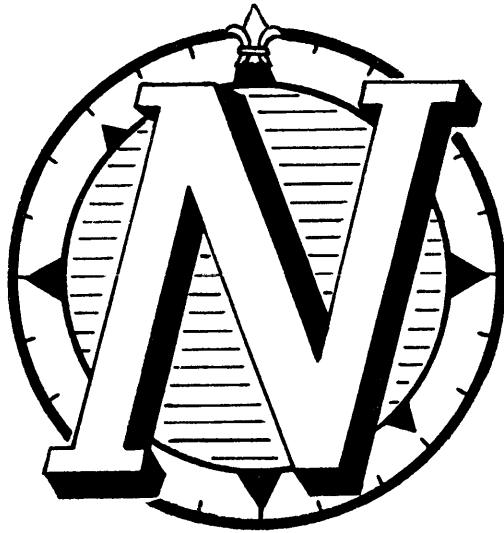


Northern Radio
Type 230 + 235

NORTHERN RADIO
18-CHANNEL TRANSISTORIZED VOICE FREQUENCY
TELEGRAPH SYSTEM, TYPE 230 MODEL 1
AND
16-CHANNEL TRANSISTORIZED VOICE FREQUENCY
TELEGRAPH DIVERSITY SYSTEM, TYPE 235 MODEL 1



NORTHERN RADIO

16-CHANNEL TRANSISTORIZED VOICE FREQUENCY

TELEGRAPH SYSTEM, TYPE 230 MODEL 1

AND

16-CHANNEL TRANSISTORIZED VOICE FREQUENCY

TELEGRAPH DIVERSITY SYSTEM, TYPE 235 MODEL 1

86.84% of ACTUAL SIZE!

Transmitters—18 Channels—Now 1/2 Former Size Receivers—18 Channels—Now 1/6 Former Size

MARK	SPACE	MARK	SPACE	MARK	SPACE	MARK	SPACE	MARK	SPACE	MARK	SPACE	MARK	SPACE	MARK	SPACE	MARK	SPACE	MARK	SPACE	MARK	SPACE				
467.5	SPACE	532.5	NORTHERN RADIO CO. F.S.TONE KEYS	1482.5	SPACE	1572.5	NORTHERN RADIO CO. F.S.TONE KEYS	2337.5	SPACE	2422.5	NORTHERN RADIO CO. F.S.TONE KEYS	3017.5	SPACE	3072.5	NORTHERN RADIO CO. F.S.TONE KEYS	3357.5	SPACE	3357.5	SPACE	3357.5	SPACE	3357.5	SPACE		
582.5	NORTHERN RADIO CO. F.S.TONE KEYS	1062.5	NORTHERN RADIO CO. F.S.TONE KEYS	1657.5	SPACE	1742.5	NORTHERN RADIO CO. F.S.TONE KEYS	2252.5	NORTHERN RADIO CO. F.S.TONE KEYS	2507.5	SPACE	2592.5	NORTHERN RADIO CO. F.S.TONE KEYS	2847.5	SPACE	2932.5	NORTHERN RADIO CO. F.S.TONE KEYS	3102.5	NORTHERN RADIO CO. F.S.TONE KEYS	3102.5	NORTHERN RADIO CO. F.S.TONE KEYS	3102.5	NORTHERN RADIO CO. F.S.TONE KEYS	3102.5	NORTHERN RADIO CO. F.S.TONE KEYS

Voice Frequency Carrier Telegraph System
the most MINIFIED of them all.

NORTHERN RADIO

Transistorized
18 channels in only 15 3/4" panel space

Top shelf shows 18 Frequency Shift Tone Converters, Type 211 Model 1; Next 2 shelves contain 9 each Frequency Shift Tone Converters, Type 212 Model 1

FREQUENCY SHIFT TONE KEYS—Type 211 Model 1
Next 2 shelves contain 9 each Frequency Shift Tone Converters, Type 212 Model 1

FREQUENCY SHIFT TONE CONVERTER—Type 212 Model 1

NORTHERN RADIO CO., INC. 147 W. 22nd Street, New York 11, N. Y.

Write for complete technical data.
Pace-Setters in Quality Communications Equipment
In Canada: Northern Radio Mfg. Co., Ltd., 1950 Bank St., Billings Bridge, Ottawa, Ontario
*Illustrated: 86.84% of actual width, 71.43% of actual height.

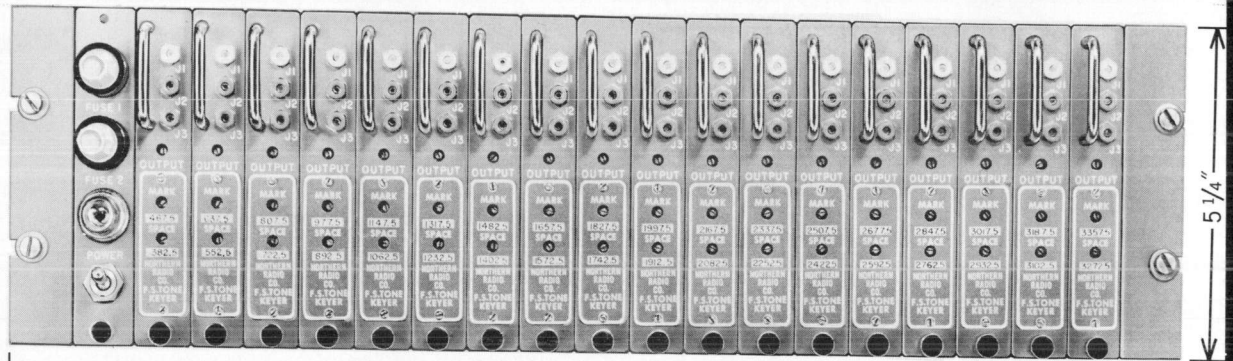
The Northern Radio Voice Frequency Telegraph Multiplex System, Type 230 Model 1 (18 channels), consists of the following:

- 1 - Transistor Tone Keyer Shelf, Type 221 Model 1, containing:
 - 1 - Automatic Power Supply Control Unit, Type NRC 690
 - 2 - Power Supply, Type 223 Model 1
- 18 - Transistor Tone Keyers, Type 211 Model 1, each containing:
 - 1 - Frequency Determining Network covering 211Z2 thru 211Z19
Carrier center frequencies 425 thru 3315 cps with ± 42.5
cps shift
 - 1 - Telephone Line Isolation Unit, Type NRC 693
- 2 - Transistor Tone Converter Shelves, Type 222 Model 1, each containing:
 - 1 - Automatic Power Supply Control Unit, Type NRC 690
 - 2 - Power Supply, Type 223 Model 1
- 9 - Transistor Tone Converters, Type 212 Model 1, each containing:
 - 1 - Frequency Determining Network covering 212Z2 thru 212Z19
Carrier center frequencies 425 thru 3315 cps with ± 42.5
cps shift
 - 1 - Output Relay Plug-In Assembly, Transistorized, NRC 691 or
Mechanical NRC 692
- 1 - Telephone Line Isolation Unit, Type NRC 693
- 1 - Line Battery Power Supply Panel, Type 227 Model 1, with automatic transfer relay containing:
 - 2 - Line Battery Power Supply (Plug-In), Type 228 Model 1



NORTHERN RADIO

18 Transistorized Frequency Shift Tone Keyers Type 211 Model 1



Purpose:

The Northern Radio Frequency Shift Tone Keyer, Type 211 Model 1, is used in multi-channel communication systems to provide the transmitting terminal for teleprinter or teletypewriter 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

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 10 1/2" 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 the 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

Technical Data:

Keying inputs, levels & impedances: 1. Contact keying (internal battery to "dry" contacts) 1 ma. min.; 2. DC current pulses, positive or negative, neutral or polar, high range, 220 ohms, 30 ma. min. low range, 2200 ohms, 0.5 ma. min.; 3. DC voltage pulses, positive or negative, neutral or polar, high range, 100,000 ohms, 10 volts min., low range, 2200 ohms, 1 volt minimum.

Frequency Stability: Standard Networks ± 2 cps total for all causes including $\pm 10\%$ line voltage change and $\pm 25^\circ\text{C}$. from 25°C temperature change.

Harmonic Content: All harmonics of the tone are more than 50 db below output level.

Output Frequencies: All standard VF carrier channels from 425 to 3315 cps. Bandwidth dependent on keying speed requirements. Other frequencies and bandwidths available on special order.

Output Level & Impedance: +5 dbm maximum, into 600

ohms, unbalanced. May be paralleled with any number of other Keyers operating on different frequencies in the same audio system.

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.

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.

Metering and Test Jacks: Tip jacks are provided for making voltage tests and to connect an oscilloscope 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 V DC, 15 MA. Two transistorized power supplies and one automatic change-over relay are mounted on the rear of each mounting shelf.

Dimensions: 7/8" wide x 5 1/4" high x 10 1/2" 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.

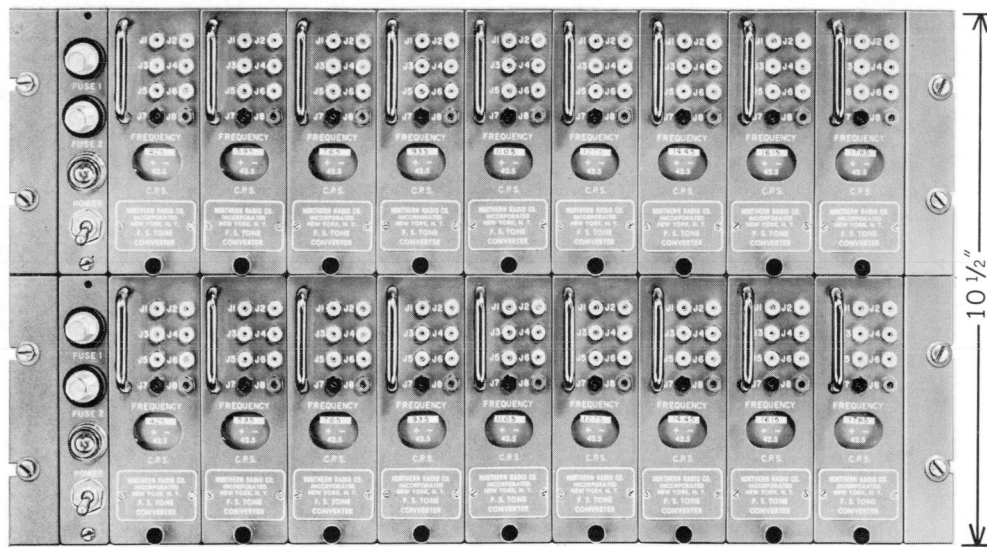
NOW 1/12 OF FORMER SIZE!



NORTHERN RADIO

18 Transistorized Frequency Shift Tone Converters Type 212 Model 1

NOW 1/6 OF FORMER SIZE!



Purpose:

The Northern Radio Frequency Shift Tone Converter, Type 212 Model 1, is used in communications systems to provide the receiving terminal for teleprinter or telemetering operation over microwave or metallic circuits.

The frequency shifted tones which contain the intelligence pulses are received over the transmission facilities and converted electronically into DC voltage pulses which are suitable for directly driving printers which are equipped

with internal repeating relays. Sockets are provided for "plugging in" either electro mechanical or electronic relay when required.

The flexible designs of this unit allows it to be used as a link in telegraph systems which may include signal improvement means such as signal regeneration and/or diversity signal receiving means. Supplemental equipment required for these systems may be connected to the Type 212 Converter.

Description:

The Frequency Shift Tone Converter, Type 212 Model 1, is a completely transistorized unit contained in a 1 7/8" x 5 1/4" x 10 1/2" housing. It 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 a DC amplifier which provides

the output voltage to the load circuit.

The use of simple pulse circuitry (following proven concepts) 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 few cycles off center frequency, a signal distortion due to noise or band width restriction is greatly minimized.

Technical Data:

Input Level & Impedance: -48 dbm to +8 dbm into 600 ohms, unbalanced. May be paralleled with any number of other converters operating on different frequencies in the same audio system.

Input Frequencies: All standard telegraph VF channels from 425 to 3315 cps. Bandwidth dependent on keying speed requirements. Other frequencies and bandwidths available on special order.

Output: Neutral DC voltage pulses of 10 volts maximum across a 2000 ohm external load. Polar pulses ± 10 volts across a 2000 ohm external load. Output drives appropriate voltage-to-current converters, such as Northern Radio Type 213 Transistor Relay, which provides proper teleprinter operating currents. Printers which are already equipped with internal repeating relays may be driven

directly from the normal voltage output terminals of the Type 212 Converter when so desired.

