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HAMMARLUND

INSTRUCTION AND SERVICE MANUAL

for

TONE SIGNALING EQUIPMENT

DUAL TRANSMITTER UNITS DTU-11 AND DTU-12

SINGLE TRANSMITTER UNIT STU-11

DUAL RECEIVER UNIT DRU-11 AND DRU-12

SINGLE RECEIVER UNIT SRU-11

DUPLEX SIGNALING UNITS DSU-11T AND DSU-12

HAMMARLUND

THE HAMMARLUND MANUFACTURING COMPANY, INC.
460 WEST 34th STREET, NEW YORK, N. Y.

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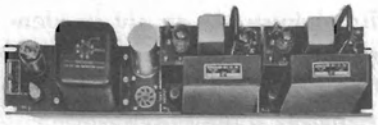
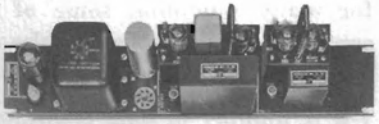


DRU-12 DUAL RECEIVING UNIT
Two audio-tone receivers
with power supply

SRU-11 SINGLE RECEIVER UNIT
Audio-tone receiver
with power supply



DSU-12 DUPLEX SIGNALING UNIT
Audio-tone transmitter and receiver
with power supply

STU-11 SINGLE TONE UNIT
Audio-tone transmitter
with power supply

DTU-12 DUAL TRANSMITTER UNIT
Two audio-tone transmitters
with power supply

Figure 1—1. Hammarlund Tone Signalling Equipment

SECTION I
INTRODUCTION

1-1. This manual covers installation, operation, and maintenance procedures for Tone Signaling Equipment manufactured by the Hammarlund Manufacturing Company, Inc. Table I lists the equipment covered by this manual. (See figure 1-1.)

TABLE I.
HAMMARLUND TONE SIGNALING EQUIPMENT

Nomenclature	Type
Transmitters:	
Dual Transmitter Unit	DTU-11
Dual Transmitter Unit	DTU-12
Single Transmitter Unit	STU-11
Receivers:	
Dual Receiver Unit	DRU-11
Dual Receiver Unit	DRU-12
Single Receiver Unit	SRU-11
Receiver-Transmitter Combinations:	
Duplex Signaling Unit	DSU-11T
Duplex Signaling Unit	DSU-12

1-2. Hammarlund tone signaling equipment is used for remote control and supervision of widely dispersed industrial and utility systems. When used in a control system it has the ability to monitor and adjust a process in all phases from a single centralized control station. Tone signals are carried over regular telephone lines, special wires, radio, carrier, or other types of communications links. Tone signaling equipment, when operating in conjunction with a control system, is made up of fixed frequency transmitters and receivers operating in the audio frequency range.

1-3. A basic tone signaling channel is composed of the power supply, tone generator and a fixed tuned frequency determining unit which comprises the tone transmitter at one station, and a power supply, receiver band pass filter and tone receiver, comprising a tone receiver at the other station. A basic tone signaling channel may operate at any one of 57 separate standard frequencies be-

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tween 425 and 6025 cps. In a control system each tone receiver is operated in conjuction with a tone transmitter functioning on the same center frequency to provide a complete data transmission channel. Data transmission channels may be used for many functions, some of which are remote control, low frequency or pulse duration telemetering, alarm signaling, and open-close operations.

1-4. A number of data transmission channels may be operated simultaneously over a single communications link without interference. This is possible provided different center frequencies are used for each tone signaling channel and that the transmission loss is within specified values. The choice of frequencies for the respective channels is determined by the transmission characteristics of the communications circuit, the presence of other frequencies used in companion services, and the character of the overall control facility. Care in the selection of proper operating frequencies must always precede the installation of tone signaling equipment on a communications circuit.

1-5. Tones may be either continuously on and negatively keyed, or normally off and keyed only on transmission, depending upon the requirements of the specific installation.

1-6. Several types of standard relays for the tone receivers are used and are selected to meet applicable service requirements. Among these types are hermetically sealed relays, relays with dust covers and magnetically biased polar relays. Units are normally equipped with the type of relay specified by the customer.

1-7. Nomenclature Breakdown. As an aid in identifying the components of any tone signaling unit the breakdown of the code letters of each of the Hammarlund tone signaling units follows:

NOTE: Last numeral of digit unit designations denotes the number of line coupling transformers present in the assembly.

S . . . Single
D . . . Dual or Duplex
T . . . Transmitter
R . . . Receiver
U . . . Unit

Examples:

S T U - 11
Single Transmitter Unit

D R U - 11
Dual Receiver Unit

D S U - 12
Duplex Signaling Unit

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SECTION II

PHYSICAL CHARACTERISTICS

2-1. GENERAL.

2-2. Hammarlund tone signaling equipment has been designed and packaged to permit complete servicing and maintenance in the field by non-technical personnel. No critical adjustment procedures are required in field maintenance as the tone generating (TG) and tone receiving (TR) circuits are entirely packaged as plug-in type units. These package assemblies plug into the basic "power panel" chassis strip. (See figures 2-1 through 2-6.)

2-3. The components of the tone signaling equipment are mounted on the basic "power panel" chassis which in turn is designed to mount on a standard 19-inch relay rack or cabinet. Each tone signaling unit is complete in itself, requiring only connection to the 110/120-volt, 50-60 cycle power source, and to the communications link and function device. Tone signaling units are independent of each other. A breakdown in one will not affect associated units.

2-4. All Hammarlund tone signaling units are of modular design. Three basic modules are arranged in various combinations. (See figures 2-1 through 2-6.) Module types are the power supply unit (SU), transmitter unit (TU) and the receiver unit (RU).

2-5. There are three variations of power supply unit modules (SU) since there are slightly different requirements for use with transmitters, receivers, or combinations of receivers and transmitters. SU-1 modules are used only with dual or single receiver units. SU-2 modules are used only with dual or single transmitter units and SU-3 modules are only used with the duplex signaling units.

2-6. There are two variations of the transmitter unit modules (TU). In the TU-2 modules the output transformer apparent in the TU-1 modules is omitted.

2-7. There are two variations of the receiver unit modules (RU). In the RU-3 module the input transformer as indicated in the RU-1 module is also omitted.

2-8. Modules assigned to specific units are listed in Table II.

TABLE II.
MODULE SECTIONS ASSIGNED TO TONE SIGNALING UNITS

Unit	Modules
Transmitter	
STU-11	SU-2, TU-1
DTU-11	SU-2, TU-1, TU-2
DTU-12	SU-2, TU-1, TU-1
Receiver	
SRU-11	SU-1, RU-1
DRU-11	SU-1, RU-1, RU-3
DRU-12	SU-1, RU-1, RU-1
Duplex Signaling Units	
DSU-11T	SU-3, RU-3, TU-1
DSU-12	SU-3, RU-1, TU-1

2-9. PHYSICAL DIMENSIONS.

2-10. With the components mounted on a 1/16-inch thick steel chassis, the tone signaling units nominally measure 19 inches by 3½ inches, with a behind panel depth of 3¾ inches and a forward-of-panel projection of 6¼ inches.

2-11. Weights. The approximate weights of the various units are shown in Table III.

