

750
INSTRUCTION BOOK

**DUAL FREQUENCY SHIFT
TONE KEYS**

TYPE 153

MODEL 2

NORTHERN RADIO COMPANY

Incorporated

143-149 WEST 22nd ST., NEW YORK 11, N. Y.

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I. GENERAL

Purpose:

The Northern Radio Type 153 Model 2 Dual Frequency Shift Tone Keyer is used in multi-channel communication systems to provide the transmitting terminals for teleprinters or telemetering operation over microwave or metallic circuits. The intelligence pulses Frequency Shift the audio tones which are then suitably amplified and controlled for inclusion in the transmission facility.

Any number of channels may be provided and a wide selection of keying speeds may be used, limited only by the pass band of the transmission system. Usually for teleprinter or telegraph work, a channel separation of 170 cps and a maximum keying speed of approximately 100 words per minute is provided, and the following specifications are confined to units of this type. However, the unit designs are very flexible and changing of plug in sub-assemblies permit use of almost any combination of channel frequencies and band widths (and associated keying speeds) to suit special requirements.

General Description:

This dual channel Tone Keyer equipment provides two completely separate F.S. telegraph transmitters on a standard 3-1/2" x 19" equipment panel. Each Tone Keyer unit is self-contained including power supply and will operate, by changing a plug-in network, on any of the standard tone channels. The oscillator frequency of each unit is shifted ± 42.5 cps about the desired channel center frequency. This frequency shift is accomplished in such a manner that no appreciable frequency transient occurs other than the smooth transition from one frequency to the other. Transient conditions that create signal distortion are therefore eliminated in this unit at the transmitting terminal.

This Keyer makes use of a new approach to the method of obtaining the maximum stability consistent with the amount of shift adjustment used. The center frequency adjustment is accomplished by a high grade inductor and capacitor. The shifts of frequency from center, are accomplished by means of two networks in the oscillator feedback loop. The oscillator circuit is electronically switched from one to the other of these networks. The frequency Determining Network unit is provided with an output filter which permits paralleling of the outputs of as many as 18 channels.

The Keyer is also equipped with one permanent and one detachable frequency nameplate. The detachable nameplate is to be used on the Keyer front panel to display the channel frequency of the particular keyer.

General Description: (cont'd)

To further ease visual identification, all plug-in networks are coded in Standard RMA Color Code, which can be seen from the rear of the Keyer when the plug-in network is placed in operating condition.

The signal input terminals to the Keyer are made "floating", that is, they are not grounded to the frame. This allows the operation of the unit from a variety of keying circuits, having positive or negative batteries with either side grounded or ungrounded.

Principle of Operation:

Referring to Block Diagram No. B-153-1-25, the keying input signal is applied to the Keying Amplifier, which causes the Keying Stage, V2, to assume a conducting or non-conducting condition. This "flip-flop" output is applied to the Electronic Switch, the output of which alternately selects the output from either the leading or lagging phase shifting network.

The output of the Electronic Switch is applied to the Oscillator Amplifier, which feeds the LC Network. The output of the LC network is applied to a cathode follower which in turn feeds the phase shifting networks thus completing the oscillating circuit. The output of the unit is obtained from the output amplifier through the filter.

If the keying input is such that the Electronic Switch has selected the leading phase Shift Network, the frequency of the LC network will be shifted to a higher value such as to cancel this phase shift. Conversely, if the keying input is such that the Electronic Switch selects the lagging phase shift network, the frequency of the LC Network, will be shifted to a lower value. The separation between these two frequencies is determined by adjustments provided in the Frequency Determining plug-in network unit.

The F.S. Tone from the oscillator amplifier, is applied to the output amplifier stage, and through the output filter to a 600 ohm unbalanced line.

Technical Data:

Keying Inputs

1. Relay contacts.
2. DC current pulses, positive or negative, neutral or polar.
3. DC voltage pulses, positive or negative, neutral or polar.

Technical Data: (cont'd)

LIST OF STANDARD CHANNEL FREQUENCIES

for

DUAL FREQUENCY SHIFT KEYER

(Other center frequencies, shift & channel speeds available for special application)

Center Frequency cps	Frequency Shift cps	Space Frequency cps	Mark Frequency cps	Max. Channel Speed Dot-Cycles	Frequency Det. Plug-In Network Type
425	± 42.5	382.5	467.5	45	153Z2
595	± 42.5	552.5	637.5	45	153Z3
765	± 42.5	722.5	807.5	45	153Z4
935	± 42.5	892.5	977.5	45	153Z5
1105	± 42.5	1062.5	1147.5	45	153Z6
1275	± 42.5	1232.5	1317.5	45	153Z7
1445	± 42.5	1402.5	1387.5	45	153Z8
1615	± 42.5	1572.5	1657.5	45	153Z9
1785	± 42.5	1742.5	1827.5	45	153Z10
1955	± 42.5	1912.5	1997.5	45	153Z11
2125	± 42.5	2082.5	2167.5	45	153Z12
2295	± 42.5	2252.5	2337.5	45	153Z13
2465	± 42.5	2422.5	2507.5	45	153Z14
2635	± 42.5	2592.5	2677.5	45	153Z15
2805	± 42.5	2762.5	2847.5	45	153Z16
2975	± 42.5	2932.5	3017.5	45	153Z17
3145	± 42.5	3102.5	3187.5	45	153Z18
3315	± 42.5	3272.5	3357.5	45	153Z19
1615	± 120	1495	1735	125	153Z51
2295	± 120	2175	2415	125	153Z52
2975	± 120	2855	3095	125	153Z53
3655	± 120	3535	3775	125	153Z68
425	± 60	365	485	60	153Z58
765	± 60	705	825	60	153Z59
1105	± 60	1045	1165	60	153Z60
1445	± 60	1385	1505	60	153Z61
1785	± 60	1725	1845	60	153Z62
2125	± 60	2065	2185	60	153Z63

Technical Data: (cont'd)

Input Level:	<ol style="list-style-type: none">a. DC voltage: ± 10 volts minimumb. DC current: 45 ma minimum, positive, negative or polar.c. Relay contacts rating: 5 ma minimum.										
Keying Input Impedance:	<ol style="list-style-type: none">1. DC voltage: 100,000 ohms2. DC current: 220 ohms										
Frequency Stability:	± 2 cps. for $\pm 10\%$ line voltage change.										
Harmonic Content:	All harmonics of the tone are more than 50 db below output level.										
Output Level:	+ 3 dbm maximum										
Output Impedance:	600 ohms, unbalanced.										
Controls: (per channel)	<ol style="list-style-type: none">1. Primary power switch2. Mark-Space-Line Switch3. Output Level.										
Power Requirements: (per channel)	110/220 volts, 50/60 cycles. Approximately 25 watts. Connections at rear of chassis.										
Dimensions:	3-1/2" x 19" x 15"										
Weight: (2 channels)	Approximately 28 pounds										
Metering and Test Jacks:	<ol style="list-style-type: none">1. Output VU Meter2. Jacks on front panel for monitoring input keying and tone output.3. Test Jack for V3 balance.										
Tube Complement:	<table><tr><td>1 - 12AU7</td><td>Input Amplifier</td></tr><tr><td>1 - 12AU7</td><td>Keying Amplifier</td></tr><tr><td>1 - 12AX7</td><td>Keyed Amplifier</td></tr><tr><td>1 - 12AU7</td><td>Oscillator-Amplifier</td></tr><tr><td>1 - 6C4</td><td>Output Amplifier</td></tr></table>	1 - 12AU7	Input Amplifier	1 - 12AU7	Keying Amplifier	1 - 12AX7	Keyed Amplifier	1 - 12AU7	Oscillator-Amplifier	1 - 6C4	Output Amplifier
1 - 12AU7	Input Amplifier										
1 - 12AU7	Keying Amplifier										
1 - 12AX7	Keyed Amplifier										
1 - 12AU7	Oscillator-Amplifier										
1 - 6C4	Output Amplifier										

2. DESCRIPTION OF OPERATION

Reference: Schematic Dwg. C-153-2-01

A good generator of frequency shift signals must satisfy two fundamental requirements. First, it must transmit the Mark and Space frequencies with a high degree of frequency stability. Secondly, it must rapidly shift from one frequency to the other, generating only the side bands required for a smooth frequency shift, and avoid the generation of superfluous "Switching transients".

To satisfy the first of the above requirements, a multi-stage oscillator design is used together with an inductance-capacity network for determining the normal operating frequency. The considerable gain reserve, which is inherent in such a circuit, allows a large degree of freedom in the design of each individual stage. Each stage is made to function at its optimum operating point and impedance matching requirements do not impose any compromise on the overall design.

In thus utilizing relatively simple circuitry, it is possible to make the oscillator frequency largely independent of vacuum tube characteristics, hence the frequency stability is made to depend primarily on the elements of the oscillator circuit.

The second requirement, that of rapid and transient free frequency shift, is readily met by using a leading or a lagging RC phase shifting network in the oscillator feed-back loop. The leading or lagging network is selected by means of an electronic switch. To sustain oscillation, the phase shift around the oscillator loop has to be Zero. The oscillator circuit has, therefore, to shift to a new operating frequency and will oscillate at a frequency at which the L-C circuit will provide a phase shift canceling the phase shift introduced by the R-C Network.

Since the switch-over is quasi-instantaneous, the very short transient that is introduced into the oscillator loop is eliminated by the L-C circuit. The introduction of a R-C phase shifting network does not impair the stability of the oscillator. The change in phase of such networks with frequency is very slow compared to that of the L-C circuit in the vicinity of its natural resonant frequency. Since the Mark and Space frequencies are close to the center frequency, the stability of the oscillator will be primarily dependent upon the L-C circuit.

It may further be mentioned that since Mark and Space frequencies are equidistant with respect to center frequency and the amplitude-frequency characteristic of an L-C circuit is for small departures essentially symmetrical about the center frequency axis, the circuit will oscillate with equal amplitude at Mark and Space frequencies.

By proper determination of the tank circuit Q for the intended speed, amount of shift and center frequency, amplitude modulation during the shift from one frequency to the other is avoided.

This Tone Keyer will therefore operate as a tone frequency shift generator, introducing but negligible amount of signal distortion and greatly reducing the requirements to be imposed upon the transmission medium.

The Dual Frequency Shift Tone Keyer Type 153 Model 2 consists of two identical but fully independent keyers. Each keyer subdivides logically into four sections:

Input Keying Stages
Oscillator Circuit
Output Circuit
Power Supply

1. Input Keying Stages. V1 and V2:

The purpose of these stages is to convert the signal supplied to the Keyer into voltages suitable to modulate the frequency of the oscillator.

Stage V2 is a conventional "flip-flop" type circuit, with the exception that the grid return to B- of the left-hand section is thru a parallel connected double triode, V1.