Metering and Test Jacks: Tip jacks are provided for making voltage tests and oscilloscope connections to the input, output and other appropriate circuit points.

Controls: A primary power switch is provided on the front panel. No other operating controls are required.

Power Requirements: 14 V DC at 30 MA. Two transistorized power supplies and one automatic change-over relay are mounted on the rear of each mounting shelf.

Dimensions: 1 7/8" wide x 5 1/4" x 11 3/4" deep. For rack mounting a number of these units, a shelf assembly is available accommodating nine (9) units in a panel height of 5 1/4".

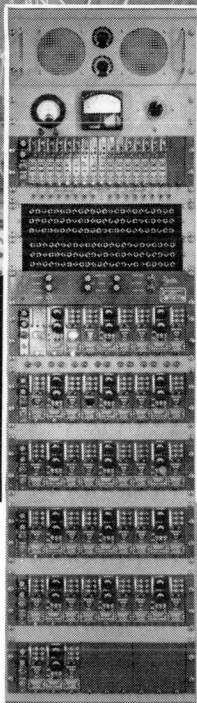
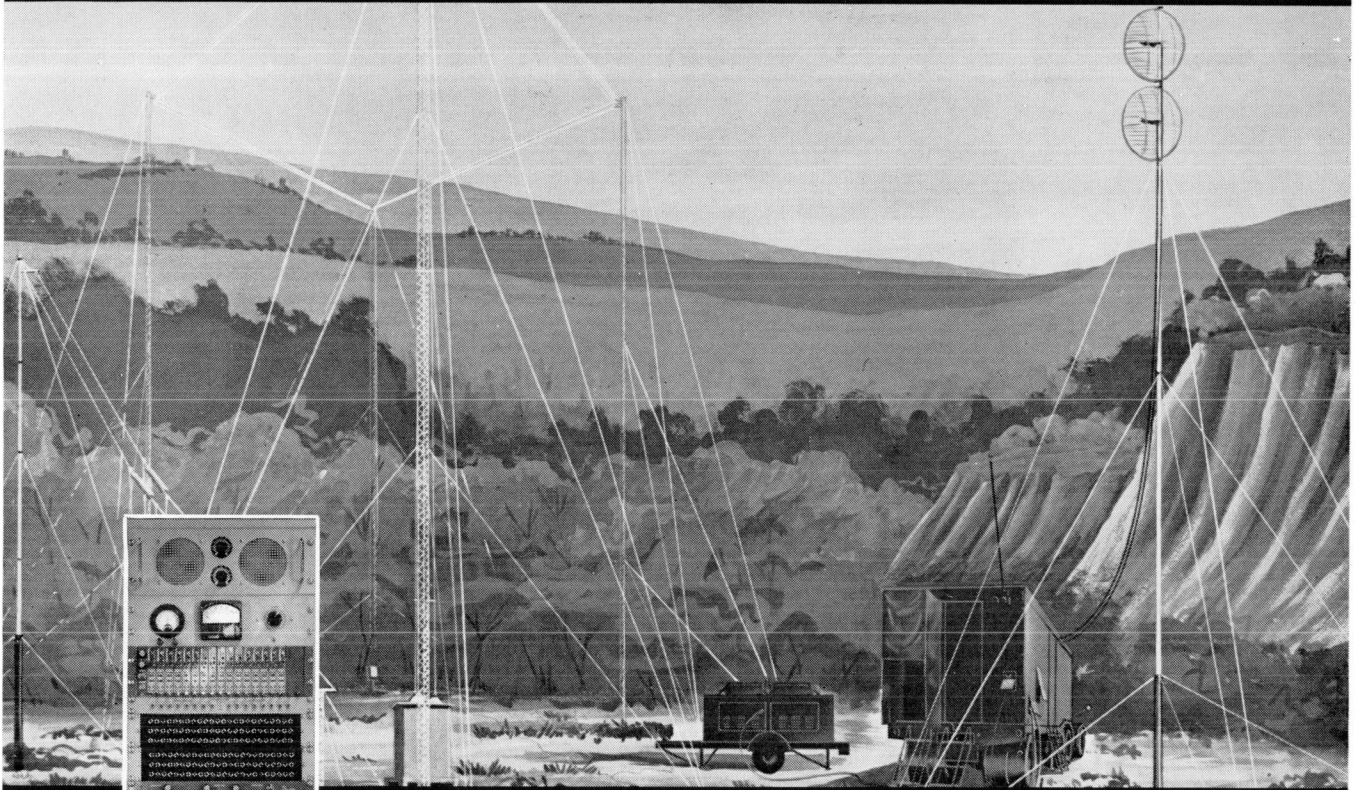
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In Canada: Northern Radio Mfg. Co., Ltd., 1950 Bank St., Billings Bridge, Ottawa, Ontario

*the STRAC Commander's
16-channel link
into the global comm net...*

SIGNAL CORPS

AN/TSC-16 EMPLOYS



NORTHERN RADIO

TRANSISTORIZED 16-Channel VF Diversity Telegraph Terminal

Write for free catalog to Dept. S.



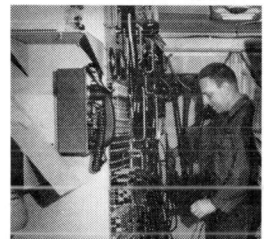
NORTHERN RADIO CO., INC.

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147 West 22nd Street, New York 11, N. Y.

In Canada: Northern Radio Mfg. Co., Ltd., 1950 Bank St.,
Billings Bridge, Ottawa, Ontario.

The Northern Radio Company Voice Frequency Telegraph Terminal, Type 235 Model 1, is a multi-channel frequency shift communications terminal used for transmission and reception of telegraph, teleprinter or telemetering signals over channels subject to fading or attenuation changes, such as long distance point-to-point radio circuits. It provides the necessary equipment for transmission of 16 intelligence channels over one (1) voice frequency circuit, and diversity reception of 16 similar channels, received through two (2) voice frequency circuits. The two (2) voice frequency receiving circuits are normally obtained from radio receivers arranged for space diversity reception. Additional means are provided to allow reception on a frequency diversity basis or a combination of space and frequency diversity may be used for maximum reliability, when conditions are such as to require same.



SPECIFICATIONS FOR
VOICE FREQUENCY TELEGRAPH TERMINAL (TRANSISTORIZED)
MULTI-CHANNEL F.S. SYSTEM FOR SPACE DIVERSITY
TYPE 235 MODEL 1

1 GENERAL

Purpose:

The Northern Radio Company Voice Frequency Telegraph Terminal, Type 235 Model 1, is a multi-channel frequency shift communications terminal used for transmission and reception of telegraph, teleprinter or telemetering signals over channels subject to fading or attenuation changes, such as long distance point-to-point radio circuits. It provides the necessary equipment for transmission of 16 intelligence channels over one (1) voice frequency circuit and diversity reception of 16 similar channels received through two (2) voice frequency circuits. The two (2) voice frequency receiving circuits are normally obtained from radio receivers arranged for space diversity reception. Means are provided to allow reception on a frequency diversity basis rather than space diversity. A combination of space and frequency diversity may be utilized for maximum reliability, when conditions are such as to require same.

Description:

The Northern Radio Company Voice Frequency Telegraph Terminal, Type 235 Model 1, includes the necessary equipment for transmission and reception of 16 channels of telegraphic intelligence, including the necessary power supplies, jack fields, terminal strips and necessary shelves and mounting hardware to provide a complete operating terminal. All necessary equipment may be mounted in approximately 2/3 of one standard 7 foot telegraph rack. For transmission, Northern Radio Frequency Shift Tone Keyers, Type 211 Model 1, are supplied. D.C. current keying is normally employed for controlling these Keyers.

Received voice frequency channels are normally passed through two (2) Line Amplifiers (Northern Radio Type 236 Model 1) and into the inputs of Northern Radio Type 212 Model 2, Frequency Shift Tone Converters. Appropriate telegraph channel filters in the Converters select out the proper tone signal for demodulation by each Converter. Pairs of Converters receiving the same intelligence over different telegraph channels are connected together by means of Northern Radio Diversity Combiners, Type 234 Model 1, and the stronger of the two signals control the telegraph channel output device (which may be either a transistorized or electro-mechanical relay), normally supplied as plug-in units in one of the Converters.

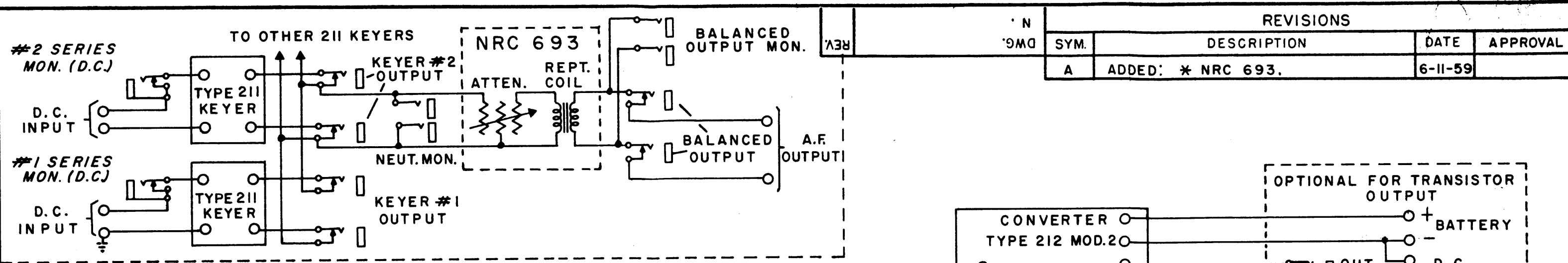
The combination of Northern Radio Diversity Combiner, Type 234 Model 1, with Frequency Shift Tone Converters, Type 212 Model 2, produces a Diversity receiving system which follows well proven concepts but, due to attention to the important design details, far outperforms previously available systems. The Diversity Combiner, Type 234 Model 1, employs logarithmic compression circuitry in obtaining the control voltage output so that useful switching control is obtained at signal input levels as low as -60 dbm. Switching sensitivity is approximately uniform on the basis of the relative db levels of the two signals over the entire

Description: (cont'd)

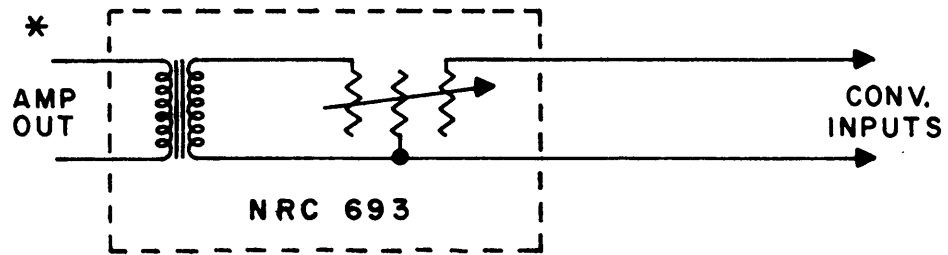
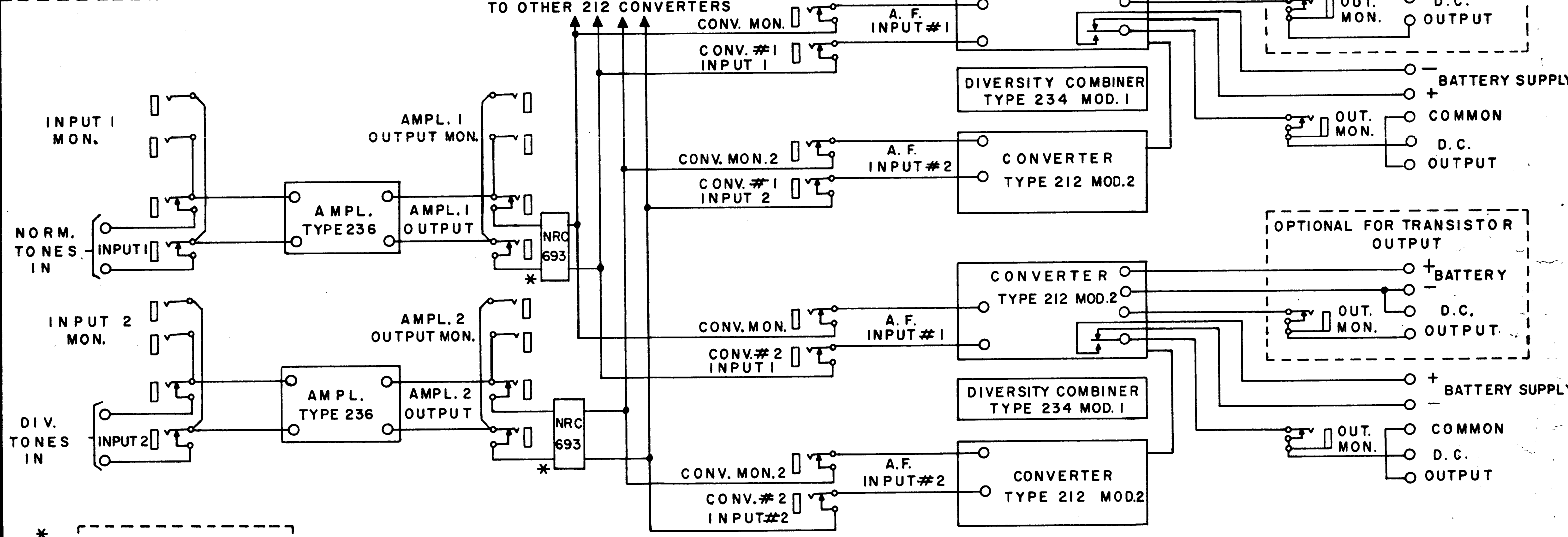
operating range of -60 dbm to 0 dbm. The companion Frequency Shift Tone Converters also function perfectly at any level within this range and handle large dynamic level changes without introducing error, due to special design of the limiting circuitry.

