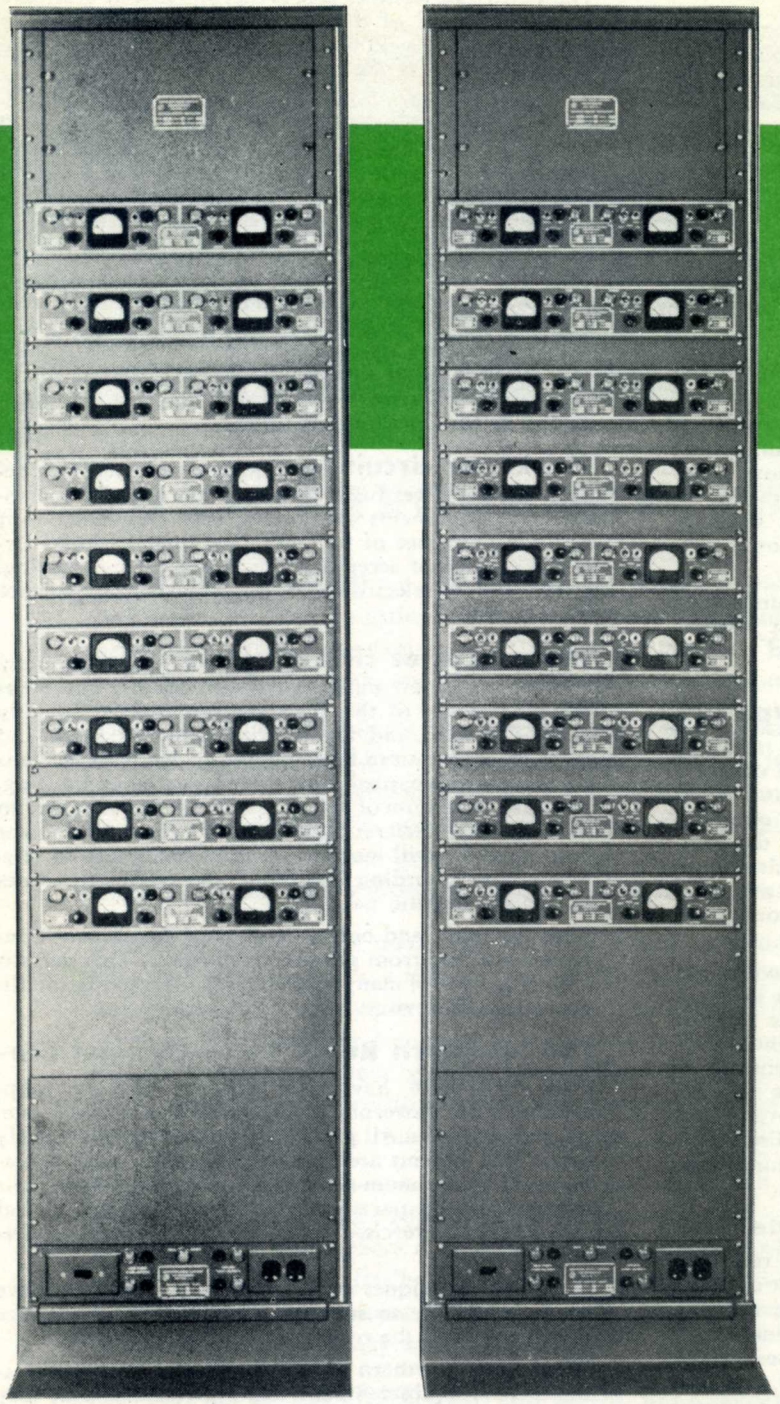
the industry's foremost and complete line of quality communications equipment



NORTHERN RADIO

MULTI-CHANNEL FREQUENCY SHIFT TELEGRAPH SYSTEMS

Today's constantly growing demand for greater, faster, more dependable communications has made the need for improved Multiplex equipment more acute than ever before. In response to this need, Northern Radio Company now makes available several new Frequency Shift Multi-Channel Telegraph Systems. Reflecting the heritage of Northern Radio's constant research and precision manufacture over the years, these multi-channel systems display novel concepts of design together with outstanding performance, fidelity and operating economy.

The Northern Radio Multi-Channel Telegraph Systems are audio carrier systems capable of multiplexing such circuits as telephone lines, VHF, UHF, or radio frequency links—or practically any type circuit from which a two-wire audio circuit can be derived.