Assuming switch S2 in position "S" (Space), V1 is cut off by cathode bleeder bias R6 and R7/R8. Since the left-hand section of "flip-flop" V2 has now only a return path to B+, thru R11 and R10, it will conduct; thus cutting off the right hand section of V2.

Placing switch S2 into position "M" (Mark) will return the grid of V1 thru a high resistance to B+, thus overriding the cathode bias, and V1 now conducts. This in turn provides a low potential on the left-hand grid of V2, cutting this section off, and by virtue of "flip-flop" action forcing its partner into conduction.

When the Switch S2 is in "L" (Line) position the grids of V1 are connected to the signal input terminals of Board E1, and are returned to B- thru series resistances R4, R1, R2, and R3. The input signal can now control the keying circuit.

When Voltage Keying is desired, the signal is connected to Terminal #1 and #2 and is polarized such that Terminal #1 is made positive. The signal voltage is now appearing across R1. If the signal is zero (or negative) V1 will remain cut off. If the signal is positive it will override

1. Input Keying Stages. V1 and V2: (cont'd)

the cathode bias of V1 and make V1 conduct, and flip V2.

For Current Keying. Connections are made to terminals 2 and 3, polarizing the connection so as to make #2 positive. The signal voltage will now be developed across the series resistances R2 and R3 (220 ohms total resistance, which is equal to a teleprinter type load), and will key V1 and V2 much the same way as above. The Input Current monitor J2 is across R3, which is a 100 ohm, 1% resistor. Thus a voltmeter plugged into J2 will permit to accurately measure the Input Keying Current, the calibration being 10 ma equals 1 volt. Of course, J2 can also be used for monitoring of the input wave form by means of a CRO.

CAUTION: Do not plug a teleprinter or other device having less than 1500 ohms internal resistance into J2.

When Contact Keying (or hand keying) is desired, connections are made to terminal #1 and #4. When the Key is open, V1 will be cut-off by its cathode bias. When the Key is closed, the grid of V1 will be shorted to its cathode and V1 will conduct and "flip" V2.

2. The Oscillator Circuit:

The oscillator is a multi-stage circuit containing two regenerative feed-back loops. Either one or the other of these feed-back loops is selected by the Electronic Switch, V3.

The double triode V3 has its two grids respectively connected to the two feed-back networks, while the two plates have a common resistor R18.

The two cathodes of V3 are directly coupled to the corresponding cathodes of V2. Thus, whichever section of V2 is conducting, it will develop sufficient cathode bias thru R17 to cut the corresponding section of V3 off.

R17 is a balancing potentiometer. In correct adjustment, it will equalize the keying voltages applied to the cathode of V3, and thus the keying voltage will not appear in the common plate circuit of V3.

V3 is therefore an electronic single-pole double-throw switch, which is "thrown" by V2 alternately into one or the other position, allowing one section of V3 to operate as a Class A amplifier while the other is kept at cut-off.

2. The Oscillator Circuit: (cont'd)

The output of V3 is coupled to the oscillator amplifier, which is the left section of V4.

The plate circuit of this stage contains an isolating resistance R28 in series with a parallel tuned circuit consisting of L1, C3 and R5, which is located in the plug-in frequency determining network.

L1/C3 is tuned to center frequency: R5 is a shunting resistor which is used only on the lower frequency channels and serves to reduce the Q of the tank circuit.

The output of the tank circuit is applied to the right-hand section of V4, which operates as a split-phase amplifier.

The cathode load of this stage consists of the parallel combination of R3 and R4, which are located in the frequency determining network, R3 and R4 in turn feed two RC phase shifting networks, respectively R1, C1, and R2, C2. The output of the R1, C1 phase shifting network is taken across C1 and this produces a lagging shift in phase, while the output across R2 is leading the voltage applied to the network.

These two phase shifted voltages are in turn applied respectively to the two grids of the Keyed Amplifier V3, which thus completes the oscillator feed-back loop. As one or the other section of V3 is made to operate as an amplifier, one or the other of the two RC phase shifting feed-back loops will be selected.

It will be recalled that one condition for oscillation is a zero phase shift around the loop circuit. Since a phase shift is introduced by the RC phase shifting network, the circuit will oscillate at a frequency such that the LC tuned circuit will provide for a phase shift cancelling that of the RC network. Thus as V3 is "switched" from a leading RC Network to a lagging RC network, the oscillator will smoothly change over from a higher to a lower frequency. L1 is adjusted to resonate with C3 at center frequency. R1 and R2 then independently adjusted to give the correct SPACE and MARK frequencies. Since MARK and SPACE frequencies are equidistant with respect to center frequency, equal amplitudes of oscillation will result at both frequencies. Potentiometers R3 and R4 in the plug-in network serve to control and equalize the loop gains of the oscillator.

3. Output Circuits:

The plate of the right-hand section of V4 feeds the Output Amplifier, V5, through an output amplitude control potentiometer R34.

3. Output Circuits: (cont'd)

The output of V5 is transformer-coupled to the channel-filter BP1 which is located in the plug-in sub-assembly.

An output level metering circuit, as well as a phone jack J3 are paralleled across the input of the channel filter for phone or CRO monitoring.

The metering circuit consists of a meter M1 calibrated in volume units and a 10VU meter attenuator consisting of resistors R100, R101 and R102.

A 10VU higher tone level than is indicated by the meter is thereby applied to the input of the filter equalizing attenuator in series with the filter. The filter insertion loss, added to the loss introduced by the equalizing attenuator, is adjusted to 10VU. The meter reading is therefore approximately equal to the output channel level of the unit.

While this Keyer may be used over the whole range of the meter, operation is recommended up to 0 VU since above this value there is a very slight effect on the frequency of the oscillator circuit.

The output impedance characteristic of the channel filter is such that it allows parallel operation of a maximum of 18 such filters on one outgoing 600 ohm line.

4. Power Supply:

The Power Supply is a conventional full wave circuit. It is to be noted that it has no connection to the chassis, making the Keyer unit "floating" with respect to ground.

It is to be understood that capacity effects to ground in an entirely floating system may impair the frequency stability of the oscillator, thus if the keying source does not have a definite impedance to ground it is necessary to ground the B- bus of the Keyer (terminal 3 E1).

3. DESCRIPTION OF CONTROLS

Following front panel controls are provided on each of the two Keyer units:

Mark - Space - Line Switch

This is a test switch. Only in LINE position does the signal control the Keyer.

In SPACE position the Keyer will emit the Space Frequency (Lower Frequency).

In MARK position the Keyer will emit the Mark Frequency (Higher Frequency).

Output Control

This control permits the control of the output level of the Keyer.

4. MECHANICAL INSTALLATION

The Tone Keyer may be installed in any convenient location so that access is provided to the rear of the equipment for periodic maintenance checks.

Installation of Frequency Determining Plug-In Network, Type 153Z MOD. 2:

Select the correct Plug-In Network Type 153Z Mod. 2 for the desired channel frequency.

Remove the small frequency nameplate located on the unit and attach it to the front panel of the Keyer.

Connect Jack J4 of Keyer unit to Plug P4 of Type 153Z Mod. 2 Plug-In Network.

Carefully place the plug-in network into the Keyer and tighten the four snap screws on the plug-in network by making a quarter turn of each screw.

5. ELECTRICAL INSTALLATION

Before connecting the equipment to the power source, check the voltage of the primary power. Units are wired at the factory for 110 volt, 50/60 cycle operation, unless otherwise specified. Further, check that the input keying connections and output load connections meet the equipment specifications.

The keying lines to the equipment should be twisted pairs. Only one type of keying line should be connected to the equipment at any time to prevent one keying signal from interfering with another. If it is necessary to alternate frequently between various types of keying, it is usually best to bring out all the keying connections to a patch panel, so that quick changes in keying connections can be made. The tone lines should be shielded. The shield should be grounded and connected to terminal #6 of E1.

FOR CURRENT KEYING:

Terminals #2 and #3 on Board E1 are current keying inputs.

A) Grounded Battery Source

If the negative side of the battery is grounded, connect the ground wire to #3 on Board E1, while the other wire is connected to terminal #2.

If the positive side of the battery is grounded, strap terminals #3 and #4 of E1 and connect the ground lead to terminal #3. The "live" wire is to be connected to terminal #2.

b) Floating Battery:

If a "floating" keying source is used, connect the negative wire to terminal #3 and the positive wire to terminal #2.

Further strap terminals #3 and #6 (ground) on E1.

FOR CURRENT KEYING: (cont'd)

c) Loop Operation:

If the keying line has a definite impedance to ground but is at some D.C. potential with respect to ground, connect the positive wire to terminal #2 and the negative wire to terminal #3 of E1.

FOR VOLTAGE KEYING:

a) Grounded Battery Source:

If the negative side of the battery is grounded, connect the ground wire to terminal #2, while the other wire connects to terminal #1 on E1.

If the positive side of the battery is grounded, strap terminals #3 and #4 on E1, connect the ground lead to terminal #2 and the other wire to terminal #1 on E1.

b) Floating Battery:

If a "Floating" keying source is used, connect the negative wire to terminal #2, the positive wire to #1 and strap terminals #3 and #6 on E1.

FOR CONTACT KEYING:

Connect contact leads to terminals #1 and #4 and strap terminals #3 and #6 on E1.

Check of Operating Frequencies:

After the above installation steps have been completed, a frequency check should be made. Allow the equipment to warm up for at least 3 hours and follow the instructions as covered in the chapter on "MAINTENANCE" (Frequency Calibration Check).

6. OPERATING INSTRUCTIONS

A. Current Keying:

Adjust current source to deliver no less than 40 ma into the Keyer. The current can be measured on the INPUT CURRENT MONITOR jack located on the front panel of the Keyer. Use a 10V. full-scale DC Voltmeter; the calibration is 1 V. for 10 ma, supplied to the Keyer.

B. Voltage Keying:

Adjust voltage source to deliver no less than 10 volts to the Keyer.

C. Contact Keying:

Make sure that the Key or relay is properly adjusted, and has no spark suppressor or other circuitry connected to its contacts. No power is required to contact-key the unit.

D. Operation Check:

Place Mark-Space-Line switch into either "Mark" or "Space" position and adjust output level to desired value. Plug earphones or CRO into Output Monitor jack and throw Mark-Space-Line switch into LINE position and observe keying.

7. MAINTENANCE

To obtain long and trouble-free operation from the Dual Frequency Shift Tone Keyer, it is recommended that a few routine checks be performed at reasonable intervals.

Check all tubes periodically for emission and mutual conductance. When any tube shows a mutual conductance or emission less than the minimum acceptable for its type, it should be replaced.

The output tone frequencies should be compared to a standard approximately once a month, and deviations rectified.