The details of the individual units used in this system are incorporated in the specification of the following units:

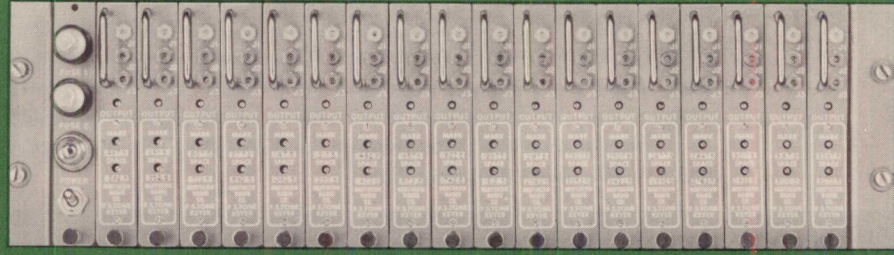
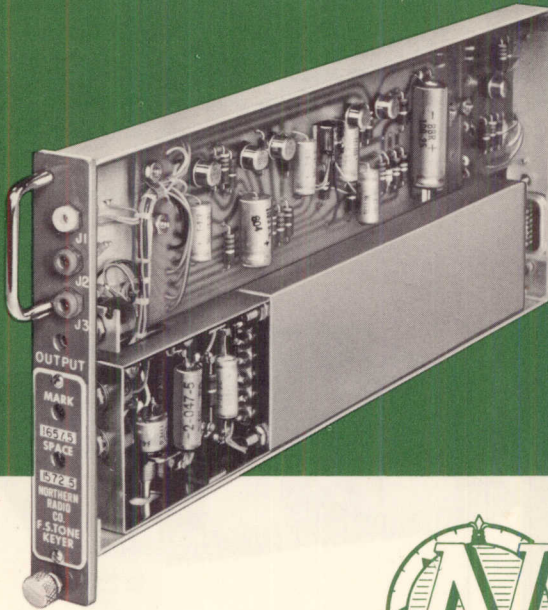
- Type 211 Model 1 - Tone Keyer
- Type 212 Model 2 - Tone Converter
- Type 234 Model 1 - Diversity Combiner
- Type 236 Model 1 - Line Amplifier
- Type 171 Model 1 - Volume Level Indicator
- Type 221 Model 1 - Tone Keyer Shelf
- Type 222 Model 2 - Tone Converter Shelf
- Type 223 Model 1 - Power Supply



REVISIONS			
SYM.	DESCRIPTION	DATE	APPROVAL
A	ADDED: * NRC 693.	6-11-59	



* UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES $\pm 1/64$ $\pm .005$ MATERIAL: FINISH:	DRAFTSMAN J. G.	DATE 4-14-59	NAME: SCHEMATIC VOICE FREQ. TELEGRAPH TERM. (TRANSISTORIZED) MULTI-CHANNEL FREQ. SHIFT SYS. FOR SPACE DIVERSITY TYPE 235 MOD. 1	NORTHERN RADIO COMPANY INCORPORATED 143-147 WEST 22ND ST. N.Y. 11 NEW YORK
	CHECKER			
	ENGINEER			
	APPROVAL			
	SCALE: NONE	SH. 1 OF 1	DWG. No. 235-1-01	DWG. SIZE B



ALL-TRANSISTOR

Frequency Shift Tone Keyer

Type 211 Model 1

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: This Tone Keyer, Type 211 Model 1, is a completely transistorized unit contained in a $\frac{7}{8}$ " x $5\frac{1}{4}$ " x $10\frac{1}{2}$ " housing. By changing a network, it will operate on any of the standard tone channels. The oscillator frequency of each unit is shifted ± 42.5 cps. about the desired channel center frequency. This frequency shift is accomplished in such a manner that no appreciable frequency transient occurs other than the smooth transition from one frequency to the other. Transient conditions that create signal distortion are, therefore, eliminated in this unit at the transmitting terminal.

This Keyer makes use of a 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 the block diagram on the next page, 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 the oscillation loop which also includes the oscillator amplifier and LC tank circuit.

(see over)

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

NORTHERN RADIO COMPANY, inc.

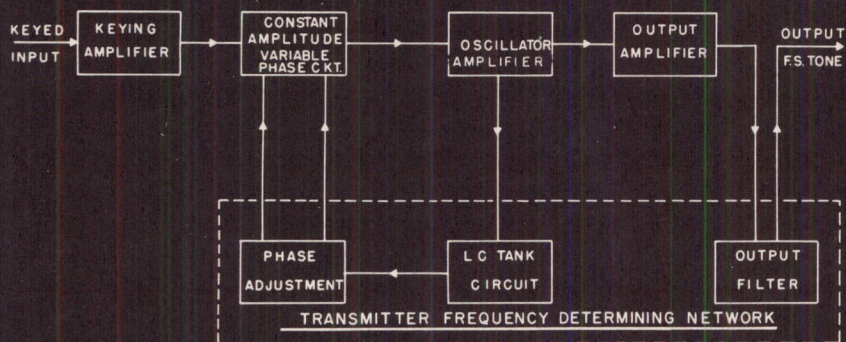
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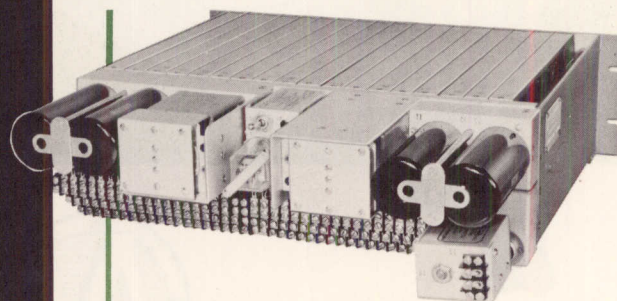
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If the keying input is such that the keying stage advances the phase of the variable phase stage, then the frequency of the LC network will be shifted to a higher value to cancel the phase shift. Conversely, if the keying stage retards the phase of 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 plug-in network unit.

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.



BLOCK DIAGRAM FS TONE KEYER TYPE 211 MOD. I



Rear view of a FS Tone Keyer Shelf, Type 221 Model 1, showing 2 Transistorized Power Supplies and Changeover Relay. Another shelf arrangement is available as the Type 239 Model 1, providing for 1 to 6 each Keyers and 1 to 6 each Converters, all on one shelf.

TECHNICAL DATA

- Keying inputs, levels and impedances:**
- Contact keying (internal battery to "dry" contacts) 1 ma. min.
 - DC current pulses, positive or negative, neutral or polar, high range, 220 ohms, 30 ma. min. low range, 2200 ohms, 0.5 ma. min.
 - DC voltage pulses, positive or negative, neutral or polar, high range, 100,000 ohms, 10 volts min., low range, 2200 ohms, 1 volt minimum.
- Frequency Stability:** Standard Networks
 ± 2 cps total for all causes including
 $\pm 10\%$ line voltage change and
 $\pm 25^\circ$ C. from 25° C. temperature change
- Harmonic Content:** All harmonics of the tone are more than 50 db below output level.
- Output Level:** + 5 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:**
- "Mark" frequency
 - "Space" frequency
 - Output Level
- All controls available from front of panel.
- Power Requirements:** 14 V DC, 15 MA.
- Dimensions:** $\frac{7}{8}$ " wide x $5\frac{1}{4}$ " high x $10\frac{1}{2}$ " deep. For rack mounting a number of these units, a shelf assembly is available accommodating eighteen (18) units in a panel height of $5\frac{1}{4}$ ".
- Weight:** Approximately 3 lbs. including transmitting frequency determining network.
- 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.

TRANSISTORIZED POWER SUPPLY

Type 223 Model 1

PURPOSE: The Northern Radio Power Supply (plug-in) Type 223 Model 1, is used as a source of operating power for transistorized equipment, such as the Northern Radio Type 211 Keyers, Type 212 Converters, and Type 234 Diversity Combiners.

The Type 223 Power Supplies are normally used in pairs, with one supply operating and the other "standing by" to supply several pieces of equipment, with loads totaling up to 450 milliamperes.

DESCRIPTION: The Power Supply, Type 223 Model 1, is a solid state regulated rectifier unit, $2\frac{1}{2}$ " wide x $7\frac{1}{2}$ " long x $5\frac{1}{2}$ " high, equipped with a plug, and locking screws for mounting on the back of appropriate panels or shelves, such as the FS Tone Keyer Shelf, Type 221 Model 1, and FS Tone Converter Shelf, Type 222 Model 2. One supply is capable of providing adequate power for the normal operating equipments associated with each shelf. However, the shelves have provision for mounting two such supplies and incorporate an automatic changeover system to place the "stand-by" supply in operation if the first unit fails. This power supply incorporates a transformer so that there is no connection between the AC input and DC output. Further, all electrical connections are floating with respect to the chassis so that any grounding arrangement desired may be used.

The use of solid state devices 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 somewhat dependent on the characteristics of the load connected to the unit. Proper stabilization circuitry and adequate heat sinks have been provided to assure continuous operation without fear that excessive temperature rises will occur due to unit dissipation.

TECHNICAL DATA:

- A. C. Input:** 115/230 volts AC, 50/60 cycles $\pm 10\%$.
- D. C. Output:** 13 volts DC $\pm 1\frac{1}{2}$ volts, 420 milliamperes DC, maximum.
- Ripple:** Less than 20 millivolts DC.
- Special Features:** Short circuit protection. The Power Supply is internally current limited to prevent damage due to external short circuits, or internal failure of filter capacitors. Maximum current under short circuit conditions is limited to less than 800 milliamperes. Plug-in construction fits on appropriate panels and shelves such as Northern Radio Type 221, 222 and 239 Shelves.

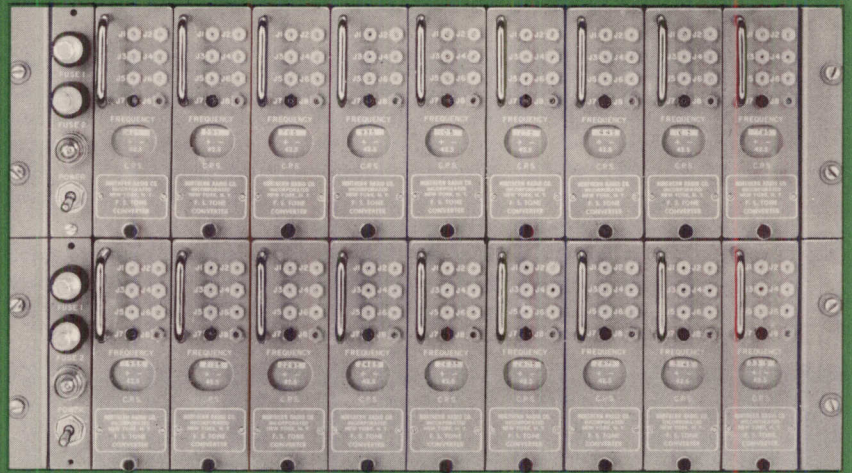
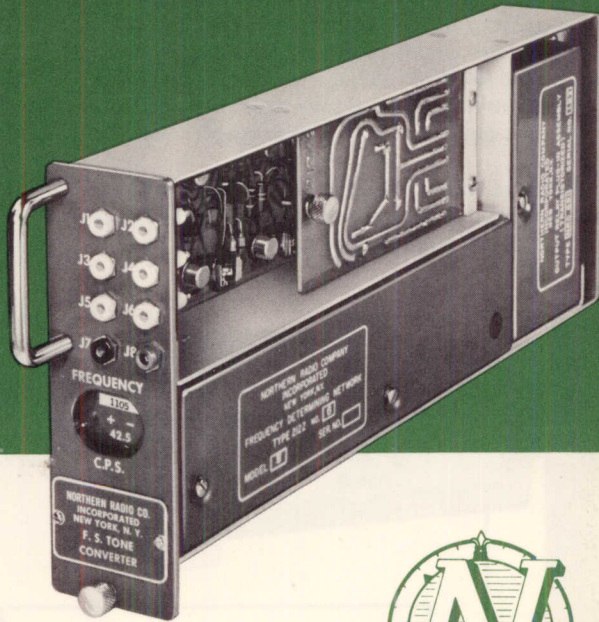
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In Canada: Northern Radio Mfg. Co., Ltd., 1950 Bank St., Billings Bridge, Ottawa, Ontario.