Designed to meet any speed requirements, these systems are fully electronic, without relays or moving parts to wear. They can be used for high-speed printer, Morse or time division Multiplex circuits, as well as in such applications as Telemetering, Control Circuits and Servo-Mechanisms.

Instantaneous and complete sending end channel control permits any binary code groups, either "Clear Text" or "Cryptographic", to be channelized without need for additional phasing or synchronizing equipment, while paralleling of channels will allow for transmission of other type codes, such as 3 element cable code.

The completely independent operation of each channel, including its own power supply, localizes faults to one channel only, leaving other channels unaffected.

Individual channel separation filters are used at both transmitting and receiving ends. This arrangement allows for sending telegraph or control signals over a circuit carrying, simultaneously, other forms of intelligence; or for two-way communications on the same line.

MONITORS
TONE FILTERS
MASTER OSCILLATORS
RADIO MULTIPLEX SYSTEMS
FREQUENCY SHIFT CONVERTERS
MULTI-CHANNEL TONE SYSTEMS
FREQUENCY SHIFT KEYERS
DIVERSITY RECEIVERS
LINE AMPLIFIERS
DEMODULATORS
TONE KEYERS

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143-7 WEST 22nd ST., NEW YORK 11, NEW YORK

Pace-Setters in Quality Communication Equipment

The audio frequency shift principle of transmission provides for high fidelity of signal reproduction over a wide range of signal levels as well as under severe noise or interference conditions.

Circuit requirements of any speed, shift and center frequency can readily be met. To simplify the explanation, the system illustrated in this brochure is for use on printer circuits up to 100 WPM channel capacity.

The system arrangement is very flexible, permitting grouping of the basic units, shown on the following pages, into various arrangements of Multiplex Systems. These systems can be made to accommodate a large variety of channel numbers and speeds to meet any individual requirements. The flexibility is further improved by the fact that the racks, power control units, and terminal connection panels are the same for both transmitting and receiving terminals.

The Northern Radio Carrier Telegraph Rack is made in two arrangements. The Type 154 Model 2 is wired for a 12-channel system and the Type 154 Model 3 is wired for an 18-channel system. Identical racks and rack wiring are used on both transmitting and receiving sets. Each rack is equipped with the required number of blank separation panels between channel units and appropriately spaced AC power outlets along the rear sides of the rack.

The system layout is such that it permits the purchase of only the number of channel units required at installation time, while more channels can be added later to meet increased traffic needs.

The Terminal Connection Panel, Type 162 Model 1 is used for both transmitting and receiving terminals and allows for a maximum of 18 channels capacity. It is located on the top of the rack and serves as the terminal connection for incoming and outgoing signal circuits and for their distribution to the individual channel units within the rack. Any desired rearrangement of signal distribution is easily made by changing straps on the standard telephone connection blocks within the unit.

The terminal connection panel further provides for signal distribution to four telephone lines. For instance, a rack equipped with 12 channelizing units can, by means of simple strapping, operate as four individual 3-channel systems. In general, this arrangement allows the combining of any number of channelizing units on any one of four tone lines. An easily removed front panel exposes the four line level attenuators, line monitoring jacks, isolation transformers and terminal connection blocks.

The Power Control Panel, Type 161 Model 1 is used on both transmitting and receiving terminals for either 12 or 18 channel operation. It is located at the bottom of the rack and provides the means for distributing and controlling the line power supplied to the rack. It is equipped with fuses, blown fuse indicators and a main power switch. It also provides a secondary fused circuit for front-panel mounted convenience outlets.

The Dual Tone Keyer, Type 153 Model 1 and the Dual Tone Converter Type 152 Model 1 are the heart of the Multi-Channel System. For compactness, two Keyers or two Converters are mounted on one 3½" panel. But each Keyer or Converter is an entirely self-contained unit, including its own power supply and its own switch-controlled and separately-fused Power Circuit. Signal meters and monitoring jacks are also provided on each unit.

The particular channel frequency, amount of shift and maximum speed of the Keyer or Converter is solely determined by a PLUG-IN TYPE SUB-ASSEMBLY which also carries the band separation filters.

