INSTRUCTION BOOK

FREQUENCY SHIFT TONE KEYER

TYPE 211 MODEL 1

NORTHERN RADIO COMPANY

Incorporated

pace-setters

in quality

communication

equipment

STANDARD WARRANTY

All items of equipment and material used in this unit are guaranteed against defects in material, workmanship, or manufacture for a period of one year from date of shipment.

Under the terms of this Warranty, all items which fail within the period defined will be replaced or repaired F.O.B. point of manufacture without cost to purchaser. Prior approval of the company shall be obtained before returning any equipment. If upon examination of the defective item the company can show that failure was not due to any defective workmanship, material or manufacture, the company will bill the purchaser for the cost of replacement or repair.

INSTRUCTION BOOK

FREQUENCY SHIFT TONE KEYER

TYPE 211 MODEL 1

ADDENDUM NO. 3

October 16, 1962

This Addendum applies to Frequency Shift Tone Keyers, Type 211 Model 1, bearing Serial Number 7221 and above.

Q3, Q4 bias resistors, R14, R15, R19 and R20, formerly 10% composition resistors, have been replaced with 1% precision resistors. R16 and R21 have been changed to higher temperature units of the same value. These changes were made to improve the starting characteristics of the oscillator circuit.

Components on the Electrical Parts List have been changed as follows:

SYMBOL	FUNCTION	DESCRIPTION	MFR.	PART NO.
R14	Q3 bias series resistor	21.5K ohms ± 1% 1/8 watt precision film resistor	ANY	RN60G2152F
R15	Q3 bias shunt resistor	3.32K ohms ± 1% 1/8 watt precision film resistor	ANY	RN60G3321F
R16	Q3-Q4 emitter resistor	619 ohms ± 1% 1/8 watt precision film resistor	ANY	RN60G6190F
R19	Q4 bias series resistor	22.6K ohms ± 1% 1/8 watt precision film resistor	ANY	RN60G2262F
R20	Q4 bias shunt resistor	3.32K ohms ± 1% 1/8 watt precision film resistor	ANY	RN60G3321F
R21	Level potentiometer series resistor	9.09K ohms ± 1% 1/8 watt precision film resistor	ANY	RN60G9091F

R104 of the 211Z Network Assembly has been re-specified to the corresponding 1/4 watt size.

The Electrical Parts List for each Network has been amend d accordingly.

ADDENDUM NO. 2

R vised Jun 3, 1965

I. KEYING CIRCUIT OPTIONS

1. The Northern Radio Type 211 Model 1 Keyers deliver the lower output frequency when Transistor Q1 is conducting and the higher frequency when Q1 is non-conducting.

2. For "NORMAL" Keyers (wired according to Dwg. No. C-211-1-01), the "Mark" frequency is high and the "Space" frequency is low. Therefore, on such Keyers, Q1 is non-conducting for "Mark" (presence of keying signal) and conducting for "Space" (absence of keying signal). Transistor Q1 is biased to a conducting condition through the circuit from -Batt., R4, P1 Pins 13 and 6; R3, R2 to +Batt., with the base of Q1 connected to the junction of R2-R3.

   Q1 may be made non-conducting (Keyer "Mark" output) by any of the following means:

   1) Negative Voltage (with respect to Plug P1 Pins 2, 3, 4, or 9) applied to Q1 Emitter (Plug P1 Pin 7 or 14).

   2) Positive Voltage (with respect to Plug P1 Pins 2, 3, 4 or 9) applied to Q1 Base through Diode CR1 (Plug P1 Pin 11).

   3) Removal of operating bias from Q1 base (Short circuit from P1 Pin 13 or 6 to 7 or 14, or from 13 or 6 to 2, 3, 4 or 9).

   If the current in the keying loop is more than a few milliamperes, it is desirable to shunt the "Negative" or "Positive" keying circuits and the current keying shunt circuit Plug P1 Pin 10 through strap ** to R1 to +Battery is provided. When this shunt is required, the mating socket for the Keyer is provided with a strap connecting Socket Pin 10 with either 7 or 11 depending on whether "Negative" or "Positive" keying is to be used.

3. For "INVERTED" Keyers (input circuit wired according to Dwg. No. A-211-1-08), the "Mark" frequency is low and the "Space" frequency is high. Therefore, on such Keyers Q1 is conducting for "Mark" and non-conducting for "Space". Transistor Q1 has no bias in the absence of signal and is therefore non-conducting unless an external bias is applied by the keying process.

   In "INVERTED" Keyers Q1 may be made conducting (Keyer "Mark" output) by any of the following means:

I. Keying Circuit Options: (cont'd)

1) Negative Voltage (with respect to Plug P1 Pins 2, 3, 4 or 9) applied to Q1 Base (Plug P1 Pin 7 or 14).

2) Positive Voltage (with respect to Plug P1 Pins 2, 3, 4 or 9) applied to Q1 Emitter (Apply positive voltage to Pin 11).

3) Apply negative operating bias to Q1 Base by completing internal biasing circuit (Short circuit from Plug P1 Pin 13 to 7 or 14).

If the current in the keying loop is more than a few milliamperes, it is desirable to shunt the "Negative" or "Positive" keying circuits and the current keying shunt circuit Plug P1 Pin 10 through strap ** to R1 +Battery is provided. When this shunt is required, the mating socket for the Keyer is provided with a strap connecting Socket Pin 10 with either 7 or 14 depending on whether "Negative" or "Positive" Keying is to be used.

4. It will be seen that the 1) and 3) options "Negative" and "Contact" keying require identical external connections to the socket mating with the Keyer. Since these two options are most usual for transistorized equipment, the external shelf wiring terminal strips are arranged to accommodate them most easily. Whenever "Positive" keying is necessary, the Keyer and/or Shelf socket wiring must be revised to meet the requirements as indicated above. Detailed instructions for external connections to various types of keyer mounting shelves follow.

II. KEYING CIRCUIT CONNECTIONS TO TYPE 221 () KEYER SHELVES

In the Type 221 () Shelves, the Keyer DC input circuit connections appear on Shelf Terminal Blocks E1, E2, and E3.

Each Keyer socket is connected to a group of three correspondingly numbered terminals on the blocks. The Keyer on the extreme left side of the shelf (as viewed from the front of the shelf) is connected to Terminals No. 1 of Terminal Blocks E1, E2 and E3; extreme left terminals as viewed from the rear of the shelf, and the keyer at the extreme right is connected to Terminals No. 18 of Terminal Blocks E1, E2, and E3.

For Neutral "Negative""Current"Keying (Square Wave):

1. Connect the "common" (Positive) side of the Keying Battery Supply to Terminal Block E1.

II. Keying Circuit Connections To Typ 221 () Keyer Shelves: (cont'd)

For Neutral "Negative" "Current" K ying(Square Wave): (cont'd)

2. Connect the Keyed "High" (Negative) side of the Keying loop (through adequate external protective resistance) to Terminal Block E2.

For Neutral "Negative" "Voltage" Keying:

1. Connect the "common" (Positive) side of the Keying Battery Supply to Terminal Block E1.

2. Connect the Keyed "High" (Negative) side of the Keying loop (through adequate external protective resistance) to Terminal Block E2.

3. Remove the strap (indicated by ** on Drawings C-211-1-01 or B-211-1-35) on the Keyer Component Board. If Keyer is early model without strap, then strap connecting socket Terminals 7 and 10 must be removed.

For "Contact" Keying:

1. Connect the external "Contact" keying circuit between Terminal Blocks E1 and E3. If the "Contact" keying circuit is "floating", either side may be connected to Terminal Block E1. If one side of the circuit is either "grounded" or "common" with other keying circuits, that side should be connected to Terminal Block E1.

2. Remove the strap (indicated by ** on Drawings C-211-1-01 or B-211-1-35) on the Keyer Component Board. If Keyer is early model without strap, then strap connecting socket Terminals 7 and 10 must be removed.

For Neutral "Positive" "Current" Keying (Square Wave):

1. A wiring change is required on the sockets of the Keyer Shelf for "Positive" Keying. Remove the rear cover plate to expose the wired side of the sockets, and transfer lead on socket pin 14 from 14 to 11. Also transfer lead on socket pin 7 from 7 to 11.

2. Connect the "Common" (Negative) side of the Keying Battery Supply to Terminal Block E1.

3. Connect the Keyed "High" (Positive) side of the Keying loop (through adequate external protective resistance) to Terminal Block E2.

II. K ying Circuit Conn ctions to Type 221 ( ) K yer Sh lves: (cont'd)

For Neutral "Positive" "Voltage" Keying:

1. A wiring change is required on the sockets of the Keyer Shelf for "Positive" Keying. Remove the rear cover plate to expose the wired side of the sockets, and transfer lead on socket pin 14 from 14 to 11. Also transfer lead on socket pin 7 from 7 to 11.

2. Connect the "Common" (Negative) side of the Keying Battery Supply to Terminal Block E1.

3. Connect the Keyed "High" (Positive) side of the Keying loop (through adequate external protective resistance) to Terminal Block E2.

4. Remove the strap (indicated by ** on Drawings C-211-1-01 or B-211-1-35) on the Keyer Component Board. If Keyer is early model without strap, then strap connecting socket Terminals 7 and 10 must be removed.

Additional Requirement for Neutral "Current" (either "Positive" or "Negative") Keying When The Keying Wave is "Shaped" by Low Pass Filtering or When The "Space" Current is Not Zero:

1. For 60 milliampere keying, place a 4 ohm ± 5% 1/2 watt (or larger) resistor across the input terminals (Terminal Blocks E1 and E2).

2. For 20 milliampere keying, place a 12 ohm ± 5% 1/2 watt (or larger) resistor across the input terminals (Terminal Blocks E1 and E2).

For Polar "Current" or "Voltage" Keying:

1. Determine which polarity (with respect to Keying Battery Supply "common") is present for the "Mark" signal condition, and use the same connections as required for a Neutral signal of that polarity.

NOTE: Special precaution when Keying "Inverted" Keyers with "Positive" Keying.

Early "Inverted" Keyers were not properly connected for positive keying without additional changes beyond those specified herein. Such units may be identified by examination to determine whether there is a lead connecting Plug P1 pin 4 to the component board. If such a lead exists, these keyers should be revised as follows:

1. Determine that lead on Plug P1 pin 11 is connected to Diode CR1. Remove this lead from Pin 11 and tap up.

2. Transfer th lead on Plug P1 pin 4 from 4 to 11.

III. KEYING CIRCUIT CONNECTIONS TO TYPE 239 () KEYER & CONVERTER SHELVES

In the Type 239 Shelves the Keyer DC input circuit connections appear on Terminal Blocks E4, E5, and E6.

For various Keying Options, the detailed instructions giv n in Section II, above, are to be followed but modified to read E4 instead of E1; E5 instead of E2; and E6 instead of E3.

IV. KEYING CIRCUIT CONNECTIONS TO TYPE 244 () KEYER SHELVES

In the Type 244 () Shelves the Keyer DC input circuit connections appear as groups of three consecutive terminals on Terminal Block E1.

For various Keying Options, the detailed instructions given in Section II, above, are to be followed, but modified to read Terminal 3 (or 6) instead of Terminal Block E1; Terminal 2 (or 5) instead of Terminal Block E2; and Terminal 1 (or 4) instead of Terminal Block E3.

V. KEYING CIRCUIT CONNECTIONS TO TYPE 245 () KEYER & CONVERTER SHELVES

In the Type 245 () Shelves the Keyer DC input circuit connections appear as three consecutive terminals on Terminal Block E1.

For various Keying Options, the detailed instructions given in Section II, above, are to be followed, but modified to read Terminal Block E1, Terminal 3 instead of Terminal Block E1; Terminal Block E1, Terminal 2 instead of Terminal Block E2; and Terminal Block E1, Terminal 1 instead of Terminal Block E3.

VI. KEYING CIRCUIT CONNECTIONS TO TYPE 267 () SPEECH PLUS TELEGRAPH SHELF

In the Type 267 Speech Plus Telegraph Shelf, the Keyer DC input circuit connections appear on Terminal Blocks E7, E8, and E9.

For various Keying Options, the detailed instructions given in Section II, above, are to be followed, but modified to read E7 instead of E1; E8 instead of E2; and E9 instead of E3.

VII. KEYING CIRCUIT CONNECTIONS TO TYPE 268 () TONE SHELF

In the Type 268 Tone Shelf the Keyer DC input circuit connections appear on Terminal Blocks E7, E8 and E9.

For various keying options, the detailed instructions given in Section II, above, are to be followed, but modified to read E7 instead of E1; E8 instead of E2; and E9 instead of E3.

ADDENDUM NO. 1

January 27, 1960

The Frequency Shift Tone Keyer, Type 211 Model 1, has been modifi d as follows for Serial Numbers 360 and up. CR1 - Germanium Diode, Type PS 1N34A Conf. A, is replaced with a Silicon Diode, Type PS592 Conf. A.

This modification has been made to provide for more uniform operation of Q1, when used in the positive keying option.

TABLE OF CONTENTS

1. GENERAL

Purpose:

The Northern Radio Frequency Shift Tone Keyer, Type 211 Model 1, 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 sub-assemblies permits use of almost any combinations of channel frequencies and bandwidths (and associated keying speeds) to suit special requirements.

Description:

The Frequency Shift Tone Keyer, Type 211 Model 1, is a completely transistorized unit contained in a 7/8" x 5-1/4" x 11-3/4" housing. It will operate, by changing a 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 th transmitting terminal.

This Keyer makes use of a high grade inductor-capacitor combination to accomplish the center frequency determination. The shifts of frequency from this center frequency, are accomplished through use of variable phase constant amplitude feed-back loops. The Frequency Determining Network is provided with an output filter which permits paralleling of the outputs of a number of Keyers.

The signal input terminals to the Keyer are not grounded to the frame so that either terminal may be externally grounded, or both terminals may be left "floating", as desired. This arrangement allows the operation of the unit from a variety of keying circuits, having positive or negative batteries with either side grounded or ungrounded.

The use of transistors throughout this unit results in a device which is more compact, more reliable and far more efficient than has been previously possible. Internal heat in the units is negligible and any required number of units may be mounted in close proximity to each other without fear that excessive temperature rises will occur due to unit dissipation.