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NORTHERN RADIO

ALL-TRANSISTOR

Frequency Shift Tone Converter

Type 212 Model 2

PURPOSE: The Northern Radio Frequency Shift Tone Converter, Type 212 Model 2, is used in communications 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 bandwidths (and associated keying speeds) to suit special requirements.

The frequency shifted tones which contain the intelligence pulses are received over the transmission facilities and converted electronically into D.C. voltage pulses which are suitable for directly driving printers which are equipped with internal repeating relays. Sockets are provided for "plugging in" either electro-mechanical or electronic relays when required.

The flexible designs of this unit allow it to be used as a link in telegraph systems which may include signal improvement means such as signal regeneration and/or diversity signal receiving means. Supplemental equipment required for these systems may be connected to the Type 212 Converter.

DESCRIPTION: The Frequency Shift Tone Converter, Type 212 Model 2, is a completely transistorized unit contained in a 1 7/8" x 5 1/4" x 11 3/4" housing. By changing a plug-in network, it will operate on any of the standard tone channels. The input of each unit consists of limiting amplifiers which are followed by a frequency discriminating circuit to demodulate the frequency shifted tones. This demodulated signal drives a DC amplifier which provides the output voltage to the load circuit.

The use of simple balanced limited circuitry following demodulation 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 few cycles off center frequency, signal distortion due to noise or bandwidth restriction is greatly minimized.

Balanced limiting amplifier circuits followed by diode limiters make it possible for this converter to handle very large instantaneous signal level variations without introducing errors.

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 dissipations.

PRINCIPLE OF OPERATION: Referring to the block diagram on the next page, the incoming frequency shift tone is first passed through an appropriate bandpass filter to remove noise, interference and any other undesired signals, and into a limiter amplifier. The output of this limiter

(see over)

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LINE AMPLIFIERS
DIVERSITY RECEIVERS
RADIO MULTIPLEX SYSTEMS
MULTI-CHANNEL TONE SYSTEMS
FREQUENCY SHIFT CONVERTERS
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MASTER OSCILLATORS
DEMODULATORS
TONE KEYS
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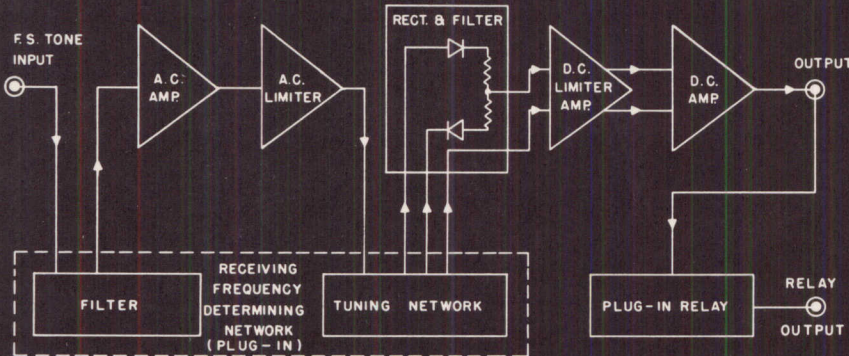
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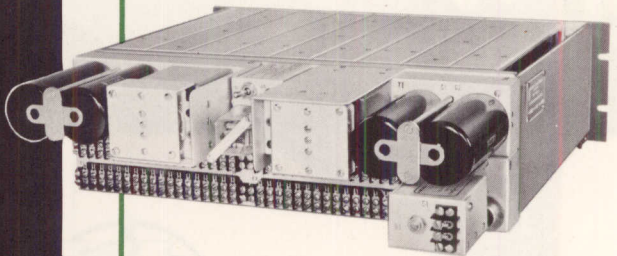
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amplifier is a push-pull square wave signal which is fed into a two-coil discriminator for demodulation. The signal from each coil is full wave rectified (to minimize signal distortion), and the outputs of the two full wave rectifiers are differentially combined. The resultant signal is applied to a balanced DC amplifier circuit, which requires only a small fraction of the available signal to produce full output. This arrangement has the effect of "slicing" a small portion from the center of the discriminator signal, thus producing full "MARK or SPACE" output condition from a small part of the frequency deviation of the incoming signal. The DC amplifier serves as a proper impedance and voltage coupler between the DC limiter and the external load.

It should be noted that the input filter and the tuning network of the phase shifter amplifier are mounted together on a sub-assembly package which plugs into the Converter package. Thus, the basic Converter unit may be used for any keying speed or tone frequency by selection of the proper receiving frequency determining network.



BLOCK DIAGRAM FUNCTION FS TONE CONVERTER TYPE 212 MOD. 2



Rear view of a FS Tone Converter Shelf, Type 222 Model 1, showing 2 Transistorized Power Supplies and Changeover Relay. Another shelf arrangement is available as the Type 239 Model 1, providing for 1 to 6 each Keyers and 1 to 6 each Converters, all on one shelf.

TRANSISTORIZED POWER SUPPLY

Type 223 Model 1

PURPOSE: The Northern Radio Power Supply (plug-in) Type 223 Model 1, is used as a source of operating power for transistorized equipment, such as the Northern Radio Type 211 Keyers, Type 212 Converters, and Type 234 Diversity Combiners.

The Type 223 Power Supplies are normally used in pairs, with one supply operating and the other "standing by" to supply several pieces of equipment, with loads totaling up to 450 milliamperes.

DESCRIPTION: The Power Supply, Type 223 Model 1, is a solid state regulated rectifier unit, 2 1/2" wide x 7 1/2" long x 5 1/2" high, equipped with a plug, and locking screws for mounting on the back of appropriate panels or shelves, such as the FS Tone Keyer Shelf, Type 221 Model 1, and FS Tone Converter Shelf, Type 222 Model 2. One supply is capable of providing adequate power for the normal operating equipments associated with each shelf. However, the shelves have provision for mounting two such supplies and incorporate an automatic changeover system to place the "stand-by" supply in operation if the first unit fails. This power supply incorporates a transformer so that there is no connection between the AC input and DC output. Further, all electrical connections are floating with respect to the chassis so that any grounding arrangement desired may be used.

The use of solid state devices 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 somewhat dependent on the characteristics of the load connected to the unit. Proper stabilization circuitry and adequate heat sinks have been provided to assure continuous operation without fear that excessive temperature rises will occur due to unit dissipation.

TECHNICAL DATA:

A. C. Input: 115/230 volts AC, 50/60 cycles $\pm 10\%$.

D. C. Output: 13 volts DC $\pm 1 1/2$ volts, 420 milliamperes DC, maximum.

Ripple: Less than 20 millivolts DC.

Special Features: Short circuit protection. The Power Supply is internally current limited to prevent damage due to external short circuits, or internal failure of filter capacitors. Maximum current under short circuit conditions is limited to less than 800 milliamperes.

Plug-in construction fits on appropriate panels and shelves such as Northern Radio Type 221, 222 and 239 Shelves.

TECHNICAL DATA

Input Impedance: 600 ohms, unbalanced. May be paralleled with any number of other converters operating on different frequencies in the same audio system.

Input Level: -60 dbm to +8 dbm

Input Frequencies: All standard telegraph V.F. channels from 255 cps to 3655 cps. Bandwidth dependent on keying speed requirements. Other frequencies and bandwidth available on special order.

Output: Neutral D.C. voltage pulses of 5 volts maximum across a 2000 ohm external load. Polar pulses ± 10 volts across a 2000 ohm external load. Output drives appropriate voltage-to-current converters, such as Northern Radio Type NRC 691 Transistor Relay which provides "Dry Contact" Keying to external battery supply. Printers which are already equipped with internal repeating relays may be driven directly from the normal voltage output terminals of the Type 212 Converter when so desired.

Metering and Test Jacks: Tip jacks are provided for making voltage tests and oscilloscope connections to the input, output and other appropriate circuit points.

Controls: None.

Power Requirements: 14 V D.C. at 30 MA.

Dimensions: 1 7/8" wide x 5 1/4" x 11 3/4" deep. For rack mounting a number of these units, a shelf assembly is available accommodating nine (9) units in a panel height of 5 1/4".

Weight: Approximately 3 lbs. including receiving frequency determining network.

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

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SPECIFICATIONS FOR
FREQUENCY SHIFT TONE KEYS & CONVERTER SHELF
TYPE 239 MODEL 1

Purpose:

The Northern Radio Frequency Shift Tone Keyer & Converter Shelf, Type 239 Model 1, is used as a mounting for holding up to six (6) each Northern Radio Company Type 211 Keyers and Type 212 Converters, and two (2) Power Supplies, Type 223 Model 1. It includes line isolation transformers and attenuators for adjusting the levels of the incoming and outgoing tone multiple signals, as well as terminal blocks for making all necessary external tone and DC connections to the Keyers and Converters. It includes a power control panel containing a power switch, pilot light, and line fuses for the Power Supplies. It also includes a power cord for connecting to the A.C. line.

Description:

The Northern Radio Frequency Shift Tone Keyer & Converter Shelf, Type 239 Model 1, is a 19" wide shelf which mounts in a standard relay rack, occupying 5-1/4" height and approximately 19" overall depth when Power Supplies are mounted in the space provided on the rear of the Shelf. The bottom of the Shelf is equipped with appropriate guides to accept a maximum of six (6) Northern Radio Company Type 211 Keyers and six (6) Type 212 Converters. Sockets are installed in the rear of the Shelf to automatically mate with matching plugs on the rear of the Type 211 Keyers and Type 212 Converters. Tapped holes along the bottom of the front of the Shelf allow individual units to be locked in place by tightening thumbscrews provided on the units.

When fully equipped with Keyers, Converters and Power Supplies, the Type 239 Model 1 Shelf provides a complete six-channel full duplex telegraph terminal, ready to operate when provided with appropriate A.C. input power and signal circuit. One (1) Shelf may be used alone as a complete six-channel terminal, including essential terminal connection blocks, or two (2) or more Type 239 Shelves may be associated with each other and/or with separate soldered type terminal connection panels, such as are used in the Northern Radio Type 229 Model 1, 12-Channel Voice Frequency Telegraph Multiplex System.

Technical Data:

Dimensions:	19" wide x 5-1/4" high x 19-1/2" deep
Mounting:	Mounts in a standard relay rack
Weight:	Unloaded: Approximately 8 lbs. Loaded with six (6) each Keyers and Converters and two (2) Power Supplies: 65 lbs.