TABLE III. WEIGHTS OF UNITS

Unit	Approximate Weight in lbs.
STU	11
DTU	13
SRU	13
DRU	17
DSU	15

2-12. TRANSMITTER UNITS.

2-13. Single Transmitter Unit STU-11 and Dual Transmitter Unit DTU-12 are illustrated in figures 2-1 and 2-2 respectively. These views are applicable

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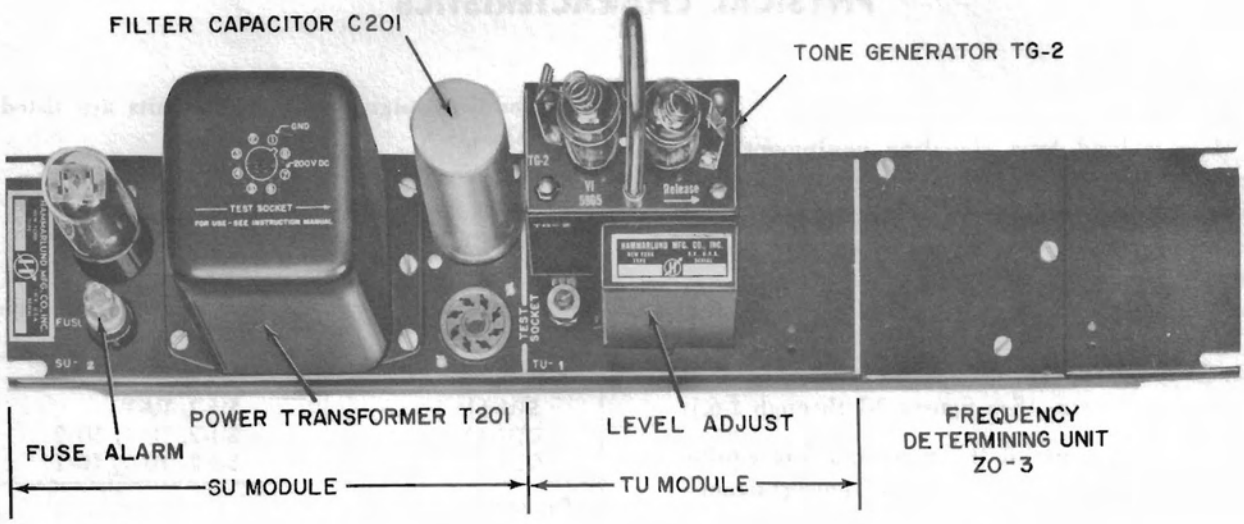
FRONT VIEW



REAR VIEW

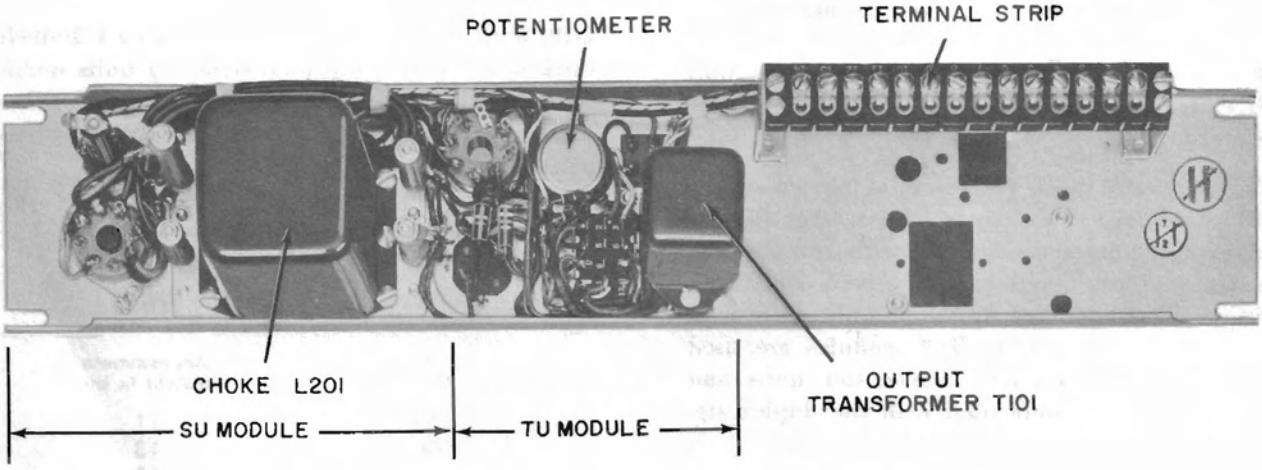


FIG. 2-1
SINGLE TRANSMITTER UNIT STU-11

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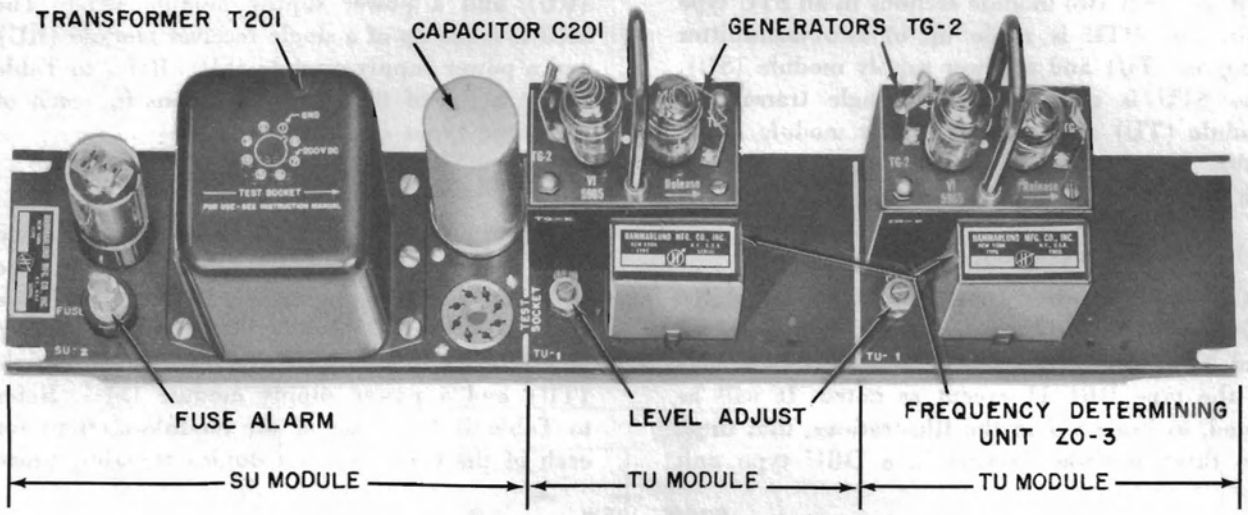
FRONT VIEW