Similarly, the keyed amplifier balance should be checked monthly. These tests can be easily performed in the following manner:

Keyed Amplifier Balance:

Connect a keying source to the Keyer unit.

Remove tube V4.

Place Mark-Space-Line Switch into LINE position. With CRO observe the wave form at J5 with respect to B-. If balance is correct, the keying wave form should not appear on the CRO. If balance has altered, the keying wave form will be seen on the CRO. Adjust R17 (located in the rear of the Keyer chassis) until the keying is cancelled.

Frequency Calibration Check and Minor Adjustments:

Let the unit warm up for at least 3 hours. Using a suitable frequency standard for reference, check MARK (higher) and SPACE (lower) frequencies respectively. If it is found that some small drift has occurred (5 cps) readjust.

Set the MARK-SPACE-LINE switch on SPACE and slightly adjust L1 on the Frequency Determining Network, till the exact SPACE frequency is obtained. This can be done without removing the unit out of the rack, using a #8 Allen wrench for the adjustment of L1.

Setting the M-S-L switch to MARK now measure the MARK frequency.

It will usually be found to be within 1 cps of the correct value, and is the only frequency adjustment required.

Should the MARK frequency be found to deviate by more than 2 cps from its correct value, after L1 has been adjusted to give the correct space figure, it is necessary to recalibrate the network, in accordance with the manner indicated in the next Paragraph.

Recalibration of the 153Z Mod. 2 Network:

The stability of the oscillator is such that the above mentioned small adjustment is all that should be normally required. If accidentally a network goes out of adjustment, a recalibration against a frequency standard is required. Proceed as follows:

If the unit has not been in operation, let it warm up for at least 3 hours before proceeding with the calibration. If the unit has been in operation, only about 1/2 hour warm up is required.

Turn R3 and R4 clockwise about 240°.

Turn R1 clockwise, completely.

Place Mark-Space-Line switch to SPACE.

Adjust L1 until center frequency is obtained at the output of the Keyer.

Back-up R1 until the Keyer oscillates at SPACE frequency.

Place Mark-Space-Line switch to MARK.

Adjust R2 until MARK frequency is obtained at the output of the Keyer.

Turn R4 slowly counterclockwise and observe the front panel meter reading. Locate the position of R4 where the front panel meter indicates a maximum. This is the correct high frequency gain adjustment.

Check back the Mark frequency. A small readjustment of R2 may be required.

Place the Mark-Space-Line switch to SPACE and adjust the low frequency gain potentiometer R3 in the same manner as described for R4. Check back on the Space frequency and readjust R1 if required.

If following the foregoing procedure does not result in equal Mark and Space frequency amplitudes (this may happen whenever the shift is wide relative to center frequency) the following additional steps should be undertaken:

Readjust L1 such that the frequency is lowered approximately 10 cycles in case of smaller amplitude space frequency or raised 10 cycles in

Recalibration of the 153Z Mod. 2 Network: (Cont'd)

case of larger amplitude space frequency. Readjust R1 & R2 for correct Mark and Space frequency. Repeat as often as necessary to reach equality of amplitude with 2 db.

NOTE: Read amplitudes at the output Monitor jack (J3) located on the front panel.

Equalizing Attenuator Adjustment:

Connect a calibrated volume level indicator (terminating input) to terminals #5 and #6 of the Keyer Output Terminal Board. Adjust the front panel output potentiometer until 0 VU reading is obtained on the front panel VU meter.

The volume level indicator may have a reading higher or lower than 0 VU.

Turn potentiometer R107 (located on Plug - in network) until equal reading on front panel meter M1 and on volume level indicator is obtained.

Check for correspondence of readings at zero VU.

TABLE OF TYPICAL TUBE SOCKET VOLTAGES

EQUIPMENT: DUAL F.S. TONE KEYER		TYPE 153 MODEL: 2															
Sym- bol	Function	Type	Pins	Volts	Pins	Volts	Pins	Volts	Pins	Volts	Pins	Volts	Pins	Volts	Pins	Volts	
V1	Input Amp.	12AU7	M S	1 36	8 36	2	6.4 0	3	6.5 4.7	6	7.7 36	7	6.4 0	8	6.5 4.7	9	AC 5.8
V2	Keying Amp.	12AU7	M S	1 40	83 40	2	8 36	3	28 35	6	39 86	7	32 20	8	32 29	9	AC 5.8
V3	Keyed Amp.	12AX7	M S	1	115	2	21 22	3	28 35	6	115	7	20 20 $\frac{1}{2}$	8	32 29	9	AC 5.8
V4	Osc.-Amp.	12AU7	1	123	123	2	0	3	5.6	6	25	7	0	8	1.2	9	5.8
V5	Out.-Amp.	6C4	4	AC 5.8	AC 5.8	5	126	6	0	7	2.9						
V6	Power Rectifier	6X4	1	AC 300	AC 300	4	AC 5.8	6	AC 300	7	245						

NOTE: ALL voltages measured to common (B-) with Simpson (Model 260) Multimeter (20,000 ohms/V) and considered to be correct within $\pm 10\%$.

CONTROL SETTINGS

1. Measured with network 153Z5 Mod. 2 (other networks should give approximately the same figures)
2. S2 in M then in S
3. R34 (output level) to Zero

9. ELECTRICAL PARTS LIST

Sym- bol	Function	Description	Mfr.	Part No.
C2	Input coupling capacitor for V3	<i>-20% + 30%</i> 0.05 mfd 400 V. paper tubular	ASC	ML-4-05
C3	Input coupling capacitor for V3	<i>-20% + 30%</i> .05 mfd 400 V. paper tubular capacitor	ASC	ML-4-05
C4	Output coupling cap. for V3	<i>-20% + 30%</i> .05 mfd 400 V. paper tubular capacitor	ASC	ML-4-05
C5A	Rectifier filter cap.	<i>-20% + 30%</i> 0.1 mfd 200 V. DC metallized tubular	ASC	ML-2-1
C5B	Same as C5A	Same as C5A		
C6	Output coupling cap. for V4	<i>-20% + 30%</i> 0.05 mfd 400 V. paper tubular capacitor	ASC	ML-4-05
C7	Input coupling cap. for V4	<i>-20% + 30%</i> .05 mfd 400 V. paper tubular capacitor	ASC	ML-4-05
C8	Plate output coupling capacitor for V4	<i>-20% + 30%</i> .05 mfd 400 V. paper tubular capacitor	ASC	ML-4-05
C9	Rectifier filter cap.	4 mfd 600 V. paper capacitor	CDC	T-6040
C10	Rectifier filter cap.	4 mfd 600 V. paper cap.	CDC	T-6040
C11	Filter capacitor across V3 cathode resistor R17	50 mfd 50 V. bathtub electrolytic capacitor (side terminals)	ASC	ED 50-50
C12	Same as C11	Same as C11		
E1	Input and output terminal strip and solder lugs	6 terminal, screw type, terminal strip and solder lugs	HBJ	6-140-3/4W. Y Solder lug
F1	Main power fuse	1 amp. glass cartridge fuse 250 V. type 3AG	LFU	312001
<i>F2</i>	<i>Spare fuse</i>	<i>Same as F1</i>		
I1	Primary power indicator lamp	Miniature bayonet base incandescent lamp, 6-8 volt, .15 amp.	GEC	47

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Electrical Parts List
Type 153 Model 2

Sym- bol	Function	Description	Mfr.	Part No.
I2	Blown fuse indicator	Miniature Bayonet base neon lamp	GEC	NE-51
J1	Main power input conn.	2 contact male chassis connector	HBJ	P-202-B
J2	Input jack	3 circuit microphone jack	MAL	SCA-2B
J3	Output jack	3 circuit microphone jack	MAL	SCA-2B
J4	Socket for 153Z	8 connector female Jones socket	HBJ	S308CCT
J5	Test Jack	Pin Jack	CAN	45E-3
L1	Power supply filter choke	7 henries 110 ma DC 160 ohms resistance (hermetically sealed)	NRC	108-H
M1	Output meter	A.C. rectifier type VU meter 2-1/2" square case - type 30 A scale	MAR VET	5-2 S 500
* P1	Main power cable conn.	2 contact female cable conn.	HBJ	S-202-CCT
R1	V1 grid resistor	100K ohms \pm 10% 1/2 watt composition resistor	ALB	EB1041
R2	Keying load resistor	120 ohms \pm 10% 1 watt comp. res.	ALB	GB 1211
R3	Keying load resistor	100 ohms \pm 1% 1 watt comp. res.	CCC	14R25- 14R25-1
R4	V1 grid isolating res.	100K ohms \pm 10% 1/2 watt comp. res.	ALB	EB1041
R5	V1 plate load res.	220K ohms \pm 10% 1/2 watt comp. res.	ALB	EB 2241
R6	V1 cathode resistor	1.8K ohms \pm 10% 1/2 watt comp. res.	ALB	EB 1821
R7	V1 bias dividing res.	100K ohms \pm 10% 1 watt comp. res.	ALB	GB 1041
R8	Same as R7	100K ohms \pm 10% 1 watt comp. res.	ALB	GB 1041

* Applicable to units bearing serial No 3814 and above See Z1

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Electrical Parts List
Type 153 Model 2

Sym- bol	Function	Description	Mfr.	Part No.
R9	V2 plate load	47K ohms \pm 10% 1/2 watt comp. res.	ALB	EB 4731
R10	V2 plate load	47K ohms \pm 10% 1/2 watt comp. res.	ALB	EB 4731
R11	V2 coupling resistor	47K ohms \pm 10% 1/2 watt comp. res.	ALB	EB 4731
R12	V2 coupling resistor	47K ohms \pm 10% 1/2 watt comp. res.	ALB	EB 4731
R13	V2 grid resistor	47K ohms \pm 10% 1/2 watt comp. res.	ALB	EB 4731
R15	Voltage divider res.	10K ohms \pm 10% 10 watt wirewound res.	WLE	10F
R16	Voltage divider res.	1.2K ohms \pm 10% 5 watt wirewound res.	WLE	5F1200
R17	V3 cathode resistor	5K ohms \pm 10% 2 watt linear potentiometer	ALB	JU 5022
R18	V3 common plate load	47K ohms \pm 10% 1/2 watt comp. res.	ALB	EB 4731
R19	V3 grid resistor	0.27 megohm \pm 10% 1/2 watt comp. res.	ALB	EB 2741
R20	V3 grid resistor	0.27 megohm \pm 10% 1/2 watt comp. res.	ALB	EB 2741
R21	V4 grid isolating res.	220K ohms \pm 10% 1/2 watt comp. res.	ALB	EB 2241
R22	V4 plate load	4700 ohms \pm 10% 1/2 watt comp. res.	ALB	EB 4721
R23	V4 plate load	220K ohms \pm 10% 1/2 watt comp. res.	ALB	EB 2241
R24	V4 isolating res.	470K ohms \pm 10% 1/2 watt comp. res.	ALB	EB 4741