A frequency determining plug-in network can be readily plugged into any Keyer (or Converter), and will operate without need for any further adjustment. This allows for great flexibility in frequency assignments and also reduces the number of spare Keyers and Converters normally required for operational safety.

Each of these plug-in networks carries, in addition to its permanent nameplate, a small detachable frequency nameplate for attachment to the panel of the Keyer or Converter unit. To further ease visual identification, each plug-in network is coded with standard RMA color code, indicating its operating frequency. These markings are visible even when the plug-in network is installed in the operating position.

The keyer circuit embodies a novel oscillator design which successfully combines the usually incompatible requirements of transient free Frequency Shift and a high degree of frequency stability. Its input circuit is capable of accepting almost any form of keying, mechanical or electronic, of high or low impedance characteristic.

The converter circuit achieves great simplicity by utilizing a new pulse-type discriminator. The operating frequency of this discriminator is fixed by only one L-C circuit and the discrimination of mark and space frequencies can be made within three cycles. This discriminator, coupled with a high degree of limiting, permits a minimum of system distortion and a maximum of noise and interference rejection. Its controlled power output circuit will meet a variety of loads such as teletypewriters, recording apparatus, powered teletype lines or simple metallic pairs.

Both the input and output circuits of Keyers and Converters are free from ground connections. This permits loop operation of many transmitting or receiving intelligence keying devices.

The Northern Radio Multi-Channel Carrier Systems have been designed in close cooperation with Government Agencies and private telegraph companies. All parts employed are conservatively rated. The systems are intended for year-round operation with a minimum amount of attention. Despite their compactness, all parts are easily accessible and special care has been exercised to reduce maintenance requirements.

The pulse techniques used in this novel approach have made it possible to substantially reduce both the size of the unit and the over-all price per channel.

While the Northern Radio Company has manufactured these equipments for many diversified uses, they have found a particularly wide acceptance in the UHF communication field.

If you are contemplating a new installation or wish to modernize your present plant, consult our Engineering staff. We know that the new Northern Radio Multi-Channel Frequency Shift Telegraph Systems will allow a substantial dollar saving as well as a more effective utilization of available facilities.

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TYPE 153, MODEL 1

DUAL FREQUENCY SHIFT TONE KEYER

PURPOSE: The Northern Radio Type 153 Model 1 Dual Frequency Shift Tone Keyer is used in multi-channel communication systems to provide the transmitting terminals for teleprinter or telemetering operation over microwave or metallic circuits. The intelligence pulses Frequency Shift the audio tones which are then suitably amplified and controlled for inclusion in the transmission facility.

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

DESCRIPTION: This dual channel Tone Keyer equipment provides two completely separate F.S. telegraph transmitters on a standard 3½" x 19" equipment panel. Each Tone Keyer unit is self-contained including power supply and will operate, by changing a plug-in network, on any of the standard tone channels. The oscillator frequency of each unit is shifted ± 42.5 cps about the desired channel center frequency. This frequency shift is accomplished in such a manner that no frequency transient occurs other than the smooth transition from one frequency to the other. Transient conditions that create bias distortion are therefore completely eliminated in this unit at the transmitting terminal.

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

PRINCIPLE OF OPERATION: The keying input signal is applied to the Input Stage, V1, which causes the Keying Stage, V2, to assume a conducting or non-conducting condition. This "flip-flop" output is applied to the Electronic Keyed Amp., V3, the output of which alternately selects the output from each of the phase shifting networks Z2 and Z3.

The common plate output of the Electronic Keyed Amp., V3, is applied to Oscillator Amplifier, V4.1, through the Isolating Resistance and to the input of the LC Network. The output of the LC Network is applied to Oscillator Amplifier V4.2 and back to the phase shifting networks Z2 and Z3, thus completing the oscillating circuit.

