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DUAL FREQUENCY SHIFT TONE CONVERTER

TYPE 152 MODEL 1

NORTHERN RADIO COMPANY
Incorporated
143-145 WEST 22nd ST., NEW YORK 11, N. Y.

INSTRUCTION BOOK

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Type 152 Model 1

CONTENTS:

I. GENERAL

Purpose:

The Northern Radio Type 152 Model 1 Dual Frequency Shift Tone Converter is used in communication systems to provide the receiving terminal for teleprinter or telemetering operation over microwave or metallic circuits.

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 permits use of almost any combination of channel frequencies and band widths (and associated keying speeds) to suit special requirements.

The frequency shifted tones which contain the intelligence pulses are received over the transmission facility and converted electronically into DC pulses of 60 ma., which will directly operate a standard teleprinter loop without the use of an external battery.

Description:

This Dual Channel Tone Converter equipment provides two completely separate F.S. telegraph receivers on a standard 3-1/2" x 19" equipment panel. Each Tone Converter unit is self contained including power supply and will operate, by changing a plug-in network, on any of the standard tone channels. The input of each unit consists of limiting amplifiers which are followed by a novel frequency discriminating circuit to demodulate the frequency shifted tones. This demodulated signal drives an output amplifier capable of delivering up to 65 ma neutral current pulses into a 2000 ohm load.

The usage of simple pulse circuitry makes it possible to achieve a discriminator frequency-output characteristic closely approximating an ideal step-function. Thus, by reducing the MARK to SPACE transition to a couple of cycles off center frequency, a signal distortion due to noise or bandwidth restriction is greatly minimized. (See Diagram No. 60022)

Principle of Operation:

Signal distortion inherent to any carrier system, is reduced by having the lower frequency channels doubled in frequency before limiting and discrimination. At higher channel frequencies, the carrier distortion is negligible and limiting and discrimination is done at fundamental frequency.

Referring to Block Diagram No. A-152110, the incoming F.S. tone is applied through an input filter and transformer to a Pre-Amplifier, V1, followed by a limiter V2. The output from this limiter is applied to the Gate Generator, V3, to produce square wave pulses, and to the Phase Shift Amplifier, V4.1, stages V3.1 and V3.2 being driven in tandem, their cathode square wave pulses are 180° out of phase.

Incorporated in the Phase Shift Amplifier, V4.1, is a phase shift network. A sine wave output will result, which lags or leads in phase the applied grid voltage depending on whether the applied frequency is above or below the center frequency.

The output from the plate of the Phase Shift Amp., V4.1, is applied to the Square Wave Generator and Differentiator, V4.2 to produce essentially square wave output. This square wave is differentiated and the resultant pulses applied to the coincidence network, consisting of Pulse Selector tube V5.

The cathodes of V5.1 and V5.2 are connected respectively to the cathodes of the Gate Generator, V3.1 and V3.2. When the negative portion of the square wave at the cathode of V5.1 occurs at the same time that positive pulses appear at the grid of this stage, negative pulses will be produced at the plate section. This will occur when the incoming frequency is below the center frequency. V5.2 will function in a similar manner when the respective pulses are applied to its input circuit, which correspond to an incoming frequency above the center frequency.

The outputs of the coincidence network operate the trigger circuit, V6, which produces two stable conditions corresponding to the "MARK" and "SPACE" conditions depending upon the incoming tone frequency. The output from one plate of the trigger stage is applied to the Output Amplifier, V7, to provide neutral DC pulses to operate a teletype loop, and the output from the other plate is applied to V10 which serves to equalize the current drain on the power supply and thus improves voltage regulation.

To further reduce the signal distortion inherent to any carrier system, the lower frequency channels are frequency doubled before limiting and discrimination. At higher channel-frequencies the "carrier distortion" is negligible and limiting and discrimination is done at fundamental frequency.

Principle of Operation: (cont'd)

Block Diagram No. A-152110 illustrates the 2nd harmonic mode of operation. In this case the pre-amplifier V1 acts as frequency doubler. Whether operation occurs at fundamental or second harmonic frequency is solely determined by the plug-in network 152Z which also determines the channel frequency. No other switching or adjustment is required.

A good Frequency Shift Converter must satisfy two fundamental requirements: First, it must be capable of a high degree of discrimination against noise, interference or other transmission disturbances. Second, it must be capable of converting the F.S. signal into its original D.C. type square wave form with a minimum systematic or randam signal distortion.

This Converter satisfies the above requirements in two steps.

The first, which is standard in the art, makes use of the well known noise and interference rejection characteristics obtained by a band-pass filter coupled to a high gain limiter.

The second step, utilizes pulse techniques, which with great circuit simplicity make up a "step discriminator" that is a circuit which will assume a constant negative voltage output for all frequencies (within the pass-band) lower than center-frequency and will be triggered positive for frequencies above center-frequency. Approximately ± 2 cps off center-frequency are only required to make the output of the discriminator assume either a marking or spacing output.

This very narrow "no-man's land" presents a number of operational advantages.

Any frequency modulation component of noise or interference, which gets past the limiter would have to be strong indeed to affect at all the output of the discriminator.

Such step-type discriminator also allows a great latitude of system operation, tending to minimize signal distortion due to such causes as frequency or amplitude misadjustment of the sending end, or differences in amplitude between mark and space frequencies due to the transmission medium.

The discriminator circuit proper is simple in design. Only one Parallel LC Tuned Circuit determines the operating frequency of the discriminator, while the pulse forming circuits, in case of trouble, lend themselves readily to rational analysis with a cathode ray oscilloscope.

It will be recalled that when the carrier frequency of any tone system is made low, while a relatively high keying rate is expected of the circuit, an appreciable amount of "Carrier Distortion" will be present in

Principle of Operation: (cont'd)

the demodulated wave. In the case of square wave keying, the demodulated square wave will appear to have "jittery" edges on the screen of a CRO. Since such "carrier distortion" subtracts from the operating margin of a telegraph signal, the lower part of the audio spectrum is usually avoided in high speed circuit application.

To extend the use of the lower audio frequencies, this converter frequency doubles the input signal prior to limiting and discrimination. In this manner the normally encountered "carrier distortion" is reduced approximately by a factor of two to one.

At higher frequencies where the carrier distortion is usually small the need for frequency doubling no longer exists, and the converter is made to operate at channel frequency.

Technical Data:

Input Impedance:	600 ohms, unbalanced
Input Level:	-40 dbm to 0 dbm
Input Frequencies:	425, 595, 765, 935, 1105, 1275, 1445, 1615, 1785, 1955, 2125, 2295, 2465, 2635, 2805, 2975, 3145, 3315, cps.
Input Frequency Shift:	± 42.5 cps nominal.
Keying Speed:	45 dot cycles per second maximum.
Output:	Neutral D.C. pulses of 65 ma. maximum into 2000 ohm external load, or 110 V. teletype line presenting 2000 ohm impedance.
Metering and Test Jacks:	Load current meter, jacks on front panel for monitoring input and output.
Controls: (per channel)	1. Primary Power Switch 2. Sense Switch 3. Output Current
Power Requirements: (per channel)	110/220 volts, 50/60 cycles. Approximately 40 watts. Connections at rear of chassis.
Dimensions:	3-1/2" x 19" x 15"
Weight: (2 channels)	Approximately 28 pounds.

(Cont'd)

Technical Data: (cont'd)

Tube Complement: (per channel)	1-12AX7	Pre-Amplifier
	1-12AX7	Limiter
	1-12AU7	Gate generator
	1-12AU7	Phase-shift amplifier and Square-wave generator
	1-12AU7	Trigger Tube
	1-12AX7	Pulse selector
	1-6AQ5	Output Amplifier
	2-6X4	Power rectifier
	1-6AQ5	Drain Equalizer

2. DESCRIPTION OF OPERATION

Reference: Schematic Diagrams C-152108, A-152142Z and A-152141Z.

The Northern Radio Company Dual Frequency Shift Tone Converter, Type 152 Model 1, consists of two identical but fully independent circuits. Each Converter subdivides logically into five sections:

Input Amplifier Circuit
Limiter Circuit
Discriminator
Power Amplifier
Power Supply

Input Amplifier Circuit:

The Input Tone Circuit is of unbalanced type, with one side of the line connected to chassis ground. It feeds the pre-amplifier V1, through a band-pass filter which is located in the Frequency Determining Plug-in Network.

The input characteristic of this filter is such that it allows parallel operation of up to 18 channels fed from one 600 ohm tone line.

Input Amplifier Circuit: (cont'd)

V1 (as well as the remainder of the Converter circuit) is isolated from ground by a line to grid transformer T2. The left hand section of V1 is a split load amplifier which provides a push-pull output to the full-wave crystal diode rectifier CR3/CR4. The output of this diode appears across R5, and while it is always present, it is utilized only at low frequencies, where frequency doubling is required.

In fundamental frequency operation, the output is taken from R1, and through a strap on the plug-in network fed directly to the limiter, V2.

In second harmonic operation, the full-wave voltage is supplied to the right hand section of V1, which is a cathode-follower, the output of which drives a series resonant circuit located in the plug-in network. This circuit consists of an inductor L101 and capacitors C104-107 which tune it to the second harmonic of the channel frequency.

The output is taken across the capacitors of this series resonant circuit and is applied to the limiter, V2.

Limiter Circuit:

The Limiter circuit consists of two conventional overdriven high gain stages, which are the 2 sections of V2.

Discriminator:

The Discriminator consists of stages V3, V4, V5, and V6. The square-wave carrier output from the limiter V2 is applied to the first section of V3, which acts as a gate generator that is, positive square-wave pulses are appearing across its cathode resistor R19. The plate output of this stage feeds the second section of V3 and across its cathode resistor R23 will appear square-waves similar to those across R19, but 180° out of phase. These "Push-Pull" square waves are directly coupled to the respective cathodes of selector tube V5.