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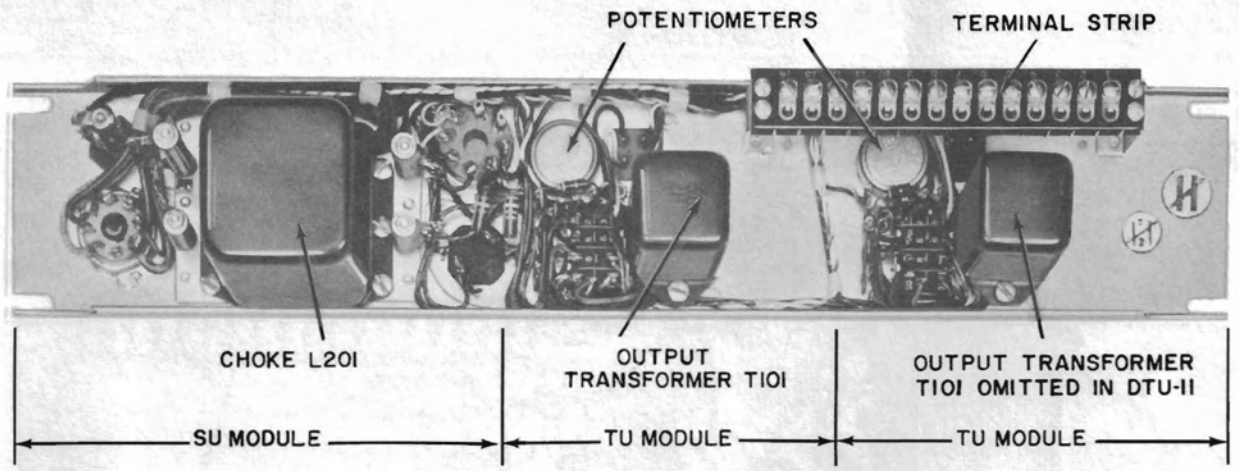

FIG. 2-2

DUAL TRANSMITTER UNITS DTU-11 AND DTU-12

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to the type DTU-11 except as noted. Note that there are three module sections in a DTU type unit and only two module sections in an STU type unit. The DTU is made up of two transmitter modules (TU) and a power supply module (SU). The STU is made up of a single transmitter module (TU) and a power supply module (SU). Table II lists the module sections for each of the three types of transmitter units.

2-14. RECEIVER UNITS.

2-15. Single Receiver Unit SRU-11 and Dual Receiver Unit DRU-12 are illustrated in figures 2-3 and 2-4 respectively. Figure 2-4 is also applicable to the type DRU-11 except as noted. It will be noted, as indicated in the illustrations, that there are three module sections in a DRU type unit and two module sections in an SRU type unit. The DRU is made up of two receiver modules (RU) and a power supply module (SU). The SRU is made up of a single receiver module (RU) and a power supply module (SU). Refer to Table II for a list of the module sections for each of the three types of receiver units.

2-16. DUPLEX SIGNALING UNITS.

2-17. Duplex Signaling Unit DSU-12 is illustrated in figure 2-5. This view is applicable to the Type DSU-11T except as noted. There are three module sections in each DSU unit. The DSU is made up of a receiver module (RU), a transmitter module (TU) and a power supply module (SU). Refer to Table II for a list of the module sections for each of the three types of duplex signaling units.