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Electrical Parts List
Type 153 Model 2

Sym- bol	Function	Description	Mfr.	Part No.
R26	V4 cathode resistor	2.7K ohms \pm 10% 1/2 watt comp. res.	ALB.	EB 2721
R27	V4 grid resistor	1 megohm \pm 10% 1/2 watt comp. res.	ALB	EB 1051
R28	Coupling resistor for V4	100K ohms \pm 10% 1/2 watt comp. res.	ALB	EB 1041
R29	V5 cathode resistor	390 ohms \pm 10% 1/2 watt comp. res.	ALB	EB 3911
R30	Power supply filter resistor	6000 ohms \pm 10% 5 watt wire-wound resistor	WLE	5F6000
R31	Neon lamp series resistor	100K ohms \pm 10% 1/2 watt comp. res.	ALB	EB 1041
R32	V5 grid isolating resistor	220K ohms \pm 10% 1/2 watt comp. res.	ALB	EB 2241
R33	V4 grid resistor	1 megohm \pm 10% 1/2 watt comp. res.	ALB	EB 1051
R34	Output control	1 megohm \pm 20% 2 watt potentiometer.	ALB	JU 1052
R100	Attenuator series resistor	4.7K ohms \pm 5% 1/2 watt comp. res.	ALB	EB 4725
R101	Attenuator shunt	5.1K ohms \pm 5% 1/2 watt comp. res.	ALB	EB 5125
R102	Attenuator series resistor	1.2K ohms \pm 5% 1/2 watt comp. res.	ALB	EB 1225
R106	Indicator Lamp resistor	12 ohms \pm 10% 2 watt comp. res.	ALB	HB 1201
S1	Primary power switch	DPST toggle, 6/3 amp. 110/220 volts	<i>CAC</i> ALB	<i>8360K7</i> 8360K7
S2	Key-Line switch	2 circuit, 3 position, non-shorting rotary switch, 3/8" shaft	MAL	3223J

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Electrical Parts List
Type 153 Model 2

Sym- bol	Function	Description	Mfr.	Part No.
T1	Power transformer	Primary: 110/220 V. 50/60 cps Sec. #1: 295-0-295 V.@ 90 ma Sec. #2: 6.3 V. @ 2 amp. (Hermetically sealed).	NRC	192H
T2	Interstage transformer	Ouncer type plate to line transformer, 15K ohms to 600 ohms (hermetically sealed, in RC-0 can, stud mounting)	UTC	0-9
V1	Input Amplifier	Standard	Any	12AU7A
V2	Keying Amplifier	Standard	Any	12AU7A
V3	Keyer tube	Standard	Any	12AX7
V4	Oscillator & Amplifier	Standard	Any	12AU7A
V5	Output Amplifier	Standard	Any	6C4
V6	Rectifier tube	Standard	Any	6X4
X1	Input amplifier socket	9 pin, mica-filled bakelite miniature tube socket	EBY	9714-21
X2	Keying amplifier socket	Same as X1		
X3	Keying tube socket	Same as X1		
X4	Oscillator and amplifier socket	Same as X1		
X5	Output amplifier socket	7 pin, mica-filled bakelite miniature tube socket	EBY	9735-11
X6	Rectifier socket	Same as X5		
X8	Socket for F1	Panel mounting, finger type knob fuse holder (for 3AG Littlefuse)	LFU	342001
X9	Primary power indicator lamp socket	Pilot lamp assembly - miniature bayonet base, frosted white jewel, with removable red disc.	DLA	67B161

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Electrical Parts List
Type 153 Model 2

Sym- bol	Function	Description	Mfr.	Part No.
X10	Blown fuse indicator socket	Pilot lamp assembly - miniature bayonet base, frosted white jewel, with removable red disc.	DLA	67B161
153Z	Frequency Determining Network	Plug-in type network	NRC	153Z Mod 2
Z1*	<i>Main power cable</i>	<i>2 conductor cable with connector</i>	<i>NRC</i>	<i>788</i>

* Applicable to units bearing Serial No. 3814 and above

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Electrical Parts List (Network)
Type 153 Model 2

Symbol	Description	Mfr.	Part No.
<u>TYPE 153Z2 MOD 2</u>			
	Carrier Frequency 425 ± 42.5 cps	Mark Frequency 467.5 cps	Space Frequency 382.5 cps
BP1	425 cps band pass filter	NRC	194
C1	.01 mfd ± 5% 300 volt silver mica capacitor	SAN	CR 06110
C2	Same as C1		
C3	.15 mfd ± 20% 400 volt tubular	CDC	TWC 4P15EG-4P
L1	.54 henry + 90% -50% variable inductor	UTC	VIC-10
P4	8 pin, male Jones plug	HBJ	P308AB
R1	100K ohms ± 10% 2 watt potentiometer	ALB	JU1041
R2	250K ohms ± 10% 2 watt potentiometer	ALB	JU2541
R3	5K ohms ± 10% 2 watt potentiometer	ALB	JU5021
R4	Same as R3		
R5	33K ohms ± 10% 1/2 watt composition resistor	ALB	EB 8271 3331
R107	2.5K ohms ± 20% .33 watt composition potentiometer	ALB	GU
R108	1 K ohms ± 5% 1/2 watt. comp. res.	ALB	EB 1025
<u>TYPE 153Z3</u>			
	Carrier Frequency 595 ± 42.5 cps	Mark Frequency 637.5 cps	Space Frequency 552.5 cps
BP1	595 cps band pass filter	NRC	195
C1	0.005 mfd ± 5% 500 volt silver mica capacitor	SAN	CR 1250
C2	Same as C1		
C3	.1 mfd ± 20% 400 volt tubular cap.	CDC	TWC 4P1EG-4P
L1	.54 henry + 90% -50% variable inductor	UTC	VIC-10
P4	8 pin male Jones plug	HBJ	P308AB
R1	Same as for Type 153Z2		
R2	Same as for Type 153Z2		
R3	Same as for Type 153Z2		
R4	Same as for Type 153Z2		
R5	47K ohms ± 10% 1/2 watt comp. res.	ALB	EB 4731
R107	2.5K ohms ± 20% .33 watt composition potentiometer	ALB	GU
R108	1 K ohms ± 5% 1/2 watt comp. res.	ALB	EB 1025

Symbol	Description	Mfr.	Part No.
<u>TYPE 153Z4 MOD. 2</u>			
	Carrier Frequency 765 ± 42.5 cps		Mark Frequency 807.5 cps Space Frequency 722.5 cps
BP1	765 cps band pass filter	NRC	196
C1	0.005 mfd ± 5% 500 volt silver mica capacitor	SAN	CR1250
C2	Same as C1		
C3	.1 mfd ± 20% 400 volt tubular cap.	CDC	TWC 4P1EG-4P
L1	.54 henry + 90% -50% variable inductor	UTC	VIC-10
P4	8 pin male Jones plug	HBJ	P308AB
R1	Same as for Type 153Z2		
R2	Same as for Type 153Z2		
R3	Same as for Type 153Z2		
R4	Same as for Type 153Z2		
R5	47K ohms ± 10% 1/2 watt composition resistor	ALB	EB 4731
R107	2.5K ohms ± 20% .33 watt composition potentiometer	ALB	GU
R108	1 K ohms ± 5% 1/2 watt, comp. res.	ALB	EB 1025

<u>TYPE 153Z5 MOD. 2</u>			
	Carrier Frequency 935 ± 42.5 cps		Mark Frequency 977.5 cps Space Frequency 892.5 cps
BP1	935 cps band pass filter	NRC	197
C1	0.003 mfd ± 5% 500 volt silver mica capacitor	SAN	CR 1230
C2	Same as C1		
C3	.047 mfd ± 20% 400 volt tubular cap.	CDC	TWC 4S47EG-4P
L1	.34 henry + 90% -50% variable inductor	UTC	VIC-9
P4	8 pin male Jones plug	HBJ	P308AB
R1	Same as for Type 153Z2		
R2	Same as for Type 153Z2		
R3	Same as for Type 153Z2		
R4	Same as for Type 153Z2		
R5	Not used		
R107	2.5K ohms ± 20% .33 watt composition potentiometer	ALB	GU
R108	1 K ohms ± 5% 1/2 watt, comp. res.	ALB	EB 1025

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Electrical Parts List (Network)
Type 153 Model 2

Symbol	Description	Mfr.	Part No.
<u>TYPE 153Z6 MOD. 2</u>			
	Carrier Frequency 1105 ± 42.5 cps	Mark Frequency: 1147.5 cps	Space Frequency: 1062.5 cps
BP1	1105 cps band pass filter	NRC	198
C1	0.003 mfd ± 5% 500 volt, silver mica capacitor	SAN	CR1230
C2	Same as C1	SAN	CR1230
C3	.047 mfd ± 20% 400 volt tubular capacitor	CDC	TWC 4S47EG-4P
L1	.34 henry + 90% -50% variable inductor	UTC	VIC-9
P4	8 pin male Jones plug	HBJ	P308AB
R1	Same as for Type 153Z2		
R2	Same as for Type 153Z2		
R3	Same as for Type 153Z2		
R4	Same as for Type 153Z2		
R5	Not used		
R107	2.5K ohms ± 20%. .33 watt composition potentiometer	ALB	GU
R108	1 K ohms ± 5% 1/2 watt comp. res.	ALB	EB1025
<u>TYPE 153Z7 MOD. 2</u>			
	Carrier Frequency 1275 ± 42.5 cps	Mark Frequency: 1317.5 cps	Space Frequency: 1232.5 cps
BP1	1275 cps band pass filter	NRC	199
C1	0.003 mfd ± 5% 500 volt silver mica capacitor	SAN	CR1230
C2	Same as C1		
C3	.047 mfd ± 20% 400 volt tubular capacitor	CDC	TWC 4S47EG-4P
L1	.34 henry + 90% -50% variable inductor	UTC	VIC-9
P4	8 pin male Jones plug	HBJ	P308AB
R1	Same as for Type 153Z2		
R2	Same as for Type 153Z2		
R3	Same as for Type 153Z2		
R4	Same as for Type 153Z2		
R5	Not used		
R107	2.5K ohms ± 20%. .33 watt composition potentiometer	ALB	GU
R108	1 K ohms ± 5% 1/2 watt comp. res.	ALB	EB1025

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Electrical Parts List (Network)
Type 153 Model 2