The plate of the left hand section of V4 contains, besides an isolating resistor R26, a parallel tuned LC circuit which is located in the Plug-in Network. This circuit consists of L100 and capacitors C100-C102. This circuit is tuned by means of the trimmer capacitor (approximately) to center frequency (or twice center-frequency in 2nd harmonic operation). The output voltage of this tuned circuit is a sine wave, which will lead or lag the plate current depending upon whether SPACE (Lower Frequency) or MARK (Higher Frequency) is being received.

Discriminator: (cont'd)

This sine wave now passes through 1 conventional stage of limiting V4.2 and is converted into a square-wave. The output of V4 is differentiated by a short time constant network C10 and R30. The resultant narrow pulses, alternating positive and negative, are simultaneously applied to the 2 grids of the pulse selector stage V5. The positive pulses are limited by diode CR5. This diode is biased to cutoff (approx. 1.0 volts) by means of a voltage divider R47 and R48.

It is to be noted that R30 is returned to a negative bias supply. This bias is derived from the filament winding of the power transformer T1 and consists of a crystal rectifier CR1 and a storage capacitor C13. To analyze the operation of V5 it is first to be understood that the above mentioned bias completely cuts off V5 in absence of other signals.

The other voltages applied to V5 are, first the push-pull square waves appearing at the two cathodes of V5. Since these square-waves are either zero or positive in voltage, they can only increase the grid to cathode negative potential of V5. Thus they will not produce any output in the 2 plate circuits of V5 which is already cut-off by negative grid bias.

The positive pulses which are applied to the 2 grids of V5 are sufficiently large to over-ride the fixed grid-bias of V5. But they are not large enough to make the tube conduct if simultaneously the positive square wave voltage appears at the cathode of V5.

Assume now that the space frequency (lower) is received. The output voltage of the tuned circuit will be leading in phase, with respect to the plate current, and in turn the positive pulses derived from it will be "leading" the gating square waves across R19, and "lagging" those across R23. That is, the positive pulses are timed to occur during the "off-time" of the R23 square wave and during the positive half-cycle of the square waves across R23. This in turn means that the right hand section of V5 has current pulses in its plate circuit, while the left section of V5 remains at off.

Each plate of V5 is respectively coupled to the 2 grids of a conventional bi-stable trigger circuit (V6). The right section of V6 has therefore negative pulses applied to it at space-frequency rate.

The first one of these pulses will cut the trigger circuit off and by trigger action make the left section of V6 conduct. This condition will now be retained by V6 until such time that a negative pulse is applied to the left section, while the pulses at the grid of the right hand section cease to appear.

This condition will be attained when the MARK frequency is received. Now the positive pulses at the grids of V5 will lag the square waves across R19 and lead them across R23. The left section of V5 will now omit

Discriminator: (cont'd)

plate current pulses, turn the left section of trigger stage V6 off, which by trigger action will make the right section of V6 conduct.

Thus as long as a frequency lower than center-frequency is received, the trigger circuit will assume one of its stable conditions. But as soon as a frequency higher than center-frequency is received, it will "flip" to the other stable condition.

The circuit will therefore act as a tone Demodulator of the F.S. signal supplied to it.

Since the 2 plates of the Trigger circuit V6 give symmetrical outputs, either "direct" or "inverted" signal outputs can be selected. This selection is made by means of the sense switch S2 which couples either one or the other plate output of V6 to the power amplifier V7.

Power Amplifier:

The input to the Power Pentode V7 is D.C. coupled to the trigger V6.

The Plate current of this stage is controlled by means of a screen potentiometer R41. The plate circuit of the stage, through a current meter M1, feeds the output load. It is designed to operate into a maximum of 2000 ohms, and its current can be varied over a range of 40-65 ma. Stage V10, being controlled from the same screen potentiometer and being fed 180° out of phase with V7, balances the current drain of the unit.

The load circuit is paralleled to an output monitor jack, J3, intended for CRO observation.

As has been noted before, the Converter output circuit is free from chassis ground. (Except for a protective network consisting of R45/C19 and C26). It can therefore be operated "floating". In particular, it can be made to operate directly into an 1800 ohm 110 V. D.C. Teletype line, which is powered by external power supply without danger of overloading the output stages. In this application proper polarization is necessary such that the external polarity is aiding the internal supply. Further it is necessary that the system is grounded only at the positive output of the Converter.

If the Converter is to operate into an inductive load, it should be understood that plate current of V7 is very abruptly switched. The load can thus generate a dangerously high back e.m.f. and should be protected by a damping circuit. (RC shunt)

Power Supply:

The Power Supply is conventional in design. V8 and V9 full wave rectify the plate power of the unit. A disc-rectifier CR2 provides a high negative bias required for the direct-coupling of stage V6 to V7 and V10.

3. DESCRIPTION OF CONTROLS

The following front panel signal controls are provided for each of the two ~~Keyer~~ Converter units.

Output Control:

The Output Control controls the current supplied to the load.

Sense Switch:

The Sense Switch allows to select either direct or inverted signal operation.

4. INSTALLATION

Mechanical Installation:

The Tone Converter 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 152Z:

Select the correct Plug-in Network Type 152Z for the desired channel frequency.

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

Connect Jack J4 of Converter unit to Plug P104 of Type 152Z Plug-In Network.

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

Electrical Installation:

Before connecting the electrical lines to the Dual Tone Converter it is desirable to check if the source of primary power is correct, the nature of the input tone and the load on the equipment.

The tone lines should be shielded and the shields grounded.

For connection of the output load refer to data given in the chapter on DESCRIPTION OF OPERATION and "The Power Amplifier" (pp7-8). Output lines to the load should be twisted pairs.

A) Connections to a local Teleprinter

Such teleprinter normally represents a load of 220 ohm resistance and requires 60 ma current impulses.

It is recommended that a 1800 ohm 10 watt resistor be connected in series with the load circuit.

Electrical Installation: (cont'd)

If the printer coil is not protected by a suitable shunt, it is imperative that a back-e.m.f. shunt be paralleled across the printer coil.

Usually a series combination of 0.5 mf (600V) capacity and 100 ohm 1 watt resistance will be found a suitable shunt for a 60 WPM teleprinter.

Location of this shunt as well as that of the series resistor can be made wherever convenient.

B) Connection to a 2 Wire Line Without Battery:

If the combined Line and Load resistance is less than 2000 ohms, it is desirable to add resistance to the load circuit so that a total of 2000 ohms resistance appears across the output terminals of the Converter. If the line has one side grounded it should be connected to the positive output terminal of the Converter.

C) Connection to a 110 V. D.C. Teletype Line:

Connections to the Converter have to be polarized such that the Converter voltage aids the line battery. If the combined Line and Load resistance is less than 2000 ohms, it is necessary to add sufficient resistance so that the load circuit totals 2000 ohms. If the line has one side grounded it should be connected to the positive output terminal of the Converter.

After the Electrical Installation has been completed, a Tuning Check should be made. Allow the equipment to warm up properly and follow the instructions covered in the Chapter on MAINTENANCE. (Tuning Check)

5. OPERATING INSTRUCTIONS

Place sense switch into + position and supply Mark Frequency to the unit. Use output control to adjust for desired current output.

Now select the proper position of the Sense Switch; + if direct keying is desired; - if an inversion of the keying is required.

Check whether the tone input level is adequate.

Apply an F.S. signal to the unit and observe with an oscilloscope the wave form at the output monitoring jack J3.

6. MAINTENANCE

To obtain trouble-free operation from the Dual Tone Converter, 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 and emission less than the minimum acceptable for its type, it should be replaced.

The discriminator tuning should be checked monthly. This test can be easily performed in the following manner:

Tuning Check:

Connect an audio oscillator thru a suitable 500 ohm attenuator pad to the tone input terminals of the Converter. Connect a 2000 ohm 10 W. resistor across the output terminals of the Converter. Adjust the level to the Converter to approximately -15 VU. Set the oscillator to the desired center-frequency (previously checked against frequency standard). Adjust the discriminator tuning capacitor (located in the plug-in unit) so that the current output meter starts oscillating between mark and space position. This is the correct tuning adjustment.

TABLE OF TUBE SOCKET VOLTAGES

EQUIPMENT: DUAL F.S. CONVERTER TYPE: 152 MODEL: 1 Serial:_____ DATE: _____

Symbol	Function	Type	Pins	Volts	Pins	Volts	Pins	Volts	Pins	Volts	Pins	Volts	Pins	Volts	Pins	Volts
V1	Pre-amp. and Freq. Doubler	12AX7	1	120	2	16	3	17	6	180	7	6	8	2	9	AC 6.3
V2	Limiter	12AX7	1	85	2	0	3	.8	6	75	7	-2	8	0	9	AC 6.3
V3	Gate Gen.	12AU7	1	112	2	0	3	8.2	6	120	7	-16	8	6.8	9	AC 6.3
V4	Phase Shift Amp. and Sq. Wave Gen.	12AU7	1	94	2	-4.2	3	0	6	96	7	-2.8	8	0	9	AC 6.3
V5	Pulse Selector	12AX7	1	9.2	2	-3.6	3	6.8	6	34	7	-36	8	8	9	AC 6.3
V6	Trigger	12AU7	1	180	2	9.2	3	31	6	65	7	34	8	31	9	AC 6.3
V7	Output Amp.	6AQ5	1	.2	2	0	4	AC 6.3	5	75	6	180	7	.2		
V8	Rectifier	6X4	1	AC 310	4	AC 6.3	6	AC 310	7	300						
V9	Rectifier	6X4	1	AC 310	4	AC 6.3	6	AC 310	7	300						
V10	Voltage Regulator	6AQ5	1	-31	2	0	4	AC 6.3	5	220	6	210	7	-31		

CONTROL SETTINGS

Dual F.S. Tone Keyer

Mark
Zero VU
20 db PAD

Dual F.S. Tone Converter

Sense +
60 ma output

NOTE: All voltages measured to Common (B-) with Simpson (Model 260) Multimeter (20,000 ohms/V.) and considered to be correct within ± 10%.

