318	35076-101	.22 +80%, −20%, 12V
C319	35100-156	.0022
C320	35091-109	47 +100%, −10%, 16WVDC Electrolytic
C321	35100-139	.01 +80%, −20%, 50V
C322	35101-141	5.6 pf, temperature compensated
C323	Not Used	
C324	35101-135	7.5 pf, temperature compensated
C325	35101-140	10 pf, temperature compensated
C326	35100-138	.005 ±20%, 100V
C327	35101-126	1.2 pf, ±0.25 ppf, temperature compensated
C328	35090-000	1-8 pf, 100VAC, Oscillator Trimmer ALPS #CTY 114B11
C329, C330	Not Used	
C331	35076-106	.1 ±20%, 25V
C332	35100-139	.01 +80%, −20%, 50V
C333, C334	35100-141	.05 +80%, −20%, 50V
C335	35076-106	.1 ±20%, 25V
C336	35100-141	.05 +80%, −20%, 50V
C337, C338	35091-109	47 +100%, −10%, 16WVDC, Electrolytic
C339	35091-103	4.7 +100%, −10%, 25WVDC, Electrolytic
C340	35076-108	.02 ±20%, 16V
C341	35100-139	.01 +80%, −20%, 50V
C342	35100-141	.05 +80%, −20%, 50V
C343	35101-148	22 pf, 1,000V
C344	35101-141	5.6 pf, temperature compensated
C345	35100-175	56 pf
C346	35100-139	.01 +80%, −20%, 50V
C347-C354	Not Used	
C355	35101-140	10 pf, temperature compensated
C356	35100-120	.001
C357	35100-134	470 pf
	CERAMIC FILTERS	
CF301	36109-000	10.7 MHz. FM IF, Ceramic Murata Corp. SFE10.7MS23 Murata Corp. FSW-10.7Ma
CF302, CF303	36087-000	455 KHz. AM IF, Ceramic Murata Corp. SFB4550
	DIODES	
D301	36617-000	Silicon Switching, 50 mAdc, 75 PIV 1N914 Texas Inst. 1N4148
	INTEGRATED CIRCUITS	
IC301	36623-000	Monolithic IC, FM IF Amplifier Detector, Audio Preamplifier, etc. RCA CA3089E
IC302	36622-000	Monolithic IC, AM Oscillator/ Mixer, IF Amplifier, Detector, Audio Preamplifier, etc. RCA CA3088E
	CONNECTORS	
J1	39339-101	Receptacle, 5-pin PC board mounting, Voltage and signal connector to Amplifier Board. Molex type A-2141-5b
J6	Not Used	(Space shown on PC Board)
	RF & IF COILS AND TRANSFORMERS	
L301	30087-000	FM Ant. Primary
L301	30086-000	AM Ant. Trap
L301	30096-000	FM Ant. Secondary
L302	30097-000	FM RF Drain Tank
L303	30088-000	FM Oscillator
	30073-000	Coil Form, for L301, L302 and L303
	31915-000	Tuning Slug, for L301, L302, and L303
L304	30092-000	10.7 MHz adjustable quadrature coil
L305-L307	30091-101	22 microhenry, fixed inductor
L308, L311	30062-000	10.7 MHz. RF Choke
L309	30597-000	Transformer, AM Ant.
L310	30598-000	Transformer, AM Oscillator
T301A	30590-000	10.7 MHz transformer primary, FM Mixer collector tank
T301B	30591-000	10.7 MHz. transformer secondary, IF filter input
T302	30589-000	IF, AM 455 KHz. transformer
	TRANSITORS	
Q301	36624-000	Dual Gate FET, FM RF Ampl. Gen. Inst. MEM615A, MEM614 Motorola MFE130 Texas Inst. 3N203
Q302	36578-000	NPN Epitaxial Planar Silicon FM Mixer Texas Inst. SKA4231 Motorola SPS-4448 National Semi. SM-43-049
Q303	36581	NPN Planar Silicon, FM Oscillator Texas Inst. SKA-4230 National Semi. SM-43-050
	RESISTORS	
R301	33082-564	560K
R302	33082-224	220K
R303	33082-154	150K
R304	33082-391	390
R305	33082-331	330
R306	33082-333	33K
R307	33082-392	3.9K
R308	33082-102	1K
R309	33082-470	47
R310	33082-331	330
R311	33082-392	3.9K
R312	33082-272	2.7K
R313	33082-153	15K
R314	33082-104	100K
R315	34043-000	0-500K variable trim potentiometer. FM SQUELCH CONTROL CTS Corp. Type X-201
R316	33082-470	47
R317	Not Used	
R318	33082-822	8.2K
R319, R320	33082-103	10K
R321	33082-182	1.8K
R322	33082-331	330
R323	33082-332	3.3K
R324	33082-331	330
R325	33082-681	680
R326	33082-222	2.2K
R327	33082-393	39K
R328	33082-103	10K
R329	33082-182	1.8K
R330	33082-101	100
	INDICATOR LAMP	
VR301	39438-000	Neon. 105-125Vdc/ac. ¼ watt; 1.9 mA. GE "Glow Lamp" #C2A-ET (NE-2H3T), or equivalent