Principle of Operation:

Referring to Block Diagram Dwg. No. A-211-1-02, the keying input signal is applied to the Keying Amplifier, causing the Keying Stage to assume a conducting or non-conducting condition. The output of the Keying Stage acts to control the phase of the Variable Phase, Constant Amplitude Stage.

The output of the Variable Phase, Constant Amplitude Stage completes th oscillation loop which also includes the Oscillator Amplifier and LC Tank circuit.

If the keying input is such that the Keying Stage advances the phase of the Variable Phase Stage, then the frequency of the LC Network will be shifted t a higher value to cancel the phase shift. Conversely, if the Keying Stage r tards the phase of the Variable Phase stage, then 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 Network.

The Frequency Shift 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:

K ying Inputs:

1. Contact keying (internal battery to "dry" contacts).
2. D.C. current pulses, positive or n gativ , neutral or polar.
3. D.C. voltage pulses, positive or n gative, neutral or polar.

Input Level:

a. D.C. current high range: 15 MA minimum, negative DC; 30 MA minimum, positive DC.
b. D.C. current low range: 1.5 MA minimum, negative DC; 0.5 MA minimum, positive DC.
c. D.C. voltage: 1 volt, minimum; positive, negative or polar.
d. Relay contact rating 1 MA minimum.

Input Impedance:

DC current: High range - 67 ohms
Low range - 220 ohms

DC voltage: 220 ohms

Technical Data: (cont'd)

Frequency Stability:	Standard Networks ± 2 cps total for all causes including ± 10% line voltage change and ± 25°C from 25 C temperature change.
Harmonic Content:	All harmonics of the tone are more than 50 db below output level.
Output Level:	Zero dbm maximum, not affected by ± 10% line voltage variation.
Output Impedance:	600 ohms, unbalanced. May be paralleled with any number of other Keyers operating on different frequencies in the same audio system.
Metering and Test Jacks:	Tip jacks are provided for making voltage tests and oscilloscope connections to the input and output and circuit points.
Controls:	1. "Mark" frequency 2. "Space" frequency 3. Output Level All controls available from front of panel.
Power Requirements:	14 volts DC, 15 MA
Dimensions:	7/8" wide x 5-1/4" high x 11-3/4" deep. For rack mounting a number of these units, a shelf assembly is available accommodating eighteen (18) units in a panel height of 5-1/4".
Weight:	Approximately 3 lbs. including Transmitting Frequency Determining Network.

Technical Data: (continued)

Special Features:	"Plug-In" construction. Mates with female multiple contact connector (furnished). All wiring options for different keying methods are accomplished on the connector rather than in the unit proper.

Technical Data: (continued)

LIST OF STANDARD CHANNEL FREQUENCIES

for

FREQUENCY SHIFT TONE KEYER

Center Frequency Cps	Frequency Shift Cps	Space Frequency Cps	Mark Frequency Cps	Max. Channel Speed Dot Cycles	Frequency Det. N t-work Type
425	± 42.5	382.5	467.5	45	211Z2
595	± 42.5	552.5	637.5	45	211Z3
765	± 42.5	722.5	807.5	45	211Z4
935	± 42.5	892.5	977.5	45	211Z5
1105	± 42.5	1062.5	1147.5	45	211Z6
1275	± 42.5	1232.5	1317.5	45	211Z7
1445	± 42.5	1402.5	1487.5	45	211Z8
1615	± 42.5	1572.5	1657.5	45	211Z9
1785	± 42.5	1742.5	1827.5	45	211Z10
1955	± 42.5	1912.5	1997.5	45	211Z11
2125	± 42.5	2082.5	2167.5	45	211Z12
2295	± 42.5	2252.5	2337.5	45	211Z13
2465	± 42.5	2422.5	2507.5	45	211Z14
2635	± 42.5	2592.5	2677.5	45	211Z15
2805	± 42.5	2762.5	2847.5	45	211Z16
2975	± 42.5	2932.5	3017.5	45	211Z17
3145	± 42.5	3102.5	3187.5	45	211Z18
3315	± 42.5	3272.5	3357.5	45	211Z19

Technical Data: (Continued)

Other frequencies and Keying speeds are available on special order.

For certain system applications it is required that th "Mark" and "Space" frequencies be interchanged on the lower frequency channels ("Inverted" keying). Since this requirement is peculiar to the channel frequency, internal circuit wiring is arranged to produce this result when so specified by the customer.

2. DESCRIPTION OF OPERATION

(Refer to Schematic Diagram NRC Dwg. No. C211-1-01 and Block Diagram A211-1-02 and Simplified Functional Oscillator Circuit A211-1-04)

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 without generating superfluous "switching transients".

To satisfy the first of the above requirements, a multi-stage oscillating design is used together with an inductance-capacity network for determining the normal operating frequency. The second requirement is satisfied by utilising a constant amplitude, variable phase RC network as the frequency controlling device in the oscillator feedback loop. In this typ of circuitry the phase of the AC signal is varied by changing the resistance part of the RC circuit. Since the amplitude of the AC signal is not affected by the keying signal, the feedback loop gain is constant. To sustain oscillation, the phase shift around the oscillator loop has to be zero. The oscillator circuit, therefore, has to shift to a new operating frequency (to maintain this criterion) whenever there is a change in the output of the RC phas shifting network. The new frequency will be that frequency at which the LC circuit will produce a phase shift cancelling the phase shift introduced by the RC network.

With this method of frequency control the switch-over from one frequency to another may be either instantaneous or slow, depending on th slope of the control signal, without transient generation or significant amplitude changes in the oscillator output. The introduction of an RC phas shifting network does not impair the stability of the oscillator, as the changing phase of such networks with frequency is very slow compared to that of the LC 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 LC circuit.

It may further be mentioned that since the MARK and SPACE frequ ncies are equidistant with respect to center frequency and the amplitude-frequency characteristic of an LC tank is essentially symmetrical about the center frequency axis for small departures from center frequency, 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 shift from one frequency to the other is avoided.

This Tone Keyer will, therefore, op rate as a tone frequency shift generator, introducing a n gligible amount of signal distortion and greatly reduc the requirements to be imposed upon the transmission medium.

In describing the detailed operation of the Keyer, the circuitry may be best understood by referring to the simplified functional diagram, Drawing No. A211-1-04. Transistors Q4 and Q5 together form a conventional "emitt r-coupled" limiter amplifier which functions in the following manner. A negative going signal applied to the base of Q4 results in a corresponding negativ going signal on the emitter of Q4 and, consequently, at the emitter of Q5. When the signal at the emitter of Q5 exceeds the value required to stop collector current in Q5 there will be no change in the output for any further chang in th input signal. On the other hand when a positive going signal is applied to th base of Q4 the emitters of Q4 and Q5 follow the signal in a positive going direction until Q5 becomes fully conducting and prevents further excursion of the emitters. In this case, any further positive direction excursion of the bas of Q4 does not appear at the collector of Q5. Thus the circuit provides clean and efficient limiter action, with the output signal in phase with the input signal (Since Q4 is operating as a common collector amplifier and Q5 is operating as a common base amplifier, there are no phase reversals in the combined circuit). This circuit offers the additional advantage that the input impedance is high, thus preventing loading on the preceding circuit. The output signal from the collector of Q5 is applied to a series resonance LC tank circuit. The signal at the junction of the inductance and capacitance is 90° out of phase with th collector signal at resonance and more or less than 90° at other frequencies. Since this junction is a point of high impedance, the signal is isolated and the output of Q3 is applied to the phase shifting circuit consisting of transformer T1 and the associated RC circuit. Transformer T1 is utilized to obtain a push-pull signal so that (with respect to Terminal No. 3) the voltage at Terminal No. 4 is 180° out of phase with the voltage of Terminal No. 5. When a capacitor and resistor are connected in series across such a circuit th signal appearing between Terminal 3 of the transformer and the junction of the capacitor and resister (Terminal No. 6 on the diagram) is equal in amplitud to the signal between Terminals 3 and 4 (or Terminals 3 and 5), but the phas of the signal is dependent on the relative reactance of the capacitor and resistor. Since a change in the value of the resistance is seen to change the phase of the signal applied to the base of Q4, it may be seen that the oscillating frequency must consequently change so that the phase of the signal delivered from the LC tank to the base of Q3 has a corresponding, but opposite, change. For the frequency at which the capacity reactance is equal to the resistance, the signal is 90° out of phase with the input signal. When resistance is infinite the signal is in phase with the signal across Terminals 3 and 4, and when the resistance is zero it is in phase with the signal between Terminals 3 and 5.

The circuit as shown illustrates the theory of the operation of the oscillator in the Type 211 Model 1 Keyer. It suffers from only one disadvantag , which is that both Terminals 5 and 6 are at points carrying AC potential rather than at ground potential. Thus external coupling to such a circuit involves consideration of this AC potential. To overcome this difficulty, the actual circuit has the connections to Terminals 3 and 6 interchanged so that Terminal 6 is the ground point and the base of Q4 is fed from Terminal 3. This hang

does not affect the theory of operation as the effective phase change is between Terminals 6 and 3. The practical effect is that one side of the resistance has been grounded and the keying technique is therefore simplified. In the Type 211 Keyer, the phase relationships are such that a reduction in the value of resistance results in a higher oscillating frequency, and an increase in the value resistance consequently results in a lower oscillating frequency. For "normal" keying where the "MARK" frequency is the higher of the two frequencies, it is necessary to reduce the resistance for MARK and increase it for SPACE signals. This may be accomplished by dividing the resistance into two series resistors, which are effectively in the circuit for "SPACE", and short circuiting one of the resistors for the "MARK" condition. Referring to Drawing No. C-211-1-01, Transistor Q2 is operated as a switch, which is open for "SPACE" and closed for "MARK" condition. In the open condition of Q2, resistors R102, R103, R104 are effectively in the network. In the closed condition R105 and R103 are shorted by the switching action of Transistor Q2 so that only R102 is ffectively in the network.

Q1 is a DC amplifier which receives the input signal and controls Q2. Various wiring options allow different polarities and methods of keying to be employed.

The preferred method of controlling the Type 211 Model 1 Keyer is current keying (20 milliampere or 60 milliampere) from a grounded circuit with negative keying voltage applied to the emitter of Q1. This option is most easily interchangeable with the "contact-keying" method, with a minimum of wiring or strapping changes.

Transistor Q6 is a straight Class A amplifier used for coupling the oscillating output to the channel filter, and subsequently to the xternal voice frequency circuit.

3. DESCRIPTION OF CONTROLS

OUTPUT Control R25:

Adjusts level of output signal applied through filter to voice frequency channel.

MARK Frequency Control R102:

Adjusts Keyer oscillator to normal "MARK" frequency.

SPACE Frequency Control R103:

Adjusts oscillator to normal "SPACE" frequency.

In addition to the above controls available from the front panel of the Type 211 Keyer there is one other variable control available through a hole in the bottom of the chassis. This is a factory calibration control, not normally adjusted in the field. Its purpose is to compensate for the insertion loss of the channel filter so that scope or high impedance voltmeter measurements between Pins Jacks J2 and J3 will indicate the signal level which actually appears on the output (voice frequency) side of the output filter.

4. INSTALLATION

Mechanical

The Type 211 Model 1 Keyer will normally be used as one of a group of such keyers mounted on a shelf, such as the Northern Radio Type 221 Model 1, Frequency Shift Tone Keyer Shelf, which is wired to accomodate up to eighteen (18) Keyers.

Prior to installation, each new Keyer should be thoroughly inspected for mechanical damage due to rough handling during shipment. If there is no sign of mechanical defect, the Keyer should be installed by inserting into the proper space in the shelf until the plug on the back of the Keyer engag s with the socket of the Shelf. The unit is secured in the shelf by turning the knurled thumbscrew finger-tight.

Electrical

Since the Type 211 Model 1 Keyer is a plug-in unit, its electrical connections are completed to the shelf when it is placed into operating position. It is only necessary to be assured that the proper circuit connections are mad t the Shelf, and that power supplies are installed on the back of the Shelf.

5. OPERATING INSTRUCTIONS

In setting up a Keyer system using the Type 211 Model 1 Keyers, it is only necessary to determine that the Keyer operates and that it is properly adjusted. With operating power applied to the Shelf and appropriate keying signals applied to the input terminals, the Keyer can be checked as follows:

1. With an oscilloscope observe the signals available at Pin Jacks 1 and 2 (as compared to the "common" Pin Jack No. 3). Square wave DC keying should appear between Jacks J1 and J3 while keyed tone should appear between J2 and J3,

2. System operation may usually be most quickly checked by feeding the tone signal from the Type 211 Keyer into a corresponding Type 212 Model 2 Converter and observing the DC output of the Converter.

3. When frequency adjustments are required, proceed as indicated in the MAINTENANCE section. New Keyers will ordinarily require little or no adjustment, unless they have received extremely rough handling in shipment.

6. MAINTENANCE

Since the Keyer employs long-life reliable semi-conductor elements and since very little heat is generated in the operating device, it is anticipated that maintenance requirements will be minimized. In the event of malfunction, it is recommended that the Keyer be removed from the Shelf and testing accomplished at the test bench. Voltage measurements of appropriat circuit points may be made most easily by inserting one voltmeter probe into J3 Pin Jack and touching the wireleads of appropriate components on the printed board. Drawing No. B211-1-03 is a layout drawing indicating the physical location of all components on the printed board. Use of this drawing in connection with the Schematic Drawing No. C211-1-01, and the Table of Voltage Measurements will serve to quickly localize any troubles.

In the infrequent instances when it is necessary to remove and replace components on the printed board, it is highly desirable that an a appropriate small soldering iron with limited heat storage be employed.

At infrequent intervals, it may be necessary to make minor readjustments to the frequency controls for MARK and SPACE. These adjustments may be simply made as follows:

1. Connect an appropriat Frequency Counter to Pin Jacks J2 and J3 with the chassis side of the Counter connected to Jack #3.

2. Using a small screwdriver, with a normal "MARK" keying signal applied to the keying input terminals, adjust the "MARK" control for proper frequency as indicated by the Counter.

3. Using a small screwdriver, with a normal "SPACE" signal at the Keyer input terminals, adjust the "SPACE" control for the proper frequency as indicated by the Counter.

4. When inverted outputs are being used an input "SPACE" condition is required for adjusting the normal "MARK" frequency, and a "MARK" input signal results in an output "SPACE" frequency.