8. ELECTRICAL PARTS LIST

Symbol	Function	Description	Mfr.	Part No.
C1	V1 coupling capacitor	.005 mfd ± 10% 500 volt mica	SAN	C 1250 ~~10%~~
C2	V1 coupling capacitor	Same as C1		
C3	V2 input coupling cap.	.01 mfd ± 20% 300 volt mica	SAN	C-06110
C4	V2 cathode bypass cap.	25 mfd 50 volt bathtub electrolytic capacitor (side term.)	~~AEO~~ ASC	~~BT-50 (25 mfd)~~ ED25-50
C5	V2 coupling capacitor	.003 mfd ± 10% 500 volt mica	SAN	C1230 ~~10%~~
C6	V3 input coupling cap.	.003 mfd ± 10% 500 volt mica	SAN	C1230 ~~10%~~
C7	V3 coupling capacitor	Same as C5		
C8	V3 output coupling cap.	Same as C5		
C9	V4 coupling capacitor	Same as C5		
C10	V4 output coupling cap.	24 mmf ± 5% 500 volt silver mica	SAN	RR 1424
C11	V6 plate decoupling cap.	1.0 mfd 600 volt drawn metal, shell paper	CDC	YAB-6100
C12	V7 bias filter capacitor	Same as C11		
C13	V5 bias filter capacitor	25 mfd 50 volt bathtub electrolytic (side terminals)	~~AEO~~ ASC	~~BT-50 (25 mfd)~~ ED 25-50
C14	Rectifier filter cap.	Same as C11		
C15	Power supply filter cap.	0.1 mfd 200 volts DC metallized tubular	ASC	ML-2-1
C16	Same as C15	Same as C15		
C17	Same as C15	4 mfd 600 volt paper	CDC	~~TUH~~ T 6040
C18	Same as C15	Same as C17		

Symbol	Function	Description	Mfr.	Part No.
C19	T1 filter capacitor	1.0 mfd (-20/+30%) 400 volts DC metallized paper tubular	ASC	ML-4-1M ASC ED25-58
C20	V1 cathode bypass	25 mfd 50 volt bathtub electrolytic (side terminals)	~~AEO~~	~~BT-50 (25 mfd)~~
C21	V7 shaping capacitor	.001 mfd ± 20% 500 V. mica cap.	SAN	C1210
C22	V6 coupling capacitor	.01 mfd ± 10% 300 volt mica	SAN	C-06110 ~~10%~~
C23	V6 coupling capacitor	.01 mfd ± 10% 300 volt mica	SAN	C-06110 ~~10%~~
C24	V10 shaping capacitor	.001 mfd ± 20% 500 volt mica	SAN	K1210
C25	V1 plate decoupling cap.	0.1 mfd (-20/+30%) 400 volt metallized paper tubular	ASC	ML-4-1
C26	T1 filter capacitor	1 mfd (-20/+30%) 400 volt metallized paper tubular	ASC	ML-4-1M
CR1	Bias Rectifier	IN54 Germanium diode	KEM	IN54
CR2	Same as CR1	Selenium rectifier 600 volts DC 1.5 ma	IRC	V30HP
CR3	Frequency doubler	Same as CR1		
CR4	Frequency doubler	Same as CR1		
CR5	Pulse clipping diode	IN54 Germanium diode	KEM	IN54
E1	Input and output terminal strip	5 terminal screw type strip + solder lugs	HBJ	5-140-3/4 W. Y sold. term.
F1	Main power fuse	1-1/2 amp. glass cartridge fuse, 250V. Type SAB.	LFU	312015 ~~8AG~~ 250 V. ~~1-1/2~~ amp.
I1	Primary power indicator lamp	Miniature bayonet base incandescent lamp 6-8 volts .15 amp.	GEC	47

Sym-bol	Function	Description	Mfr.	Part No.
I2	Blown fuse indicator	Miniature bayonet base neon lamp	GEC	NE-51
J1	Main power input connector	2 contact male chassis connector	HBJ	P-202-B
J2	Input jack	3 circuit microphone jack	MAL	SCA-2B
J3	Output jack	Same as J2		
J4	Socket for 152Z	10 pin female Jones plug	HBJ	S310CCT
L1	Power supply filter choke	7 henries 110 ma DC 160 ohms resistance hermetically sealed	NRC	108H
M1	Output current meter	DC milliammeter 2-1/2" square case 0-75 ma scale (Zero at left)	WEI	506
P1	Main power cable connector	2 contact female cable connector	HBJ	S-202-CCT
R1	V1 load resistor	33K ohms ± 10% 1/2 watt	ALB	EB 3331
R2	V1 cathode resistor	2.2K ohms ± 10% 1/2 watt	ALB	EB 2221
R3	V1 plate resistor	33K ohms ± 10% 1/2 watt	ALB	EB 3331
R4	V1 cathode resistor	2K ohms ± ~~10%~~ 5% 1 watt	ALB	GB ~~2021~~ 2025
R5	V1 grid resistor	220K ohms ± 10% 1/2 watt	ALB	EB 2241
R6	CR3 diode resistor	47K ohms ± 10% 1/2 watt	ALB	EB 4731
R7	CR4 diode resistor	47K ohms ± 10% 1/2 watt	ALB	EB 4731
R9	V2 grid isolating res.	1 megohm ± 10% 1/2 watt	ALB	EB 1051
R10	V2 plate resistor	470K ohms ± 10% 1/2 watt	ALB	EB 4741
R11	V2 cathode resistor	4300 ohms ± ~~10%~~ 5% 1/2 watt	ALB	EB ~~4021~~ 4325
R12	V2 grid resistor	100K ohms ± 10% 1/2 watt	ALB	EB 1041
R13	V2 grid isolating resistor	1 megohm ± 10% 1/2 watt	ALB	EB 1051

Sym-bol	Function	Description	Mfr.	Part No.
R14	V2 grid resistor	390K ohms ± 10% 1/2 watt	ALB	EB 3941
R15	V2 plate resistor	470K ohms ± 10% 1/2 watt	ALB	EB 4741
R16	V2 grid resistor	390K ohms ± 10% 1/2 watt	ALB	EB 3941
R17	V3 grid isolating resistor	470K ohms ± 10% 1/2 watt	ALB	EB 4741
R18	V3 plate resistor	47K ohms ± 10% 1/2 watt	ALB	EB 4731
R19	V3 cathode resistor	4.7K ohms ± 10% 1/2 watt	ALB	EB 4721
R20	V3 grid isolating resistor	470K ohms ± 10% 1/2 watt	ALB	EB 4741
R21	V3 grid resistor	390K ohms ± 10% 1/2 watt	ALB	EB 3941
R22	V3 plate resistor	47K ohms ± 10% 1/2 watt	ALB	EB 4731
R23	V3 cathode resistor	4.7K ohms ± 10% 1/2 watt	ALB	EB 4721
R24	V4 grid isolating resistor	470K ohms ± 10% 1/2 watt	ALB	EB 4741
R25	V4 grid resistor	390K ohms ± 10% 1/2 watt	ALB	EB 3941
R26	V4 plate resistor	150K ohms ± 10% 1/2 watt	ALB	EB 1541
R27	V4 grid isolating resistor	470K ohms ± 10% 1/2 watt	ALB	EB 4741
R28	V4 grid resistor	390K ohms ± 10% 1/2 watt	ALB	EB 3941
R29	V4 plate resistor	100K ohms ± 10% 1/2 watt	ALB	EB 1041
R30	V5 grid resistor	150K ohms ± 10% 1/2 watt	ALB	EB 1541
R31	V6 grid resistor	150K ohms ± 10% 1/2 watt	ALB	EB 1541
R32	V6 plate resistor	47K ohms ± 10% 1/2 watt	ALB	EB 4731
R33	V6 plate resistor	47K ohms ± 10% 1/2 watt	ALB	EB 4731
R34	V6 coupling resistor	470K ohms ± 10% 1/2 watt	ALB	EB 4741
R35	V6 coupling resistor	470K ohms ± 10% 1/2 watt	ALB	EB 4741
R36	V6 Grid resistor	150K ohms ± 10% 1/2 watt	ALB	EB 1541
R37	V6 cathode resistor	10K ohms ± 5% 1/2 watt	ALB	EB 1035

Symbol	Function	Description	Mfr.	Part No.
R38	V6 decoupling resistor	1.3K ohms ± 5% 1/2 watt	ALB	EB 1325
R39	V7 grid isolating resistor	680K ohms ± 5% 1/2 watt	ALB	EB 6841
R40	V7 grid resistor	2 megohms ± 5% 1/2 watt	ALB	EB 2055
R41	Output current control	50K ohms ± 10% 2 watts pot. 3/8" bushing, 3/8" shaft	ALB	JU 5031 (P3048)
R42	V7 screen resistor	47K ohms ± 10% 1/2 watt	ALB	EB 4731
R43	Power supply filter res.	6K ohms ± 10% 5 watts	WLE	5F 6000
R45	T1 protection resistor	1 megohm ± 10% 1/2 watt	ALB	EB 1051
R46	Neon lamp series resistor	100K ohms ± 10% 1/2 watt	ALB	EB 1041
R47	CR5 bias resistor	300 ohms ± 5% 1/2 watt	ALB	EB 3015
R48	CR5 bias resistor	100K ohms ± 5% 1/2 watt	ALB	EB 1045
R49	V7 screen series resistor	2.2K ohms ± 10% 1/2 watt	ALB	EB 2221
R50	V10 screen series resistor	2.2K ohms ± 10% 1/2 watt	ALB	EB 2221
R51	V10 plate load resistor	2K ohms ± 10% 25 watt wirewound	ALB	25F 2000
R52	V10 grid resistor	2 megohm ± 5% 1/2 watt	ALB	EB 2055
R53	V10 grid isolating resistor	680K ohms ± 5% 1/2 watt	ALB	EB 6845
R54	V1 plate decoupling resistor	100K ohms ± 10% 1/2 watt	ALB	EB 1041
R55	Power supply filter res.	900 ohms ± 10% 5 watt wirewound	WLE	5F 900
R56	Power supply filter res.	900 ohms ± 10% 5 watt wirewound	WLE	5F 900
S1	Primary power switch	DPST toggle, 2/1 amp. 110/220 volts	APH	81024
S2	Sense switch	2 circuit, 2 position non-shorting rotary switch, 3/8" shaft	MAL	3222J