Specifications
FS Tone Keyer & Converter Shelf

Type 239 Model 1

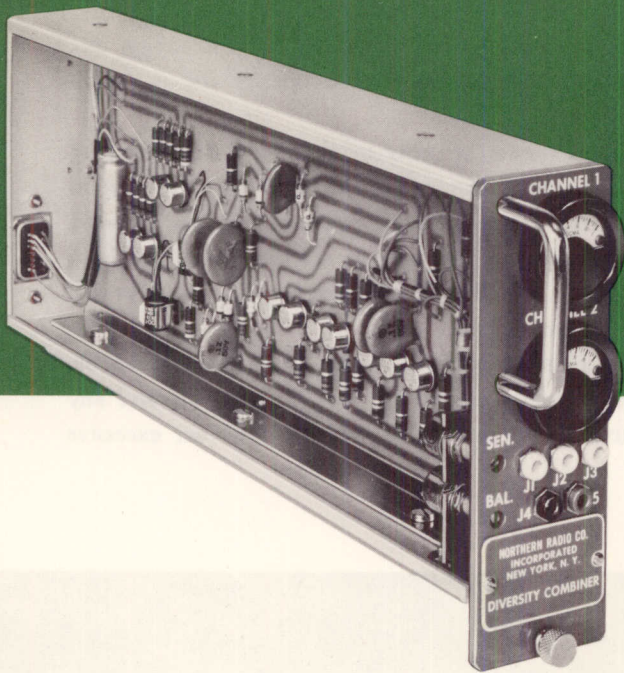
Technical Data: (cont'd)

AC Input:

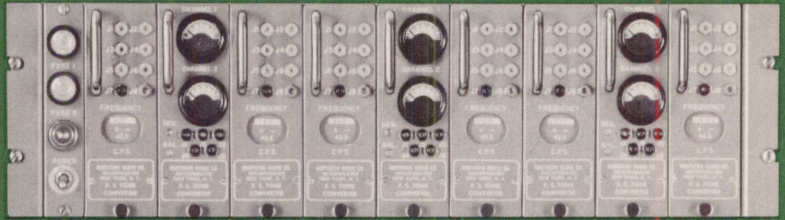
115/230 volts AC, 50/60 cycles \pm 10%,
6 watts

Special Features:

Mounts six (6) each Type 211 Keyers and Type 212 Converters and two (2) Type 223 Power Supplies. Includes line isolation transformers and attenuators for tone multiple circuits. Includes terminal blocks for connection with external signal circuits.



TYPE 234 MODEL 1



NORTHERN RADIO

TRANSISTORIZED DIVERSITY COMBINER

PURPOSE: The Northern Radio Company Diversity Combiner (Transistorized), Type 234 Model 1, is used on telegraph communication circuits which are subject to variations in attenuation, such as point-to-point radio circuits, to improve reliability of reception.

The Diversity Combiner is located at the receiving end of a circuit, as a part of a Diversity Receiving System, Northern Radio Type 235 Model 1. Two Northern Radio Frequency Shift Tone Converters, Type 212 Model 2, are used in conjunction with each Diversity Combiner, Type 234 Model 1.

The unit is primarily intended to continuously monitor two (2) frequency shift signals (containing the same intelligence) which are applied to the inputs of the Type 212 Converters, and to select the better of these two signals and to provide necessary controls so that the combined output from the two Type 212 Converters will be essentially the output of the better channel.

DESCRIPTION: (Refer to Block Diagram on next page.)

The Northern Radio Company Diversity Combiner, Type 234 Model 1, is a completely transistorized unit contained in a 1 $\frac{7}{8}$ " x 5 $\frac{1}{4}$ " x 11 $\frac{3}{4}$ " housing. It will continuously compare the levels of two signals applied to its two input terminals and produce two output control signals with the amplitudes of these control signals determined by the relative amplitudes of the incoming signals.

The method of operation of the Type 235 Diversity System is conventional and well known. The actual combining of the two signals is done at the output of the discriminator demodulators, which are connected in parallel. The signal which is instantaneously stronger is passed by diode selection to the common lowpass filter terminating circuit. This method of selection has no time constants of its own and is therefore instantaneous. Also, it functions at all signal levels. However, it is not completely satisfactory since fairly large differences in the signal amplitude are necessary to effect complete suppression of the weaker signal. The function of the Diversity Combiner, Type 234 Model 1, is to accentuate the difference in the dis-

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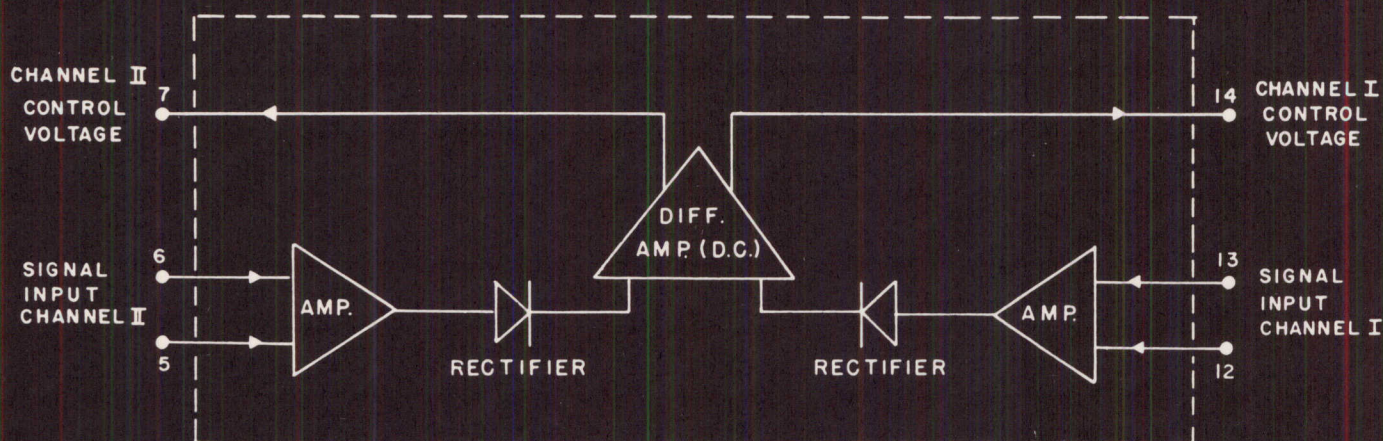
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criminator outputs and thus complete the desired suppression of the weaker signal. In order to obtain this result, the Combiner either increases or decreases the supply voltage available to operate the push-pull limiters which drive the two discriminators.

The Type 234 Model 1, Diversity Combiner, uses novel means in order to obtain effective diversity action over a wide dynamic operating range. Signal amplification is combined with semi-logarithmic compression to provide a control voltage effective over a 60 db range of input signal level variation. Furthermore, the control voltage variation is approximately the same for a given *db difference* in the signal levels without regard to their actual strengths. The end result of this action is that the Diversity action is as good at low signal levels (where it is needed) as it normally is at high signal levels.

The use of transistors throughout this unit results in a device which is more compact, more reliable and far more effective than has been previously possible. Internal heat in the unit 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.



TECHNICAL DATA:

NORTHERN RADIO DIVERSITY COMBINER Type 234 Model 1

Modulation: ... Frequency shift keying, 300 cps to 10 K.C.

Signal Keying Speed: ... 50 dot cycles/sec., normal. Higher speeds on special order.

Signal Level: ... 0 dbm to -60 dbm at input of Type 212 Model 2 Converters.

Output Control Voltage: ... Differential voltage control to push-pull limiter in Type 212 Model 2 Converters.

Control Sensitivity: ... Effective over entire signal level range of 0 dbm to -60 dbm.

Diversity Switching Method: ... Diode level selection and limiter output control.

Controls (on front panels): ... Signal Balance - Sensitivity

Power Requirements: ... 14 V D.C. 30 MA

Dimensions: ... 1 7/8" wide x 5 1/4" x 11 3/4" deep. For rack mounting a number of these or similar units, a shelf assembly is available accommodating nine (9) units in a panel height of 5 1/4".

Weight: ... Approximately 1 1/2 lbs.

SPECIFICATIONS FOR

LINE AMPLIFIER (TRANSISTORIZED)

TYPE 236 MODEL 1

Purpose:

The Northern Radio Line Amplifier (Transistorized), Type 236 Model 1, is a transistorized low distortion speech input amplifier. Its gain and frequency are more than adequate for use in communication systems. It is ideally suited for studio or program amplification to boost the output of microphones, preamplifiers, or teletype tone signals to a level suitable for telephone lines or radio transmitter input. It is also suited for use as a low level monitoring amplifier.

This amplifier is designed to slide into the Northern Radio Company Type 222 Shelf. The shelf is equipped to accommodate nine units of this amplifier or combinations of amplifiers and Type 212 Converters or other similar size units.

Description:

The Type 236 Model 1, Line Amplifier, is a two-stage push-pull amplifier. The frequencies are limited to the range of 300 to 10,000 cps for use in teletype tones and speech intelligence. Within its range, it has excellent amplitude response and very low distortion due to the use of push-pull Class A amplification, and adequate negative feedback. Satisfactory input attenuation is provided as are balanced input and output terminals for 600 or 150 ohms. Impedance change is effected by straps easily accessible on the amplifier printed circuit board. Pin jacks are included for monitoring purposes.

Technical Data:

Input Impedance:	150 ohm single ended and 600 ohm balanced
Output Impedance:	150 ohm single ended and 600 ohm balanced
Transmission Gain:	40 VU
Input Level:	For rated output of +8 VU, -32 VU to +8 VU
Output Level:	Maximum +14 VU at 8% distortion Rated +8 VU at 1% distortion
Frequency Response:	+ 1VU 300 to 10,000 cps
Noise Level:	80 VU below output level of +8 VU
Controls:	Input Level Control

NORTHERN RADIO COMPANY, Incorporated
Specifications

Line Amplifier (Transistorized)
Type 236 Model 1

Technical Data: (cont'd)

Power Requirements:

14 V DC, 50 milliamperes

Dimensions:

1-7/8" wide x 5-1/4" high x 11-3/4" deep
For rack mounting a number of these or
similar units, a shelf assembly is available
accommodating nine (9) units in a panel
height of 5-1/4".

Weight:

2-1/2 lbs

SPECIFICATIONS FOR
REGENERATIVE REPEATER (TRANSISTORIZED)
TYPE 217 MODEL 1

1. GENERAL

Purpose:

The Northern Radio Company Regenerative Repeater (Transistorized), Type 217 Model 1, is used on telegraph communication circuits such as land lines, long or short distance point-to-point Radio circuits, tone telegraph links or on most circuits using printer type signals.

The Regenerative Repeater (Transistorized) is usually located at the receiving end of a circuit where it reshapes and retimes the signals, mutilated in transmission, into optimum signals for local usage or retransmission to a distant point.

The unit is primarily intended to regenerate standard teletype signals. A special provision has been made for use of the Regenerative Repeater (Transistorized) on half duplex circuits. For such application it will not only regenerate the ordinary teletype signals but also faithfully reproduce such special signals as "break signals" and "mark restoration" information.

Further provision has been made for use of the Regenerator with synchronous binary signals, such as on single or multi-channel time Division Multiplex circuits. Input and output circuits on the Regenerative Repeater (Transistorized) permit connection to an external synchronizing units.

Description:

The Northern Radio Company Regenerative Repeater(Transistorized), Type 217 Model 1, provides an electronic polar output current of 10 MA at ± 10 V. Sockets are provided for "plugging-in" either electro-mechanical or electronic relays when other voltages or currents are required.

The equipment is designed for usage as a Regenerator or Regenerative Repeater in conjunction with radio telegraph systems or for direct usage in D. C. type telegraph circuits.

The design of the unit will match most standard teletype input and output circuit requirements. The basic design incorporates input and output circuits compatible with Voice Frequency Telegraph Channel equipment as produced by Northern Radio Company and most other manufacturers. Optional circuit and accessory arrangements provide for special requirements such as "floating" input and output circuits, choice of self-contained or external "line battery", and choice of input and output signal polarities.

The re-timing circuits are, of course, the heart of any Regenerator. In this design advantage has been taken of the precision that is possible with electronic pulse techniques. In particular, a single high quality L-C type oscillator is used to provide the time-base for all the timing circuits to the Regenerator. A switch selector permits matching the timing circuits to the standard teletype speeds of 61, 75 or 100 words per minute. (Other speeds are possible by change of plug-in unit).

Description: (cont'd)

The design of the timing circuits is such as to be readily adaptable to other speeds or codes, as for instance the 10 unit card data processing code.

Long term stability of all timing circuits as well as their independence from power line variations is further insured by the use of an electronically regulated supply.

On the front panel of the Regenerator are also located the test points associated with circuits of the equipment. A simple procedure for the judicious use of these test points is given in the instruction book which permits maintenance or repair to be performed with the minimum of test instrumentation.