5. After adjusting the normal "SPACE" frequency, it is well to recheck the normal "MARK" frequency adjustment. Ordinarily there is no interaction between these two adjustments, provided the higher frequency (normal "MARK") is the first one adjusted.

In the event of failure of oscillation in a Keyer voltag , measurements should be made. If voltages do not correspond fairly clos ly with those listed in the TABLE OF CIRCUIT VOLTAGES in this book, th n appropriate components should be examined to determine whether a chang in characteristics has occurred. In particular, the collector voltag of Q5 should be checked. If in the absence of oscillation the collector voltag is not within the limits of -7.5 to -10.5 volts, then the base voltag of ither Q4 or Q5 is probably incorrect. This may be due to a defectiv C3 Capacitor or to a change in the value of one or more of Resistors R14, R15, R19 or R20.

7. TEST PROCEDURE

Test Apparatus:

1) D. C. Vacuum Tube Voltmeter - Simpson Model 303 or equivalent
2) A. C. Vacuum Tube Voltmeter - Hewlett-Packard 400D or quival nt
3) Frequency Counter - Berkley EPUT Meter Type 554F or equival nt
* 4) Keyer Test Circuit per NRC Dwg. No. A-211-1-07
* 5) Extension Adapter - NRC 750

Test Procedure:

* 1) Connect the Keyer to a test circuit as indicated on NRC Dwg. No. A-211-1-07. Apply power and observe AC VTVM and Frequency Counter for indication of Tone Output from K yer.

2) With Keying Switch S1 operated to the MARK position, observ output frequency indicated on Counter and compare with the "Mark" Frequency marking on the Name Plate on the Keyer front panel. If necessary, adjust "MARK" control to produce corr ct frequency output within ± 1 cps.

3) Operate Keying Switch S1 to the SPACE position and obs rve output frequency indicated on Counter. Adjust "SPACE" control if necessary to produce correct frequency (within ± 1 cps) as indicated on Keyer Name Plate.

4) Vary OUTPUT control from minimum to maximum settings. Obs rv that control operates smoothly. Observe maximum output level which should be in excess of 0.775 volts rms. Set Output Control for 0.775 volts output at Space frequency.

5) Operate Keying Switch to MARK position and observe output voltag as indicated on the AC VTVM. If different from Space output level, readjust OUTPUT control for average reading of 0.775 volts.
NOTE: MARK and SPACE levels should not differ from the av rag reading by more than approximately ± 10%.

6) Transfer the AC VTVM from the Keyer output circuit to Pin Jacks J2 and J3 on the Keyer Front Panel. Observe voltage readings as Keying Switch is operated to MARK and SPACE positions. Th average of these readings should be the same as the av rag reading obtained in step 5) above. If the average reading is incorrect, readjust Control R101 (bottom forward part of chassis) as necessary to obtain correct reading.

Test Procedure: (cont'd)

7) Using the DC VTVM, measure the operating voltages at the terminals of Transistor Q1-Q6, inclusive. Voltage measurements may be made most conveniently by inserting one voltmeter prob into J3 Pin Jack and touching the wireleads of appropriat components on the etched board with the other probe. Drawing No. B-211-1-03 is a layout drawing indicating the physical location of all components on the etched board. Use of this drawing and the Schematic Diagram, Dwg. No. C-211-1-01 will make it easy to find appropriate points to make desired voltage measurements. Voltage readings obtained should compare closely with readings indicated on the TABLE OF CIRCUIT VOLTAGES on the following page.

NOTE: Keyers can be individually tested in their normal operating shelves (such as NRC Type 221 Model 1 Shelf) provided no oth r Keyers are in place at the time of test. In this case, a 600 ohm load resistor and the Frequency Counter and AC VTVM are placed across the appropriate TONE OUTPUT terminals at the back of the Shelf. Contact keying to MARK condition is accomplished by placing a wire jumper between appropriate KEYING INPUT terminals (Terminals to Socket Pins 13 and 14 of the K y r und r test). Internal adjustments and voltage measurements may b made by using NRC 750 EXTENSION ADAPTER to connect the Key r and Shelf.

8. TABLE OF CIRCUIT VOLTAGES

Symbol	Function	Input State	VOLTAGES		
			Base	Emitter	Collector
Q1	Keying Control Transistor	Mark	0	0	-1.1
		Space	-0.13	0	-.02
Q2	Keying Transistor	Mark	-0.79	-.63	-.63
		Space	-0.02	-.62	-.62
Q3	Quadrature Amplifier		-5.0	-4.7	-10.8
Q4	1st Limiter		-1.4	-1.4	-10.8
Q5	2nd Limiter		-1.4	-1.4	-8.0 *
Q6	Output Amplifier		-2.0	-1.9	-10.8

Measured with contact keying input.

* In the absence of oscillation, this voltage should read within the limits of -7.5 to -10.5 volts. Base voltages of Q4 and Q5 should be carefully checked if Q5 collector is outside of voltag limits.

9. ELECTRICAL PARTS LIST

Symbol	Function	Description	Mfr.	Part No.
C1	Q3 base input coupling capacitor	10 mfd 12 volt electrolytic capacitor	SPR MAL	TE-1128 or TT010H012P1A
C2	Q3 emitter output coupling capacitor	60 mfd 6 volt electrolytic capacitor	SPR MAL	TE-1101 or 30D606G006CB2
C3	Q4 base input coupling capacitor	10 mfd 12 volt electrolytic capacitor	SPR MAL	TE-1128 or TT010H012P1A
C4	Q6 base input coupling capacitor	10 mfd 12 volt electrolytic capacitor	SPR MAL	TE-1128 or TT010H012P1A
C5	Q6 emitter bypass capacitor	110 mfd 3 volt electrolytic capacitor	SPR MAL	TE-1060 or 30D117G003CB2
C6	Filter capacitor	100 mfd 25 volt electrolytic capacitor with insulating sleeve	ABO MAL MAL	E26-E577 or 20-41809 r 30-40843
CR1	Input diode	High conductance silicon diode	TXI PSC	G130 or PS592 Conf A
CR2	Q2 bias diode	High conductance silicon diode	TXI PSC	G130 or PS592 Conf A
J1	Input signal monitor jack	White pin jack	ANY	MS16108-1A
J2	Output signal monitor jack	Blue pin jack	ANY	MS16108-7A
J3	"Common" jack	Red pin jack	ANY	MS16108-2A
P1	Main connector plug	14 pin male connector	AMP	57-10140
Q1	Keying control transistor	General purpose germanium transistor, high gain 250 milliampere, 200 milliwatt	MOT	2N652A
Q2	Keying transistor	General purpose germanium transistor, high gain 250 milliampere, 200 milliwatt	MOT	2N652A
Q3	Quadrature amplifier	General purpose germanium transistor, high gain 250 milliampere, 200 milliwatt	MOT	2N652A
Q4	First limiter transistor	General purpose germanium transistor, high gain 250 milliampere, 200 milliwatt	MOT	2N652A
Q5	Second limiter transistor	General purpose germanium transistor, high gain 250 milliampere, 200 milliwatt	MOT	2N652A

Sym-bol	Function	Description	Mfr.	Part No.
Q6	Output amplifier transistor	General purpose germanium transistor high gain, 250 mA 200 mw	MOT	2N652A
R1	Input signal shunt resistor	100 ohms ± 10% 1 watt composition resistor	ALB	GB 1011
R2	Q1 base shunt resistor	470 ohms ± 10% 1/2 watt composition resistor	ALB	EB 4711
R3	Q1 base series resistor	1K ohm ± 10% 1/2 watt composition resistor	ALB	EB 1021
*R4	Q1 base bias resistor	22K ohms ± 10% 1/2 watt composition resistor	ALB	EB 2231
R5	Q1 emitter resistor	220 ohms ± 10% 1/2 watt composition resistor	ALB	EB 2211
R6	Q1 collector resistor	33K ohms ± 10% 1/2 watt composition resistor	ALB	EB 3331
R7	Keying input voltage divider resistor	1K ohm ± 10% 1/2 watt composition resistor	ALB	EB 1021
R8	Input monitor isolation resistor	10K ohms ± 10% 1/2 watt composition resistor	ALB	EB 1031
R9	Input monitor shunt resistor	10K ohms ± 10% 1/2 watt composition resistor	ALB	EB 1031
R10	Q2 bias series resistor	3.3K ohms ± 10% 1/2 watt composition resistor	ALB	EB 3321
R11	Q3 bias series resistor	68K ohms ± 10% 1/2 watt composition resistor	ALB	EB 6831
R12	Q3 bias shunt resistor	68K ohms ± 10% 1/2 watt composition resistor	ALB	EB 6831
R13	Q2 emitter resistor	1.5K ohms ± 10% 1/2 watt composition resistor	ALB	EB 1521
R14	Q4 bias series resistor	21.5K ohms ± 1% 1/8 watt precision film resistor	ANY ANY	RN60G2152F or RN60D2152F
R15	Q5 bias shunt resistor	3.32K ohms ± 1% 1/8 watt precision film resistor	ANY ANY	RN60G3321F r RN60D3321F

*For Keyer wired for "Inverted Keying", R4 is:

	2.2K ohms ± 10% 1/2 watt composition resistor	ALB	EB 2221

Sym-bol	Function	Description	Mfr.	Part No.
R16	Q4-Q5 emitter resistor	619 ohms ± 1% 1/8 watt precision film resistor	ANY ANY	RN60G6190F or RN60D6190F
R17	Q5 collector output shunt resistor	470 ohms ± 10% 1/2 watt composition resistor	ALB	EB 4711
R18	Q5 collector series resistor	2.2K ohms ± 10% 1/2 watt composition resistor	ALB	EB 2221
R19	Q5 bias series resistor	22.6K ohms ± 1% 1/8 watt precision film resistor	ANY ANY	RN60G2262F or RN60D2262F
R20	Q5 bias series resistor	3.32K ohms ± 1% 1/8 watt precision film resistor	ANY ANY	RN60G3321F or RN60D3321F
R21	Level potentiometer series resistor	9.09K ohms ± 1% 1/8 watt precision film resistor	ANY ANY	RN60G9091F or RN60D9091F
R22	Q6 bias series resistor	18K ohms ± 10% 1/2 watt composition resistor	ALB	EB 1831
R23	Q6 bias shunt resistor	2.2K ohms ± 10% 1/2 watt composition resistor	ALB	EB 2221
R24	Q6 emitter resistor	330 ohms ± 10% 1/2 watt composition resistor	ALB	EB 3311
R25	Signal level control potentiometer	5K ohms miniature potentiometer screwdriver adjustment	ALB	GA2N040S502MA
R26	Filter resistor	150 ohms ± 10% 1/2 watt composition resistor	ALB	EB 1511
R27	Q6 feedback resistor	22K ohms ± 10% 1/4 watt composition resistor	ALB	CB 2231
T1	Phasing transformer	500 ohms center tapped to 600 ohms, 500 milliwatt miniature transformer	UTC	DO-T20
Z	Frequency Determining Networks	Standard - See individual Electrical Parts Lists for each Network Frequency	NRC	211Z2 thru 211Z19

Sym-bol	Description	Mfr.	Part No.
	TYPE 211Z2 — Mark Frequency 467.5 cps		
	Carrier Frequency 425 ± 42.5 cps — Space Frequency 382.5 cps		
BP1	425 cps bandpass filter and frequency determining tank circuit	NRC	639
C101	5 mfd 25 volt miniature electrolytic capacitor	SPR MAL	TE-1202 or TT005H025P1A
C102	0.33 mfd ± 10% 100 volt hermetically sealed paper capacitor	ANY	CP09A1KB334K
R101	25K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S253MA
R102	2.5K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S252MA
R103	10K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S103MA
R104	2.2K ohms ± 10% 1/4 watt composition resistor	ANY	RC07GF222K
	TYPE 211Z3 — Mark Frequency 637.5 cps		
	Carrier Frequency 595 ± 42.5 cps — Space Frequency 552.5 cps		
BP1	595 cps bandpass filter and frequency determining tank circuit	NRC	640
C101	5 mfd 25 volt miniature electrolytic capacitor	SPR MAL	TE-1202 or TT005H025P1A
C102	0.22 mfd ± 10% 100 volt hermetically sealed paper capacitor	ANY	CP09A1KB224K
R101	25K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S253MA
R102	2.5K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S252MA
R103	5K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S502MA
R104	2 2K ohms ± 10% 1/4 watt composition resistor	ANY	RC07GF222K

Symbol	Description	Mfr.	Part No.
	TYPE 211Z4 — Mark Frequency		807.5 cps
	Carrier Frequency 765 ± 42.5 cps — Space Frequency		722.5 cps
BP1	765 cps bandpass filter and frequency determining tank circuit	NRC	641
C101	5 mfd 25 volt miniature electrolytic capacitor	SPR MAL	TE-1202 or TT005H025P1A
C102	0.15 mfd ± 10% 100 volt hermetically sealed paper capacitor	ANY	CP09A1KB154K
R101	25K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S253MA
R102	2.5K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S252MA
R103	5K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S502MA
R104	2.2K ohms ± 10% 1/4 watt composition resistor	ANY	RC07GF222K
	TYPE 211Z5 — Mark Frequency		977 5 cps
	Carrier Frequency 935 ± 42.5 cps — Space Frequency		892.5 cps
BP1	935 cps bandpass filter and frequency determining tank circuit	NRC	642
C101	10 mfd ± 20% 20 volt DCWV tantalum capacitor with mylar sleeve	TXI ANY ANY ANY	SCM106BP020D4 or CS13AE100M or SC13BE106K or CS13AC106M
C102A	0.10 mfd ± 10% 100 volt hermetically sealed paper capacitor	ANY	CP09A1KB104K
C102B	0.022 mfd ± 10% 200 volt hermetically sealed paper capacitor	ANY	CP09A1KC223K
R101	25K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S253 MA
R102	2.5K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S252MA
R103	5K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S502MA
R104	1.5K ohms ± 10% 1/4 watt compositi n resistor	ANY	RC07GF152K