Symbol	Function	Description	Mfr.	Part No.
T1	Power transformer	Primary: 110/220 volts 50/60 cps Sec. #1: 295-0-295 V. at 90 ma (Hermetically sealed) Sec. #2: 6.3 V. at 2 amps.	NRC	192H
T2	Audio transformer	Line to grid transformer	NRC	252
V1	Input amplifier	Standard	any	12AX7
V2	Limiter	Standard	any	12AX7
V3	Gating tube	Standard	any	12AU7
V4	Phase shift and squaring tube	Standard	any	12AU7
V5	Coincidence tube	Standard	any	12AX7
V6	Keyer tube	Standard	any	12AU7
V7	Output amplifier tube	Standard	any	6AQ5
V8	Rectifier tube	Standard	any	6X4
V9	Same as V8	Same as V8		
V10	Drain Equalizer	Standard	any	6AQ5
X1	Socket for V1	9 pin mica filled bakelite miniature tube socket	~~AMP~~ EBY	~~58-467~~ 9114-21
X2	Socket for V2	Same as X1		
X3	Socket for V3	Same as X1		
X4	Socket for V4	Same as X1		
X5	Socket for V5	Same as X1		
X6	Socket for V6	Same as X1		
X7	Socket for V7	7 pin mica filled bakelite miniature tube socket	~~AMP~~ EBY	147-913 9225-11
X8	Socket for V8	Same as X7		

Symbol	Function	Description	Mfr.	Part No.
X9	Socket for V9	Same as X7		
X10	Socket for V10	Same as X7		
X11	Socket for F1	Panel mounting finger type knob fuse holder (for 3AG Littlefuse)	LFU	342001
X12	Socket for I1	Pilot lamp assembly miniature bayonet base, with frosted white jewel and removable red disc.	DLA	~~67BB~~ 67361
X13	Socket for I2	Same as X12		
152Z	Frequency Determining Network	Plug in type network	NRC	152Z

ELECTRICAL PARTS LIST - FREQUENCY DETERMINING NETWORK 152 Z

(All capacitors listed larger than .002 MF are bridged to 1%)

Circuit Symbol	Description	Mfr.	Part No.
	TYPE 152Z2		
	Carrier Frequency 425 ± 42.5 cps Mark Freq. 467.5 cps Space Freq. 382.5 cps		
BP100	425 cps band pass filter	NRC	212
C100	.01 mfd ± 2% 300 volts silver mica cap.	SAN	CR-06110
C101	.006 mfd ± 2% 500 volt silver mica cap.	SAN	CR 1260
C103	1300-2830 mmf compression type capacitor	ELM	Type 30 #314
C104	.033 mfd ± 5% 200 volt high temperature tubular cap.	ASC	AQP2-033
C105	Same as C104	ASC	AQP2-033
C106	.004 mfd ± 2% 500 volt silver mica cap.	SAN	CR 1240
L100	2 hy. ± 1% toroidal inductor	NRC	248

Circuit Symbol	Description	Mfr.	Part No.
TYPE 152Z2 (cont'd)			
L101	.5 hy. ± 1% toroidal inductor	NRC	247
P104	10 pin male jones plug	HBJ	P310-AB
R100	560 ohm ± 10% 1/2 watt composition res.	ALB	EB 5611
R101	390K ohm ± 10% 1/2 watt composition res.	ALB	EB 3941
C102,C107	Not used.		
TYPE 152Z3			
	Carrier Frequency 595 ± 42.5 cps Mark Freq.637.5 cps Space Freq.552.5 cps		
BP100	595 cps band pass filter	NRC	213
C100	.007 mfd ± 2% 300 volt silver mica cap.	SAN	CR 06270
C103	1300-2830 mmf compression type capacitor	ELM	Type 30 #314
C104	.01 mfd ± 2% 300 volt silver mica cap.	SAN	CR 06110
C105	Same as C104	SAN	CR 06110
C106	Same as C104	SAN	CR 06110
C107	.006 mfd ± 2% 500 volt silver mica cap.	SAN	CR 1260
L100	2.0 hy. ± 1% toroidal inductor	NRC	248
L101	.5 henry ± 1% toroidal inductor	NRC	247
P104	10 pin male Jones plug	HBJ	P310-AB
R100	560 ohms ± 10% 1/2 watt composition res.	ALB	EB 5611
R101	470K ohms ± 10% 1/2 watt composition res.	ALB	EB 4741
C101,C102	Not used.		
TYPE 152Z4			
	Carrier Frequency 765 ± 42.5 cps Mark Freq.807.5 cps Space Freq.722.5 cps		
BP100	765 cps band pass filter	NRC	214
C100	.01 mfd ± 2% 300 volt silver mica capacitor	SAN	CR 06110
C101	.009 mfd ± 2% 300 volt silver mica cap.	SAN	CR 06290
C103	1300-2830 mmf compression type capacitor	ELM	Type 30 #314
C104	Same as C100	SAN	CR 06110
C105	Same as C100	SAN	CR 06110
C106	.002 mfd ± 2% 500 volt silver mica cap.	SAN	CR 1220
L100	.5 henry ± 1% toroidal inductor	NRC	247
L101	Same as L100	NRC	247
P104	10 pin male Jones plug	HBJ	P310-AB
R100	560 ohm ± 10% 1/2 watt composition res.	ALB	EB 5611

Circuit Symbol	Description	Mfr.	Part No.
TYPE 152Z4 (cont'd)			
R101	220K ohms ± 10% 1/2 watt composition res.	ALB	EB 2241
C102,C107	Not used.		
TYPE 152Z5			
	Carrier Frequency 935 ± 42.5 cps Mark Freq.977.5 cps Space Freq.892.5 cps		
BP100	935 cps band pass filter	NRC	215
C100	.01 mfd ± 2% 300 volt silver mica cap.	SAN	CR 06110
C101	Same as C100	SAN	CR 06110
C102	.001 mfd ± 2% 500 volt silver mica cap.	SAN	CR 1210
C103	1300-2830 mmf compression type cap.	ELM	Type 30 #314
C104	Same as C100	SAN	CR 06110
C105	Same as C100	SAN	CR 06110
C106	Same as C100	SAN	CR 06110
C107	.006 mfd ± 2% 500 volt silver mica cap.	SAN	CR 1260
L100	.300 hy ± 1% toroidal ~~coil~~ inductor	NRC	246
L101	.200 hy ± 1% toroidal ~~coil~~ inductor	NRC	245
P104	10 pin male Jones plug	HBJ	P310-AB
R100	560 ohm ± 10% 1/2 watt composition res.	ALB	EB 5611
R101	220K ohm ± 10% 1/2 watt composition res.	ALB	EB 2241
TYPE 152Z6			
	Carrier Frequency 1105 ± 42.5 cps Mark Freq.1147.5 cps Space Freq. 1062.5 cps		
BP100	1105 cps band pass filter	NRC	216
C100	.01 mfd ± 2% 300 volt silver mica capacitor	SAN	CR 06110
C101	.004 mfd ± 2% 500 volt silver mica cap.	SAN	CR 1240
C103	1300-2830 mmf compression type capacitor	ELM	Type 30 #314
C104	Same as C100	SAN	CR 06110
C105	Same as C100	SAN	CR 06110
C106	.006 mfd ± 2% 500 volt silver mica cap.	SAN	CR 1260
L100	.300 hy ± 1% toroidal ~~coil~~ inductor	NRC	246
L101	.200 hy ± 1% toroidal ~~coil~~ inductor	NRC	245
P104	10 pin male Jones plug	HBJ	P310-AB
R100	560 ohms ± 10% 1/2 watt composition res.	ALB	EB 5611
R101,C102,C107	Not used	~~ALB~~	~~EB 2241~~

Circuit Symbol	Description	Mfr.	Part No.
TYPE 152Z7			
	Carrier Frequency 1275 ± 42.5 cps Mark Freq. 1317.5 cps Space Freq. 1232.5 cps		
BP100	1275 cps band pass filter	NRC	217
C100	.01 mfd ± 2% 300 volt silver mica cap.	SAN	CR 06110
C103	1300-2830 mmf compression type capacitor	ELM	Type 30 #314
C104	Same as C100	SAN	CR 06110
C105	Same as C100	SAN	CR 06110
L100	.300 hy ± 1% toroidal ~~coil~~ inductor	NRC	246
L101	.200 hy ± 1% toroidal ~~coil~~ inductor	NRC	245
P104	10 pin male Jones plug	HBJ	P310-AB
R100	560 ohms ± 10% 1/2 watt composition res.	ALB	EB 5611
C101, C102, C106, C107, R101	Not used		
TYPE 152Z8			
	Carrier Frequency 1445 ± 42.5 cps Mark Freq. 1487.5 cps Space Freq. 1402.5 cps		
BP100	1445 cps band pass filter	NRC	218
C100	.005 mfd ± 2% ~~800~~ 500 volt silver mica cap.	SAN	CR 1250
C101	.002 mfd ± 2% 500 volt silver mica cap.	SAN	CR 1220
C103	1300-2830 mmf compression type capacitor	ELM	Type 30 #314
C104	.01 mfd ± 2% 300 volt silver mica cap.	SAN	CR 06110
L100	.300 hy ± 1% toroidal ~~coil~~ inductor	NRC	246
L101	.300 hy ± 1% toroidal ~~coil~~ inductor	NRC	246
P104	10 pin male Jones plug	HBJ	P310-AB
R100	560 ohms ± 10% 1/2 watt composition res.	ALB	EB 5611
C102, C105, C106, C107, R101	Not used		
TYPE 152Z9			
	Carrier Frequency 1615 ± 42.5 cps Mark Freq. 1657.5 cps Space Freq. 1572.5 cps		
BP100	1615 cps band pass filter	NRC	219
C100	.01 mfd ± 2% 300 volt silver mica capacitor	SAN	CR 06110