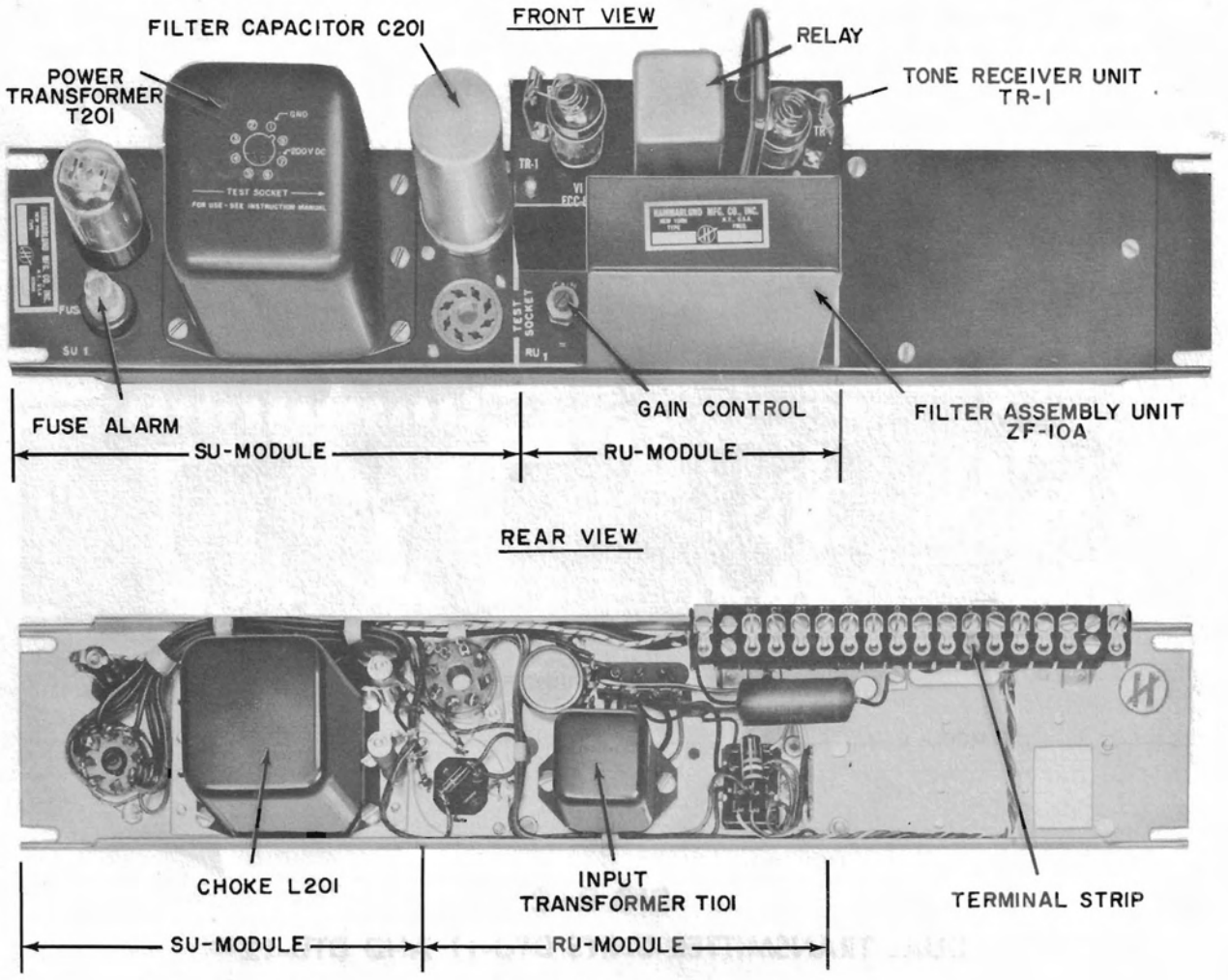

FIG. 2-3
SINGLE RECEIVER UNIT SRU-11

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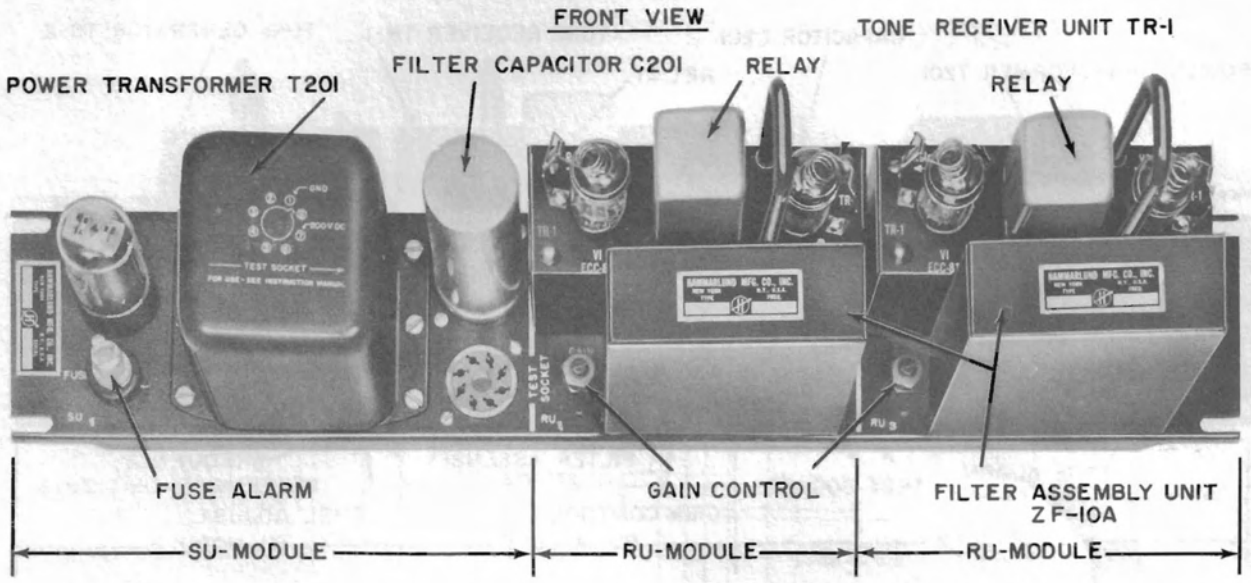

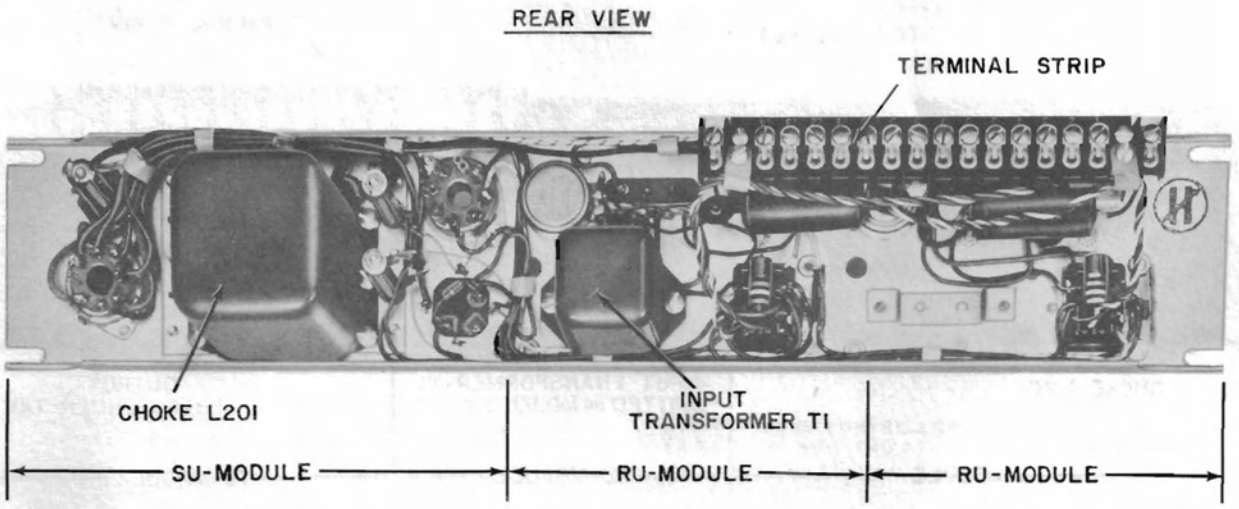

FIG. 2-4

DUAL RECEIVER UNIT DRU-11 AND DRU-12

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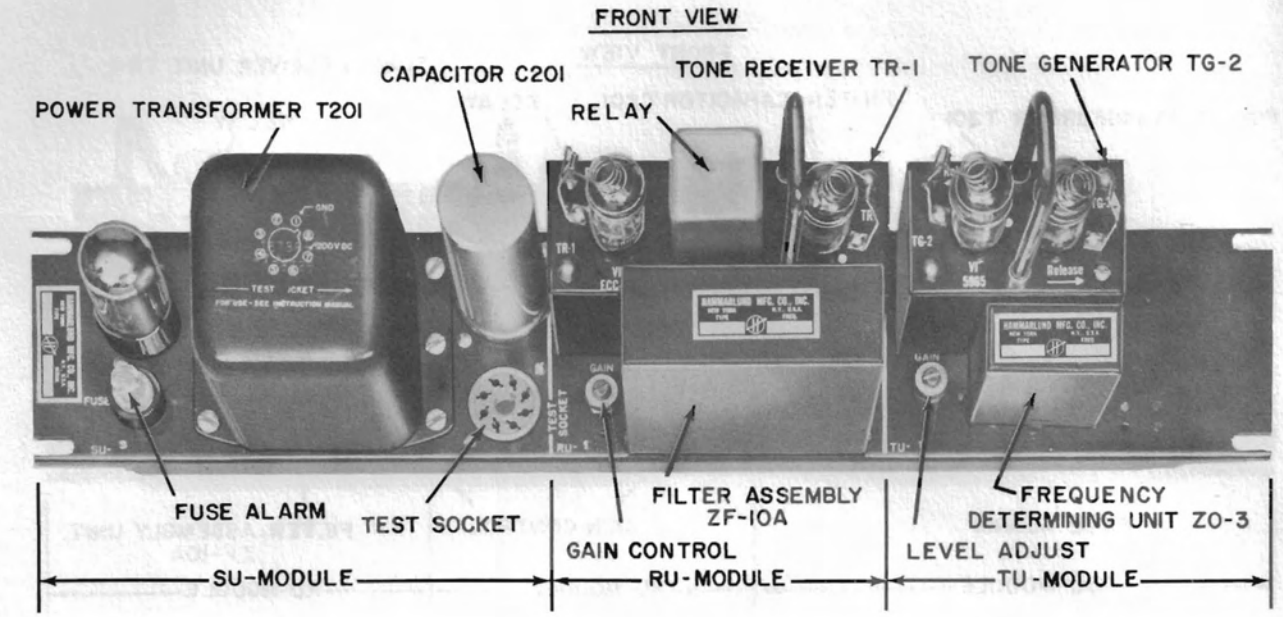