Symbol	Description	Mfr.	Part N.
	TYPE 211Z6 Mark Frequency 1147.5 cps		
	Carrier Frequency 1105 ± 42.5 cps Space Frequency 1062.5 cps		
BP1	1105 cps bandpass filter and frequency determining tank circuit	NRC	643
C101	5 mfd 25 volt miniature electrolytic capacitor	SPR MAL	TE-1202 or TT005H025P1A
C102	0.10 mfd ± 10% 100 volt hermetically sealed paper capacitor	ANY	CP09A1KB104K
R101	25K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S253MA
R102	2.5K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S252MA
R103	2.5K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S252MA
R104	1.5K ohms ± 10% 1/4 watt composition resistor	ANY	RC07GF152K
	TYPE 211Z7 Mark Frequency 1317.5 cps		
	Carrier Frequency 1275 ± 42.5 cps Space Frequency 1232.5 cps		
BP1	1275 cps bandpass filter and frequency determining tank circuit	NRC	644
C101	10 mfd ± 20% 20 volt DCWV tantalum capacitor with mylar sleeve	TXI ANY ANY ANY	SCM106BP020D4 r CS13AE100M or SC13BE106K or CS13AC106M
C102A	0.047 mfd ± 10% 100 volt hermetically sealed paper capacitor	ANY	CP09A1KB473K
C102B	0.033 mfd ± 10% 200 volt hermetically sealed paper capacitor	ANY	CP09A1KC333K
R101	25K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S253MA
R102	2.5K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S252MA
R103	2.5K ohms miniature pot ntiomet r, screwdriver adjustment	ALB	GA2N040S252MA
R104	1K ohm ± 10% 1/4 watt composition r sistor	ANY	RC07GF102K

Symbol	Description	Mfr.	Part No.
	TYPE 211Z8		
	Carrier Frequency 1445 ± 42.5 cps — Mark Frequency 1487.5 cps; Space Frequency 1402 5 cps		
BP1	1445 cps bandpass filter and frequency determining tank circuit	NRC	645
C101	5 mfd 25 volt miniature electrolytic capacitor	SPR MAL	TE-1202 or TT005M025P1A
C102	0.068 mfd ± 10% 200 volt hermetically sealed paper capacitor	ANY	CP09A1KC683K
R101	25K ohms miniature potentiometer, screwdriver Adjustment	ALB	GA2N040S253MA
R102	2.5K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S252MA
R103	2.5K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S252MA
R104	1K ohm ± 10% 1/4 watt composition resistor	ANY	RC07GF102K
	TYPE 211Z9		
	Carrier Frequency 1615 ± 42.5 cps — Mark Frequency 1657.5 cps; Space Frequency 1572.5 cps		
BP1	1615 cps bandpass filter and frequency determining tank circuit	NRC	646
C101	5 mfd 25 volt miniature electrolytic capacitor	SPR MAL	TE-1202 or TT005H025P1A
C102	0.068 mfd ± 10% 200 volt hermetically sealed paper capacitor	ANY	CP09A1KC683K
R101	25K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S253MA
R102	2.5K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S252MA
R103	2.5K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S252MA
R104	680 ohms ± 10% 1/4 watt composition resistor	ANY	RC07GF681K

Symbol	Description	Mfr.	Part No.
	TYPE 211Z10		
	Carrier Frequency 1785 ± 42.5 cps — Mark Frequency 1827.5 cps; Space Frequency 1742.5 cps		
BP1	1785 cps bandpass filter and frequency determining tank circuit	NRC	647
C101	10 mfd ± 20% 20 volt DCWV tantalum capacitor with mylar sleeve	TXI ANY ANY ANY	SCM106BP020D4 or CS13AE100M r SC13BE106K r CS13AC106M
C102A	0.033 mfd ± 10% 200 volt hermetically sealed paper capacitor	ANY	CP09A1KC333K
C102B	0.022 mfd ± 10% 200 volt hermetically sealed paper capacitor	ANY	CP09A1KC223K
R101	25K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S253MA
R102	2.5K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S252MA
R103	2.5K ohms minature potentiometer, screwdriver adjustment	ALB	GA2N040S252MA
R104	1K ohm ± 10% 1/4 watt composition resistor	ANY	RC07GF102K
	TYPE 211Z11		
	Carrier Frequency 1955 ± 42.5 cps — Mark Frequency 1997.5 cps; Space Frequency 1912.5 cps		
BP1	1955 cps bandpass filter and frequency determining tank circuit	NRC	648
C101	10 mfd ± 20% 20 volt DCWV tantalum capacitor with mylar sleeve	TXI ANY ANY ANY	SCM106BP020D4 r CS13AE100M or SC13BE106K or CS13AC106M
C102A	0.033 mfd ± 10% 200 volt hermetically sealed paper capacitor	ANY	CP09A1KC333K
C102B	0.022 mfd ± 10% 200 volt hermetically sealed paper capacitor	ANY	CP09A1KC223K
R101	25K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S253MA
R102	2.5K ohms miniature potentiometer, screwdriver adjustm nt	ALB	GA2N040S252MA
R103	2.5K hms miniature potentiomet r, screwdriver adjustm nt	ALB	GA2N040S252MA
R104	560 ohms ± 10% 1/4 watt composition resistor	ANY	RC07GF561K

Sym-bol	Description	Mfr.	Part No
	TYPE 211Z12 — Mark Frequency 2167.5 cps		
	Carrier Frequency 2125 ± 42.5 cps — Space Frequency 2082.5 cps		
BP1	2125 cps bandpass filter and frequency determining tank circuit	NRC	649
C101	5 mfd 25 volt miniature electrolytic capacitor	SPR MAL	TE-1202 or TT005H025P1A
C102	0.047 mfd ± 10% 100 volt hermetically sealed paper capacitor	ANY	CP09A1KB473K
R101	25K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S253MA
R102	2.5K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S252MA
R103	2.5K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S252MA
R104	680 ohms ± 10% 1/4 watt composition resistor	ANY	RC07GF681K
	TYPE 211Z13 — Mark Frequency 2337.5 cps		
	Carrier Frequency 2295 ± 42.5 cps — Space Frequency 2252.5 cps		
BP1	2295 cps bandpass filter and frequency determining tank circuit	NRC	650
C101	5 mfd 25 volt miniature electrolytic capacitor	SPR MAL	TE-1202 or TT005H025P1A
C102	0.047 mfd ± 10% 100 volt hermetically sealed paper capacitor	ANY	CP09A1KB473K
R101	25K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S253MA
R102	2.5K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S252MA
R103	2.5K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S252MA
R104	560 ohms ± 10% 1/4 watt composition resistor	ANY	RC07GF561K

Symb l	Description	Mfr:	Part No
	TYPE 211Z14 — Mark Frequency		2507.5 cps
	Carrier Frequency 2465 ± 42.5 cps — Space Frequency		2422.5 cps
BP1	2465 cps bandpass filter and frequency determining tank circuit	NRC	651
C101	10 mfd ± 20% 20 volt DCWV tantalum capacitor with mylar sleeve	TXI ANY ANY ANY	SCM106BP020D4 r CS13AE100M or SC13BE106K or CS13AC106M
C102A	0.022 mfd ± 10% 200 volt hermetically sealed paper capacitor	ANY	CP09A1KC223K
C102B	0.022 mfd ± 10% 200 volt hermetically sealed paper capacitor	ANY	CP09A1KC223K
R101	25K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2NO40S253MA
R102	2.5K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2NO40S252MA
R103	2.5K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2NO40S252MA
R104	330 ohms ± 10% 1/4 watt composition resistor	ANY	RC07GF331K
	TYPE 211Z15 — Mark Frequency		2677.5 cps
	Carrier Frequency 2635 ± 42.5 cps — Space Frequency		2592.5 cps
BP1	2635 cps bandpass filter and frequency determining tank circuit	NRC	652
C101	5 mfd 25 volt miniature electrolytic capacitor	SPR MAL	TE-1202 or TT005H025P1A
C102A	0.033 mfd ± 10% 200 volt hermetically sealed paper capacitor	ANY	CP09A1KC333K
C102B	0.0068 mfd ± 10% 200 volt hermetically sealed paper capacitor	ANY	CP09A1KC682K
R101	25K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2NO40S253MA
R102	2.5K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2NO40S252MA
R103	2.5K ohms miniature pot ntiom t r, screwdriv r adjustm nt	ALB	GA2NO40S252MA
R104	470 ohms ± 10% 1/4 watt composition resistor	ANY	RC07GF471K

Symbol	Description	Mfr.	Part No
	TYPE 211Z16	Mark Frequency	2847.5 cps
	Carrier Frequency 2805 ± 42.5 cps	Space Frequency	2762.5 cps
BP1	2805 cps bandpass filter and frequency determining tank circuit	NRC	653
C101	5 mfd 25 volt miniature electrolytic capacitor	SPR MAL	TE-1202 or TT005H025P1A
C102A	0.022 mfd ± 10% 200 volt hermetically sealed paper capacitor	ANY	CP09A1KC223K
C102B	0.015 mfd ± 10% 100 volt hermetically sealed paper capacitor	ANY	CP09A1KB153K
R101	25K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S253MA
R102	2.5K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S252MA
R103	2.5K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S252MA
R104	330 ohms ± 10% 1/4 watt composition resistor	ANY	RC07GF331K
	TYPE 211Z17	Mark Frequency	3017 5 cps
	Carrier Frequency 2975 ± 42.5 cps	Space Frequency	2932 5 cps
BP1	2975 cps bandpass filter and frequency determining tank circuit	NRC	654
C101	5 mfd 25 volt miniature electrolytic capacitor	SPR MAL	TE-1202 or TT005H025P1A
C102	0.033 mfd ± 10% 200 volt hermetically sealed paper capacitor	ANY	CP09A1KC333K
R101	25K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S253MA
R102	2.5K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S252MA
R103	2.5K ohms miniature pot ntiometer, screwdriver adjustment	ALB	GA2N040S252MA
R104	330 ohms ± 10% 1/4 watt composition resistor	ANY	RC07GF331K

Symbol	Description	Mfr.	Part No.
	TYPE 211Z18 Mark Frequency		3187 5 cps
	Carrier Frequency 3145 ± 42.5 cps Space Frequency		3102.5 cps
BP1	3145 cps bandpass filter and frequency determining tank circuit	NRC	655
C101	5 mfd 25 volt miniature electrolytic capacitor	SPR MAL	TE-1202 or TT005H025P1A
C102A	0.015 mfd ± 10% 100 volt hermetically sealed paper capacitor	ANY	CP09A1KB153K
C102B	0.015 mfd ± 10% 100 volt hermetically sealed paper capacitor	ANY	CP09A1KB153K
R101	25K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S253MA
R102	2.5K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S252MA
R103	2.5K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S252MA
R104	150 ohms ± 10% 1/4 watt composition resistor	ANY	RC07GF151K
	TYPE 211Z19 Mark Frequency		3357 5 cps
	Carrier Frequency 3315 ± 42.5 cps Space Frequency		3272.5 cps
BP1	3315 cps bandpass filter and frequency determining tank circuit	NRC	656
C101	5 mfd 25 volt miniature electrolytic capacitor	SPR MAL	TE-1202 or TT005H025P1A
C102A	0.015 mfd ± 10% 100 volt hermetically sealed paper capacitor	ANY	CP09A1KB153K
C102B	0.015 mfd ± 10% 100 volt hermetically sealed paper capacitor	ANY	CP09A1KB153K
R101	25K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S253MA
R102	2.5K ohms miniature potentiometer, screwdriver adjustment	ALB	GA2N040S252MA
R103	2.5K ohms miniatur potentiometer, screwdriver adjustment	ALB	GA2N040S252MA
R104	150 ohms ± 10% 1/4 watt composition r sistor	ANY	RC07GF151K

FREQUENCY SHIFT TONE KEYER SHELF, TYPE 221 MODEL 1:

Sym-bol	Function	Description	Mfr.	Part No
E1	Terminal connector strip	18 terminal barrier strip	KUL HBJ	600-3/4ST-18-SI r 18-140-3/4W-E
E2	Terminal connector strip	18 terminal barrier strip	KUL HBJ	600-3/4ST-18-SI r 18-140-3/4W-E
E3	Terminal connector strip	18 terminal barrier strip	KUL HBJ	600-3/4ST-18-SI or 18-140-3/4W-E
E4	Terminal connector strip	18 terminal barrier strip	KUL HBJ	600-3/4ST-18-SI or 18-140-3/4W-E
E5	Terminal connector strip	18 terminal barrier strip	KUL HBJ	600-3/4ST-18-SI or 18-140-3/4W-E
E6	Terminal connector strip	18 terminal barrier strip	KUL HBJ	600-3/4ST-18-SI or 18-140-3/4W-E
F1	Power Supply #1 fuse	1/2 amp "Slo Blo" fuse	LFU	313.500
F2	Power Supply #2 fuse	1/2 amp "Slo Blo" fuse	LFU	313.500
*I1	Main power light	Bayonet base, neon lamp	GEC	NE 51
J1	Main power chassis connector	Male chassis power connector	HBJ	P-202-B
J2	Receptacle for Tone Keyer	14 prong female connector with floating bushing	AMP	57-20140
J3	Receptacle for Tone Keyer	14 prong female connector with floating bushing	AMP	57-20140
J4	Receptacle for Tone Keyer	14 prong female connector with floating bushing	AMP	57-20140
J5	Receptacle for Tone Keyer	14 prong female connector with floating bushing	AMP	57-20140
J6	Receptacle for Tone Keyer	14 prong female connector with floating bushing	AMP	57-20140
J7	Receptacle for Tone Keyer	14 prong female connector with floating bushing	AMP	57-20140

Sym-bol	Function	Description	Mfr.	Part No.
J8	Receptacle for Tone Keyer	14 prong female connector with floating bushing	AMP	57-20140
J9	Receptacle for Tone Keyer	14 prong female connector with floating bushing	AMP	57-20140
J10	Receptacle for Tone Keyer	14 prong female connector with floating bushing	AMP	57-20140
J11	Receptacle for Tone Keyer	14 prong female connector with floating bushing	AMP	57-20140
J12	Receptacle for Tone Keyer	14 prong female connector with floating bushing	AMP	57-20140
J13	Receptacle for Tone Keyer	14 prong female connector with floating bushing	AMP	57-20140
J14	Receptacle for Tone Keyer	14 prong female connector with floating bushing	AMP	57-20140
J15	Receptacle for Tone Keyer	14 prong female connector with floating bushing	AMP	57-20140
J16	Receptacle for Tone Keyer	14 prong female connector with floating bushing	AMP	57-20140
J17	Receptacle for Tone Keyer	14 prong female connector with floating bushing	AMP	57-20140
J18	Receptacle for Tone Keyer	14 prong female connector with floating bushing	AMP	57-20140
J19	Receptacle for Tone Keyer	14 prong female connector with floating bushing	AMP	57-20140
J20	Receptacle for NRC 690	14 prong female connector with floating bushing	AMP	57-20140
R1	Series resistor	150K ohms ± 10% 1/2 watt composition resistor	ANY	RC20GF154K
S1	Main power switch	DPST toggle switch	CHC	8360K7
TB1	B+, B- terminal strip	36 lug terminal board	NRC	C-5-0670
*XI1	Socket for I1	Pilot light assembly with clear lens and internal resistor	DLA	26408W-1137