Circuit Symbol	Description	Mfr.	Part No.
TYPE 152Z9 (cont'd)			
Carrier Frequency 1615 ± 42.5 cps Mark Freq. 1657.5 cps Space Freq. 1572.5 cps			
C103	1300-2830 mmf compression type cap.	ELM	Type 30 #314
C104	.008 mfd ± 2% 300 volt silver mica cap.	SAN	CR 06280
C105	.001 ~~.001~~ mfd ± 2% 500 volt silver mica cap.	SAN	KR 1310
L100	.200 hy ± 1% toroidal ~~coil~~ inductor	NRC	245
L101	.300 hy ± 1% toroidal ~~coil~~ inductor	NRC	246
P104	10 pin male Jones plug	HBJ	P310-AB
R100	560 ohms ± 10% 1/2 watt composition res.	ALB	EB5611
C102, C106, C101, C107, R101	Not used		

TYPE 152Z10

Carrier Frequency 1785 ± 42.5 cps Mark Freq. 1827.5 cps Space Freq. 1742.5 cps			
BP100	1785 cps band pass filter	NRC	220
C100	.005 mfd ± 2% ~~300~~ 500 volt silver mica capacitor	SAN	CR ~~06250~~ 1250
C101	.003 mfd ± 2% 500 volt silver mica cap.	SAN	CR 1230
C103	1300-2830 mmf compression type capacitor	ELM	Type 30 #314
C104	.0068 mfd ± 2% 300 volts silver mica cap.	SAN	CR 06268
L100	.200 hy ± 1% toroidal ~~coil~~ inductor	NRC	245
L101	.300 hy ± 1% toroidal ~~coil~~ inductor	NRC	246
P104	10 pin male Jones plug	HBJ	P310-AB
R100	560 ohm ± 10% 1/2 watt comp. res.	ALB	EB 5611
C102, C105, C106, C107, R101	Not used		

TYPE 152Z11

Carrier Frequency 1955 ± 42.5 cps Mark Freq. 1997.5 cps Space Freq. 1912.5 cps			
BP100	1955 cps band pass filter	NRC	221
C100	.01 mfd ± 2% 300 volt silver mica capacitor	SAN	CR 06110
C101	.009 mfd ± 2% 300 volt silver mica cap.	SAN	CR 06290
C103	1300-2830 mmf compression type capacitor	ELM	Type 30 #314
L100	.300 hy. ± 1% toroidal inductor	NRC	246
P104	10 pin male Jones plug	HBJ	P310-AB
R100	560 ohm ± 10% 1/2 watt composition resistor	ALB	EB 5611
C102, C104, C105, C106, C107, L101, R101	Not used		

Circuit Symbol	Description	Mfr.	Part No.
TYPE 152Z12			
Carrier	Frequency 2125 ± 42.5 cps Mark Freq. 2167.5 cps Space Freq. 2082.5 cps		
BP100	2125 cps band pass filter	NRC	222
C100	.01 mfd ± 2% 300 volt silver mica capacitor	SAN	CR 06110
C101	.006 mfd ± 2% 500 volt silver mica cap.	SAN	CR 1260
C103	1300-2830 mmf compression type cap.	ELM	Type 30 #314
L100	.300 hy. ± 1% toroidal inductor	NRC	246
P104	10 pin male Jones plug	HBJ	P310-AB
R100	560 ohm ± 10% composition resistor	ALB	EB 5611
C102, C104, C105, C106, C107, L101, R101	Not used		
TYPE 152Z13			
Carrier	Frequency 2295 ± 42.5 cps Mark Freq. 2337.5 cps Space Freq. 2252.5 cps		
BP100	2295 cps band pass filter	NRC	223
C100	.01 mfd ± 2% 300 volt silver mica capacitor	SAN	CR 06110
C101	.003 mfd ± 2% 500 volt silver mica cap.	SAN	CR 1230
C103	1300-2830 mmf compression type cap.	ELM	Type 30 #314
L100	.300 hy. ± 1% toroidal inductor	NRC	246
P104	10 pin male Jones plug	HBJ	P310-AB
R100	560 ohm ± 10% composition resistor	ALB	EB 5611
C102, C104, C105, C106, C107, L101, R101	Not used		
TYPE 152Z14			
Carrier	Frequency 2465 ± 42.5 cps Mark Freq. 2507.5 cps Space Freq. 2422.5 cps		
BP100	2465 cps band pass filter	NRC	224
C100	.01 mfd ± 2% 300 volt silver mica capacitor	SAN	CR 06110

Circuit Symbol	Description	Mfr.	Part No.
TYPE 152Z14 (cont'd)			
C101	.001 mfd ± 2% 500 volt silver mica cap	SAN	CR 1210
C103	1300-2830 mmf compression type capacitor	ELM	Type 30 #314
L100	.300 hy. ± 1% toroidal inductor	NRC	246
P104	10 pin male Jones plug	HBJ	P310-AB
R100	560 ohms ± 10% 1/2 watt comp. res.	ALB	EB 5611
C102,C104, C105,C106, C107,L101, R101	Not used		

TYPE 152Z15

Carrier Frequency 2635 ± 42.5 cps Mark Freq. 2677.5 cps Space Freq. 2592.5 cps

BP100	2635 cps band pass filter	NRC	225
C100	.01 mfd ± 2% 300 volts silver mica cap.	SAN	CR 06110
C101	.005 mfd ± 2% 500 volt silver mica cap.	SAN	CR 1250
C103	1300-2830 mmf compression type cap.	ELM	Type 30 #314
L100	.200 hy. ± 1% toroidal inductor	NRC	245
P104	10 pin male Jones plug	HBJ	P310-AB
R100	560 ohms ± 10% 1/2 watt composition resistor	ALB	EB 5611
C102,C104, C105,C106, C107,L101, R101	Not used		

TYPE 152Z16

Carrier Frequency 2805 ± 42.5 cps Mark Freq. 2847.5 cps Space Freq. 2762.5 cps

BP100	2805 cps band pass filter	NRC	226
C100	.01 mfd ± 2% 300 volt silver mica cap.	SAN	CR 06110
C101	.003 mfd ± 2% 500 volt silver mica cap.	SAN	CR 1230
L100	.200 hy. ± 1% toroidal inductor	NRC	245
P104	10 pin male Jones plug	HBJ	P310-AB
R100	560 ohms ± 10% 1/2 watt comp. res.	ALB	EB 5611
C103	1300-2830 mmf compression type cap.	ELM	Type 30 #314
C102,C104, C105,C106, C107,L101, R101	Not used		

Circuit Symbol	Description	Mfr.	Part No.
TYPE 152Z17			
Carrier	Frequency 2975 ± 42.5 cps Mark Freq. 3017.5 cps Space Freq. 2932.5 cps		
BP100	2975 cps band pass filter	NRC	227
C100	.01 mfd ± 2% 300 volt silver mica cap.	SAN	CR 06110
C101	.0015 mfd ± 2% 500 volt silver mica cap.	SAN	CR 1215
C102	.0005 mfd ± 5% 500 volt silver mica cap.	SAN	KR 1350
C103	1300-2830 mmf compression type capacitor	ELM	Type 30 #314
L100	.200 hy. ± 1% toroidal inductor	NRC	245
P104	10 pin male Jones plug	HBJ	P310-AB
R100	560 ohm ± 10% 1/2 watt comp. res.	ALB	EB 5611
C104, C105, C106, C107, L101, R101	Not used		
TYPE 152Z18			
Carrier	Frequency 3145 ± 42.5 cps Mark Freq. 3187.5 cps Space Freq. 3102.5 cps		
BP100	3145 cps band pass filter	NRC	228
C100	.01 mfd ± 2% 300 volt silver mica cap.	SAN	CR 06110
C101	.008 mfd ± 2% 300 volt silver mica cap.	SAN	CR 06280
C103	1300-2830 mmf compression type capacitor	ELM	Type 30 #314
L100	.125 hy. ± 1% toroidal inductor	NRC	244
P104	10 pin male Jones plug	HBJ	P310-AB
R100	560 ohm ± 10% 1/2 watt comp. res.	ALB	EB 5611
C102, C104, C105, C106, C107, L101, R101	Not used		
TYPE 152Z19			
Carrier	Frequency 3315 ± 42.5 cps Mark Freq. 3357.5 cps Space Freq. 3272.5 cps		
BP100	3315 cps band pass filter	NRC	254
C100	.01 mfd ± 2% 300 volt silver mica cap.	SAN	CR 06110
C101	.0056 mfd ± 2% 500 volt silver mica cap.	SAN	CR 1256
C103	1300-2830 mmf compression capacitor	ELM	Type 30 #314
L100	.125 hy. ± 1% toroidal inductor	NRC	244
P104	10 pin male Jones plug	HBJ	P310-AB

Circuit Symbol	Description	Mfr.	Part No.
TYPE 152Z19 (cont'd)			
R100	560 ohm ± 10% 1/2 watt comp. res.	ALB	EB 5611
C102,C104, C105,C106, C107,L101, R101	Not used		