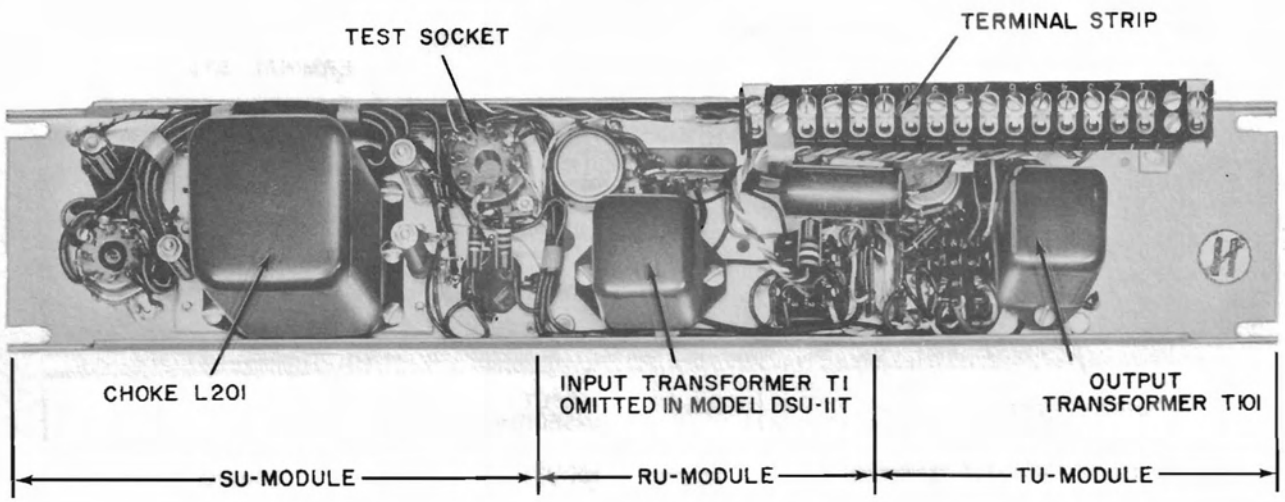

FIG. 2-5
DUPLEX SIGNALING UNITS DSU-11T AND DSU-12

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SECTION III

ELECTRICAL CHARACTERISTICS

3-1. GENERAL.

3-2. Fifty-seven tone channel frequencies, as indicated in Table IV following, are available in the Hammarlund tone signaling equipment.

3-3. Power Requirements: 105 to 125-volts, 50 to 60-cps, single-phase ac as follows:

Type	*Volt-Amperes*
DTU	36
STU	30
DRU	59
SRU	32
DSU	53

The power factor of all units is approximately 95%.

3-4. Ambient Temperature Range: —30°C to +65°C.

3-5. TRANSMITTERS.

3-6. Refer to Table V for Transmitter Electrical Characteristics.

3-7. RECEIVERS.

3-8. Refer to Table VI for Receiver Electrical Characteristics.

TABLE IV. FREQUENCY RANGE CHARACTERISTICS

HAMMARLUND STANDARD FREQUENCIES				A T & T FREQUENCIES
BAND A (cps)	BAND B (cps)	BAND C (cps)	BAND D (cps)	(cps)
465	1075	2000	3625	425
565	1175	2100	3775	595
665	1275	2200	3925	765
765	1375	2300	4075	935
865	1475	2400	4225	1105
965	1575	2500	4375	1275
	1675	2600	4525	1445
	1775	2700	4675	1615
	1875	2800	4825	1785
		2900	4975	1955
		3000	5125	2125
		3100	5275	
		3200	5425	
		3300	5575	
		3400	5725	
		3500	5875	
			6025	

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TABLE V. TRANSMITTER ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	DESCRIPTION
Frequency Range	Supplied in range of 425 to 6025 cps. Adjacent channels can be spaced at 100 cps intervals for center frequencies in the range of 465 to 965 (Band A) and 1075 to 1875 (Band B) and 2000 to 3500 cps (Band C). Spaced at 150 cps intervals for frequencies in the range of 3625 to 6025 cps (Band D). This provides a maximum of 48 channels. Eleven channels can be provided at Standard A T & T frequencies in the range 425 to 2125 cps.
Frequency Accuracy	Frequency changes resulting from line voltage variations of ±20% are less than ±0.1%. Frequency changes resulting from temperature variations between +60°C. and −30°C. will be less than ±0.6% for Band A, ±0.5% for Bands B and C, and ±0.4% for Band D. Tolerances on center frequencies are ±2 cycles or ±0.1%, whichever is larger.
Output Impedance	500/600-ohm line bridging (nominal impedance presented to line check is 7.5 K ohms at 1000 cps).
Output Level	Adjustable from −45 DBM to +4 DBM (0.003 VRMS to 0.87 VRMS across a 300 ohm load).
Keying	Transmitter is energized by keying against ground. This may be a pair of switch contacts or an auxiliary relay. Nominal keying current is less than 20 milliamperes and voltage at keyer terminals when unkeyed is less than 48 V.D.C.
Harmonic Output	Minimum of 42 db down from fundamental for each harmonic component for frequencies between 765 cps and 5125 cps inclusive. Minimum of 38 db for frequencies down to 465 cps and up to 6025 cps.
Operating Speed	Maximum practical keying rate is determined by receiver.
Tube Complement	Oscillator . . . . . 5965 Buffer Amplifier . . . 5963

TABLE VI. RECEIVER ELECTRICAL CHARACTERISTCS

CHARACTERISTIC	DESCRIPTION
Frequency Range	Available for the same frequencies as the Transmitters described above. Each individual receiver matches its corresponding transmitter.
Filter Frequency Stability	Changes in filter frequency response resulting from temperature variations between +60°C. and −30°C. will be less than ±0.6% for Band A, ±0.5% for Bands B and C, and ±0.4% for Band D.
Input Impedance	500/600 ohm line bridging, (nominal impedance to line is 60 K Ω at 1000 cps).
Sensitivity	Adjustable; maximum sensitivity −25 DBM (0.031 VRMS from a 300 ohm source).
Output	SPDT relay contacts rated at 2 amps for resistive loads at 24 V.D.C. or 115 V.A.C.
Adjacent Channel Attenuation	32 db down minimum. 35 db down nominal.
Operating Speed	The maximum keying speed is a function of receiving filter bandwidth. The maxima possible, based on receiving the fundamental and second harmonic of a 50% duty cycle square wave with standard filters are: Band A — 25 pps to 26 pps Band B — 28 pps to 29 pps Band C — 27 pps to 31 pps Band D — 34 pps to 40 pps These keying speeds vary, due to the variation in filter bandwidths with frequency. Special wide band filters which allow keying up to 45 pps are also available.
Tube Complement	2-stage Amplifier . . . . . ECC81 Amplifier and Keyer 5965

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SECTION IV

INSTALLATION

4-1. SYSTEM CONSIDERATIONS.

4-2. Hammarlund tone signaling units are designed for use on voice-grade circuits, such as is achieved on commercial telephone lines, carrier telephone, power line carrier, radio and micro-wave.

4-3. Input and output circuits of the tone signaling units present a high impedance to permit bridging of many units on a circuit without loading the circuit excessively. The impedance of each receiver input presented to the line is in the order of 60,000 ohms. The impedance of each transmitter line coupling network presented to the line is in the range of 6,000 to 11,000 ohms (varies with frequency and/or level setting). It may be assumed to be a nominal 7,500 ohms at 1,000 cps. In many applications, such as when used on telephone lines, it is important for the tone equipment to present the correct impedance to the transmission medium. While characteristic impedances of telephone lines vary with the frequency and from line to line, it is usually desirable to terminate each end of the circuit in an effective load impedance of 600 ohms. With only receivers at a line terminal a 620 ohm (nearest standard value to 600 ohms) resistor would be placed across the line terminals. Since the input impedance of the receivers is 60,000 ohms each, the effect of their shunting down the 600 terminating resistor is negligible. However, the shunting effect of transmitter coupling networks is not negligible, particularly when many are used. Therefore the effective value of the transmitter line coupling networks should be taken into account by *increasing the value of the terminating resistor* to allow for it. (Adding additional transmitters requires increasing the terminating resistance value.) A chart showing the effective impedance of various numbers of transmitter unit transformers connected in parallel, and the appropriate value of resistance that should be connected across the line terminals to produce 600 ohms is given in Table VII following. If combinations of transmitters and receivers are used at a terminal, the shunting effect of receiver line coupling networks can be ignored. The number of transmitter transformers, as per Table VII, should be used to determine the correct value of shunting resistance.