Symbol	Function	Description	Mfr.	Part No
XF1	Fuse holder for F1	Fuse holder with light fuse indicator	BUS	HKLX
XF2	Fuse holder for F2	Fuse holder with light fuse indicator	BUS	HKLX
Z1	Relay Subassembly	Automatic Power Supply Control Unit	NRC	690
Z2	Isolation Subassembly	Telephone Line Isolation Unit	NRC	693
Z3	Power Cable	Main Power Cable	NRC	788

* These components to be replaced by items listed below for D. C. Input Option

I1	Main power light	Bayonet base lamp	GEC	1829
J1	Main power chassis connector	2 terminal barrier strip	HBJ	2-140-Y
R1	Series resistor	470 ohms ± 10% 2 watts composition resistor	ANY	RC42GF471K
XF1	Fuse holder for F1	Fuse holder	BUS	HCM
XF2	Fuse holder for F2	Fuse holder	BUS	HCM
XI1	Socket for I1	Pilot light assembly with clear lens	DLA	26410W-1137

ELECTRICAL PARTS LIST for AUTOMATIC POWER SUPPLY CONTROL UNIT NRC 690

Symbol	Function	Description	Mfr.	Part No.
J1	Power supply receptacle	8 prong female connector	AMP	26-4201-8S
J2	Power Supply receptacle	8 prong female connector	AMP	26-4201-8S
J3	Pin Jack	Black pin jack	CAM	45E-3
K1	Relay	SPDT relay	PRM	KRP5D
P1	Plug-in connector	14 prong male connector	AMP	57-10140
S1	Power Supply Selector switch	DPDT toggle switch	CHC	8363K7
XK1	Socket for K1	Octal socket	EBY	TS101P02

MANUFACTURERS' DESIGNATIONS

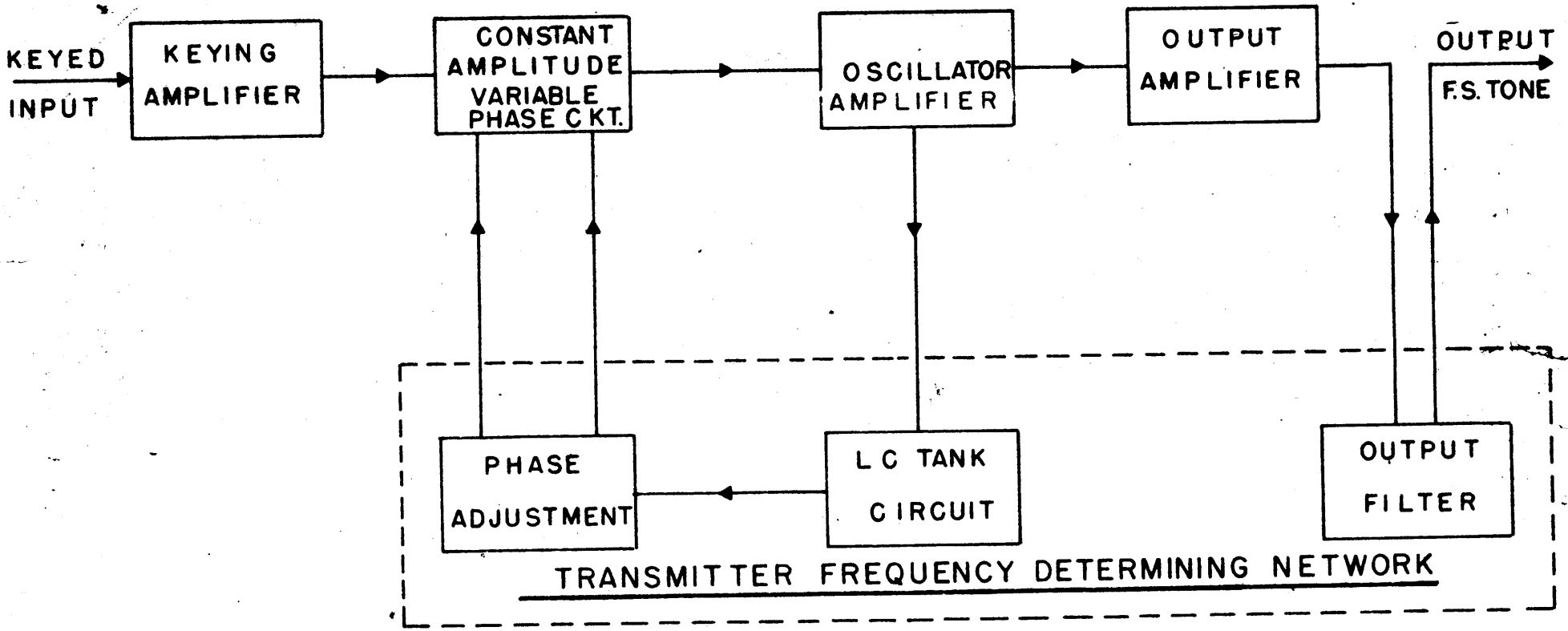
MFR. CODE	FEDERAL CODE NO.	NAME
AEO	00656	Aerovox Corporation
ALB	01121	Allen-Bradley Company
AMP	02660	Amphenol-Borg Electronics Corporation
BUS	71400	Bussman Manufacturing
CAN	71468	Cannon Electric Company
CHC	15605	Cutler-Hammer, Incorporated
CIN	71785	Cinch Manufacturing Corporation
DLA	72619	Dialight Corporation
EBY	72825	Hugh H. Eby, Incorporated
GEC	24446	General Electric Company
HBJ	75173	Howard B. Jones, Division Cinch Manufacturing Corporation
KUL	75382	Kulka Electric Corporation
LFU	75915	Littelfuse, Incorporated
MAL	37942	P. R. Mallory Company, Incorporated
MOT	04713	Motorola Semiconductor Products Incorporated
NRC	88183	Northern Radio Company, Incorporated
PBM	77342	Potter & Brumfield
PSC	01281	Pacific Semi-Conductors, Incorporated
SPR	56289	Sprague Electric Company
TXI	01295	Texas Instruments, Incorporated
UTC	80223	United Transformer Company

ELECTRICAL PARTS LIST for TELEPHONE LINE ISOLATION UNIT NRC 693

Symbol	Function	Description	Mfr.	Part No.
E1	Terminal Strip	2 terminal barrier strip	CIN	2-140-Y
R1	Attenuator	600 to 600 ohm variable attenuator	MAL	T600
T1	Isolation Transformer	Transformer 600-600 ohms	NRC	234

DWG. N. 211-1-02 REV.

REVISIONS			
SYM.	DESCRIPTION	DATE	APPROVAL



UNLESS OTHERWISE SPECIFIED	DRAFTSMAN	DATE	NAME:
DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS ± 1/64 DECIMALS ± .005 ANGLES	J.G.	1-8-59	DIAGRAM, BLOCK, FUNCTION F.S. TONE KEYER TYPE 211 MOD.1,2&3
MATERIAL:	CHECKER		
FINISH:	ENGINEER		
	APPROVAL	8/31/61	

NORTHERN RADIO COMPANY INCORPORATED

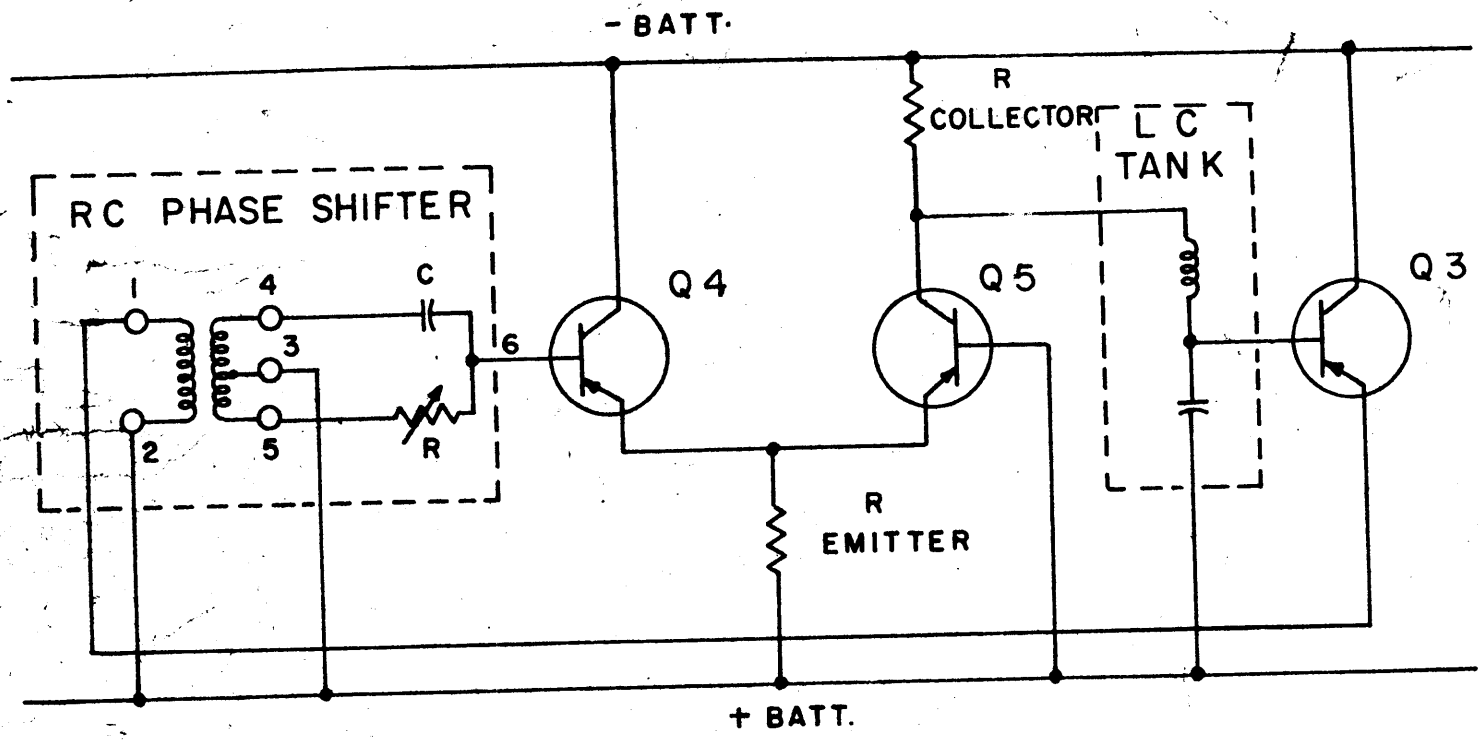
DWG. No. 211-1-02

SCALE: NONE · SH. 1 OF 1 DWG. SIZE A

DWG. N. 211-1-0

REVISIONS

SYM.	DESCRIPTION	DATE	APPROVAL



UNLESS OTHERWISE SPECIFIED	DRAFTSMAN	DATE
DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS ± 1/64 DECIMALS ± .005 ANGLES	J. G.	1-8-59
MATERIAL:	CHECKER	
FINISH:	ENGINEER	
	APPROVAL	

NAME:
SIMPLIFIED FUNCTIONAL OSCILLATOR

F. S. TONE KEYER

TYPE 211 MOD. 1

SCALE: NONE | SH. 1 OF 1

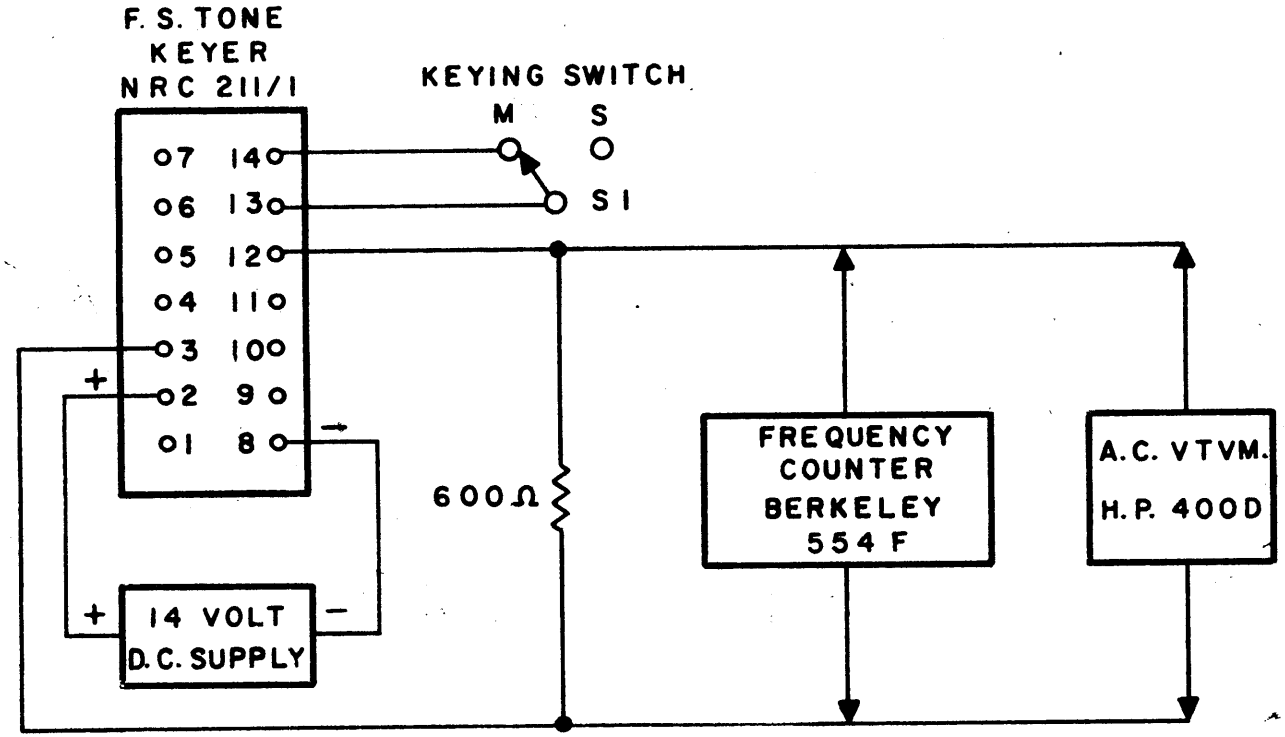
NORTHERN RADIO COMPANY
INCORPORATED

DWG. N. 211-1-04

DWG. SIZE A

DWG. N. 211-1-07 REV

REVISIONS			
SYM.	DESCRIPTION	DATE	APPROVAL



UNLESS OTHERWISE SPECIFIED	DRAFTSMAN	DATE	NAME:
DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS ± 1/64 DECIMALS ± .005 ANGLES	F. N. G.	1-25-61	TEST CIRCUIT F. S. TONE KEYER TYPE 211 MOD. 1
MATERIAL:	CHECKER		
FINISH:	ENGINEER		
	APPROVAL	1/25/61	SCALE: NONE SH. 1 OF 1