TYPE 152Z51

Carrier	Frequency 1615 ± 120 cps Mark Freq. 1735 cps Space Freq. 1495 cps		
BP100	1615 cps band pass filter	NRC	240
C100	.006 mfd ± 2% 500 volt silver mica cap.	SAN	CR 1260
C101	Not used		
C102	Not used		
C103	1300-2830 mmf compression type capacitor	ELM	Type 30 #314
C104	.0056 mfd ± 2% 500 volt silver mica cap.	SAN	CR 1256
C105	.002 mfd ± 2% 500 volt silver mica cap.	SAN	CR 1220
C106	.0001 mfd ± 2% 500 volt silver mica cap.	SAN	KR 1310
C107	Not used		
L100	.3 hy ± 1% toroidal ~~coil~~ inductor	NRC	246
L101	.3 hy ± 1% toroidal ~~coil~~ inductor	NRC	246
P104	10 pin male Jones plug	HBJ	P310-AB
R100	560 ohms ± 10% 1/2 watt comp. res.	ALB	EB 5611
R101	Not used		

TYPE 152Z52

Carrier	Frequency 2295 ± 120 cps Mark Freq. 2415 cps Space Freq. 2175 cps		
BP100	2295 cps band pass filter	NRC	241
C100	.003 mfd ± 2% 500 Volt silver mica cap.	SAN	CR 1230
C101	Not used		
C102	Not used		
C103	350-1180 mmf compression type capacitor	ELM	Type 30 #307
C104	.0056 mfd ± 2% 500 Volt silver mica cap.	SAN	CR 1256
C105	.0001 mfd ± 2% 500 Volt silver mica cap.	SAN	KR ~~06280~~ 1310
C106	Not used		
C107	Not used		

Circuit Symbol	Description	Mfr.	Part No.
TYPE 152Z52 (cont'd)			
L100	.3 hy ± 1% toroidal ~~coil~~ inductor	NRC	246
L101	.2 hy ± 1% toroidal ~~coil~~ inductor	NRC	245
P104	10 pin male Jones plug	HBJ	P310-AB
R100	560 ohm ± 10% 1/2 W. comp. res.	ALB	EB 5611
R101	Not used		

TYPE 152Z53

Carrier	Frequency 2975 ± 120 cps Mark Freq. 3095 cps	Space Freq. 2855 cps	
BP100	2975 cps band pass filter	NRC	242
~~C100~~ C104	.01 mfd ± 2% 500 volt silver mica capacitor	SAN	CR 06110
C103	275 - 970 mmf compression type cap.	ELM	Type 30 #306
C104	~~.005~~ .007 mfd ± 2% 500 volt silver mica cap.	SAN	CR ~~1250~~ 1247
~~C105~~	~~.0003 mfd ± 2% 500 volt silver mica cap.~~	~~SAN~~	~~KR 1330~~
~~L100~~ L101	.0625 hy ± 1% toroidal ~~coil~~ inductor	NRC	253
~~L101~~ L100	.125 hy ± 1% toroidal ~~coil~~ inductor	NRC	244
P104	10 pin male Jones plug	HBJ	P310-AB
R100	560 ohm ± 10% 1/2 W. comp. res.	ALB	EB 5611
R101,C101, C102,C106, C107, C105	Not used		

MANUFACTURERS' DESIGNATIONS

AEO	Aerovox Corp.
AHH	Arrow Hart & Hegeman Co.
ALB	Allen-Bradley Co.
AMP	American Phenolic Corp.
ASC	Astron Corp.
CCC	Continental Carbon Co.
CDC	Cornell-Dubilier Elec. Co.
DLA	Dial Light Corp. of America.
ELC	Elco Corp.
ELM	Electro Motive Mfg. Co. (EL MENCO)
GEC	General Electric Co.
HBJ	Howard B. Jones Div. Cinch Mfg. Co.
IRC	International Resistance Corp.
KEM	Kemtron Electron. Prod.Inc.
LFU	Littlefuse, Inc.
MAL	P. R. Mallory & Co.
NRC	Northern Radio Co. Inc.
SAN	Sangamo Elec. Co.
UTC	United Transformer Co.
WEI	Weston Electrical Instrument Co.
WLE	Ward Leonard Elec. Co.

EBY

Hugh H. Eby Inc.

DWG. NO. C-152108

ITEM	DESCRIPTION	DWG. NO.	QUAN.	PART NO.

FINISH:

R54 100K
C25 .1
R3 33 K
C2 .005
CR3 IN54
V1 X1 12 AX 7
R6 47 K
R5 220 K
T2
C20 25
R2 2.2K
C1 .005
R7 47 K
CR4 IN54
R1 33K
R4 2K
TWISTED PAIR
J2 INPUT MONITOR
R10 470 K
C5 .003
R15 470 K
C6 .003
R18 47 K
C7 .003
V2 X2 12 AX 7
V3 X3 12 AU 7
R9 1M
R13 1M
R17 470 K
R22 47 K
C8 .003
R26 150 K
C9 .003
R29 100 K
C10 24 MMF
V4 X4 12 AU 7
R12 100 K
R11 4,300
C3 .01
C4 25
R14 390 K
R16 390 K
R19 4.7K
R20 470 K
R21 390 K
R23 4.7K
R24 470 K
R25 390 K
R27 470 K
R28 390 K
CR5 IN54
R30 150K
R47 300
R48 100 K
V5 X5 12 AX 7
J4
R53 680K
S2B SENSE
E1
600 Ω
INPUT
OUTPUT
P104
FREQUENCY DETERMINING NETWORK 152 Z
V10 X10 6AQ5
R51 2K
R50 2.2K
R38 1.3K
S2A SENSE
R32 47 K
R33 47 K
V7 X7 6AQ5
R39 680K
C22 .01
C23 .01
V6 X6 12 AU 7
R41 50K
R49 2.2K
R35 470 K
R34 470 K
C21 .001
R40 2 M
C11 .1
R36 150 K
R37 10K
R31 150 K
C24 .001
R52 M1 (MA)
R42 47K
TWISTED PAIR
J3 OUTPUT MONITOR
R45 1M
C19 .1
C26 .1
I2 X13 NE 51
R46 100 K
V8 X8 6X4
R55 900
L1 7 HY
R43 6K
R56 900
C15 .1
C18 .4
C17 .4
C14 .1
CR2 V 30 HP
C12 .1
V9 X9 6X4
C13 25
CR1 IN54
S1
T1
F1 X11
J1 A.C. INPUT
PWR. SW.
I1 X12
V1 V2 V3 V4 V5 V6 V7 V8 V9 V10
SHOWN FOR 110 VOLT. OPERATION
CONNECTIONS FOR 220 VOLT. OPERATION

NOTES:
1. ALL RESISTANCES IN OHMS.
2. ALL CAPACITANCES IN MICROFARADS. UNLESS OTHERWISE SPECIFIED.

ISSUE	DWN.	CKD.	APPR.	DATE	CHANGE
5	DS	AM		4-16-52	CORRECTED
4	DS	AM		4-11-52	CORRECTED
3	DS	AM		4-2-52	CORRECTED
2	TCR	AM		1-9-52	V7 PLATE CIRCUIT CORRECTED, P104 WAS P4, ADDED SHIELD ON B+ LEAD S2 +B- TWISTED, C10-43 WAS 30 MMF
1	TCR			12-27-51	ORIG DWG.

MATERIAL

SCALE

ENGR. APPR.