TABLE VII.

SHUNTING RESISTANCES AT LINE TERMINALS

No. of Transmitter Transformers	Effective Impedance	Shunting Resistance*
1	7500	680
2	3750	750
3	2500	820
4	1875	910
5	1500	1000
6	1250	1200
7	1071	1500
8	938	1800
9	833	2200
10	750	3300
11	681	5100
12	625	15000

* Nearest standard value; a 0.5 watt power rating is sufficient.

IMPORTANT

When tone units are connected at some intermediate point along the line, no termination resistor should be added. The loss to the "through transmission", due to bridging, is approximately 0.4 db per transmitter tone unit transformer.

4-4. If the tone units are to be used on a line which is also used for DC or very low audio frequencies, it is necessary to use a blocking capacitor in series with the leads to the tone unit line transformer. A value of 0.1 microfarads with suitable voltage rating is usually satisfactory. Care should be taken that the DC equipment does not present a short circuit to the tone signals.

4-5. Integrating Capacitor. When tone units are used on circuits that are subject to considerable amounts of induced noise, cross-talk, or other transient voltages it may be desirable to increase the delay of the tone unit response. This is accomplished by the addition of an integrating capacitor, as described in Section V. The integrating capacitor, C7, is used to increase the time constant of the keyer tube and relay circuit. Increasing

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the size of the capacitor increases the time the desired signal frequency must be present before the relay will pull-in, thus making it more immune to spurious operations. Screw type terminals for mounting C7 are provided on the terminal strip of receiver units.

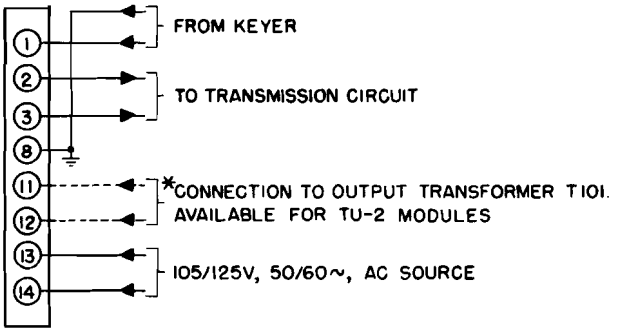
4-6. TRANSMITTER UNIT CONNECTIONS AND OUTPUT LEVEL ADJUSTMENTS.

4-7. TU-2 module sections are identical to TU-1 modules (see figure 2-2) except that the line coupling network included in the TU-1 module is omitted in the TU-2 module. The line coupling network consists primarily of a transformer and resistors. One line coupling network can serve more than one TU module of a control system provided only one transmitter is keyed at a given instant. This variation is provided so that less shunt resistance may be presented to the transmission circuit terminals than would be the case with all TU-1 modules. Note that transmitters may share output coupling networks only if one transmitter will be keyed at a time. It can be seen from figures 4-1, 4-2 and 4-3, and the corresponding schematic diagrams, that each unit, since it contains at least one output coupling network, has terminals provided for connection of TU-2 modules to the input of the coupling network.

4-8. Connection of dual transmitter units or single transmitter unit, to a control system, is as follows:

Make all external connections to the terminal strip as indicated in figure 4-1 for Single Transmitter Unit STU-11, figure 4-2 for Dual Transmitter Unit DTU-11, and figure 4-3 for Dual Transmitter Unit DTU-12. Note that when a common transmission line is used for both sections of the DTU-12, jumpers between 2 and 9, and 3 and 10 may be added, and 2 wires carried to the transmission circuit instead of 4. The "Keyer" shown in these figures may be a simple switch, relay contacts, supervisory contacts, telephone dial, telemeter transmitter contacts, etc.

4-9. Proper output level of the transmitter is dependent upon such factors as channel attenuation to the receiver with which the transmitter will be used, other communication channel services, and local regulations. The output level has been arbitraily set at 0.5-volt rms at the factory with the unit operating into a 300-ohm dummy load. The 300-ohm dummy load is equivalent to



*ONLY USED WHEN TU-2 OF A DTU-11 IS TO BE COUPLED TO THE LINE THRU THE OUTPUT TRANSFORMER OF THIS STU

FIG. 4-1. EXTERNAL CONNECTIONS TO SINGLE TRANSMITTER UNIT STU-11

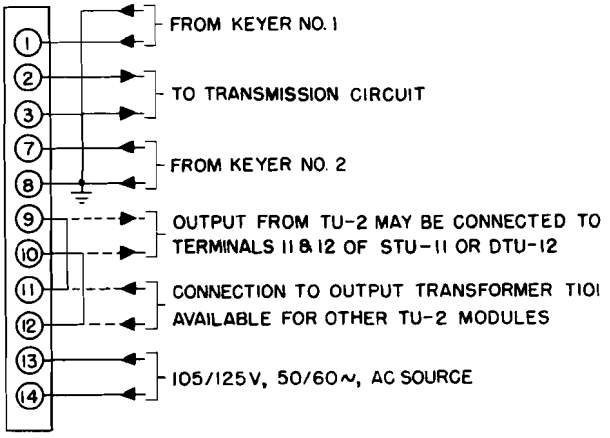


FIG. 4-2. EXTERNAL CONNECTIONS TO DUAL TRANSMITTER UNIT DTU-11

bridging across a properly terminated 600-ohm line. The output level may be readjusted below the 0.5-volt rms level or up to at least 0.87-volt rms by means of the LEVEL ADJUST control R114. Be sure to secure the control in the adjusted position by using the lock-nut that is provided.

4-10. In checking or adjusting the output level, measurements should be made directly at the transmitter input to the telephone line or other communications link *with only one transmitter keyed at a time.*

4-11. Perform the adjustment as follows:

a. Connect the equipment to a properly terminated 600-ohm transmission line or a 300-ohm dummy load.

b. Plug the Hammarlund TM-1 or TM-1A Test Meter into the test socket X202 and set the test meter switch to monitor the output level of the

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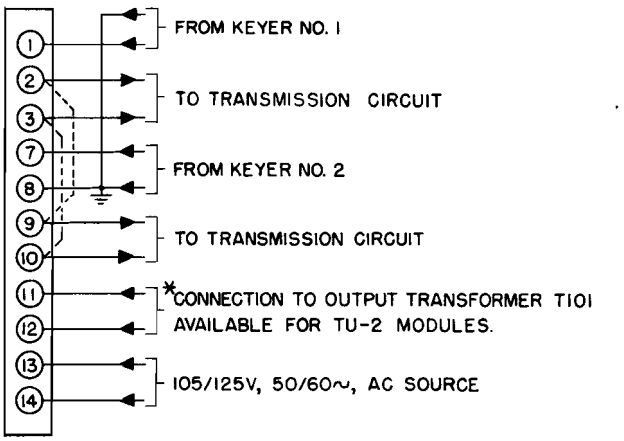
left hand transmitter (TU) module. (Refer to the test meter chart for proper switch position applicable to the transmitter unit under test.) Key the transmitter by means of the test meter and adjust the output level by means of R114 to the desired value. Repeat the adjustment for the right hand transmitter (TU) module.

c. If the Hammarlund Test Meter is unavailable use a V. T. V. M. or 20,000-ohms-per-volt meter for monitoring. Make the test meter connections as indicated in Table VIII for each TU module.