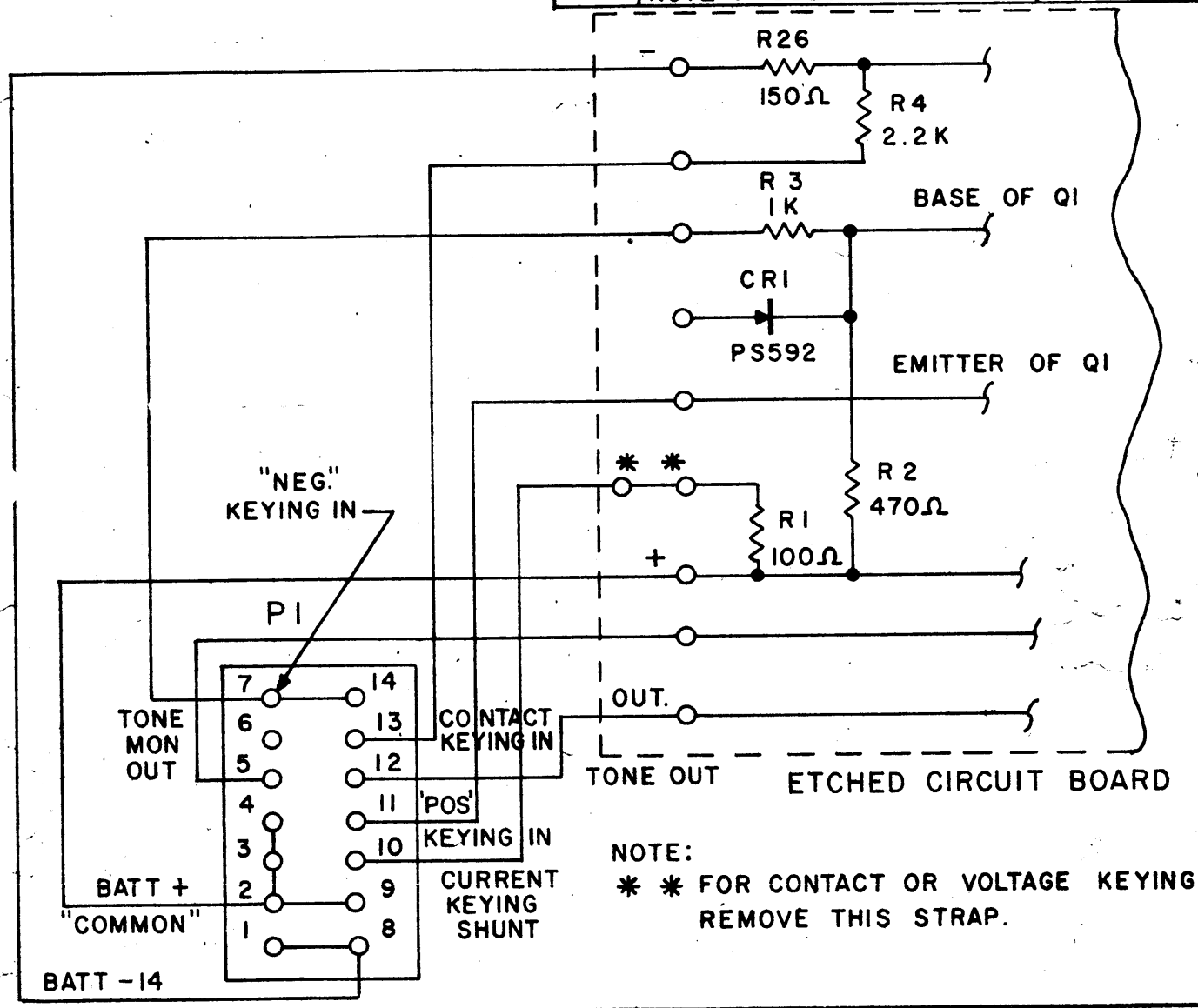
NORTHERN RADIO COMPANY INCORPORATED

DWG. N. 211-1-07 DWG. SIZE A

NOTE:
1. EFFECTIVE SERIAL NO. 9708 THROUGH 10,107 & 10,194 & ABOVE.

DWG. No. 211-1-08

REVISIONS			
SYM.	DESCRIPTION	DATE	APPROVAL
A	CRI WAS IN34A	1-27-60	
B	REDRAWN	8-2-62	
C	PI DESIGNATIONS ADDED	2-6-63	
D	PI DESIGNATIONS CORRECTED	5-13-63	
E	REMOVED CONNECTION FROM PI # 4, PI # 11 WAS CONNECTED TO ANODE OF CRI & NOTE 1 ADDED.	6-3-65	



NOTE:
* * FOR CONTACT OR VOLTAGE KEYING REMOVE THIS STRAP.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES ± 1/64 ± .005	DRAFTSMAN A.W.	DATE 8-2-62	NAME: WIRING DIAGRAM INVERTED KEYING F.S. TONE KEYER TYPE 211 MOD. 1
MATERIAL:	CHECKER R.F.	8-2-62	NORTHERN RADIO CO. INCORPORATED
FINISH:	ENGINEER		
	APPROVAL	2/6/63	SCALE: NONE DWG. No. 211-1-08 SH. 1 OF 1 DWG. SIZE A

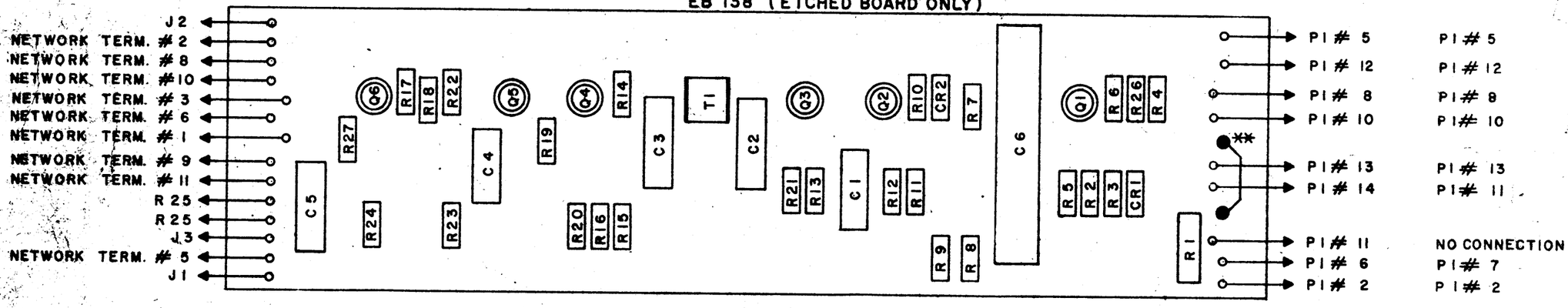
REVISIONS			
SYM.	DESCRIPTION	DATE	APPROVAL
A	ADDED: INFORMATION FOR "NORMAL" AND "INVERTED" KEYING, NOTES 2 & 3	6-4-65	
B	DESCRIPTIVE INFORMATION ADDED TO CIRCUIT BOARD AND TITLE BOX.	10-1-68	

DWG. N
REV.

NOTES:

1. THIS DWG. REPLACES A-211-1-06 IN UNITS HAVING SERIAL NO. 7221 & UP.
** 2. FOR "CONTACT" OR "VOLTAGE" KEYING REMOVE THIS STRAP.
*** 3. EFFECTIVE WITH SERIAL Nº. 9708 THROUGH 10,107 AND 10,194 AND ABOVE.

CIRCUIT BOARD SUB-ASSEMBLY NRC 1213
(CONSISTS OF ETCHED BOARD WITH COMPONENTS)
EB 138 (ETCHED BOARD ONLY)



FOR "NORMAL" KEYERS	*** FOR "INVERTED" KEYERS
P1 # 5	P1 # 5
P1 # 12	P1 # 12
P1 # 8	P1 # 8
P1 # 10	P1 # 10
P1 # 13	P1 # 13
P1 # 14	P1 # 11
P1 # 11	NO CONNECTION
P1 # 6	P1 # 7
P1 # 2	P1 # 2

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTIONS ± 1/64 DECIMALS ± .005 ANGLES
MATERIAL:
FINISH:

DRAFTSMAN	A.W.	8-9-62
CHECKER		5-17-65
ENGINEER		
APPROVAL		5/17/65

NAME:
LAYOUT, COMPONENT
SUB-ASSEMBLY NRC 1213
F.S. TONE KEYER

TYPE 211 MOD. 1

SCALE: NONE | SHEET 1 OF 1 | DWG SIZE B

NORTHERN RADIO COMPANY
INCORPORATED
[illegible] MELBOURNE FLA.

DWG. N. 211-1-35

SYM	
G	ADDED COLOR COD TERMINAL LUGS WIRE RELOCATED PANEL TO ETCHE
H	R19 & R14 WERE R15 & R20 WERE THESE REVISION HAVING SERIAL
J	CORRECTS REV. H

ETCHED CIRCUIT BOARD # 103

NOTE

1. INTERCONNECTIONS BETWEEN P1 AND PRINTED CIRCUIT BOARD SHOWN FOR "NORMAL" CURRENT KEYING FOR CONNECTIONS FOR "INVERTED" KEYING SEE DWG A-211-1-08
   * R4 IS 2K ON KEYER WIRED FOR "INVERTED" KEYING
   ** FOR CONTACT OR VOLTAGE KEYING REMOVE THIS STRAP
2. ALL INPUTS ARE MADE RELATIVE TO COMMON (P1 PINS 2,3,4 OR 9)

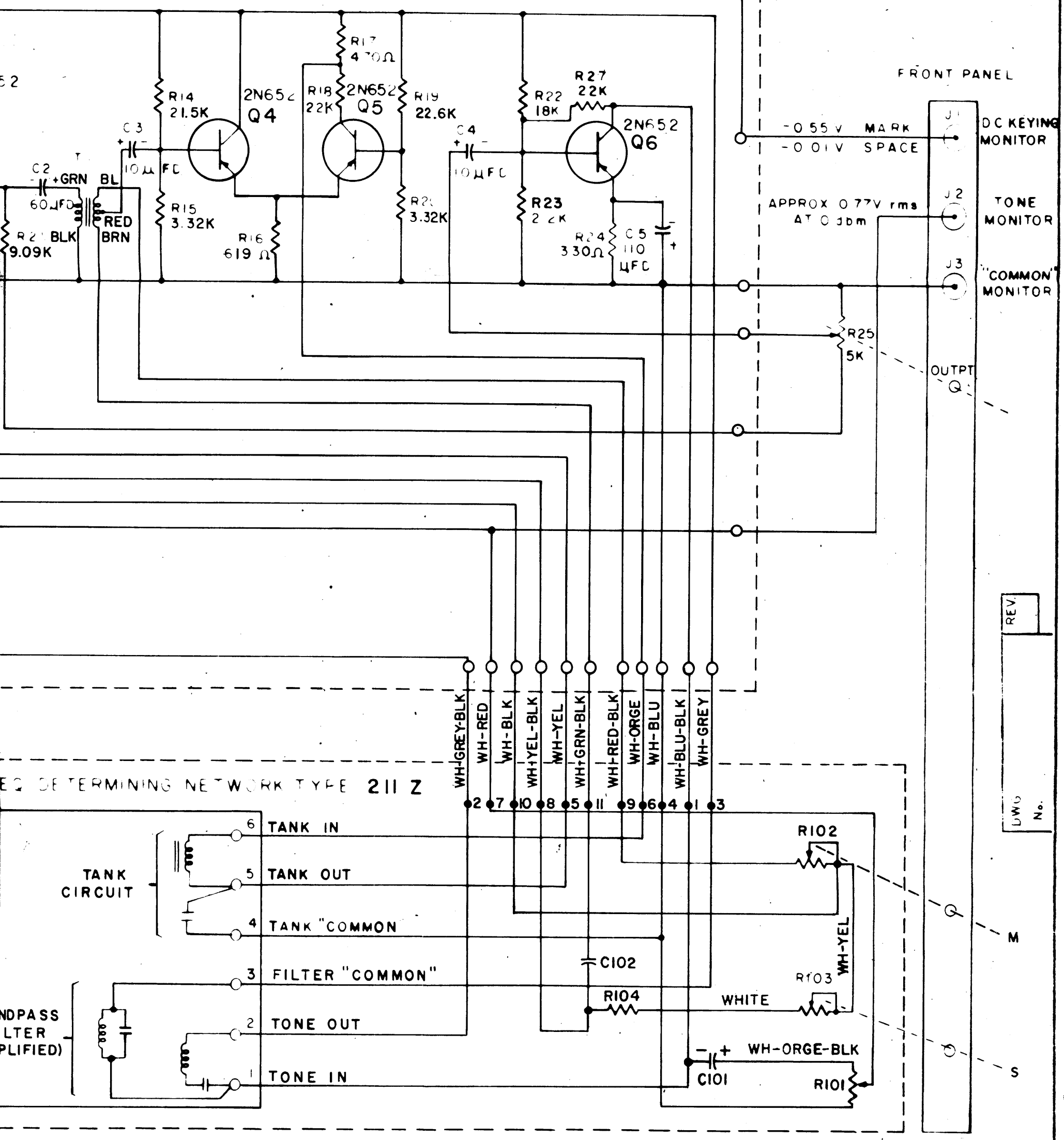
UNLESS OTHERWI
DIMENSIONS AR
TOLERANCES ON
FRACTIONS ± 1/64 DECIMA ± .00
MATERIAL:
FINISH:

M	DESCRIPTION	DATE	APPROVAL
	ADDED COLOR CODE & NUMERALS TO TERMINAL LUGS ON NETWORK BOARD. WIRE RELOCATED FROM J2 ON FRONT PANEL TO ETCHED CIRCUIT BOARD.	8-2-62	
	R19 & R14 WERE 22K R15 & R20 WERE 3.3K THESE REVISIONS MADE ON UNITS HAVING SERIAL NO. 7221 & UP	10-22-62	KDO
	CORRECTS REV. H. R15 & R20 WERE 3.31K	2-6-63	KDC.