REFERENCE DWGS.
INDEX NO. A-152100

TOLERANCE (UNLESS SPECIFIED) FRACT. ± 1/64 DECIMAL ± .005

DWN. TCR CKD. AM

APPR. APPR. DATE 12-27-51

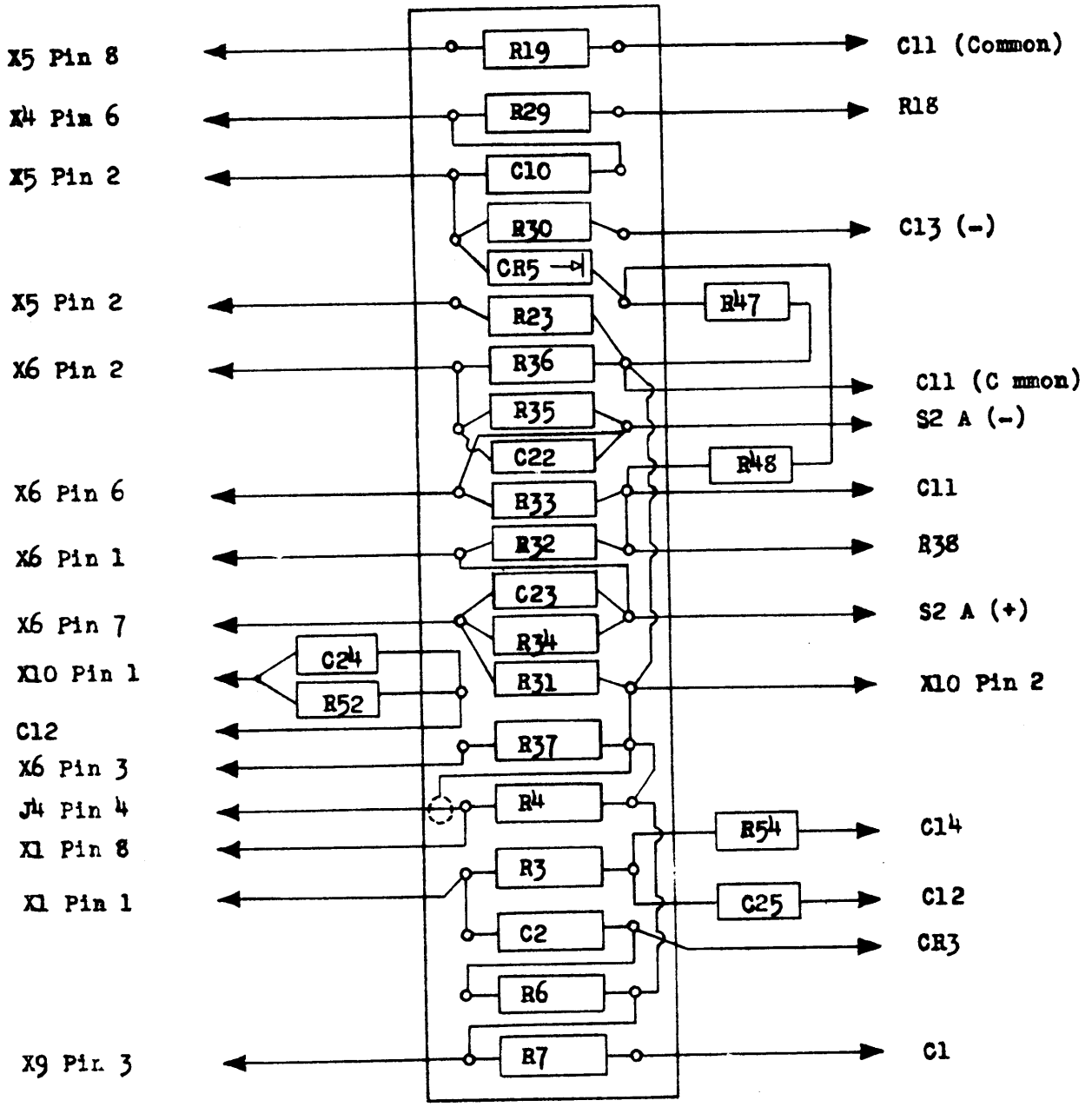
USED ON

TITLE
SCHEMATIC
DUAL F.S.TONE CONVERTER
TYPE 152 MODEL 1

NORTHERN RADIO COMPANY
INCORPORATED

DWG. NO. C-152108

NORTHERN RADIO COMPANY
INCORPORATED
NEW YORK 11, NEW YORK •

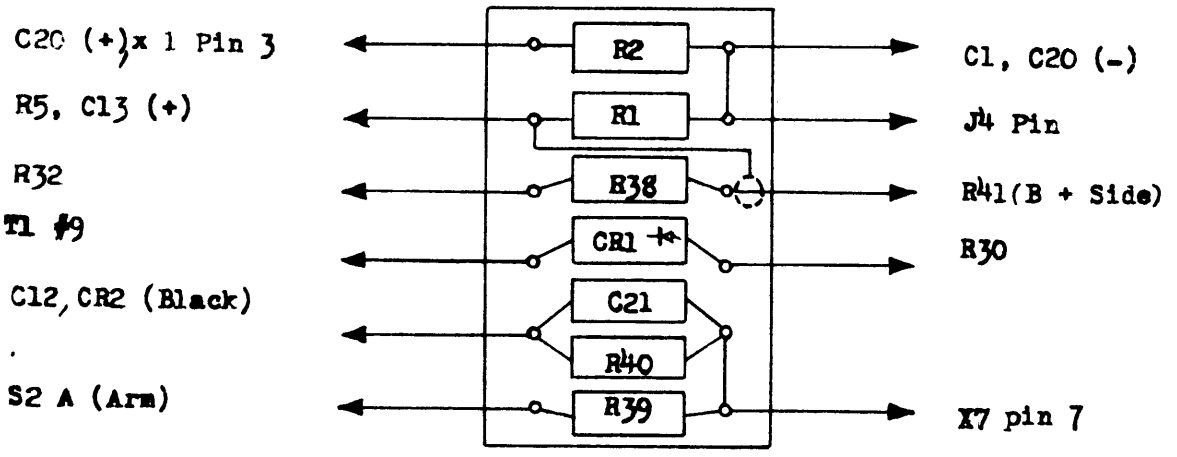


TERMINAL BOARD DIAGRAM NO. 2
DUAL F. S. TONE CONVERTER TYPE 152 Mod 1 1

SHEET 1 OF 1
ISSUE 5
DWG. NO. A - 152106

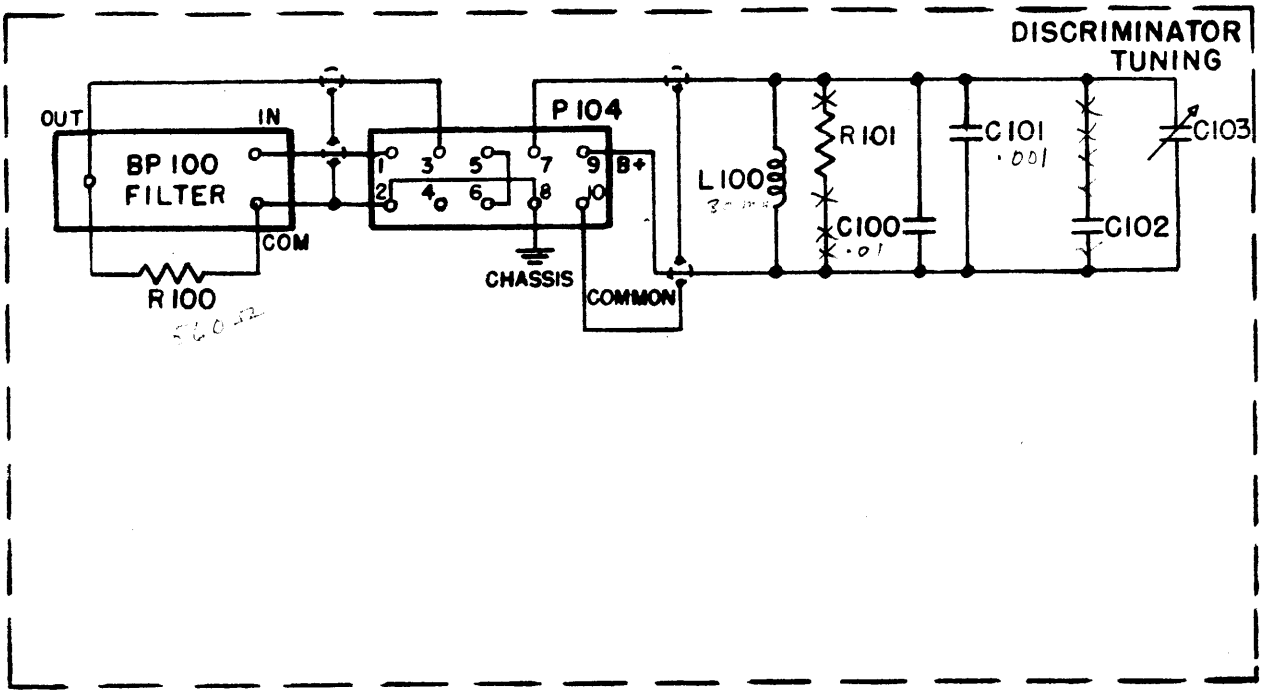
DATE	DWN. BY	CKD. BY	APP. BY
6-18-52	TCR	TR	AM

NORTHERN RADIO COMPANY
INCORPORATED
• NEW YORK 11, NEW YORK •



TERMINAL BOARD DIAGRAM NO. 3 DUAL F. S. TONE CONVERTER TYPE 152 Mod 1 1				SHEET 1 OF 1	
				ISSUE 2	
TE 1-2-51	DWN. BY TCR	CKD. BY TR	APP. BY AM	DWG. NO.	A - 152109

NORTHERN RADIO COMPANY
INCORPORATED
NEW YORK 11, NEW YORK •



Schematic of Frequency Determining Networks	
152 Z Numbers	Frequency (cps)
11	1955
12	2125
13	2295
14	2465 ✓
15	2635
16	2805
17	2975
18	3145
19	3315

NOTE:

Key to electrical symbols given on Electrical Parts List, Article No. 4-54.

SCHEMATIC of Frequency Determining Network 152Z
For use with
FREQUENCY SHIFT TONE CONVERTER, Type 152 Model 1

SHEET 1 OF 1
ISSUE 3

DATE	DWN. BY	CKD. BY	APP. BY	DWG. NO.	Size
1/16/52	TCR			152-1-42-Z	A

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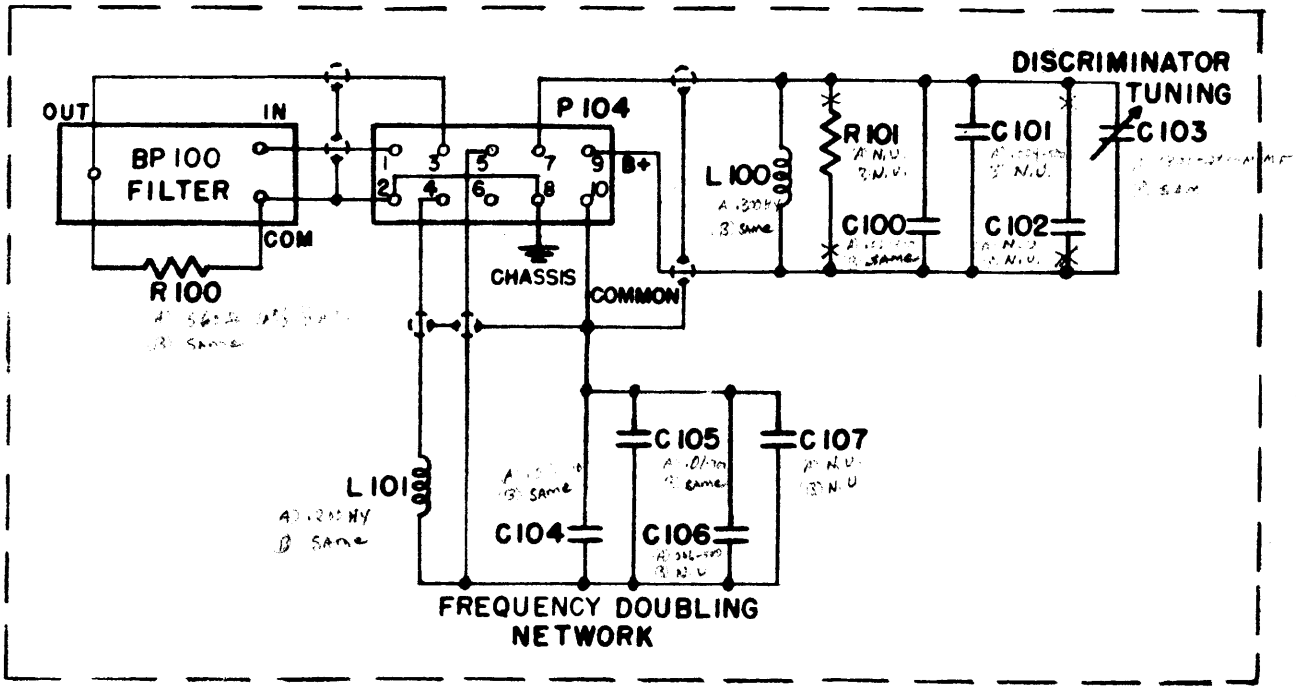