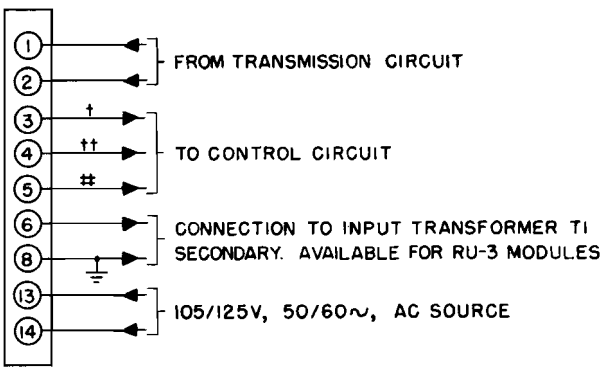
TABLE VIII. TEST METER CONNECTIONS FOR OUTPUT LEVEL ADJUSTMENT

Module	Test Socket X202 Pin Connections	Meter Range	Maximum Adjustment (Operating into 300Ω)
TU-1 (Left Hand)	Pin 3 to Pin 4 (jumper from Pin 1 to Pin 2 for keying)	0 — 3 V. AC	1.0 V. AC ±20%
TU-1 (Right Hand) and DSU units	Pin 5 to Pin 6 (jumper from Pin 8 to Pin 1 for keying)	0 — 3 V. AC	1.0 V. AC ±20%
TU-2 (Right Hand)	Pin 3 to Pin 4 (jumper from Pin 8 to Pin 1 for keying)	0 — 3 V. AC	1.0 V. AC ±20%



*ONLY USED WHEN TU-2 OF A DTU-11 IS TO BE COUPLED TO THE LINE THRU THE OUTPUT TRANSFORMER OF THIS DTU.

FIG. 4-3. EXTERNAL CONNECTIONS TO DUAL TRANSMITTER UNIT DTU-12



† = NORMALLY CLOSED
†† = ARM
# = NORMALLY OPEN

FIG. 4-4. EXTERNAL CONNECTIONS TO SINGLE RECEIVER UNIT SRU-11

4-12. RECEIVER UNIT CONNECTIONS AND GAIN ADJUSTMENTS.

4-13. Connection of dual receiver units or single receiver units to a control system is as follows:

Make all external connections to the terminal strip as indicated in figure 4-4 for Single Receiver Units SRU-11, figure 4-5 for Dual Receiver Unit DRU-11, and figure 4-6 for DRU-12. Note that when a common transmission line is used for both sections of the DRU-12, jumpers between 1 and 7, and 2 and 9 may be added, and 2 wires carried to the transmission circuit instead of 4. These jumpers are shown dotted on figure 4-6.

4-14. RU-3 module sections are identical to the RU-1 module (see figure 2-4) except that the input transformer included in the RU-1 module is omitted in type RU-3 modules. One input transformer can generally serve several RU-3 modules. As noted in figures 4-4, 4-5, and 4-6, terminals 6 and 8 (ground) are available for tapping off the secondary of the input transformer T1 in the RU-1 module for other RU-3 modules in the system.

On the DRU-11, the jumper between Terminals 6 and 7 is normally included when the unit is

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shipped. If the RU-3 module is to be connected to an RU-1 module other than the one on the same chassis, this jumper must be removed.

4-15. Receiver input level is determined by the line loss in any particular installation and the output level of the associated transmitter. Receiver sensitivity should be adjusted for proper operation at this input level.

4-16. Adjust the GAIN control R19 of each RU module as follows:

a. Connect the equipment to the transmission line with normal operating signal imposed thereon.

b. Plug the Hammarlund TM-1 or TM-1A Test Meter into the test socket X202 and set the test meter switch to monitor the output level of the left hand RU module. (Refer to the test meter chart for proper switch applicable to the receiver unit under test.) Adjust the GAIN control R19 for a D.C. reading on the test meter of 34 volts dc. With this adjustment the receiver unit will operate properly over an attenuation variation of 6 db. Repeat the adjustment for the right hand receiver (RU) module.

c. If a Hammarlund Test Meter is unavailable use a V. T. V. M. or 20,000-ohms-per-volt meter for monitoring. Make the test meter connections as indicated in Table IX for each RU module.

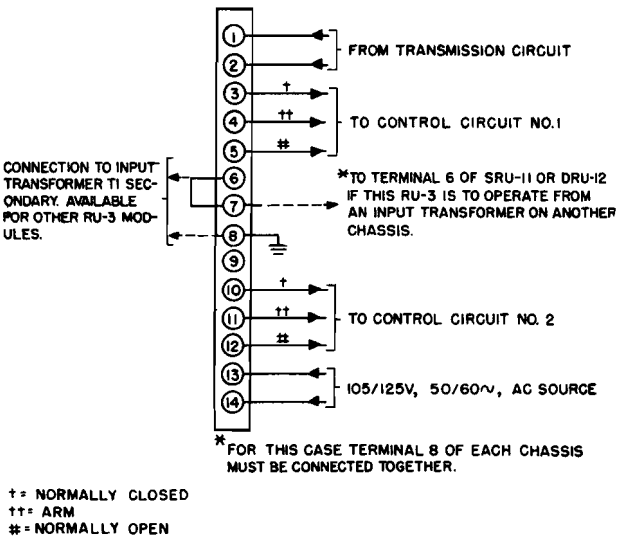

FIG. 4–5. EXTERNAL CONNECTIONS TO DUAL RECEIVER UNIT DRU-11

TABLE IX. TEST METER CONNECTIONS FOR INPUT LEVEL ADJUSTMENT

Module	Test Socket X202 Pin Connections	Meter Range	Adjustment
RU-1 or RU-3 (Left Hand) and DSU units	Pin 2 to Pin 1 (Grd)	0 — 60 V. DC	34 V. DC
RU-1 or RU-3 (Right Hand)	Pin 8 to Pin 1 (Grd)	0 — 60 V. DC	34 V. DC

4-17. ARC SUPPRESSION (RELAY CONTACTS).

In service applications where the contacts of the plug-in relays of the RU modules are used to make and break inductive loads, such as relay coils, small motors, contactors, transformers, etc., arc suppression will most likely be required. An indication of sparking or arcing of the relay contacts will be evidenced by random chattering of the relay contacts, which if permitted to continue for any length of time may permanently damage the relay.