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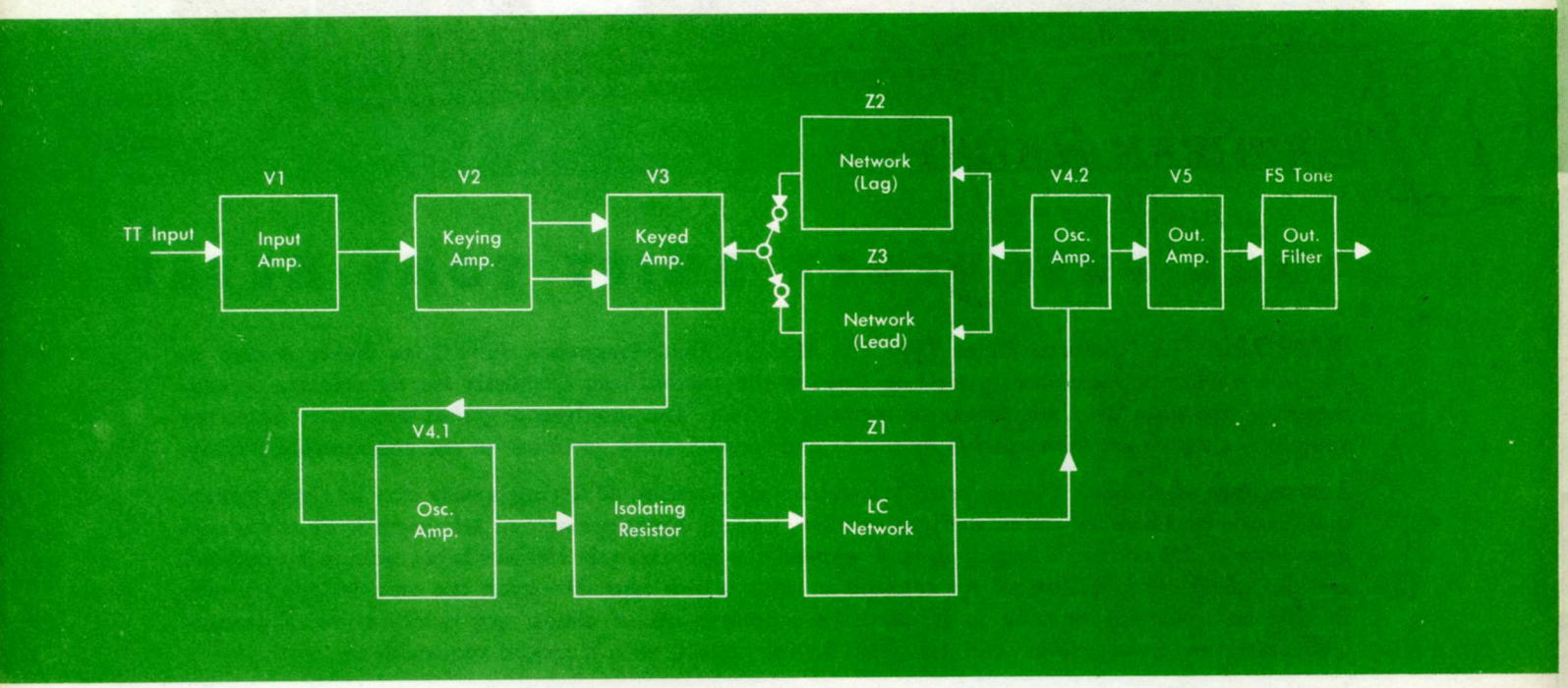
If the Keying Input is such that the Electronic Keyed Amp., V3, has selected leading phase Shift Network, Z3, the resonant frequency of the LC Network, Z1, will be shifted to a higher value. Conversely, if the keying input is such that the Electronic Keyed Amp., V3, selects the lagging phase shift network, Z2, the resonant frequency of the LC Network Z1, will be shifted to a lower value. The separation between these two frequencies is determined by the Q of the LC portion and the phase angles of the RC portion of the network.

The F.S. Tone from oscillator amplifier V4.2 is applied to the Output Amplifier Stage, V5, and through the Output Filter to a 600 ohm unbalanced line.