AMPLIFIER MODULE

	42524-000	Complete Assembly
	37740-000	PC Board
	CAPACITORS	
C401, C402	35100-127	.1 +80%, −20%, 50V
C403	35100-140	.02 ±20%, 50V
C404	35100-127	.1 +80%, −20%, 50V
C405, C406	35091-103	4.7 +100%, −10%, 25WVDC
C407	35091-108	100 +100%, −10%, 35WVDC
C408	35100-127	.1 +80%, −20%, 50V
C409	35068-129	470 +100%, −10%, 25WVDC
C410	35091-108	100 +100%, −10%, 35WVDC
C411, C412	35100-188	100 pf
C413	35100-125	220 pf
C414	35100-127	.1 +80%, −20%, 50V
	DIODES	
D401	36683-000	Light Emitting Diode (LED); Red, Forward Voltage 1.6V @ 20mA typical; 2.0Vmax. Litronix RL4403 Fairchild FLV-160
D402-D404	36549-000	Silicon Rectifier, 1A, 100PIV 1N4002

Schematic Symbol	NuTone Part No.	Description
		CONNECTORS
J401, J402	39797-000	Jack, for audio pin-plug, PHONO and TAPE connectors, PC mounting
P401	39338-000	5-Pin Assembly, to AM/FM Tuner Module
ⓔ, ⓓ	39723-000	Terminal, push-on, tuner antenna coax lead-in connector
	39708-003	Screw, interconnecting wiring terminals; #6-20 x 3/8", PH/SL "25"
		TRANSISTORS
Q401	36580-000	NPN Planar Silicon, Low-noise Motorola SPS-1216 National Semi. SMO-7329 Texas Inst. SKA-4242
Q402	36613-000	PNP Silicon Motorola MPS-A20 Texas Inst. TIS-98 NPC Elect. NPC-069
		RESISTORS
R401	Not Used	
R402	33101-027	2.7, ½-watt
R403	33039-010	1 ±10%, 1 watt wirewound
R404	33082-102	1K
R405	33082-222	2.2K
R406	33101-561	560, ½-watt
R407	33101-101	100, ½-watt
R408	33082-103	10K
R409	33082-104	100K
R410	33082-564	560K
R411, R412	34679-000	0 to 100K ±20%, ½-watt, carbon composition; variable slide-tap; VOLUME, TONE Stackpole Type 5020
	35219-000	Knob, for R411 and R412
R413	33082-102	1K
R414	33082-104	100K
R415	Not Used	
R416	33082-123	12K
		SWITCHES
S401	34676-000	Push for ON, interlocking release, POWER ON/OFF; 25W maximum; 0.5A @ 50Vdc/ac
	35213-000	Button, for S401 (early production)
	35233-000	Button, for S401 (later production)
S402	34680-000	DP4T, break before make, PROGRAM SELECTOR
		INTEGRATED CIRCUITS
Z401	36641-000	Audio Amplifier National Semi. LM380N
	39811-000	IC Socket, 14-pin for Z401
		SPEAKER
	36110-000	3" x 5" Oval, 16 ohm voice coil Pioneer #A132BP45
	32256-W57	Black Speaker wire with terminals
	32258-W3	Blue Speaker wire with terminals
	39789-003	Screw, 6-20 x 5/16" PH/SLT, Speaker mounting
		MISCELLANEOUS
	40072-000	Inside FM Antenna Assembly
	48531-000	Installation Instructions