Technical Data:

Input Keying Speeds:	61, 75 and 100 WPM (others by change of plug-in sub-assembly). 5-10 unit teleprinter code by adjustment.
Input Keying Signal Requirements:	1. a) Neutral current keying. Positive or negative on-off current pulses, 30 MA minimum. b) Neutral voltage keying. Positive or negative on-off voltage pulses, 5 volts minimum. 2. a) Polar current keying \pm current pulse 20 MA minimum. b) Polar voltage keying \pm voltage pulses 5 volts minimum.
Input Characteristics:	1. Grounded input. Either polarity grounded. (May be operated on a floating basis if <u>either</u> input or output circuit is equipped with "plug-in" relay accessory.) 2. Adjustment for signal limiting to eliminate characteristic distortion (Adjustment is not sensitive to signal amplitudes).
Maximum Acceptable Signal Distortion:	48% MARK or SPACE
Frequency Stability of Time Base Generator:	\pm 0.1% for \pm 10% line voltage variation or \pm 20°C ambient change from 25°C

Technical Data: (cont'd)

Sampling Time:

Approximately 50 microseconds

Output:

Low voltage transistorized polar output stage \pm 10 volts into 1000 ohm load.

Equipped for "plug-in" Transistorized Relay Type NRC 691, for "Dry Contact" Keying.

Output Distortion:

- a) Signal bias distortion less than 0.5% signal element
- b) Signal element random jitter less than 1%
- c) Signal history (Duty Cycle) distortion less than 0.5%
- d) Total distortion less than 2%

Optional Output:

Also equipped for "plug-in" Telegraph Relay for "Dry Contact" Keying. Includes spark suppression filtering.

Output Distortion: (Relay Output)

Less than 4% total

Principle of Operation:

1. General

A Regenerative Repeater is usually located at the receiving end of a telegraph circuit. It is used to reshape and to retime the received telegraph impulses before their local utilization or their retransmission to some distant point. This process of "signal regeneration" eliminates a large part of the distortion which the signal has suffered in transmission. When such regenerated signal is used on a local printer it will usually increase the circuit reliability while easing printer maintenance requirements.

When the Regenerator is inserted at repeater stations it will tend to nullify the distortion at each station.

The retiming function of the Regenerator is basically similar to the start-stop timing mechanism of a teleprinter or reperforator. Normally the device is at rest awaiting the reception of a signal. Upon detection of the first pulse (start pulse of a group of pulses constituting a character) the device sets itself in motion, and for the duration of a character samples the polarity of the individual character elements. Upon completion of this task the mechanism returns to its rest position.

The sampling of each signal element is usually performed by taking a sample of very short duration and the sampling time is made to coincide with the approximate center of the signal elements, where the signal reliability is highest. The polarity of the signals, as determined by the samples (Mark or Space) is then assumed to be the correct polarity for a whole signal element.

While a teleprinter will utilize these samples to determine and print the desired symbol, the Regenerator will merely use the polarity information of the samples to reconstruct from it a perfectly timed and polarized signal. Such signal will now be free of the distortions of the raw or unregenerated signal, such as signal splits, edge jitter, systematic bias distortion, duty cycle or history distortion, etc.

While the sampling process is similar for a printer and for the Regenerator, the electronic circuitry of the latter achieves a much higher order of precision than the electro-mechanical mechanism of the former. In particular, the sampling intervals can be timed electronically with great precision and be made of extremely short duration. It is evident that the shorter the sampling time, the more signal deterioration can be tolerated (such as the edge of a signal element occurring close to the normal signal center) before the sample becomes erroneous.

Principle of Operation: (Cont'd)

1. General (cont'd)

In a well adjusted printer operating at 61 words per minute (7-1/2 unit code) the equivalent sampling time is approximately 2 milliseconds out of a signal element of 22 milliseconds. In the Regenerative Repeater, the sampling time is only 50 microseconds, or a gain of approximately 10 points in range over a printer.

While a printer does not provide for protection against signal splits (which, if they occur at sampling time, would produce an error) the Regenerative Repeater filters severely and resquares the raw signal before sampling it. This method is very effective in suppressing (smoothing out) signal splits and its effectiveness is greatest if the signal splits occur in the center region of the signal element, that is at sampling time.

The above paragraphs point out some of the advantages of using a regenerated signal over a "raw" signal. Yet it is to be understood that a Regenerator does not simply eliminate distortion. It is true, that as long as a minute portion of the signal center remains of correct polarity (that is essentially as long as the signal is at all definable) the output of the Regenerator will consist of a correct and precisely time sequence of impulses. Yet it is inherent in the concept of a start-stop code that the timing of the signal elements constituting a character is based on the timing of the "start pulse".

Thus an erroneous advance or retardation of the start pulse will tend to correspondingly advance or retard the whole regenerated character. A Regenerator will, therefore, eliminate the timing error of the individual signal elements, but retain largely the initial starting phase error. It will, in other words, shorten or lengthen the stop time between characters. Since during the stop time no intelligence is being received, at all but maximum speeds, this "character distortion", of the regenerated signal will not affect the operation of a printer. At maximum word speeds the shortening of the stop time will reduce the printer range. But most printers are far less sensitive to "stop time distortion" than they are to individual element phase errors.

In conclusion, we may say that the use of a Regenerative Repeater will improve circuit reliability and will find its largest application on teletype circuit having large distortion factors which are due either to the media of transmission or the idiosyncrasies of the transmitting and receiving equipment.

Principle of Operation: (cont'd)

2. Block Diagram:

For the following, reference is made to the Drawings A-6-0827 and A-6-0828.

a. The Input Shaping and Keying Circuits:

The purpose of this circuit is to convert the raw input signal into a waveform most suitable for retiming and sampling. It performs a signal squaring function by "thresholding and limiting" means, removes "splits" by filtering means and permits the removal of "characteristic" distortion in the incoming signal prior to the regeneration retiming function. Automatic control circuits permit these functions to be properly accomplished despite normal variations in signal levels applied to the input of the unit.

b. The Retiming Circuits:

The purpose of these circuits is to sample the signal at the (approximate) center of the signal elements and to reconstruct from these samples a properly retimed signal.

For the following, additional reference is made to the time waveforms illustrated on Drawing A-6-0828. The equipment is normally at rest with both input and output circuits in "Mark" condition. The first Mark-to-Space transition passing through the Input Shaping and Keying Circuits (signifying the "Start" of a character transmission) initiates the "character period" by operating the Oscillator to function. This Oscillator, which operates at a period equal to one-half a signal element (11 milliseconds for 61 words per minute) always has the same starting phase, as illustrated. Through limiting, clipping, and differentiation means, pulses are derived from each cycle of the Oscillator output. These pulses are fed into a frequency divider circuit which in turn delivers pulses at one-half the rate of the Oscillator frequency, or once per signal element, commencing one-half signal element after the "Mark-to-Space" transition which initiated the action. These "selecting" pulses are fed to a pulse counter circuit which, in turn, reacts on the Oscillator control circuit to stop the Oscillator when the required number of pulses (normally 7 for the "5" unit teleprinter code) has been delivered. Simultaneously, these pulses are fed to a signal coincidence circuit which acts as a "gate" to transfer the signal sense (Mark or Space) at the selecting pulse instant to the regenerator stage. The regenerator stage is a "bi-stable circuit" which can be actuated during the regenerating cycle only through the signal coincidence circuit as just described. Thus the Regenerator serves as a "memory" stage preserving the signal intelligence passed into it by the selecting pulses, and accomplishing the desired regeneration function.

Principle of Operation: (cont'd)

2. Block Diagram (cont'd)

b. The Retiming Circuits: (cont'd)

The Mark Inserter function shown has a two-fold purpose. It assures that under any steady state idle "Mark" input condition, the output circuit will also be in "Mark" condition, thus guarding against any possibility that a momentary power interruption or improper "start-up" could cause improper functioning of the Regenerator. This function is accomplished by a logic requirement that "Mark" input and Oscillator stopped conditions must result in "Mark" output. The second function of this circuit is that of inserting a timed "stop" signal in the output at the end of a character in the event that the input circuit does not return to Mark. The timed "stop" signal may be adjusted between 100% and 200% of unit-interval. This is a special requirement for certain operating procedures and is obtained by optional switching of circuits within the Regenerator.

The Output Amplifier is an impedance coupler delivering output signals in proper magnitude and polarity to allow interconnection with other telegraph equipment.

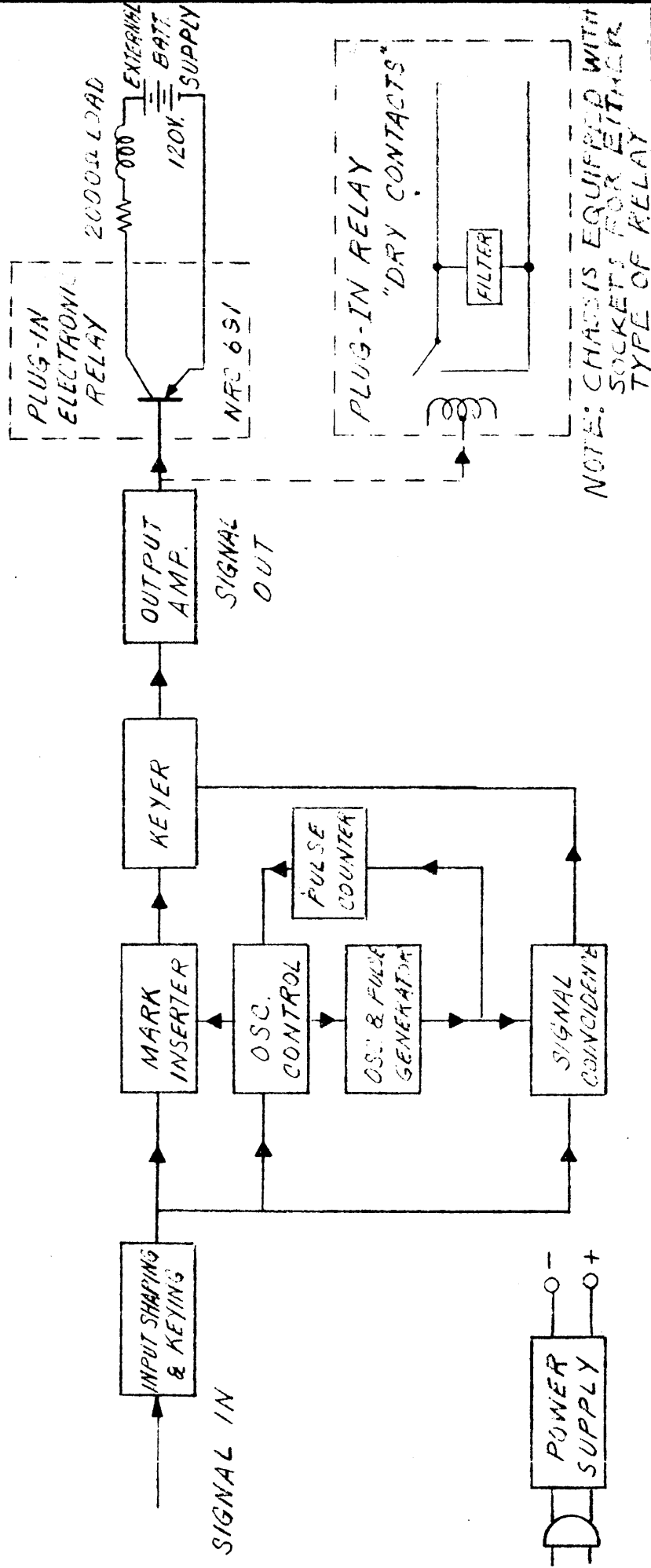
The unit is arranged for the plug-in addition of a Northern Radio Company Transistorized Relay, Type NRC 691, when 60 MA output loop current is required. This Relay will provide "Dry Contact" Keying for an externally supplied current loop.

Alternatively, a conventional Polar Telegraph Relay may be plugged into a socket provided on the Chassis. This relay will provide "Dry Contact" Keying for an externally supplied current loop.

DWG. N. 6-0827 REV.