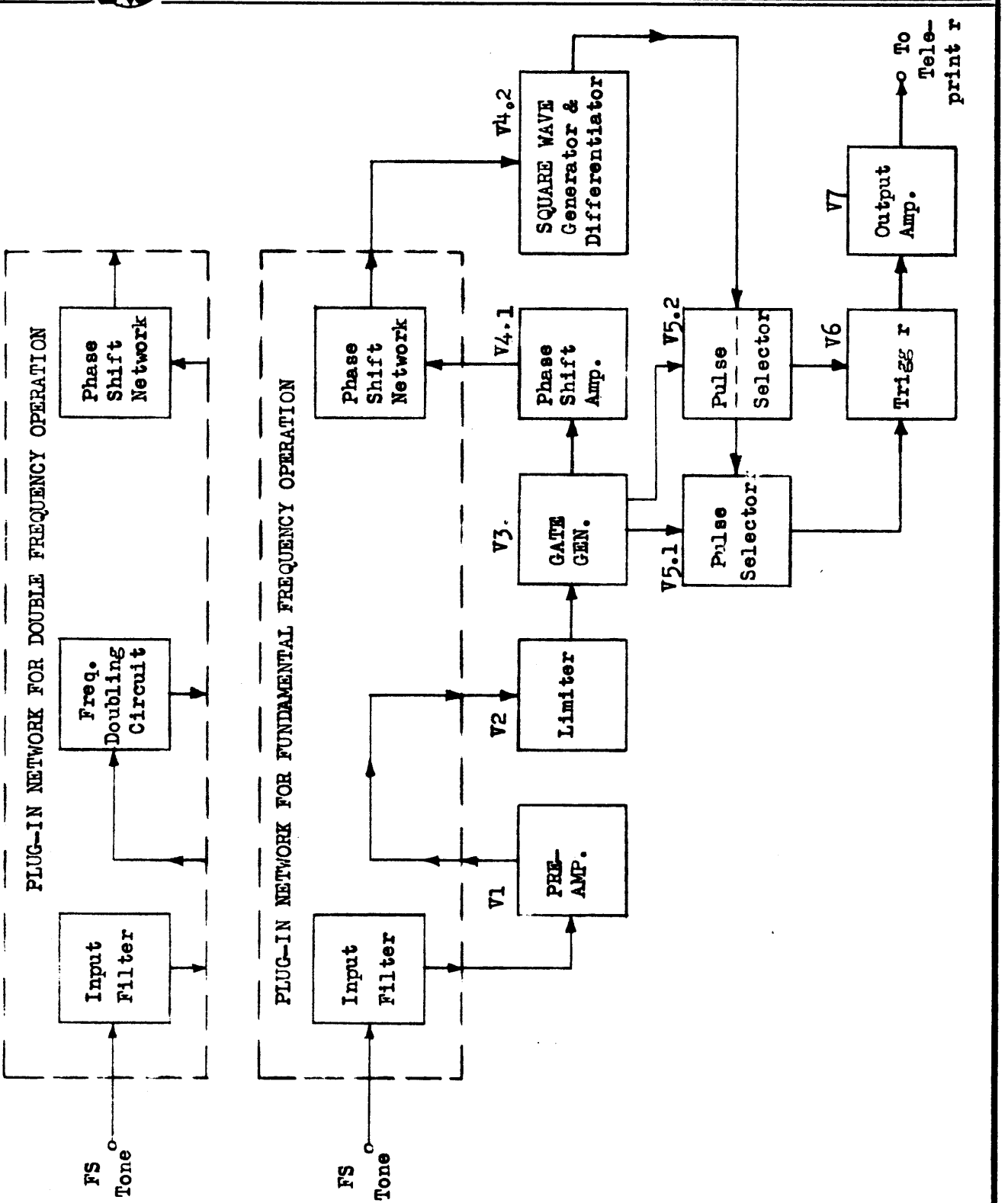
Schematic of Frequency Determining Networks	
152 Z Numbers	Frequency (cps)
2	425
3	595
4	765
5	935
6	1105
7	1275
8	1445
9	1615
10	1785
51	1615
52	2295
53	2975

NOTE:

Key to electrical symbols given on Electrical Parts List, Article No. 4-54.

SCHEMATIC of Frequency Determining Network 152Z For use with FREQUENCY SHIFT TONE CONVERTER, Type 152 Model 1				SHEET 1 OF 1	
				ISSUE 2	
DATE 1/16/52	DWN. BY TCR	CKD. BY	APP. BY	DWG. NO. -152-1-41-7	Size A

NORTHERN RADIO COMPANY
INCORPORATED
NEW YORK 11, NEW YORK

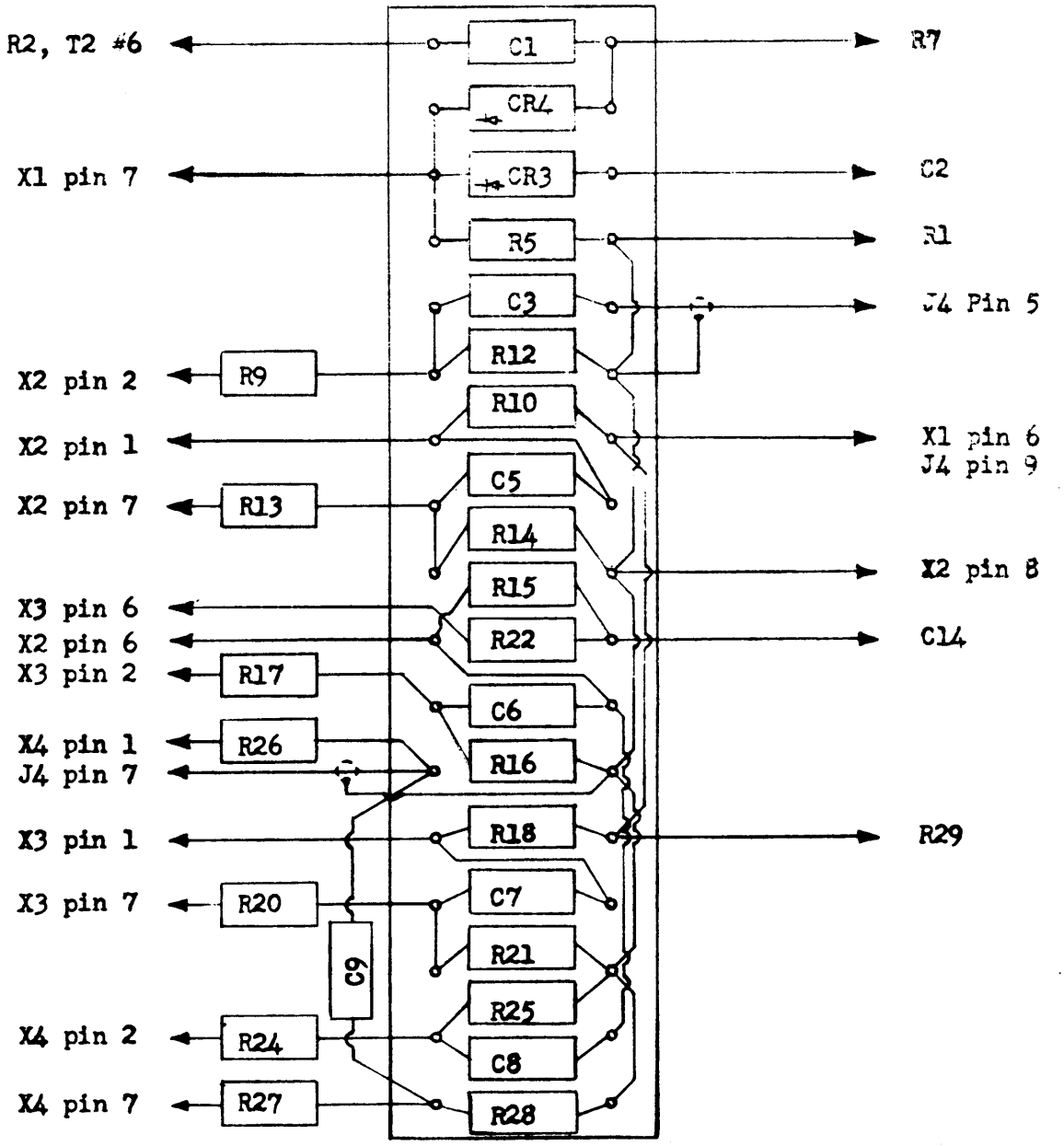


BLOCK DIAGRAM
Dual F.S. Tone Conv rter
Type 152 Model 1

SHEET 1 OF 1
ISSUE 2
DWG. NO. A-152110

DATE	DWN. BY	CKD. BY	APP. BY
2/7/52B	TCR	AM	

NORTHERN RADIO COMPANY
INCORPORATED
NEW YORK 11, NEW YORK •



TERMINAL BOARD DIAGRAM #1 (Bottom) DUAL F. S. CONVERTER TYPE 152 Mod 1 1				SHEET 1 OF 1 ISSUE 4	
DATE 6/18/51B	DWN. BY TCR	CKD. BY TR	APP. BY	DWG. NO.	A - 152105