M-640R ROUGH IN HOUSING

42489-000	Frame Assy. Complete
42488-005	"A" Housing Assy.
39096-000	Terminal Strip
40072-000	Antenna Assy.—F.M.
42490-000	Hardware Bag Assy.
25511-015	Screw #6 x ¼ Slt. Pan Hd. #23
35210-000	Spring
64823-000	Spring Clamp
31986-000	Strap
31987-000	"S" Hook
48478-000	Instruction Sheet

Schematic Symbol	NuTone Part No.	Description

M-640 AM/FM RADIO RECEIVER (Later Production Units)

		AM/FM TUNER MODULE
	42567-000	Complete Assembly
	37751-000	PC Board
		CAPACITORS
C301	35100-174	150 pf
C302	35101-142	15 pf
C303A-J	35092-000	Ganged, AM and FM Tuning
C304	35100-120	.001
C305	35100-139	.01 ±20%, 50V
C306	35100-120	.001
C307	35100-139	.01 ±20%, 50V
C308	35076-101	.22 +80%, −20%, 12V
C309	35101-142	15 pf
C310	35100-138	.005 ±20%, 100V
C311, C312, C313	Not Used	
C314	35100-139	.01 ±20%, 50V
C315	35101-147	1.2 pf, 0.25%/pf
C316	35100-125	220 pf
C317	35100-120	.001
C318, C319	35100-139	.01 ±20%, 50V
C320	35076-101	.22 +80%, −20%, 12V
C321	35100-156	.0022
C322	35100-139	.01 ±20%, 50V
C323	35101-139	470 pf
C324	35100-139	.01 ±20%, 50V
C325	35100-138	.005 ±20%, 100V
C326	35101-140	10 pf
C327	35101-141	5.6 pf
C328	35101-135	7.5 pf
C329	35101-148	22 pf, 100V
C330	35090-000	1-8 pf, 100VAC, Oscillator Trimmer ALPS #CTY 114B11
C331	35101-126	1.2 pf, ±0.25%/pf
C332	Not Used	
C333	35091-109	47 +100%, −10%, 25WVDC Electrolytic
C334	35100-141	.05 +80%, −20%, 50V
C335	35101-140	10 pf
C336, C337	35100-139	.01 ±20%, 50V
C338	35076-106	.1 ±20%, 25V
C339	35100-141	.05 +80%, −20%, 12V
C340, C341	35076-104	.082 +80%, −20%, 12V
C342	35100-141	.05 +80%, −20%, 50V
C343	35076-108	.02 ±20%, 16V
C344	35100-139	.01 ±20%, 50V
C345	35091-102	10 +100%, −10%, 16WVDC, Electrolytic
C346	35091-109	47 +100%, −10%, 25WVDC, Electrolytic
C347	35101-141	5.6 pf
C348	35100-139	.01 ±20%, 50V
C349	35100-141	.05 +80%, −10%, 50V
C350	35076-104	.082 +80%, −20%, 12V
C351	Not Used	
C352	35091-109	47 +100%, −10%, 25WVDC, Electrolytic
C353	35100-139	.01 ±20%, 50V
C354	35100-174	150 pf
C355	35100-193	.03 +80%, −20%, 50V
C356	35101-139	470 pf
		CERAMIC FILTERS
CF301	36109-000	FM 10.7 MHz. IF; Ceramic Murata Corp. SFE10.7MS23 Murata Corp. SFW-10.7Ma
CF302	36087-000	AM 455 KHz. IF; Ceramic Murata Corp. SFB4550
		INTEGRATED CIRCUITS
IC301	36623-000	Monolithic IC, FM IF Amplifier, Detector, Audio Preamplifier, etc RCA CA3089E
IC302	36622-000	Monolithic IC, AM Oscillator/Mixer, IF Amplifier, Detector, AF Preamplifier, etc. RCA CA3088E