REVISIONS

SYM	DESCRIPTION	DATE	APPROVAL
A	C5 RETURNED TO PLUS BUSS.	8-14-59	
B	CR1 WAS IN34A	1-27-60	
C	ADD R27, R22 WAS 10K, R24 WAS 680Ω FOR SER. # 1194 AND UP	7-1-60	
D	DESCRIPTIVE INFORMATION ADDED ON FRONT PANEL 'BP1' & 'P1'	1-23-61	
E	ADDED NOTE # 2	5-10-62	
F	R16 WAS 680Ω, R21 WAS 10K	7-3-62	

UIT BOARD # 103



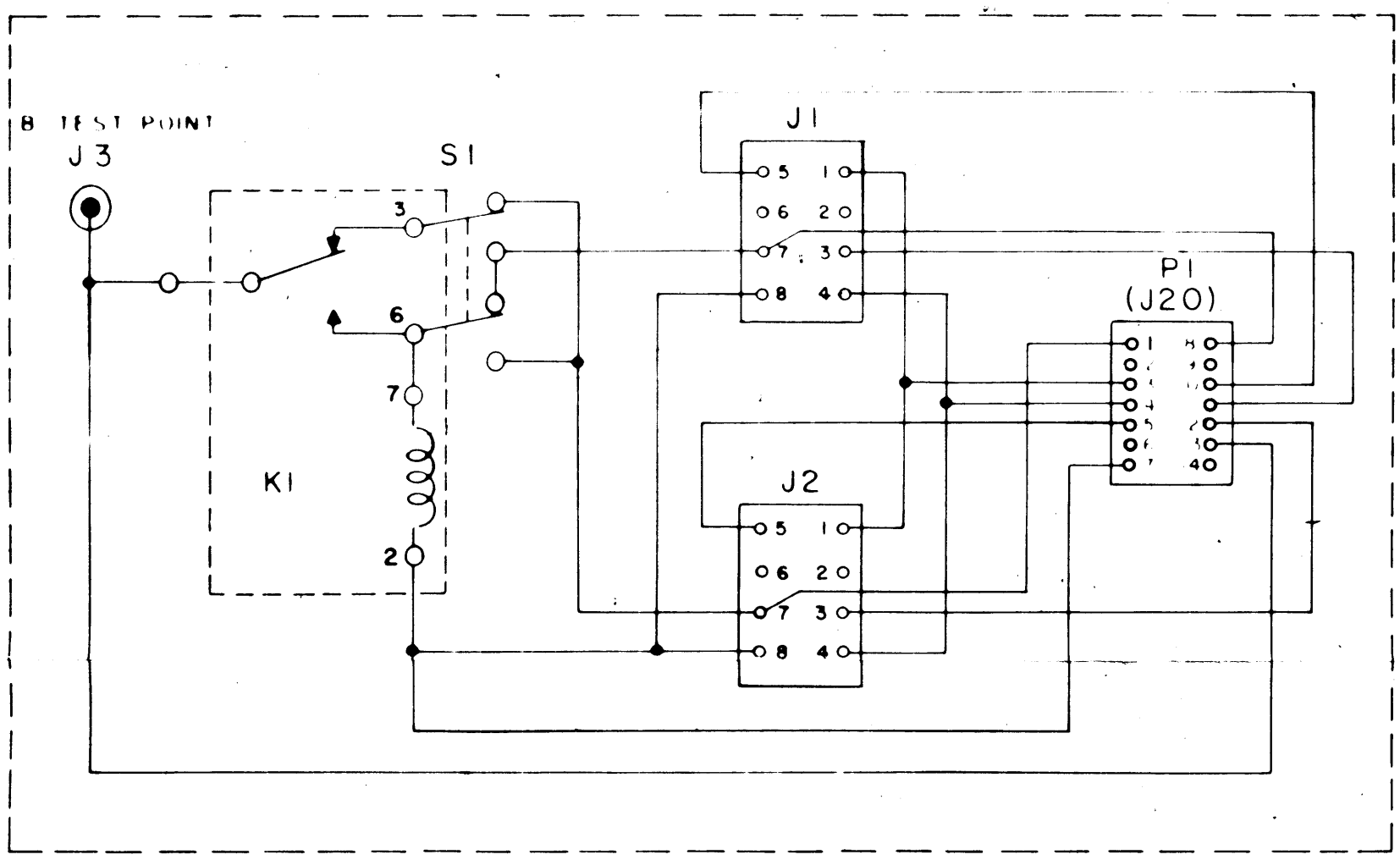
UNLESS OTHERWISE SPECIFIED	DRAFTSMAN	DATE	NAME
DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS ± 1/64 DECIMALS ± .005 ANGLES	J G	12-12-58	SCHEMATIC F.S. TONE KEYER TYPE 211 MOD I
MATERIAL:	CHECKER RLat.	8-3-62	
FINISH:	ENGINEER		
	APPROVAL KH	1-14-63	

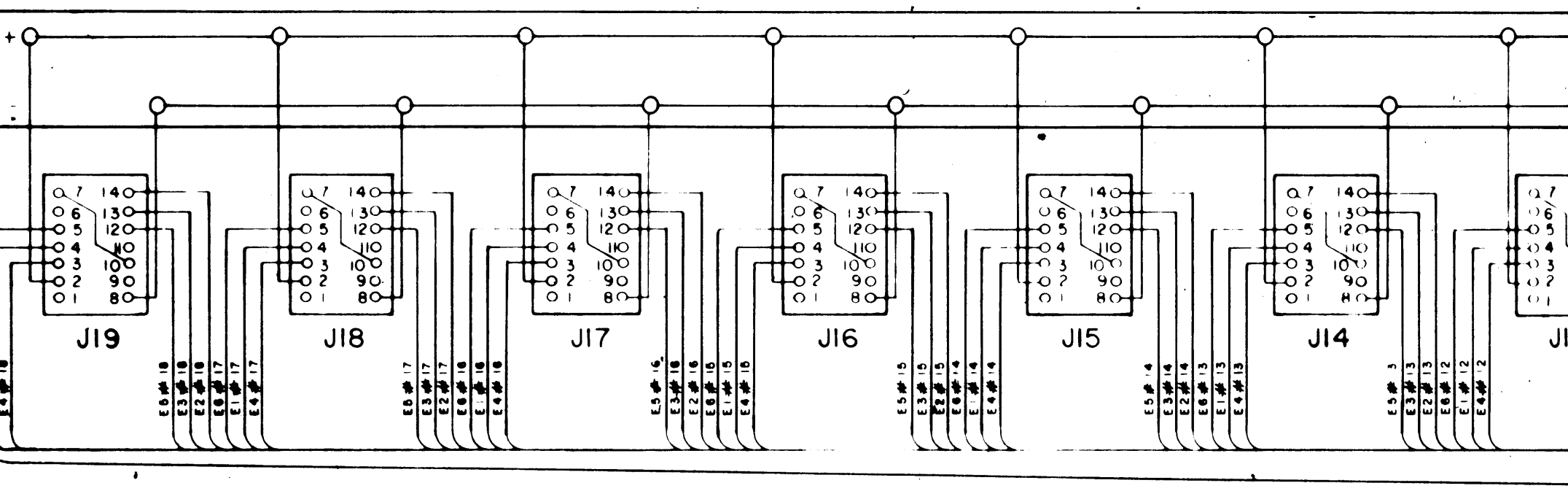
NORTHERN RADIO COMPANY
INCORPORATED
143-147 WEST 22ND ST NY 11
NEW YORK

DWG. No. 211-1-01

SCALE: NONE SH. 1 OF 1 DWG SIZE C

AUTOMATIC P.S. CONTROL UNIT
Z1 NRC 690



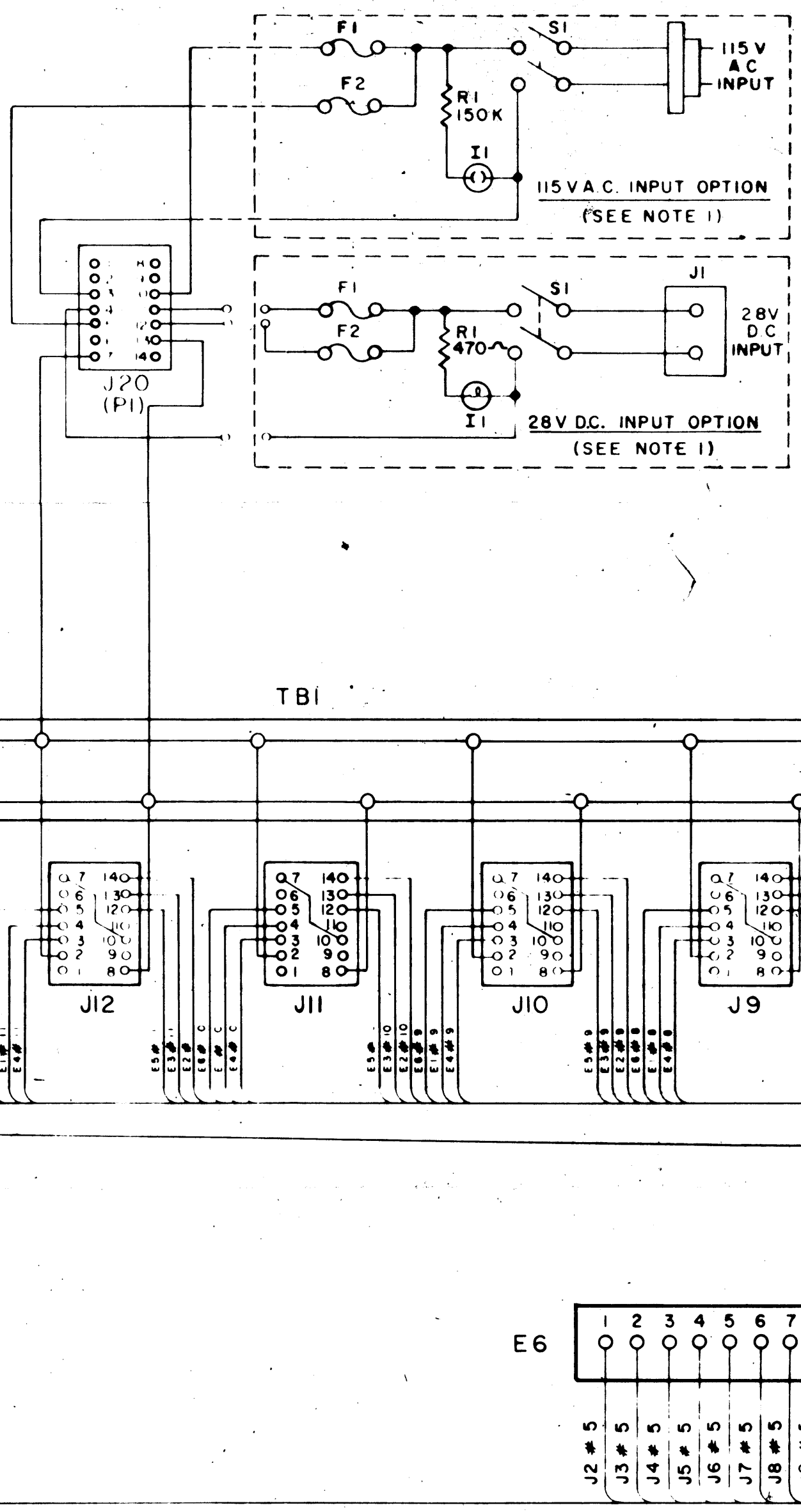


NOTE:

1. THIS SHELF IS NORMALLY
   SPECIFIED, IN WHICH CASE
   "28 V D.C. INPUT OPTION."
2. THE WIRING SHOWN IS FOR
   FOR "POSITIVE CURRENT K
   FROM PIN 7 TO PIN 11 & FI
3. IF CURRENT KEYING IS E
   FOLLOWING TABLE PLACE
   FOR EACH CHANNEL WILL
   MAGNITUDE TO 1/2 THE