Symbol	Description	Mfr.	Part No.
<u>TYPE 153Z8 MOD. 2</u>			
	Carrier Frequency 1445 ± 42.5 cps	Mark Frequency:	1487.5 cps
		Space frequency:	1402.5 cps
BP1	1445 cps band pass filter	NRC	200
C1	0.003 mfd ± 5% 500 volt silver mica capacitor	SAN	CR1230
C2	Same as C1		
C3	.047 mfd ± 20% 400 volt tubular capacitor	CDC	TWC 4S47EG-4P
L1	.34 henry + 90% -50% variable inductor	UTC	VIC-9
P4	8 pin male Jones plug	HBJ	P308AB
R1	Same as for Type 153Z2		
R2	Same as for Type 153Z2		
R3	Same as for Type 153Z2		
R4	Same as for Type 153Z2		
R5	Not used		
R107	2.5K ohms ± 20%. .33 watt composition potentiometer	ALB	GU
R108	1 K ohms ± 5% 1/2 watt comp. res.	ALB	EB1025

TYPE 153Z9 MOD. 2

	Carrier Frequency 1615 ± 42.5 cps	Mark Frequency:	1657.5 cps
		Space Frequency:	1572.5 cps
BP1	1615 cps band pass filter	NRC	201
C1	0.003 mfd ± 5% 500 volt silver mica cap.	SAN	CR 1230
C2	Same as C1		
C3	.022 mfd ± 20% 400 volt tubular capacitor	CDC	TWC 4S22EG-4P
L1	.34 henry + 90% -50% variable inductor	UTC	VIC-9
P4	8 pin male Jones plug	HBJ	P308AB
R1	Same as for Type 153Z2		
R2	Same as for Type 153Z2		
R3	Same as for Type 153Z2		
R4	Same as for Type 153Z2		
R5	Not used		
R107	2.5K ohms ± 20% .33 watt composition potentiometer	ALB	GU
R108	1 K ohms ± 5% 1/2 watt comp. res.	ALB	EB1025

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Electrical Parts List (Network)
Type 153 Model 2

Symbol	Description	Mfr.	Part No.
<u>TYPE 153Z10 MOD. 2</u>			
	Carrier Frequency 1785 ± 42.5 cps	Mark Frequency: 1827.5 cps	Space Frequency: 1742.5 cps
BP1	1785 cps band pass filter	NRC	202
C1	0.003 mfd ± 5% 500 volt silver mica cap.	SAN	CR 1230
C2	Same as C1		
C3	.022 mfd ± 20% 400 volt tubular capacitor	CDC	TWC 4S22EG-4P
L1	.34 henry + 90% -50% variable inductor	UTC	VIC-9
P4	8 pin male Jones plug	HBJ	P308AB
R1	Same as for Type 153Z2		
R2	Same as for Type 153Z2		
R3	Same as for Type 153Z2		
R4	Same as for Type 153Z2		
R5	Not used		
R107	2.5K ohms ± 20% .33 watt composition potentiometer	ALB	GU
R108	1 K ohms ± 5% 1/2 watt comp. res.	ALB	EB1025

TYPE 153Z11 MOD. 2

	Carrier Frequency 1955 ± 42.5 CPS	Mark Frequency: 1997.5 cps	Space Frequency: 1912.5 cps
BP1	1955 cps band pass filter	NRC	203
C1	0.003 mfd ± 5% 500 volt silver mica cap.	SAN	CR 1230
C2	Same as C1		
C3	.022 mfd ± 20% 400 volt tubular capacitor	CDC	TWC 4S22EG-4P
L1	.34 henry + 90% -50% variable inductor	UTC	VIC-9
P4	8 pin male Jones plug	HBJ	P308AB
R1	Same as for Type 153Z2		
R2	Same as for Type 153Z2		
R3	Same as for Type 153Z2		
R4	Same as for Type 153Z2		
R5	Not used		
R107	2.5K ohms ± 20% .33 watt composition potentiometer	ALB	GU
R108	1 K ohms ± 5% 1/2 watt comp. res.	ALB	EB1025

Symbol	Description	Mfr.	Part No.
<u>TYPE 153Z12 MOD. 2</u>			
	Carrier Frequency 2125 ± 42.5 cps	Mark Frequency: 2167.5 cps	Space Frequency: 2082.5 cps
BP1	2125 cps band pass filter	NRC	204
C1	0.003 mfd ± 5% 500 volt silver mica cap.	SAN	CR 1230
C2	Same as C1		
C3	.022 mfd ± 20% 400 volt tubular capacitor	CDC	TWC 4S22EG-4P
L1	.34 henry + 90% -50% variable inductor	UTC	VIC-9
P4	8 pin male Jones plug	HBJ	P308AB
R1	Same as for Type 153Z2		
R2	Same as for Type 153Z2		
R3	Same as for Type 153Z2		
R4	Same as for Type 153Z2		
R5	Not used		
R107	2.5K ohms ± 20% .33 watt composition potentiometer	ALB	GU
R108	1 K ohms ± 5% 1/2 watt comp. res.	ALB	EB1025

TYPE 153Z13 MOD. 2

	Carrier Frequency 2295 ± 42.5 cps	Mark Frequency: 2337.5 cps	Space Frequency: 2252.5 cps
BP1	2295 cps band pass filter	NRC	205
C1	0.001 mfd ± 5% 500 volt silver mica cap.	SAN	CR 1210
C2	0.005 mfd ± 5% 500 volt silver mica cap.	SAN	CR 1250
C3A	.01 mfd ± 5% 300 volt silver mica cap.	SAN	CR 06110
C3B	.01 mfd ± 5% 300 volt silver mica cap.	SAN	CR 06110
L1	.34 henry + 90% -50% variable inductor	UTC	VIC-9
P4	8 pin male Jones plug	HBJ	P308AB
R1	Same as for Type 153Z2		
R2	Same as for Type 153Z2		
R3	Same as for Type 153Z2		
R4	Same as for Type 153Z2		
R5	Not used		
R107	2.5K ohms ± 20% .33 watt composition potentiometer	ALB	GU
R108	1 K ohms ± 5% 1/2 watt comp. res.	ALB	EB1025

Symbol	Description	Mfr.	Part No.
<u>TYPE 153Z14 MOD. 2</u>			
	Carrier Frequency 2465 ± 42.5 cps	Mark Frequency: 2507.5 cps	Space Frequency: 2422.5 cps
BP1	2465 cps band pass filter	NRC	206
C1	0.001 mfd ± 5% 500 volt silver mica cap.	SAN	CR 1210
C2	0.005 mfd ± 5% 500 volt silver mica cap.	SAN	CR 1250
C3A	.01 mfd ± 5% 300 volt silver mica cap.	SAN	CR 06110
C3B	.007 mfd ± 5% 300 volt silver mica cap.	SAN	CR 06270
L1	.34 henry + 90% -50% variable inductor	UTC	VIC-9
P4	8 pin male Jones plug	HBJ	P308AB
R1	Same as for Type 153Z2		
R2	Same as for Type 153Z2		
R3	Same as for Type 153Z2		
R4	Same as for Type 153Z2		
R5	Not used		
R107	2.5K ohms ± 20% .33 watt composition potentiometer	ALB	GU
R108	1 K ohms ± 5% 1/2 watt comp. res.	ALB	EB1025

<u>TYPE 153Z15 MOD. 2</u>			
	Carrier Frequency 2635 ± 42.5 cps	Mark Frequency: 2677.5 cps	Space Frequency: 2592.5 cps
BP1	2635 cps band pass filter	NRC	207
C1	0.001 mfd ± 5% 500 volt silver mica cap.	SAN	CR 1210
C2	0.005 mfd ± 5% 500 volt silver mica cap.	SAN	CR 1250
C3A	0.008 mfd ± 5% 300 volt silver mica cap.	SAN	CR 06280
C3B	0.007 mfd ± 5% 300 volt silver mica cap.	SAN	CR 06270
L1	.34 henry + 90% -50% variable inductor	UTC	VIC-9
P4	8 pin male Jones plug	HBJ	P308AB
R1	Same as for Type 153Z2		
R2	Same as for Type 153Z2		
R3	Same as for Type 153Z2		
R4	Same as for Type 153Z2		
R5	Not used		
R107	2.5K ohms ± 20% .33 watt composition potentiometer	ALB	GU
R108	1 K ohms ± 5% 1/2 watt comp. res.	ALB	EB1025

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Electrical Parts List (Network)
Type 153 Model 2

Symbol	Description	Mfr.	Part No.
<u>TYPE 153Z16 MOD. 2</u>			
	Carrier Frequency 2805 ± 42.5 cps	Mark Frequency: 2847.5 cps	Space Frequency: 2762.5 cps
BP1	2805 cps band pass filter	NRC	208
C1	0.001 mfd ± 5% 500 volt silver mica cap.	SAN	CR 1210
C2	0.005 mfd ± 5% 500 volt silver mica cap.	SAN	CR 1250
C3A	0.008 mfd ± 5% 300 volt silver mica cap.	SAN	CR 06280
C3B	0.005 mfd ± 5% 500 volt silver mica cap.	SAN	CR 1250
L1	.34 henry + 90% -50% variable inductor	UTC	VIC-9
P4	8 pin male Jones plug	HBJ	P308AB
R1	Same as for Type 153Z2		
R2	Same as for Type 153Z2		
R3	Same as for Type 153Z2		
R4	Same as for Type 153Z2		
R5	Not used		
R107	2.5K ohms ± 20% .33 watt composition potentiometer	ALB	GU
R108	1 K ohms ± 5% 1/2 watt comp. res.	ALB	EB1025

TYPE 153Z17 MOD. 2

	Carrier Frequency 2975 ± 42.5 cps	Mark Frequency: 3017.5 cps	Space Frequency: 2932.5 cps
BP1	2975 cps band pass filter	NRC	209
C1	0.001 mfd ± 5% 500 volt silver mica cap.	SAN	CR 1210
C2	0.005 mfd ± 5% 500 volt silver mica cap.	SAN	CR 1250
C3A	0.008 mfd ± 5% 300 volt silver mica cap.	SAN	CR 06280
C3B	0.003 mfd ± 5% 500 volt silver mica cap.	SAN	CR 1230
L1	.34 henry + 90% -50% variable inductor	UTC	VIC-9
P4	8 pin male Jones plug	HBJ	P308AB
R1	Same as for Type 153Z2		
R2	Same as for Type 153Z2		
R3	Same as for Type 153Z2		
R4	Same as for Type 153Z2		
R5	Not used		
R107	2.5K ohms ± 20% .33 watt composition potentiometer	ALB	GU
R108	1 K ohms ± 5% 1/2 watt comp. res.	ALB	EB1025

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Electrical Parts List (Network)
Type 153 Model 2