Schematic Symbol	NuTone Part No.	Description
		CONNECTORS
J1	39339-101	5-pin receptacle
J6	Not Used	
J6	39339-105	3-pin receptacle
		COILS
L301	30106-000	22 microh ±10% @ 100 mA
L302	35232-000	Ferrite Bead, FM RF amplifier drain-lead parasitic suppressor
L303	30590-000	10.7 MHz. tank circuit for FM Mixer collector load
L304	30591-000	10.7 MHz. adjustable coupling between FM Mixer collector and CF301
L305	30062-000	RF Choke (decoupler)
L306	30105-000	220 microH ±10% @ 50 mA
L307	30092-000	10.7 MHz. adjustable quadrature coil
L308	30062-000	RF Choke (decoupler)
L309	30088-000	Coil, FM Oscillator
	30073-000	Form, for oscillator coil L309
	31915-000	Core, powdered iron (Tuning Slug) for oscillator coil
L310	30062-000	RF Choke (decoupler)
L311	35232-000	Ferrite Bead, AM RF amplifier drain-lead parasitic suppressor
		TRANSISTORS
Q301	36624-000	DGFET, FM RF Amplifier General Instruments Corp MEM615A, MEM614 Motorola MFE-130 Texas Inst. 3N203
Q302	36578-000	Silicon, NPN, Epitaxial Planar, FM Mixer Texas Inst. SKA-4231 Motorola SPS 4484 National Semi SM-43-049
Q303	36581-000	Silicon, NPN Planar FM Oscillator Texas Inst. SKA-4230 National Semiconductor SM-43-050
Q304	36624-000	DGFET, AM RF Amplifier (for suppliers, see Q301 above)
		RESISTORS
R301	33082-474	470K
R302	33082-684	680K
R303	33082-124	120K
R304	33082-334	330K
R305	33082-391	390
R306, R307	33082-103	10K
R308	33082-331	330
R309	33082-333	33K
R310	33082-392	3.9K
R311	33082-102	1K
R312	33082-221	220
R313	33082-331	330
R314	33082-392	3.9K
R315	33082-471	470
R316	33082-623	62K
R317	34043-000	0-500K ±30%, 0.1 watt, linear taper SQUELCH CONTROL CTS Corp. Type X-201
R318	33082-272	2.7K
R319	33082-822	8.2K
R320, R321	33082-103	10K
R322	Not Used	
R323	33082-564	560K
R324, R325	33082-334	330K
R326	33082-103	10K
R327	33082-393	39K
R328	33082-121	120
R329	33082-820	82
R330	33082-391	390
R331	33082-271	270
R332	33082-332	3.3K
R333	33082-222	2.2K
R334	33082-153	15K
R335	33082-562	5.6K
R336	33082-682	6.8K
R337	33082-152	1.5K
R338	33082-332	3.3K
R339	33082-182	1.8K
R340	33082-331	330
R341	Not Used	
R342	33082-101	100
R343	33082-470	47
R344	33082-621	620
		TRANSFORMERS
T301		RF, Antenna/RF-Amplifier input
	30087-000	Primary Winding
	30108-000	Secondary Winding
	30107-000	Tap Section Secondary Winding
	31915-000	Core, powered iron (Tuning Slug)
	30073-000	Coil Form
T302	30597-000	AM, 537-1620 KHz. operating range Antenna/RF-Amplifier Input Toko America RHR-42185R G.I. Ex. #27402
T303	30598-000	AM, 992-2075 KHz. operating range Oscillator Tuning/Coupling Toko America RWR-42209N Gen. Inst. Tex #3227
	30599-000	Alternate EL-Filters, Inc. EO #405
T304	30579-000	AM IF, 455 KHz. TRW #50137 *Gen. Inst. Corp. #22562*
T305		RF, RF Amplifier output/FM Detector input
	30087-000	Primary Winding
	30109-000	Secondary Winding
	31915-000	Core, powered iron (Tuning Slug)
	30073-000	Coil Form
		MISCELLANEOUS
	42491-000	Cable, Coaxial Assembly Complete, Antenna Lead-in
	39598-003	Shield, RF