TECHNICAL DATA

NORTHERN RADIO DUAL FREQUENCY SHIFT TONE KEYER

Type 153, Model 1

Keying Input:	1. Relay contacts 2. DC current pulses, positive or negative, neutral or polar 3. DC voltage pulses, positive or negative, neutral or polar
Input Level:	1. DC voltage: ±10 volts minimum 2. DC Current: 45 ma min., positive, negative or polar. 3. Relay: contact rating, 5 ma min.
Keying Input Impedance:	1. DC voltage: 100,000 ohms 2. DC current: 220 ohms
Output Frequencies:	425, 595, 765, 935, 1105, 1275, 1445, 1615, 1785, 1955, 2125, 2295, 2465, 2635, 2805, 2975, 3145 and 3315 cps.
Frequency Shift:	±42.5 cps.
Frequency Stability:	±2 cps for ±10% line voltage change.
Harmonic Content:	All harmonics of the tone are more than 50 db below output level.
Output Level:	+3 dbm
Output Impedance:	600 ohms, unbalanced
Keying Speed:	45 dot cycles
Controls: (per channel)	1. Primary power switch 2. Mark-Space-Line switch 3. Output Level
Power Requirements: (per channel)	110/220 volts, 50/60 cycles. Approximately 25 watts. Connections at rear of chassis.
Dimensions:	3½" x 19" x 15"
Weight: (2 channels)	Approximately 28 pounds
Metering and Test Jacks:	1. Output VU meter 2. Jacks on front panel for monitoring input keying and tone output.
Tube Complement:	1–12AU7 Input Amplifier 1–12AU7 Keying Amplifier 1–12AX7 Keyed Amplifier 1–12AU7 Oscillator-Amplifier 1–6C4 Output Amplifier 1–6X4 Power Rectifier

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TYPE 152,
MODEL 1

NORTHERN RADIO

DUAL FREQUENCY SHIFT TONE CONVERTER

PURPOSE: The Northern Radio Type 152 Model 1 Dual Frequency 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 3½" 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 0 to 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, signal distortion due to noise or bandwidth restriction is greatly minimized.

PRINCIPLE OF OPERATION: To 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.

The incoming F.S. tone, when using fundamental frequency operation, 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, V3.1, to produce square wave pulses. The output of this stage is applied to the Phase Shift Amplifier, V3.2, to produce at its cathode square wave pulses 180 degrees out of phase with those pulses produced at the Cathode of the Gate Generator, V3.1.

Incorporated in the Phase Shift Amplifier V3.2, 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., V3.2, is applied to the Square Wave Generator and Differentiator, V4, 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.

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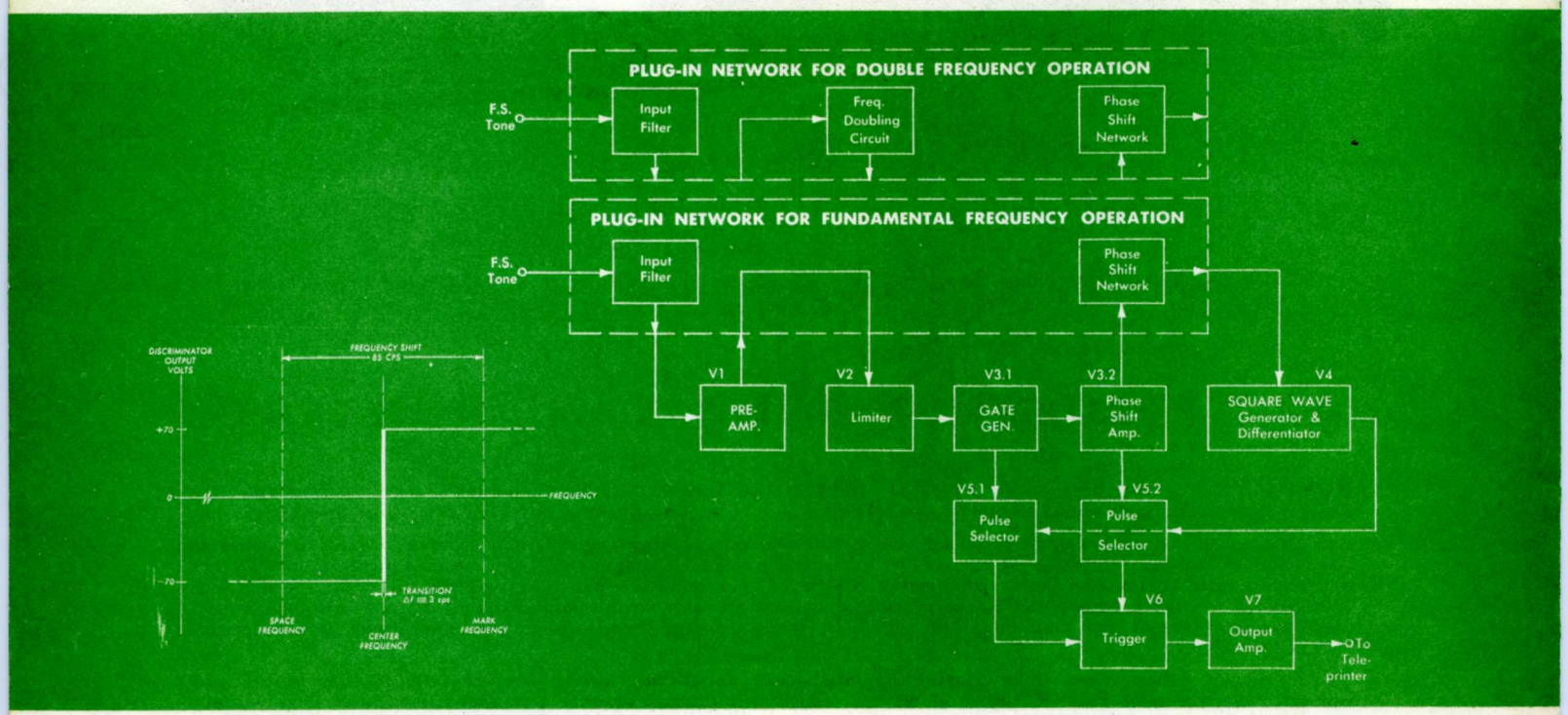
The cathodes of V5.1 and V5.2 are connected respectively to the cathodes of the Gate Generator, V3.1 and Phase Shift Amplifier, V3.2. When the negative portion of the square wave at the cathode of V5.1 occurs at the same time that positive pulses appear at the grid of this stage, negative pulses will 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.