REVISIONS

SYM.	DESCRIPTION	DATE	APPROVAL



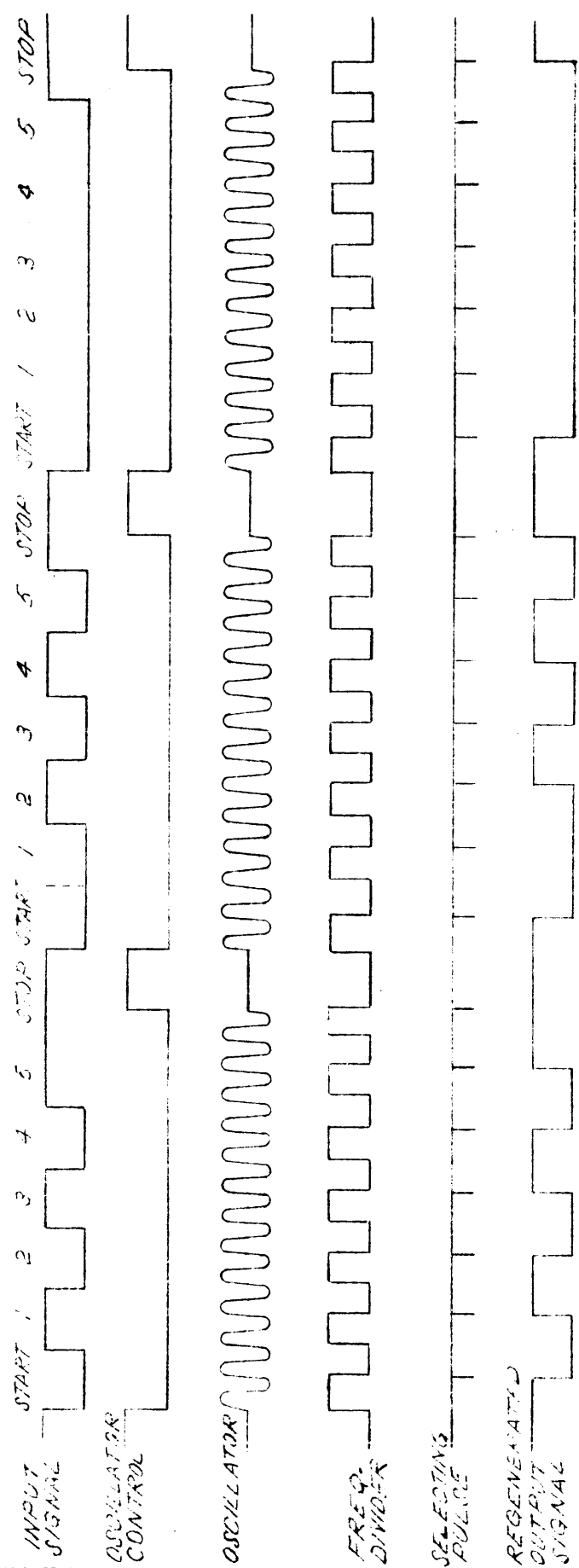
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES		DRAFTSMAN		DATE		NAME:	
TOLERANCES ON FRACTIONS DECIMALS ANGLES ± 1/64 ± .005		U. G.		4-9-58		BLOCK DIAGRAM	
MATERIAL:		CHECKER		4/9/58		REGENERATIVE REPEATER (TRANSISTORIZED)	
FINISH:		ENGINEER		APPROVAL		TYPE 217 MOD. 1	
						SCALE: NONE SHEET 1 OF 1	

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NEW YORK

DWG. N. 6-0827

DWG. N. 6-0828 REV.

REVISIONS		
SYM.	DESCRIPTION	DATE



<p>NORTHERN RADIO COMPANY INCORPORATED 143-147 WEST 22ND ST. N.Y. 11 NEW YORK</p>		<p>DWG. N. 6-0828 DWG. A SIZE</p>	
<p>NAME: <i>TIMING DIAGRAM REGENERATIVE REPEATER (TRANSFORMERLESS)</i></p>		<p>SCALE: NONE SHEET 1 OF 1</p>	
<p>DRAFTSMAN: <i>R. L. H.</i></p>		<p>DATE: 4-9-58</p>	
<p>CHECKER:</p>		<p>ENGINEER: <i>J. H.</i></p>	
<p>APPROVAL:</p>		<p>FINISH:</p>	
<p>UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON ANGLES FRACTIONS DECIMALS ± .005 ± 1/64</p>			
<p>MATERIAL:</p>			

SPECIFICATION FOR
LINE BATTERY POWER SUPPLY
TYPE 228 MODEL 1

1. GENERAL

Purpose:

The Northern Radio Line Battery Power Supply, Type 228 Model 1, is used as a source of DC power for teleprinter, telegraph, and similar circuits. Two such supplies are normally mounted on one panel (Northern Radio Line Battery Power Supply Panel, Type 227 Model 1), with one supply operating and the second "standing by". An automatic transfer circuit is provided on the panel to place the "stand-by" unit in operation should the first supply fail.

One Type 227 Panel, equipped with two Type 228 Supplies, is normally provided to handle the DC requirements for a group of eighteen (18) or less teleprinter channels.

Description:

The Line Battery Power Supply, Type 228 Model 1, is a solid state rectifier contained in a plug-in package 3-7/16" wide x 7-7/16" long x 7" high. Two such supplies are mounted on one Line Battery Power Supply Panel, Type 227 Model 1, which is 3-1/2" high x 19" long. The AC input and DC output circuits are isolated from each other and also from chassis so that either side of the circuit may be grounded, or left ungrounded as may be determined.

Principle of Operation: (Reference Schematic Diagram Dwg. No. A-228-1-01)

Referring to Drawing No. A-228-1-01, Line Battery Power Supply, Type 228 Model 1, is a conventional transformer isolated full-wave bridge rectifier with heavy capacitor filtering. The primary of the transformer is tapped so that it may be operated from 115 volts or 230 volts nominal AC supply lines, and the secondary has taps for more accurate adjustment of the DC output voltage.

Technical Data:

A. C. Input:	115/230 volt, 50/60 cycles AC \pm 10%
Output Voltage:	120 volts DC nominal
Maximum Output Current:	1.2 amperes
Maximum Output Ripple Voltage:	2%
Special Features:	Plug-in construction. Mounts on Line Battery Power Supply Panel, Type 227 Model 1



NORTHERN RADIO

TRANSISTORIZED PRINTER RELAY

Type 237 Model 1

- replaces electro-mechanical signal relays
- eliminates associated local DC power supplies
- eliminates electro-mechanical maintenance problems
- isolates the reactance of printer selector magnet
- presents resistive termination to the signal loop



PURPOSE: The Northern Radio Printer Relay, Type 237 Model 1, is used as a coupling device between a DC teleprinter signal loop and the printer selector magnet. It is intended to replace electro-mechanical signal relays and their associated local DC power supplies normally used with printers, providing the advantages of relays and improving printer performance but eliminating the maintenance problems which electro-mechanical relays introduce.

This device effectively isolates the reactance of the printer selector magnet, presenting a resistive termination to the signal loop. Several printers equipped with this device can, therefore, be connected in series with the same signal loop without harmful interaction between them. The Printer Relay may be used with either polar or neutral keyed signals. When neutral signals are supplied, the device automatically selects the proper operating level for the loop current supply, and can therefore tolerate large changes in absolute values of loop current without introducing appreciable distortion into the printer selector magnet. It will normally be mounted within the housing of the teleprinter.

DESCRIPTION: This Relay is a completely electronic solid state device contained in a 2-11/16" deep x 3-1/16" wide x 4-1/4" high housing. It operates from DC printer signal loops of nominally 20 or 60 milliamperes and provides nominally 60 ma to the printer selector magnet coils. (Where printer selector magnet options of 20 ma with coils in series, or 60 ma with coils in parallel are provided, the parallel arrangement is preferred.) The printer selector magnet operating current is supplied from a self-contained rectifier circuit, including an isolating power transformer.

The signal input circuit presents a resistive termination to the signal loop thus eliminating any unnecessary problems in coupling several devices in the printer loop. Wear on any metallic contacts involved in supplying the printer loop current is also minimized with the resistive load.

A transistor switching circuit controls the flow of current to the printer selector magnet. This use of a solid-state switch eliminates any problem of contact wear which would normally occur at this point with use of electro-mechanical relays. Appropriate "surge suppression" circuits are provided to protect the switching transistor from inductive voltage surges produced by the selector magnet.

The use of solid-state devices 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 unit is negligible, and proper stabilizing circuits are employed to assure that the device will function properly under any anticipated ambient temperature conditions to be encountered.

PRINCIPLE OF OPERATION: Referring to the block diagram, the DC signal loop is connected to Pin Terminals 1 and 2 of the Relay (Terminal No. 8 is strapped to Terminal No. 1 for 60 milliamper operation, or left open for 20 milliamper operation). An Input Signal Conditioning Circuit is used to couple the input signal to the switching transistor. The function of this circuit is to provide proper operating bias so that the transistor switch will open and close at one-half of the maximum signal amplitude, thus eliminating any signal distortion due to improper signal currents. 115 volts A.C. is supplied to the self-contained rectifier through Pin Terminals 5 and 6 to produce the necessary selector magnet operating power. The selector magnet is connected to Pin Terminals 3 and 4 and the transistor switch opens and closes the circuit as indicated.

TECHNICAL DATA:

Input Impedance: 60 ma input 150 ohms, resistive (Socket Pin 8 connected to Pin 1). 20 ma input 470 ohms, resistive (Socket Pin 8 open). All circuits insulated from chassis and from "ground." Units may be series connected.

Input Current: 60 ma input: 30 to 100 ma, polar or neutral. 20 ma input: 10 to 30 ma, polar or neutral.

Input Polarity: Either polarity with respect to ground. Current flow through relay must be in direction to make Terminal 2 positive with respect to Terminal 1 for "Mark" condition.

Output: 60 ma nominal into 60 ma "pulling" or "holding" magnet selector circuits. Series or parallel coil connections may be used, but parallel arrangement is normally preferred.

Distortion: Negligible. Not sensitive to loop current changes.

Temperature: -50 to +55° C.

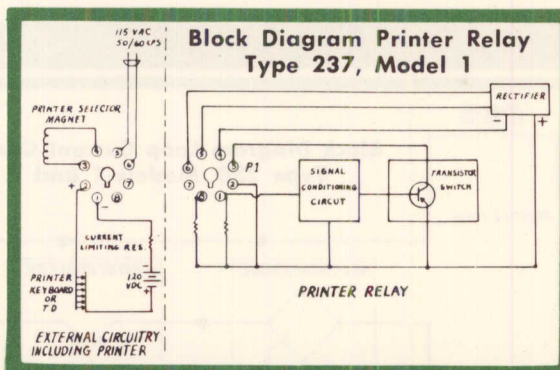
Controls: None.

Power Requirements: 115 volts 50/60 cps ±10%, 5 watts.

Dimensions: 2-11/16" deep x 3-1/16" wide x 4-1/4" high.

Weight: Approximately 2 lbs.

Special Features: "Plug-In" construction. Octal plug connects into mating socket in mounting bracket arranged for installation within printer housing. Sturdy construction to prevent damage due to shock, vibration or hot, oily atmosphere encountered inside printers.



NORTHERN RADIO COMPANY, inc.
147 WEST 22nd ST., NEW YORK 11, NEW YORK

In Canada: Northern Radio Mfg. Co., Ltd., 1950 Bank St., Billings Bridge, Ottawa, Ontario.

Pace-Setters in Quality
Communication Equipment

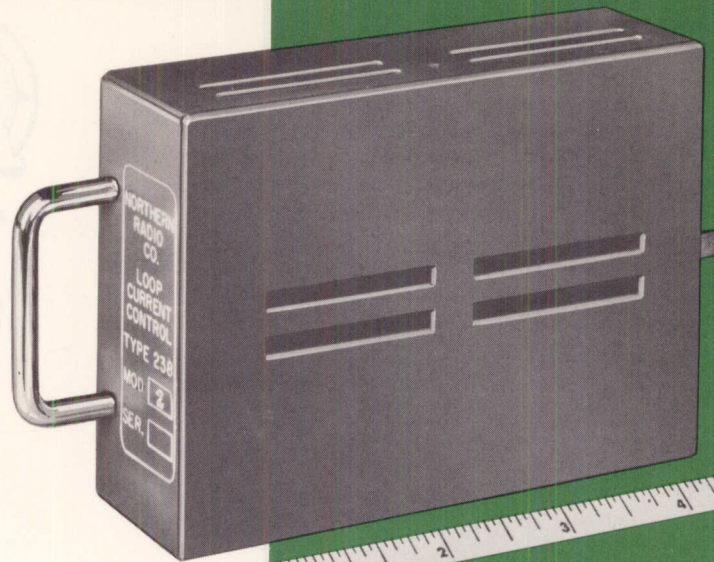


NORTHERN RADIO

TRANSISTORIZED LOOP CURRENT CONTROL

Type 238: Model 1, for 60 ma DC loops;
Model 2, for 20 ma DC loops

- automatically normalizes current in DC teleprinter signal loops
- eliminates metering and manual adjustments
- effects savings in maintenance costs
- may be used on polar or neutral DC circuits
- requires no supplemental power supply



PURPOSE: The Northern Radio Loop Current Control, Type 238 Model 1, is used as a current "normalizer" in DC teleprinter signal loops, to automatically maintain loop current at the optimum value despite changes in loop resistance or loop supply voltage.