MARK CURRENT
-20 MA
-60 MA

4. STRAPPING SHOWN IS O

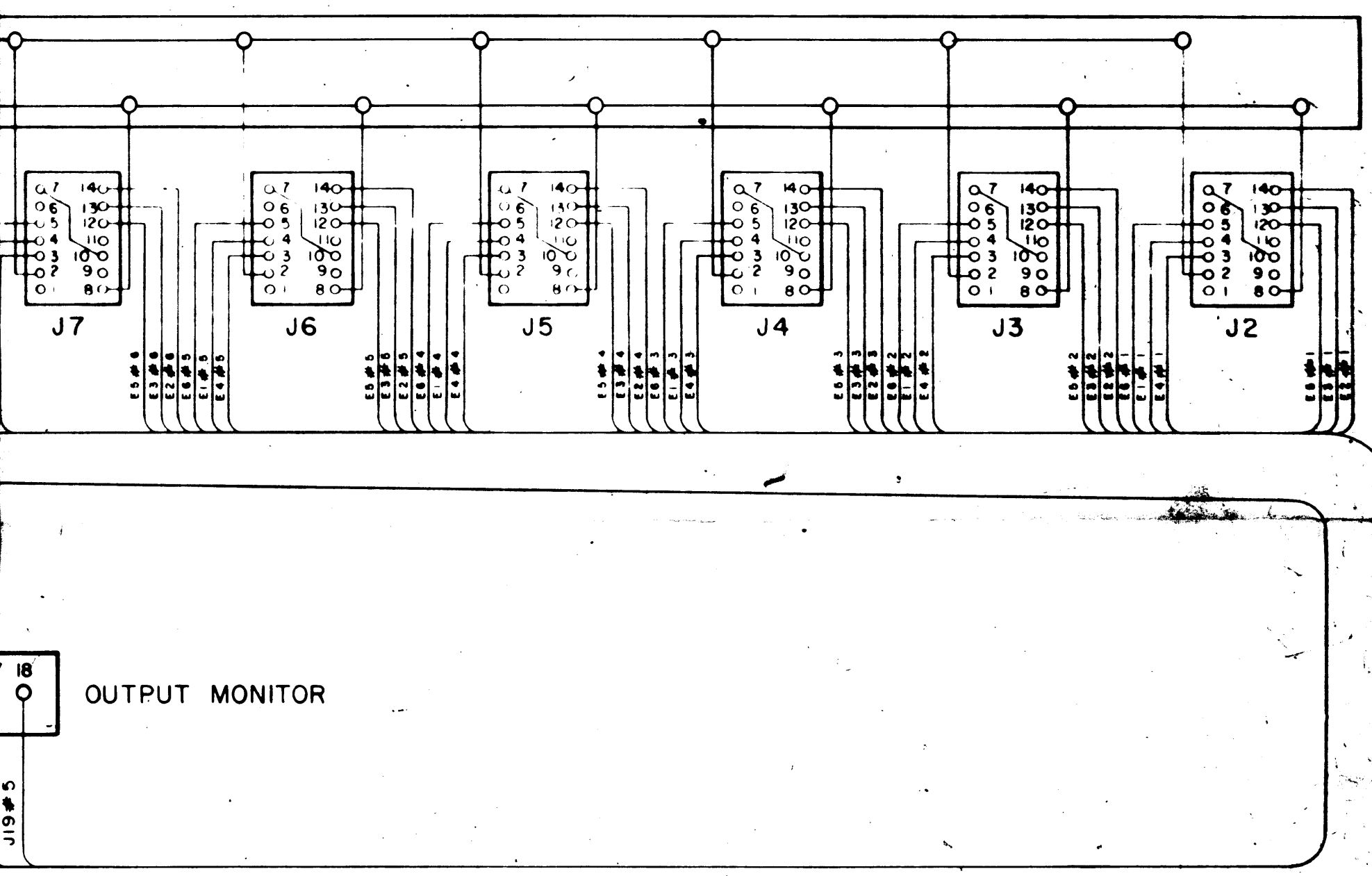


MALLY WIRED FOR 115V A.C. UNLESS 28V D.C. OPERATION IS
I CASE WIRING WILL BE AS SHOWN IN THE BLOCK LABELED
TION."
I IS FOR "NEGATIVE CURRENT KEYING" OR "CONTACT KEYING."
RENT KEYING" USING TYPE 211/1 KEYERS TRANSFER THE LEAD
11 & FROM PIN 14 TO PIN 11 ON EACH OF J2 — 19.
G IS EMPLOYED A RESISTOR OF THE VALUE LISTED IN THE
PLACED BETWEEN THE TERMINALS OF E2 AND E1
L WILL PREVENT KEYING UNLESS A SIGNAL EQUAL IN
2 THE MARK CURRENT IS PRESENT.

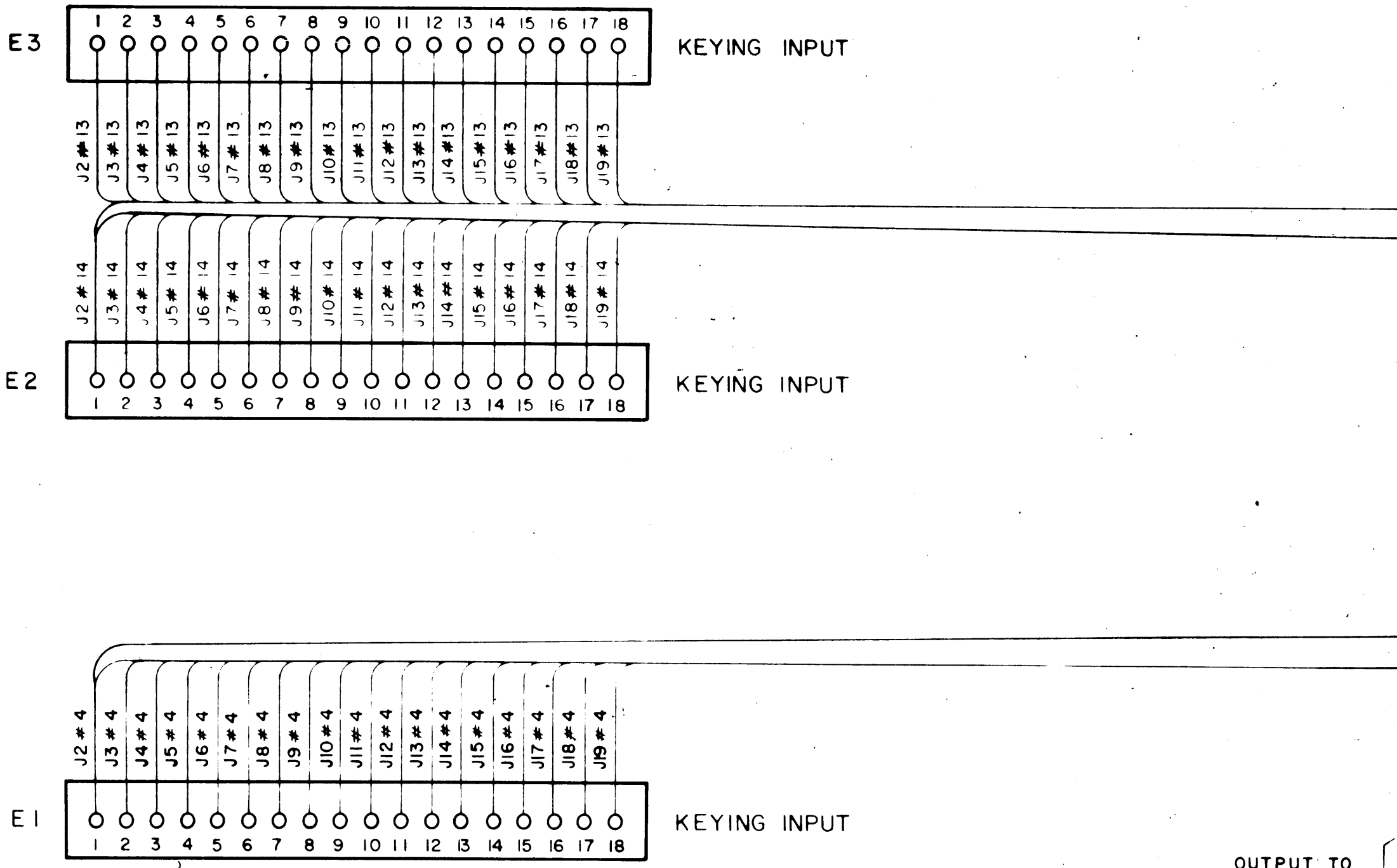
RENT	RESISTOR (1/2 WATT 5%)
A	12.0Ω
A	4.0Ω

I IS OF REMOVABLE TYPE.

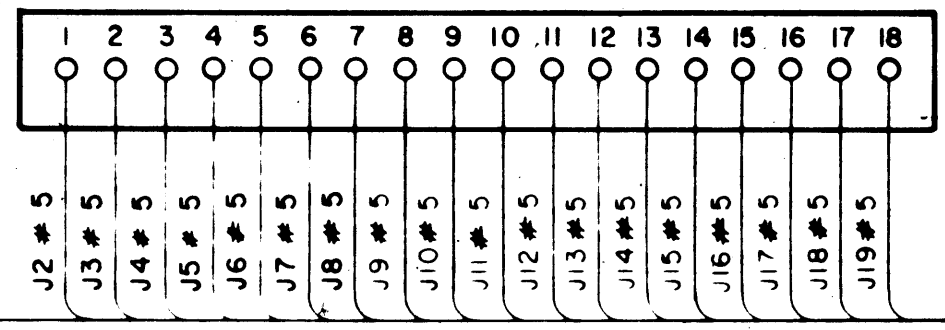
REVISIONS			
SYM	DESCRIPTION	DATE	APPROVAL
[illegible]	REDRAWN	1-16-59	[illegible]
[illegible]	ADDED 28V D.C. INPUT PINS 7 & 4 ON J1 & [illegible] PIN 4, 11 & 12 ON P1	8-6-59	[illegible]
C	NOTE 1 REWORDED, A.C.-D.C. OPTIONS REDRAWN.	8-27-59	[illegible]
D	NOTES 2, 3 & 4 ADDED	1-26-60	[illegible]
E	NOTE 5 ADDED	1-13-61	[illegible]
F	NOTE 6 ADDED	2-13-61	
G	NOTES 2, 3 & 4 REWORDED NOTES 5 & 6 REMOVED	8-62	[illegible]
H	NOTE "2" REVISED.	4-16-63	[illegible]



REV.
DWG. 221-1-01
No.

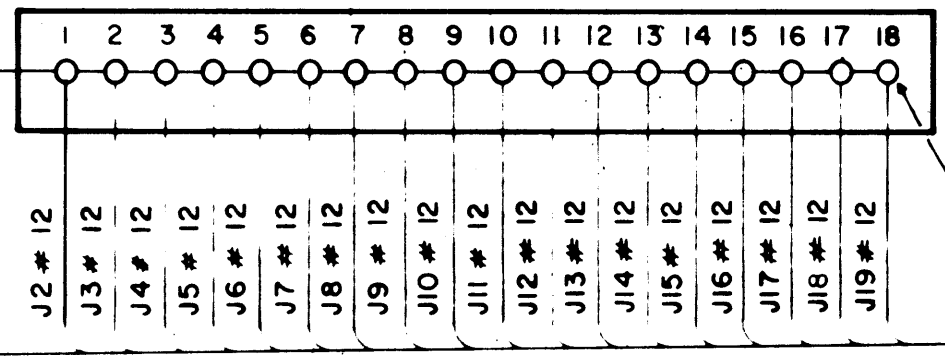

E3
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
KEYING INPUT
J2#13 J3#13 J4#13 J5#13 J6#13 J7#13 J8#13 J9#13 J10#13 J11#13 J12#13 J13#13 J14#13 J15#13 J16#13 J17#13 J18#13 J19#13
J2#14 J3#14 J4#14 J5#14 J6#14 J7#14 J8#14 J9#14 J10#14 J11#14 J12#14 J13#14 J14#14 J15#14 J16#14 J17#14 J18#14 J19#14
E2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
KEYING INPUT
J2#4 J3#4 J4#4 J5#4 J6#4 J7#4 J8#4 J9#4 J10#4 J11#4 J12#4 J13#4 J14#4 J15#4 J16#4 J17#4 J18#4 J19#4
E1
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
KEYING INPUT
OUTPUT TO
TELEPHONE LINE

E6



OUTP

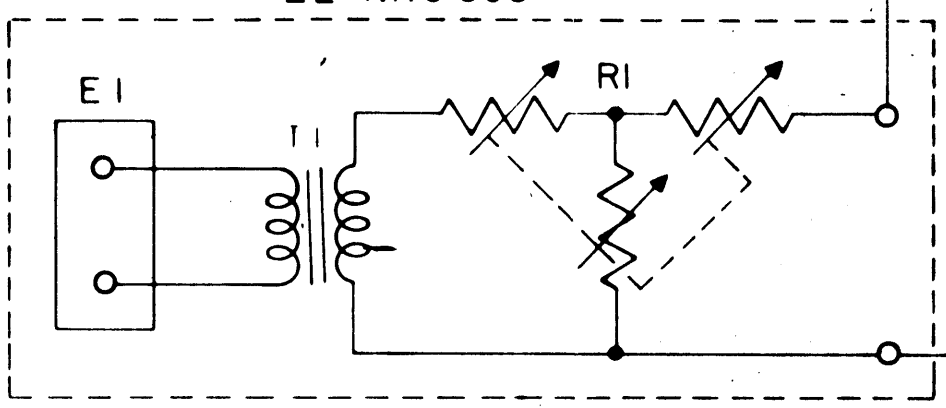
E5



TONE

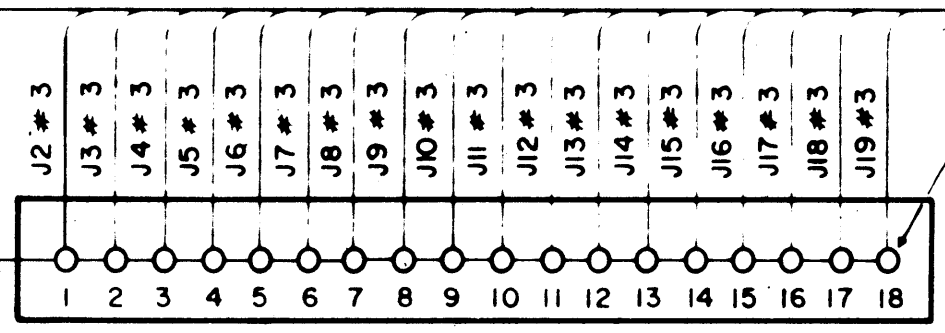
SEE

TELEPHONE LINE ISOLATION UNIT
Z2 NRC 693



TPUT TO
PHONE LINE

E4



SEE

TONE

UNLES
DIM
TOLER
FRACTION
± 1/64

MATERI

FINISH

18

OUTPUT MONITOR

18

TONE OUTPUT

SEE NOTE 4

SEE NOTE 4

O
18

TONE OUTPUT. COMMON

REV.

DWG. 221-1-01

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS ± 1/64 DECIMALS ± .005 ANGLES	DRAFTSMAN R. L. F	DATE 1 15 59	NAME. SCHEMATIC,	NORTHERN RADIO COMPANY INCORPORATED
MATERIAL:	CHECKER		SHELF, F.S. TONE KEYER	
FINISH:	ENGINEER		TYPE 221 MODEL 1	DWG. No. 221-1-01
	APPROVAL		SCALE: NONE SHEET 1 OF 1	SIZE D