In the 2nd harmonic mode of operation, 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.



TECHNICAL DATA

NORTHERN RADIO DUAL FREQUENCY SHIFT TONE CONVERTER

Type 152, Model 1

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 and 3315 cps.

Input Frequency Shift: ..... ±42.5 cps nominal.

Keying Speed: ..... 45 dot cycles per second maximum.

Output: ..... Neutral DC pulses of 65 ma maximum into 2000 ohm external load, or 110 V. teleprinter 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: ..... 3½" x 19" x 15"

Weight: (2 channels) ..... Approximately 28 pounds

Tube Complement: (per channel) .....
1–12AX7 Pre-Amplifier
1–12AX7 Limiter
1–12AU7 Gate generator and phase-shift amplifier
1–12AU7 Square-wave generator
1–12AU7 Trigger tube
1–12AX7 Pulse selector
1–6AQ5 Output amplifier
2–6X4 Power rectifier
1–OB2 Voltage regulator

NORTHERN RADIO

TERMINAL CONNECTION PANEL Type 162 Model 1

PURPOSE: The Terminal Connection Panel, Type 162 Model 1, is intended for use with telegraph terminal systems such as the 12 and 18 channel Carrier Telegraph bays Type 154 Models 2 and 3. The same Terminal Connection Panel is used on both transmitting and receiving terminals.

The unit provides the terminal connection of incoming and outgoing signal circuits and for their distribution to the individual channel units within the bay.

DESCRIPTION: The Terminal Connection Panel is intended to occupy the top panel space of a standard relay rack. The unit is completely enclosed and provides separate cable inlets for the incoming and outgoing signal circuits (at the top), and for distribution of said signals to the rack mounted units (at the bottom).

Behind an easily removable front plate are located 4 standard telephone terminal blocks, 4 line attenuators and 4 isolation transformers.

When used on a transmitting system, any one of the incoming teletype lines can be tied to any of the Tone Keyer units by suitable connection between two adjacent terminal blocks. Provision is made for 4 outgoing tone telephone lines; each circuit being equipped with an individual level attenuator and isolation transformer. Thus any number of Tone Keyer outputs can be fed into from one to four telephone lines as desired by suitable connection on the Terminal Connection block.

When used in a receiving system the above principle of inter-connection applies, except that the attenuators are not used and are set for zero attenuation.

TECHNICAL DATA:

MOUNTING: Standard 19" Rack.

DIMENSIONS: 19" wide x 10½" high x 3⅝" deep.

WEIGHT: Approximately 6 pounds.

MATERIAL AND FINISH: Aluminum, N.R.C. Grey semi-gloss.

CONNECTIONS: Solder connection to standard telephone terminal blocks.