Teleprinter "Equipment" or "Subscriber" loop extensions ordinarily require manually adjusted current normalizing facilities for the purpose of adjusting the total loop resistance, including the wireline in any equipment connected thereto, to a standard value. Any variation in the resistance of the wireline, or any change in the equipment installed in the loop, ordinarily requires that the normalizing resistance be changed. Extensions which are capable of being switched require extra attention to assure that all such extensions maintain uniform resistance. Thus, such circuits not only require facilities for metering and manually adjusting circuit characteristics, but also require a number of expensive "man-hours" of installation and maintenance effort to effect the required adjustments.

Use of the Type 238 Model 1 Loop Current Control eliminates this necessity for manual adjustment of the resistance of such printer loop extensions. Initial cost of installations including the Northern Radio Loop Current Control, will ordinarily be approximately the same as installations including facilities for manual adjustments. Initial savings will result from the elimination of the adjustment procedure before placing such circuits into operation. The "maintenance-free" characteristics of the Loop Current Control will effect savings in maintenance costs thereafter. In many cases it will be practicable to install the Loop Current Control devices in "common" portions of the circuit involved and thus effect considerable savings in initial investments.

The Loop Current Control is designed for use in loops requiring a nominal 60 milliamperes operating current, while the Model 2 is designed for a nominal 20 milliamperes circuit. Both models incorporate a calibration control to allow reasonable variations from these design values.

DESCRIPTION: This Loop Current Control is a completely electronic solid-state device contained in a 1" wide x 3" high x 4" deep housing. It is a "two-terminal" device intended to be placed in series with a DC current loop. It is a "constant current" device which will maintain the loop current at a predetermined value (within the designed limits of the device) regardless of changes in the resistance of other parts of the loop circuits, or of the supply voltage connected to the loop.

Since this Control requires no source of operating power other than the normal loop current passing through it, it is a completely "floating" device which may be connected anywhere in the loop. Two or more such devices may be connected in series within the same loop whenever the limits of variation of resistance or supply voltage exceed the design limits of one such device.

This unit, requiring no supplemental power supply to perform its functions, is a new development made possible through the use of solid-state devices. It is a reliable, long-life, maintenance-free device that will result in more efficient operation of printer loops. Internal heat is determined by the amount of regulation required, being maximum when the device is required to present the appearance of maximum resistance. Proper mechanical design is employed to assure adequate heat sink characteristics, and proper stabilizing circuits assure that the device will function properly under any anticipated ambient temperature conditions to be encountered. A number of these devices may be mounted in close proximity without undue worries as to any possible ill effects due to elevated temperatures resulting from such assembly.

TECHNICAL DATA:

Input Impedance: Variable. Automatically changes as necessary to maintain "constant current" in the circuit to which connected. Maximum and minimum limit of operation are specified by allowable voltage drops across the terminals of the device.

Voltage Limits: Maximum: 90 volts, Minimum: 10 volts.

Operating Currents: Model 1: 60 milliamperes (adjustable 55-75 milliamperes). Model 2: 20 milliamperes (adjustable 10-30 milliamperes).

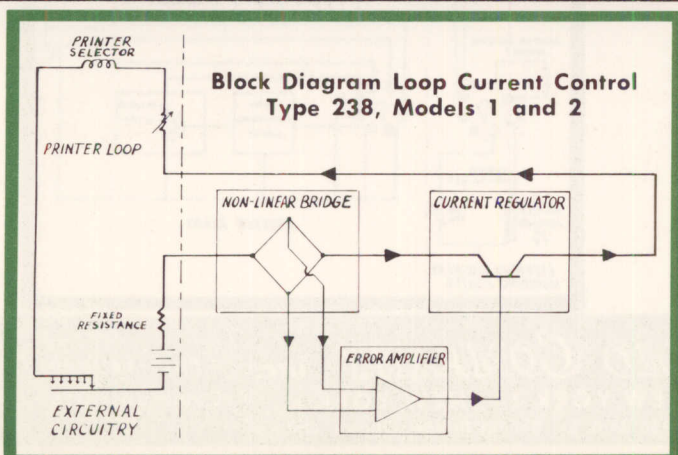
Controls: A current calibrating adjustment is provided within the device. No operating controls are required.

Power Requirements: None, other than the normal loop current passing through the device.

Dimension: 1" wide x 3" high x 4" deep. For rack mounting a number of these units, a shelf assembly is available accommodating nine (9) units in a panel height of 3 1/2".

Weight: Approximately 1/2 lb.

Special Features: "Plug-In" construction. Polarized to assure current flow in proper direction. With supplemental equipment, may be used on "polar" as well as "neutral" BC circuits.



PRINCIPLE OF OPERATION: Referring to the block diagram, the Loop Current Control, Type 238 Model 1, is connected in series with the printer loop. The loop current passes through a "Non-Linear Bridge" which balances at the rated normal current but delivers an "error" voltage for any other current value. The "error" voltage is fed to an "Error Amplifier" and the output of the "Error Amplifier" controls a "Current Regulator" circuit which effectively changes in internal resistance in the direction required to return the loop current to the normal value.

SPECIFICATIONS FOR
MULTIPLIER, TYPE 248 MODEL 1
AND
DEMULTIPLIER, TYPE 249 MODEL 1

Purpose:

The Northern Radio Multiplier, Type 248 Model 1, and Demultiplier, Type 249 Model 1, are intended for use with twin-channel, single-sideband radio circuits operating in the high-frequency (hf) range. Their purpose is to derive two voice-frequency (vf) circuits from each of the radio channels. By means of frequency division multiplexing, the radio bandwidth from 200 to 6000 cycles per second (cps) is divided into two transmission circuits, each with a bandwidth from 375 to 3025 cps. Four (4) such vf circuits are derived from the twin-channel radio and these are used to transmit carrier telegraph signals or to provide telephone or facsimile service.

Two (2) Multipliers, Type 248 Model 1, are required for full utilization of the capacity of a radio transmitter. One (1) is used to transmit telegraph, telephone, or facsimile signals from two vf circuits to the radio channel designated as sideband A. The second Multiplier performs the same function for sideband B. In this way, four vf circuits are applied to the twin-channel radio transmitter.

Two (2) Demultipliers, Type 249 Model 1, are required for full utilization of the capacity of a radio receiver. One is used to receive telegraph, telephone, or facsimile signals for two vf circuits from the radio channel designated as sideband A. The second Demultiplier performs the same function for sideband B. In this way, four vf circuits are derived from the twin-channel radio receiver.

The Multiplier, Type 248 Model 1, and Demultiplier, Type 249 Model 1, are designed for use in circuits having an impedance of 600 ohms. They are not provided with line impedance matching transformers and should not be connected directly to transmission line facilities.

The Multiplier, Type 248 Model 1, and Demultiplier, Type 249 Model 1, are designed to slide into the Northern Radio Company Type 250 Model 1 Shelf. The Shelf is equipped to accommodate two (2) Multipliers, or two (2) Demultipliers, or one (1) Multiplier and one (1) Demultiplier.

Description:

The Multiplier, Type 248 Model 1, and Demultiplier, Type 249 Model 1, are transistorized equipments, including necessary bandpass filters, line amplifiers, carrier frequency sources, modulators and attenuators to accomplish the purposes indicated.

Specifications
Multiplexer & Demultiplexer

Types 248 & 249, Model 1

Description: (cont'd)

The Multiplexer requires a nominal 14 volts DC power supply at 125 milliamperes, and the Demultiplexer, requires approximately 200 milliamperes at the same voltage. This power supply is normally provided from the Northern Radio Power Supply, Type 223 Model 1, which is plugged into the rear of the Type 250 Model 1 Shelf.

Technical Data:

Characteristics of the Multiplexer, Type 248 Model 1:

Transmission Circuits:

1. Input:
Number: 2
Bandwidth, each: 375 to 3025 cps
2. Output:
Number: 1
Bandwidth: 375 to 5915 cps

Normal Operating Levels:

1. Input:
Telephone (referred to 0-db level point): -4 db
Facsimile: 0 dbm
Telegraph (16-channel system): -10 dbm per channel
2. Output:
Telephone (referred to 0-dbm level point): -4 db
Facsimile: 0 dbm
Telegraph (16-channel system): -10 dbm per channel

Maximum Permissible Levels:

1. Input:
Single frequency: +13 dbm
Multichannel telegraph: +3 dbm (rms)
2. Output:
Single frequency: +22 dbm
Multichannel telegraph: +12 dbm (rms)

Gain:

24 db max in 2 db steps

Impedance:

Input: 600 ohms
Output: 600 ohms

Specifications
Multiplexer & Demultiplexer

Types 248 & 249, Model 1

Technical Data: (cont'd)

Characteristics of the Multiplexer, Type 248 Model 1: (cont'd)

Power Requirements: Voltage 14 volts DC, nominal, 125 milliamperes

Dimensions: 8" wide x 5-1/4" high x 11-3/4" deep. For rack mounting a number of these or similar units, a shelf assembly is available accommodating two (2) units in a panel height of 5-1/4".

Weight: 25 lbs.

Characteristics of the Demultiplexer, Type 249 Model 1:

Transmission Circuits:

1. Input:
Number: 1
Bandwidth: 375 to 5915 cps
2. Output:
Number: 2
Bandwidth:, each: 375 to 3025 cps

Normal Operating Levels:

1. Input:
Telephone (referred to 0-db level point): -9 db
Facsimile: -5 dbm
Telegraph (16-channel system): -15 dbm per channel
2. Output:
Telephone (referred to 0-db level point): +1 db
Facsimile: 0 dbm
Telegraph (16-channel system): 0 dbm per channel

Maximum Permissible Levels:

1. Input:
Single frequency: +13 dbm
Multichannel telegraph: +6 dbm (rms)

NOTE: The maximum multichannel telegraph level of +6 dbm is permissible only when the input signals are divided between the two output paths of the Demultiplexer. Multichannel telegraph signals intended for one output path should not exceed a level of +3 dbm. An input level control is provided to reduce the incoming signal level when it exceeds the correct input level for the Demultiplexer.

Specifications
Multiplexer & Demultiplexer

Types 248 & 249, Model 1

Technical Data: (cont'd)

Characteristics of the Demultiplexer, Type 249 Model 1: (cont'd)

Maximum Permissible Levels: (cont'd)

2. Output:
Single frequency: +22 dbm
Multichannel telegraph: +12 dbm (rms)

Gain: 24 db max in 1 db steps

Impedance: Input: 600 ohms
Output: 600 ohms

Power Requirements: Voltage 14 volts DC, nominal 200 milliamperes

Dimensions: 8" wide x 5-1/4" high x 11-3/4" deep. For rack mounting a number of these or similar units, a shelf assembly is available accommodating two (2) units in a panel height of 5-1/4".

Weight: 25 lbs.

SPECIFICATION FOR
VOLUME AND CURRENT LEVEL INDICATOR
TYPE 254 MODEL 1

Purpose:

The Volume and Current Level Indicator, Type 254 Model 1 is used as a signal level and loop current indicator at both transmitting and receiving terminals.

Description:

The Volume and Current Level Indicator is essentially two stage constant gain amplifier. The input signal is attenuated while the output of the amplifier is measured by a voltmeter calibrated in VU. A DC Milliammeter is provided to measure the current in the DC Loop. Jacks are provided on the front panel and terminal strips are provided on the rear panel for inputs to both meters.

Technical Data:

Range: VU Meter	-40 to +26 DBM (meter reading 0)
DC Current Meter	<u>±</u> 75 ma
Input Impedance: (VU Meter)	7500 ohms for bridging 600 ohms for terminating
Frequency Response: (VU Meter)	Within <u>±</u> 0.5 DBM from 30 to 50 CPS Within <u>±</u> 0.4 DBM to 17,000 CPS
Reference Level: (VU Meter)	0 DBM equals 1 mw into 600 ohms
Front Panel Controls:	1. Primary Power Switch 2. Input Termination (VU Meter) 3. Attenuator 4. Zero Adjustment (VU Meter)
Power Requirements:	110/220 volts 60 cycle 30 watts
Dimensions:	5-1/4" x 19" x 9-1/2"
Weight:	20 pounds
Metering:	1. VU Meter 2. 75-0-75 ma DC Meter
Tube Complement:	1 - 6X4 Rectifier 1 - OA2 Voltage Regulator 1 - 12AU7 Amplifier 1 - 6C4 Buffer 1 - 6C20 Relay Tube