AMPLIFIER MODULE

	42565-000	Complete PC Assembly
	37749-000	PC Board
		CAPACITORS
C401, C402	35100-127	.1, +80%, −20%, 50V
C403	35100-140	.02 ±20%, 50V
C404	35055-101	.47 ±20%, 100V, Polyester Film
C405, C406	35091-103	4.7, +100%, −10%, 25WVDC, Electrolytic
C407	35091-108	100, +100%, −10%, 25WVDC, Electrolytic
C408	35100-127	.1, +80%, −20%, 50V
C409	35068-129	470, +100%, −10%, 25WVDC, Electrolytic
C410	35091-108	100, +100%, −10%, 25WVDC, Electrolytic
C411, C412	35100-188	100pf
C413	35100-184	.001
C414	35100-127	.1, +80%, −20%, 50V
C415	35091-102	10, +100%, −10%, 16WVDC, Electrolytic
C416	35091-103	4.7, +100%, −10%, 25WVDC, Electrolytic
C417	35100-155	.0027, +80%, −20%, 50V
C418	35091-108	100, +100%, −10%, 25WVDC, Electrolytic
		DIODES
D401	36683-000	Light Emitting Diode (LED), Red; Forward Voltage @ 20mA, 1.6V typical, 2.0Vmax. Litronix RL4403 Fairchild FLV-160
D402	Not Used	
D403, D404	36549-000	Silicon Rectifier, 1A, 100PIV 1N4002
		CONNECTORS
J401, J402	39797-000	Jack, for audio pin-plug, Phono and Tape connectors, PC mounting

Schematic Symbol	NuTone Part No.	Description
P401	39338-110	5-Pin assembly, to AM/FM Tuner Module
ⓔ, ⓓ	39723-000	Terminal, push-on, tuner antenna coax lead-in connector
	39708-003	Screw, interconnecting wiring terminals, #6-20 x ⅜", PH/SL "25"
		TRANSISTORS
Q401	36580-000	NPN Planar Silicon, Low-noise Motorola SPS-1216 National Semi. SMO-7329 Texas Inst. SKA-4242
Q402	36613-000	NPN Silicon Motorola MPS-A20 Texas Inst. TIS-98 NPC Elect. NPC-069
		RESISTORS
R401	Not Used	
R402	33101-220	22, ½ watt
R403	33039-010	1, 1 watt, wirewound
R404	33082-102	1K
R405	33082-122	1.2K
R406	33101-561	560, ½ watt
R407	33101-101	100, ½ watt
R408	33082-103	10K
R409	33082-104	100K
R410	33082-564	560K
R411, R412	34679-000	0 to 100K ±20%, ¼ watt, carbon comp., variable slide-tap, VOLUME, TONE Stackpole Type 5020
	35219-000	Knob, for R411 and R412
R413	33082-102	1K
R414	33082-104	100K
R415	33082-102	1K
R416	33082-123	12K
R417	33101-181	180, ½ watt
R418	33101-101	100, ½ watt

Schematic Symbol	NuTone Part No.	Description
		SWITCHES
S401	34676-000	Push for ON, interlocking release, power on/off, 25 watt maximum, .5A @ 50 Vdc/ac
	35233-000	Knob, for S401
S402	34680-000	DP4T, break before make, Program Selector
		INTEGRATED CIRCUIT
Z401	36641-000	Audio Amplifier National Semi. LM380N
	39811-000	IC Socket, 14-pin for Z401
		MISCELLANEOUS
	42522-000	Front Panel Assembly
	39331-000	Nameplate
	35231-000	Tuning Wheel
	42523-000	Dial Cord Assembly
	39786-000	Pointer, AM/FM Dial
	39262-000	Spring, AM/FM Dial Pointer
	39327-000	Pulley, Dial Cord
	39135-000	Cap, Pulley
	39465-015	Screw, #6 x ¼, Slotted Hex "17" Pulley retention
	31396-000	Washer, #6
	35220-000	Friction Band, tuning drive
	35218-000	Turning Knob

I-650 WIRING TERMINAL BLOCK

	42477-000	Wiring Block Assy. Complete
	35205-000	Base—Terminal Board
	42478-000	Terminal Board Assy.
	37734-000	P.C. Board—Terminal
	39777-000	Terminal
	35206-000	Cover—Terminal Board
	42479-000	Envelope Assy.
	39778-000	Terminal Cap
	39247-000	Cable Clamp
	25075-003	Screw #6 x ⅜ Slt. Rd. "A" To Attach Cable Clamp
	48452-000	Instruction Sheet