Symbol	Description	Mfr.	Part No.
<u>TYPE 153Z18 MOD. 2</u>			
	Carrier Frequency 3145 ± 42.5 cps	Mark Frequency: 3187.5 cps	Space Frequency: 3102.5 cps
BP1	3145 cps band pass filter	NRC	210
C1	0.001 mfd ± 5% 500 volt silver mica cap.	SAN	CR 1210
C2	0.005 mfd ± 5% 500 volt silver mica cap.	SAN	CR 1250
C3	0.008 mfd ± 5% 500 ³⁰⁰ volt silver mica cap.	SAN	CR 06280
L1	.34 henry + 90% -50% variable inductor	UTC	VIC-9
P4	8 pin male Jones Plug	HBJ	P308AB
R1	Same as for Type 153Z2		
R2	Same as for Type 153Z2		
R3	Same as for Type 153Z2		
R4	Same as for Type 153Z2		
R5	Not used		
R107	2.5K ohms ± 20% .33 watt composition potentiometer	ALB	GU
R108	1 K ohms ± 5% 1/2 watt comp. res.	ALB	EB1025
<u>TYPE 153Z19 MOD. 2</u>			
	Carrier Frequency 3315 ± 42.5 cps	Mark Frequency: 3357.5 cps	Space Frequency: 3272.5 cps
BP1	3315 cps band pass filter	NRC	243
C1	0.001 mfd ± 5% 500 volt silver mica capacitor	SAN	CR 1210
C2	0.005 mfd ± 5% 500 volt silver mica capacitor	SAN	CR 1250
C3	0.008 mfd ± 5% 500 ³⁰⁰ volt silver mica capacitor	SAN	CR 06280
L1	.34 henry + 90% -50% variable inductor	UTC	VIC-9
P4	8 pin male Jones plug	HBJ	P308AB
R1	Same as for Type 153Z2		
R2	Same as for Type 153Z2		
R3	Same as for Type 153Z2		
R4	Same as for Type 153Z2		
R5	Not used		
R107	2.5K ohms ± 20% .33 watt composition potentiometer	ALB	GU
R108	1 K ohms ± 5% 1/2 watt comp. res.	ALB	EB1025

Symbol	Description	Mfr.	Part No.
<u>TYPE 153Z51 MOD. 2</u>			
	Carrier Frequency 1615 cps \pm 120 cps	Mark Frequency: 1735 cps	Space Frequency: 1495 cps
BP1	1615 cps band pass filter	NRC	240
C1	0.003 mfd \pm 5% 500 volt silver mica capacitor	SAN	CR 1230
C2	Same as C1		
C3	.022 mfd \pm 20% 400 volt tubular capacitor	CDC	TWC 4S22EG-4P
L1	.34 henry + 90%-50% variable inductor	UTC	VIC-9
P4	8 pin male Jones plug	HBJ	P308AB
R1	Same as for Type 153Z2		
R2	Same as for Type 153Z2		
R3	Same as for Type 153Z2		
R4	Same as for Type 153Z2		
R5	Not used		
R107	2.5K ohms \pm 20% .33 watt composition potentiometer	ALB	GU
R108	1K ohms \pm 5% 1/2 watt comp. res.	ALB	EB1025

TYPE 153Z52 MOD. 2

	Carrier Frequency 2295 \pm 120 cps	Mark Frequency: 2415 cps	Space Frequency: 2175 cps
BP1	2295 cps band pass filter	NRC	241
C1	0.001 mfd \pm 5% 500 volt silver mica capacitor	SAN	CR 1210
C2	.003 mfd \pm 5% 500 volt silver mica capacitor	SAN	CR 1230
C3	.01 mfd \pm 5% 500 ³⁰⁰ volt silver mica capacitor	SAN	CR 06110
L1	.34 henry + 90% -50% variable inductor	UTC	VIC-9
P4	8 pin male Jones plug	HBJ	P308AB
R1	Same as for Type 153Z2		
R2	Same as for Type 153Z2		
R3	Same as for Type 153Z2		
R4	Same as for Type 153Z2		
R5	Not used		
R107	2.5K ohms \pm 20% .33 watt composition potentiometer	ALB	GU
R108	1K ohms \pm 5% 1/2 watt comp. res.	ALB	EB1025

Symbol	Description	Mfr.	Part No.
<u>TYPE 153Z53 MOD. 2</u>			
	Carrier Frequency 2975 ± 120 cps	Mark Frequency: 3095 cps	Space Frequency: 2855 cps
BP1	2975 cps band pass filter	NRC	242
C1	0.001 mfd ± 5% 500 volt silver mica capacitor	SAN	CR 1210
C2	0.005 mfd ± 5% 500 volt silver mica capacitor	SAN	CR 1250
C3	0.008 mfd ± 5% 500 ³⁰⁰ volt silver mica capacitor	SAN	CR 06280
L1	.34 henry + 90% -50% variable inductor	UTC	VIC-9
P4	8 pin male Jones plug	HBJ	P308AB
R1	Same as for Type 153Z2		
R2	Same as for Type 153Z2		
R3	Same as for Type 153Z2		
R4	Same as for Type 153Z2		
R5	Not used		
R107	2.5K ohms ± 20% .33 watt composition potentiometer	ALB	GU
R108	1K ohms ± 5% 1/2 watt comp. res.	ALB	EB1025

<u>TYPE 153Z68 MOD. 2</u>			
	Carrier Frequency 3655 ± 120 cps	Mark Frequency: 3775 cps	Space Frequency: 3535 cps
BP1	3655 cps band pass filter	NRC	302
C1	.001 mfd ± 5% 500 volt silver mica capacitor	SAN	CR 1210
C2	.003 mfd ± 5% 500 volt silver mica capacitor	SAN	CR 1230
C3	.006 mfd ± 5% 500 volt silver mica capacitor	SAN	CR 1260
L1	.34 henry + 90% -50% variable inductor	UTC	VIC-9
P4	8 pin male Jones plug	HBJ	P308AB
R1	Same as for Type 153Z2		
R2	Same as for Type 153Z2		
R3	Same as for Type 153Z2		
R4	Same as for Type 153Z2		
R5	Not used		
R107	2.5K ohms ± 20% .33 watt composition potentiometer	ALB	GU
R108	1K ohms ± 5% 1/2 watt comp. res.	ALB	EB1025

Instruction Book
Dual Frequency Shift Tone Keyer

Electrical Parts List (Network)
Type 153 Model 2

Symbol	Description	Mfr.	Part No.
<u>TYPE 153Z58 MOD. 2</u>			
	Carrier Frequency 425 ± 60 cps	Mark Frequency: 485 cps	Space Frequency: 365 cps
BP1	425 cps band pass filter	NRC	288
C1	.01 mfd ± 5% 300 volt silver mica capacitor	SAN	CR 06110
C2	.01 mfd ± 5% 300 volt silver mica capacitor	SAN	CR 06110
C3	.1 mfd ± 20% 400 volt tubular capacitor	CDC	TWC 4P1EG-4P
L1	1.3 henry + 90% -50% variable inductor	UTC	VIC-12
P4	8 pin male Jones plug	HBJ	P308AB
R1	100K ohms ± 10% 2 watts potentiometer	ALB	JU1041
R2	250K ohms ± 10% 2 watts potentiometer	ALB	JU2541
R3	5K ohms ± 10% 2 watts potentiometer	ALB	JU5021
R4	5K ohms ± 10% 2 watts potentiometer	ALB	JU5021
R5	33K ohms ± 10% 1/2 watt comp. res.	ALB	EB 8221
R107	2.5K ohms .33 watt potentiometer	ALB	GU
R108	1K ohms ± 5% 1/2 watt comp. res.	ALB	EB 1025

TYPE 153Z59 MOD. 2

	Carrier Frequency 765 ± 60 cps	Mark Frequency: 825 cps	Space Frequency: 705 cps
BP1	765 cps band pass filter	NRC	289
C1	.005 mfd ± 5% 500 volt silver mica capacitor	SAN	CR 1250
C2	.005 mfd ± 5% 500 volt silver mica capacitor	SAN	CR 1250
C3	.1 mfd ± 20% 400 volt tubular capacitor	CDC	TWC 4P1EG-4P
L1	.54 henry + 90% -50% variable inductor	UTC	VIC-10
P4	8 pin male Jones plug	HBJ	P308AB
R1	100K ohms ± 10% 2 watts potentiometer	ALB	JU1041
R2	250K ohms ± 10% 2 watts potentiometer	ALB	JU2541
R3	5K ohms ± 10% 2 watt potentiometer	ALB	JU5021
R4	5K ohms ± 10% 2 watt potentiometer	ALB	JU5021
R5	47K ohms ± 10% 1/2 watt comp. res.	ALB	EB 4731
R107	2.5K ohms .33 watt potentiometer	ALB	GU
R108	1K ohms ± 5% 1/2 watt comp. res.	ALB	EB 1025

Symbol	Description	Mfr.	Part No.
<u>TYPE 153Z60 MOD. 2</u>			
	Carrier Frequency 1105 ± 60 cps	Mark Frequency: 1165 cps	Space Frequency: 1045 cps
BP1	1105 cps band pass filter	NRC	290
C1	.003 mfd ± 5% 500 volt silver mica capacitor	SAN	CR 1230
C2	.003 mfd ± 5% 500 volt silver mica capacitor	SAN	CR 1230
C3	.047 mfd ± 20% 400 volt tubular capacitor	CDC	TWC 4S47EG-4P
L1	.34 hy + 90% -50% variable inductor	UTC	VIC-9
P4	8 pin male Jones plug	HBJ	P308AB
R1	100K ohms ± 10% 2 watt potentiometer	ALB	JU1041
R2	250K ohms ± 10% 2 watt potentiometer	ALB	JU2541
R3	5K ohms ± 10% 2 watt potentiometer	ALB	JU5021
R4	5K ohms ± 10% 2 watt potentiometer	ALB	JU5021
R5	Not Used		
R107	2.5K ohms .33 watt potentiometer	ALB	GU
R108	1K ohms ± 5% 1/2 watt comp. res.	ALB	EB 1025

TYPE 153Z61 MOD. 2

	Carrier Frequency 1445 ± 60 cps	Mark Frequency: 1505 cps	Space Frequency: 1385 cps
BP1	1445 cps band pass filter	NRC	291
C1	.003 mfd ± 5% 500 volt silver mica capacitor	SAN	CR 1230
C2	.003 mfd ± 5% 500 volt silver mica capacitor	SAN	CR 1230
C3	.047 mfd ± 20% 400 volt tubular capacitor	CDC	TWC 4S47EG-4P
L1	.34 hy + 90% -50% variable inductor	UTC	VIC-9
P4	8 pin male Jones plug	HBJ	P308AB
R1	100K ohms ± 10% 2 watt potentiometer	ALB	JU1041
R2	250K ohms ± 10% 2 watt potentiometer	ALB	JU2541
R3	5K ohms ± 10% 2 watt potentiometer	ALB	JU5021
R4	5K ohms ± 10% 2 watt potentiometer	ALB	JU5021
R5	Not used		
R107	2.5K ohms .33 watt potentiometer	ALB	GU
R108	1K ohms ± 5% 1/2 watt comp. res.	ALB	EB 1025