CIRCUITS:

1. 18 direct current signal circuits (teletype, etc.) which can be cross connected to any of the channel units.
2. 4 balanced 600 ohm tone line circuits. Cross-connection allows to connect any of the individual channel units to one to four tone lines.

CONTROLS: Individual 600 ohm T-pad attenuators for each of the 4 tone lines.

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POWER CONTROL PANEL

Type 161 Model 1

PURPOSE: The Power Control Panel, Type 161 Model 1, provides the means for distributing and controlling the line power supplied to a standard 19" rack, such as the Carrier Telegraph Racks Type 154 Models 2 and 3. The same power supply panel is used on both transmitting and receiving terminals.

DESCRIPTION: The Power Control Panel distributes the line power into two circuits.

The MAIN POWER circuit supplies the units mounted on the Rack. It is controlled by a front panel switch, is fused and equipped with blown-fuse indicators.

The other circuit powers the front panel mounted convenience outlets. This circuit is also fused and equipped with blown-fuse indicator.

TECHNICAL DATA:

MOUNTING: Standard 19" Rack.

DIMENSIONS: 19" wide x 3½" high x 2½" deep.

WEIGHT: Approximately 4½ pounds.

MATERIAL & FINISH: ⅛" steel panel and 1/16" aluminum dust-cover. NRC Grey Semi-Gloss.

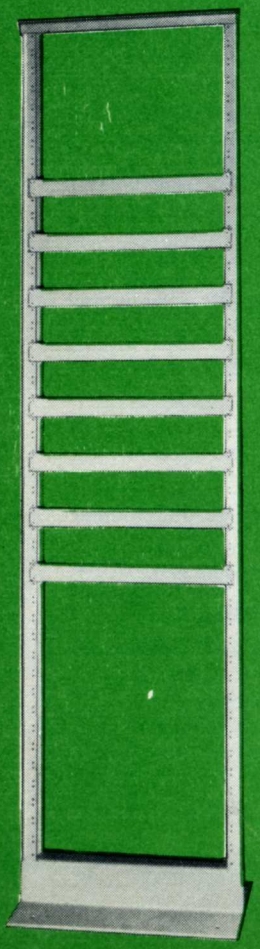
CONNECTIONS: (INPUT & OUTPUT) Standard BX cable or conduit, solder or screw connected.

CIRCUITS:

1. Input: 110/220 volts 50/60 cps
2. Output: a—Two MAIN POWER Outputs for powering the rack units, fused 8 A.
   b—Convenience Outlets fused 8 A.

CONTROLS AND INDICATORS:

1. MAIN POWER On-Off Switch.
2. MAIN POWER Pilot Light.
3. Four (4) Blown-fuse Indicators for Main and Outlet power circuits.



◀ CARRIER TELEGRAPH RACK Type 154, Model 2

PURPOSE: The Type 154 Model 2 Carrier Telegraph Rack is designed to house a complete 12 channel telegraph system. The same rack is used on either transmitting or receiving terminals.

DESCRIPTION: The Type 154 Model 2 consists of:

1. An open channel relay rack, Type NRC 249.

2. Space is provided for one Terminal Connection Panel, Type 162 Model 1.

3. Space is provided for one Power Control Panel, Type 161 Model 1.

4. Separation panels with panel space for a maximum of 9 Dual F.S. Tone Keyers Type 153 Model 1 or F.S. Converters Type 152 Model 1.

5. Cable harness for signal distribution to the rack mounted units, wired for 12 channel operation.

6. 110/220 V. 50/60 cps power wiring both for the rack mounted units and convenience outlets.

The Type 154 Model 3 is similar to the Model 2 except that the cable harness and power wiring is for 18 channels instead of 12.

The illustration on the right shows the combination of three pieces of equipment to make up a basic transmitting or receiving system. This rack combination contains:

one Rack wired for 12 or 18 channels (i.e., Type 154 Model 2 or Model 3 respectively)
one Power Control Panel Type 161 Model 1
one Terminal Connection Panel Type 162 Model 1

When using the Type 154 Model 2, any number of channels may be used up to a maximum of 12 for either transmitting or receiving, by the insertion of the appropriate number of Tone Keyers (Transmitters) Type 153 Model 1 or Converters (Receivers) Type 152 Model 1. Similarly, when using the Type 154 Model 3, a maximum of 18 channels may be used.