Instruction Book
Dual Frequency Shift Tone Keyer

Electrical Parts List (Network)
Type 153 Model 2

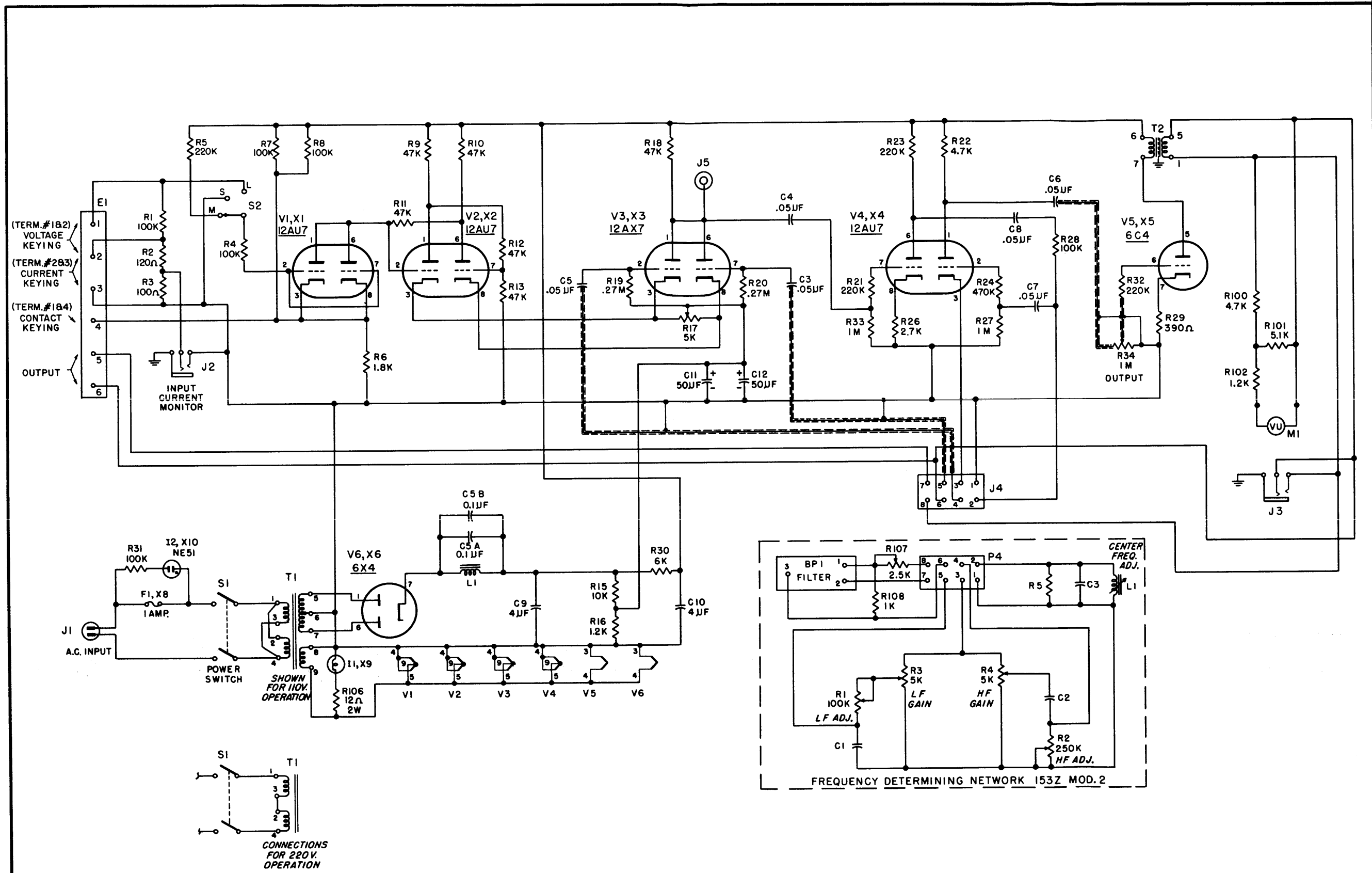
Symbol	Description	Mfr.	Part No.
<u>TYPE 153Z62 MOD. 2</u>			
	Carrier Frequency 1785 ± 60 cps		Mark Frequency: 1845 cps Space Frequency: 1725 cps
BP1	1785 cps band pass filter	NRC	292
C1	.003 mfd ± 5% 500 volt silver mica capacitor	SAN	CR 1230
C2	.003 mfd ± 5% 500 volt silver mica capacitor	SAN	CR 1230
C3	.022 mfd ± 20% 400 volt tubular capacitor	CDC	TWC 4S22EG-4P
L1	.34 hy + 90% -50% variable inductor	UTC	VIC-9
P4	8 pin male Jones plug	HBJ	P308AB
R1	100K ohms ± 10% 2 watt potentiometer	ALB	JU1041
R2	250K ohms ± 10% 2 watt potentiometer	ALB	JU2541
R3	5K ohms ± 10% 2 watt potentiometer	ALB	JU5021
R4	5K ohms ± 10% 2 watt potentiometer	ALB	JU5021
R5	Not Used		
R107	2.5K ohms .33 watt potentiometer	ALB	GU
R108	1K ohms ± 5% 1/2 watt comp. res.	ALB	EB 1025

TYPE 153Z63 MOD. 2

	Carrier Frequency 2125 ± 60 cps		Mark Frequency: 2185 cps Space Frequency: 2065 cps
BP1	2125 cps band pass filter	NRC	293
C1	.003 mfd ± 5% 500 volt silver mica capacitor	SAN	CR 1230
C2	.003 mfd ± 5% 500 volt silver mica capacitor	SAN	CR 1230
C3	.022 mfd ± 20% 400 volt tubular capacitor	CDC	TWC 3S22EG-4P
L1	.34 hy + 90% -50% variable inductor	UTC	VIC-9
P4	8 pin male Jones plug	HBJ	P308AB
R1	100K ohms ± 10% 2 watt potentiometer	ALB	JU1041
R2	250K ohms ± 10% 2 watt potentiometer	ALB	JU2541
R3	5K ohms ± 10% 2 watt potentiometer	ALB	JU5021
R4	5K ohms ± 10% 2 watt potentiometer	ALB	JU5021
R5	Not Used		
R107	2.5K ohms .33 watt potentiometer	ALB	GU
R108	1K ohms ± 5% 1/2 watt comp. res.	ALB	EB 1025

MANUFACTURERS DESIGNATIONS

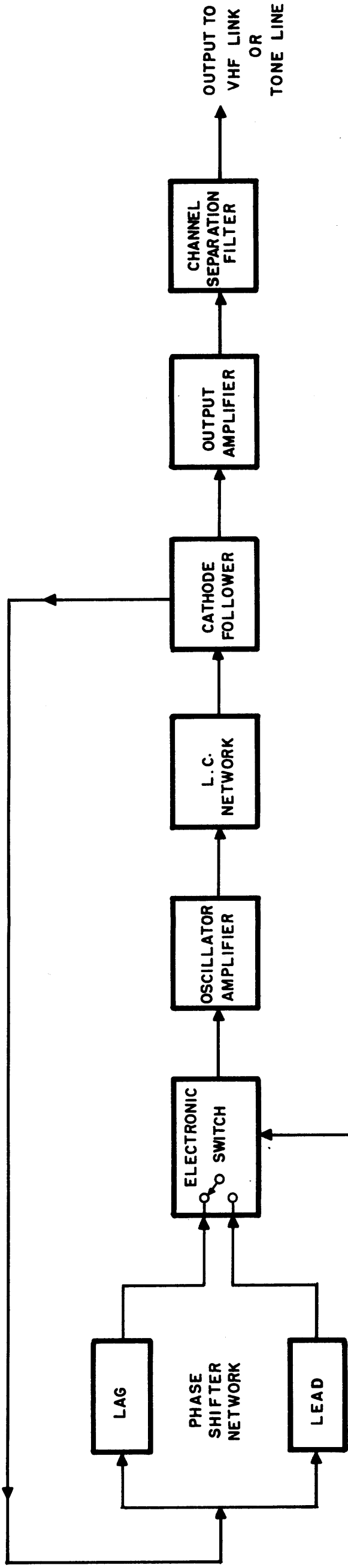
AHH	Arrow Hart & Hegeman Co.
ALB	Allen Bradley Co.
ASC	Astron Corp.
CAN	Cannon Electric Company
CCC	Continental Carbon Company
CDC	Cornell Dubilier Elec. Corp.
<i>CAC</i> DLA	<i>Cutter Hammer Inc.</i> Dial Light Corp. of America
EBY	Hugh H. Eby Inc.
GEC	General Electric Co.
HBJ	Howard B. Jones Div. Cinch Mfg. Co.
LFU	Littlefuse, Inc.
MAL	P. R. Mallory & Co.
<i>MAR</i> NRC	<i>Marion Electric Instrument Co.</i> Northern Radio Company, Inc.
SAN	Sangamo Elec. Co.
UTC	United Transformer Co.
WEI	Weston Electrical Instrument Co.
WLE	Ward Leonard Elec. Co.



ADDED Z1 EFFECTIVE SER 3844 & UP

				MATERIAL				REFERENCE DWGS. DWG. INDEX A-153200 A-153200-Z				TITLE SCHEMATIC DUAL F.S. TONE KEYS TYPE 153 MODEL 2				
								TOLERANCE (UNLESS SPECIFIED) FRACT. ± 1/64 DECIMAL ± .005				NORTHERN RADIO COMPANY INCORPORATED				
I	DS	AM	ML	12-8-54	ORIG. DWG				SCALE				DWN.			
ISSUE	DWN.	CKD.	APPR.	DATE	CHANGE				ENGR.	APPR.	APPR.	APPR.	DATE	DWG. NO. 153-2-01		SIZE: C

FEEDBACK LOOP



BINARY INTELLIGENCE
MODULATION SOURCE SUCH
AS TELETYPEWRITER OR KEY

KEYING
AMPLIFIER

ELECTRONIC
SWITCH

OSCILLATOR
AMPLIFIER

L.C.
NETWORK

CATHODE
FOLLOWER

OUTPUT
AMPLIFIER

CHANNEL
SEPARATION
FILTER

OUTPUT TO
VHF LINK
OR
TONE LINE

LAG

PHASE
SHIFTER
NETWORK

LEAD

TWO SUCH UNITS ON ONE 3 1/2" X 19" RACK PANEL
INCLUDING INDIVIDUAL POWER SUPPLY FOR EACH

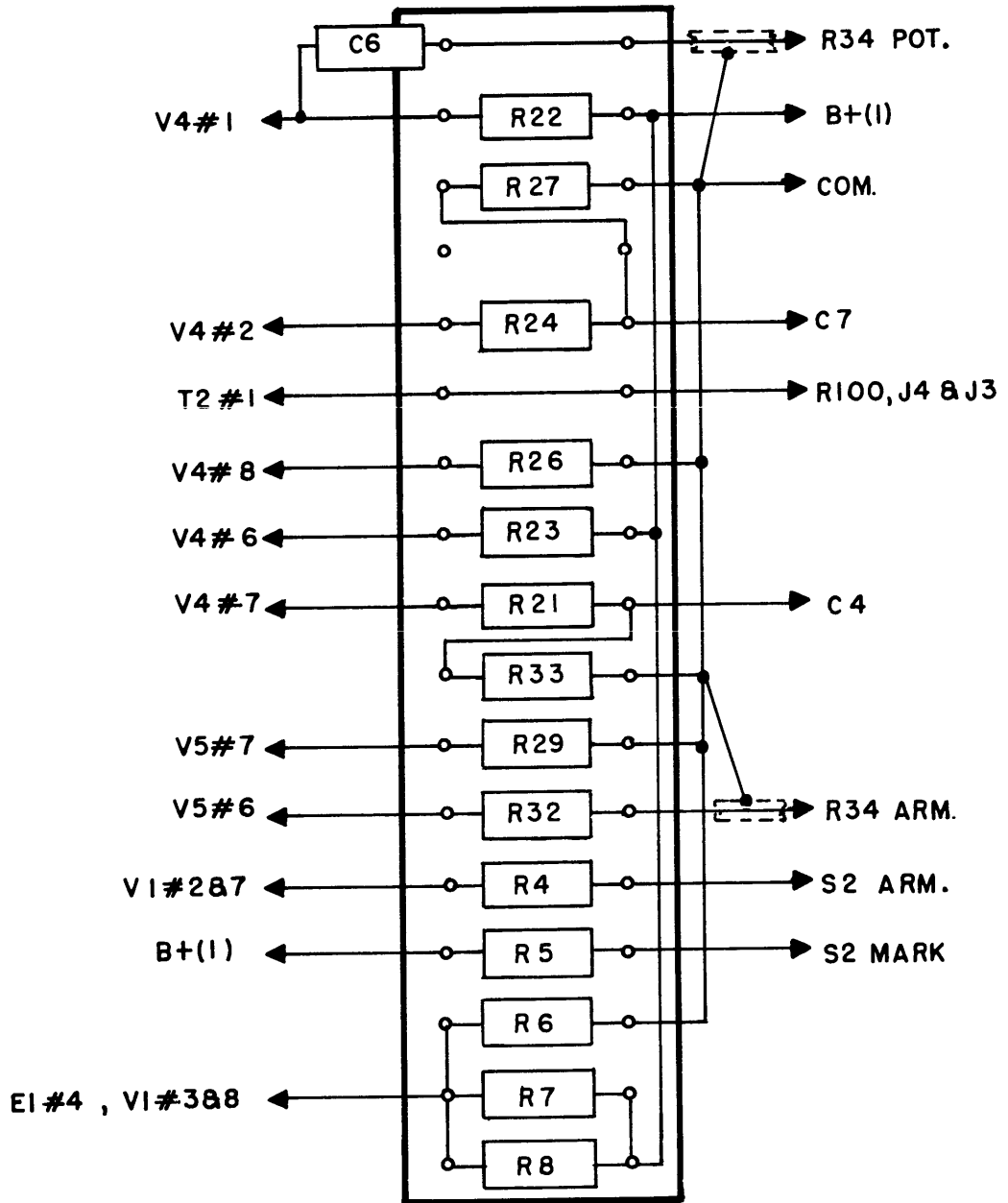
ISSUE		DWN.	CKD.	APPR.	DATE	CHANGE	ENGR.	APPR.	MATERIAL	REFERENCE DWGS. INDEXES	TITLE	USED ON
1	DS		Am							A - 153100 A - 153200	BLOCK DIAGRAM DUAL F. S. TONE KEYS TYPE 153 MODEL 1 & 2	
REDRAWN & CORRECTED ORIG. DWG No WAS A-153107		4-52								TOLERANCE (UNLESS SPECIFIED) FRACT. ± 1/64 DECIMAL ± .005	NORTHERN RADIO COMPANY INCORPORATED	
SCALE										DWN. RA		
ENGR.										APPR.		
DATE										DATE		
										7-6-51		
DWG. NO.	153-1-25		SIZE		B							



NORTHERN RADIO COMPANY

INCORPORATED

• NEW YORK 11, NEW YORK •



DIAGRAM, TERMINAL BOARD N. 1
DUAL F.S. TONE KEYS
TYPE 153 MODEL 2

SHEET 1 OF 1

ISSUE 1

DWG. NO. 153-2-02

SIZE A

DATE 12-3-54

DWN. BY DS

CKD. BY A.M.

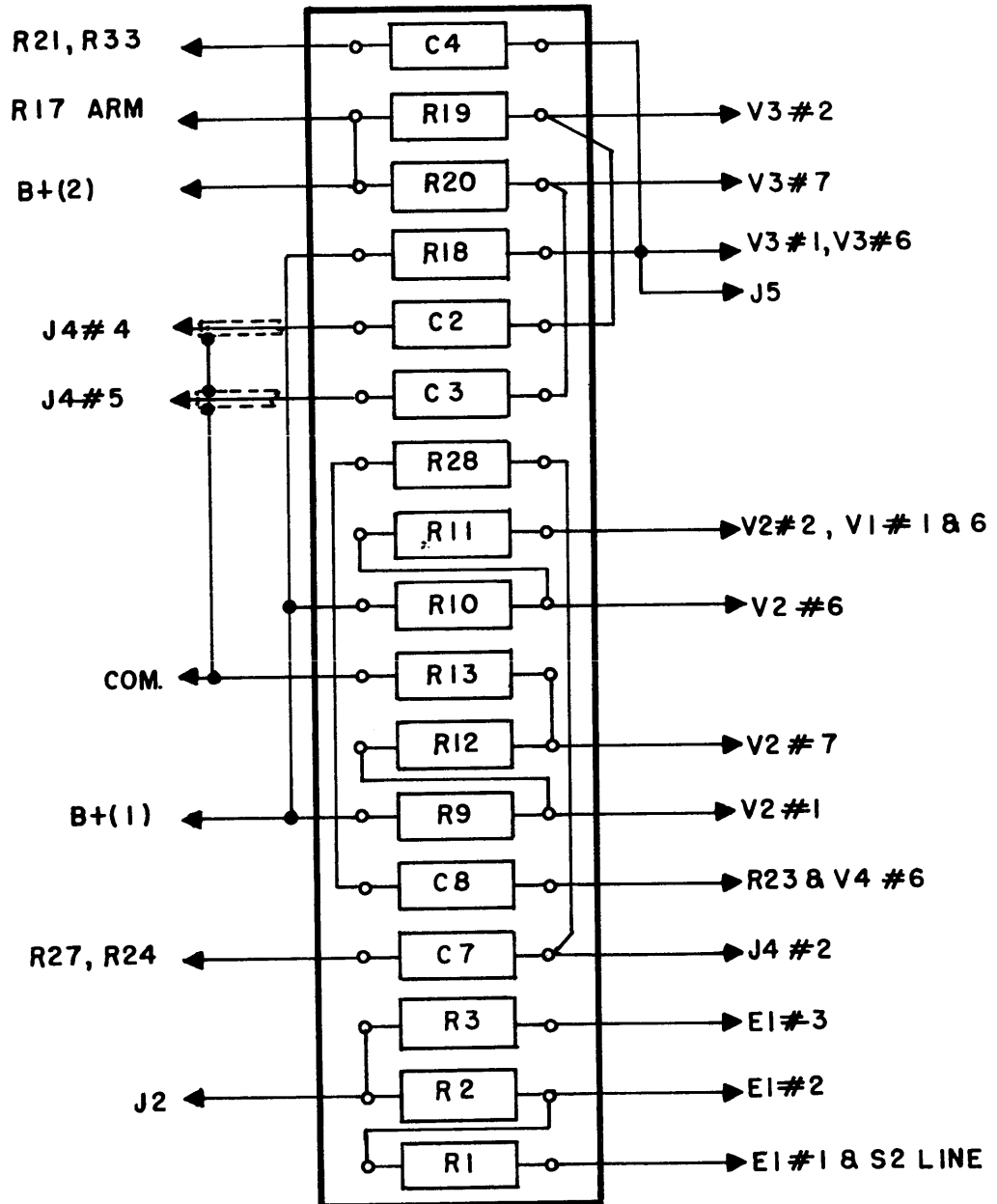
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NORTHERN RADIO COMPANY

INCORPORATED

NEW YORK 11, NEW YORK



DIAGRAM, TERMINAL BOARD No. 2
DUAL F.S. TONE KEYER
TYPE 153 MODEL 2

SHEET 1 OF 1

ISSUE 1

DWG. NO. 153-2-03

SIZE
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DATE 12-3-54

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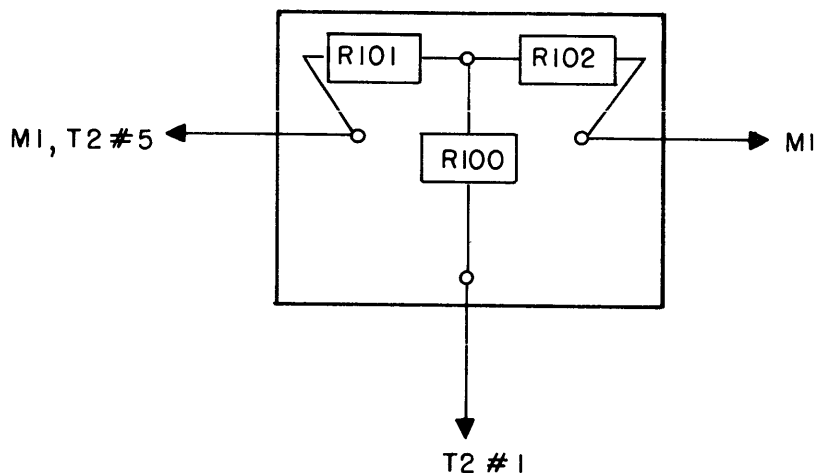
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NORTHERN RADIO COMPANY

INCORPORATED
NEW YORK 11, NEW YORK



DIAGRAM, TERMINAL BOARD No.3
OUTPUT METER ATTENUATOR
DUAL F.S. TONE KEYS
TYPE 153 MODEL 2

SHEET 1 OF 1

ISSUE 1

DWG. NO. 153-2-04

SIZE:
A

DATE J2-6-54

DWN. BY DS

CKD. BY

APP. BY

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