4-18. The arc suppressor network must be applied *directly across* the *external* inductance *coil terminals (at the coil itself—not across the relay contacts)*. While the values of capacitance and resistance of the arc suppressor network (see figure 4-7) will vary for different contact loads, a suitable arc suppressor network for most installations can be made by using a composition resistor

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of 270 ohms, ½-watt, connected in series with a tubular paper capacitor of 0.25 microfarads, 400 W. V. D. C. These networks may be ordered from Hammarlund Mfg. Co., Inc. under Part No. 43192.

4-19. DUPLEX SIGNALING UNIT CONNECTIONS AND ADJUSTMENTS.

4-20. Connection of duplex signaling units to a control system is as follows:

Make connections to the proper terminals as indicated in figure 4-8 for Duplex Signaling Unit DSU-12 and figure 4-9 for Duplex Signaling Unit DSU-11T. Note that when a common transmission line is used for both sections of the DSU-12, jumpers between 1 and 9, and 2 and 10 may be added, and 2 wires carried to the transmission circuit instead of 4. These jumpers are shown dotted on figure 4-8.

4-21. Because RU-3 module of the Duplex Signaling Unit DSU-11T does not have its own input transformer (refer to paragraph 4-14) it will be noted that receiver input from the transmission circuit will be obtained at terminals 6 and 8 (ground) of an RU-1 module in the control system.

4-22. For installation adjustments, refer to installation adjustments for transmitters as covered in paragraph 4-11 and receivers as covered in paragraph 4-16. These installation adjustments are also applicable to the Duplex Signaling Unit.

4-23. For arc suppression requirements, refer to paragraphs 4-17 and 4-18 as applicable to Duplex Signaling Units.

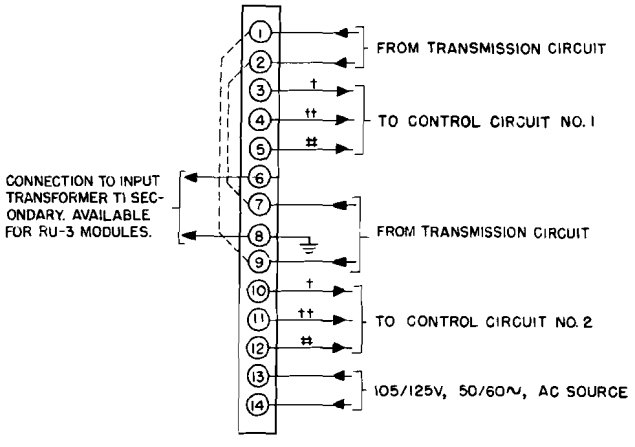

FIG. 4-6. EXTERNAL CONNECTIONS TO DUAL RECEIVER UNIT DRU-12

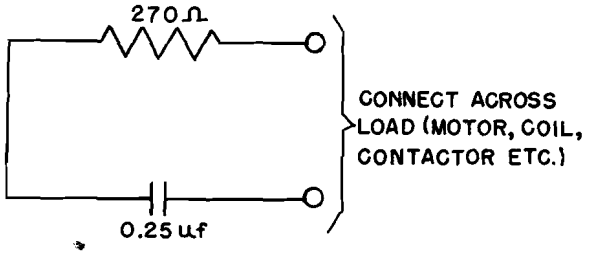

FIG. 4-7. ARC SUPPRESSION NETWORK, PART NO. 43192

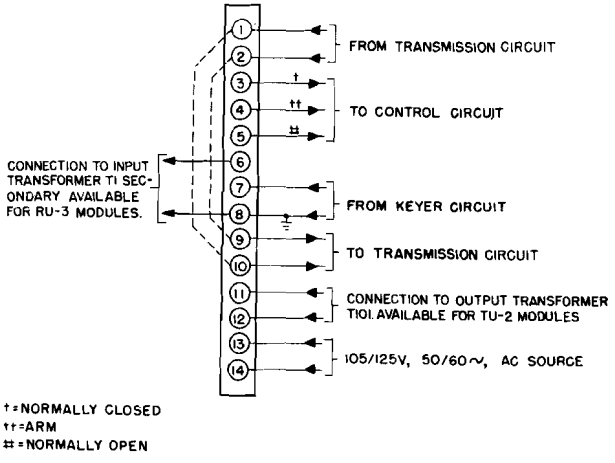

FIG. 4-8. EXTERNAL CONNECTIONS TO DUPLEX SIGNALING UNIT DSU-12

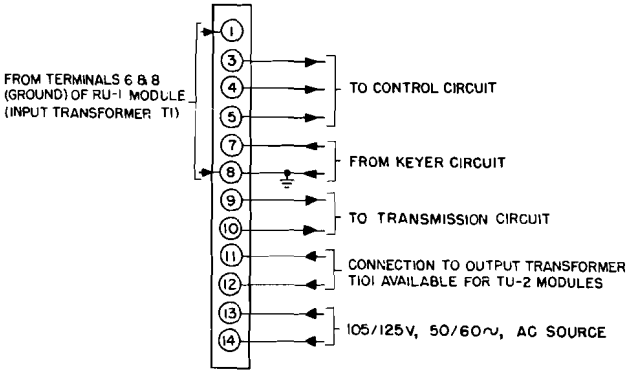

FIG. 4-9. EXTERNAL CONNECTIONS TO DUPLEX SIGNALING UNIT DSU-11T

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SECTION V

THEORY OF OPERATION

5-1. GENERAL.

5-2. A detailed theory of operation for each of the three module sections (SU, TU and RU) of the Hammarlund tone signaling equipment is covered in the following paragraphs. As noted in Section II, combinations of these modules form the various tone units covered by this manual. Table X indicates the applicable schematic diagram for each tone signaling unit covered by this manual. The diagrams are located at the rear of this manual.

TABLE X. APPLICABLE SCHEMATICS

Unit	Schematic Figure No.
DTU-11	1
DTU-12	2
STU-11	3
DRU-11	4
DRU-12	5
SRU-11	6
DSU-11T	7
DSU-12	8

5-3. POWER SUPPLY MODULES.

5-4. The power supply modules SU-1, SU-2 and SU-3 are of the full-wave electron tube rectifier type each using a type 5Y3GT tube for rectification. (See figure 5-1.) The power supply provides B+ and A-C heater voltage for the equipment group of which it is a part. Each Supply Unit (SU) contains an overload fuse F201, a fuse alarm indicator I201, full wave rectifier tube V201 and a two-part choke input filter network. Filament Supply for V201 in each SU is 5 volts AC, tapped from one of the low-voltage secondary windings of power transformer T201. The second low-voltage winding of T201 is used to provide the 6.3 volts AC heater supply required for the tubes in the receiver or transmitter modules. Variations among the SU-1, SU-2, and SU-3 are in the filter network and voltage divider of the modules.

5-5. Specific functions of each of the three variations of Supply Units (SU) are outlined in the following paragraphs.

5-6. SU-1 Module: This module is used only in single receiver units (SRU) and dual receiver units (DRU). See figure 4 for a schematic drawing of a typical receiver tone signaling unit using the SU-1 module. The first part of the filter network of this module is comprised of choke L201 and resistor R203 in series, and shunt capacitor C201A. The second part of the filter network consists of resistor R205 and the shunt capacitor C201B. Resistor R204 functions as a bleeder resistor.

5-7. SU-2 Module: The SU-2 module is used only in single transmitter units (STU) or dual transmitter units (DTU). See figure 1 for a schematic drawing of a typical transmitter tone signaling unit using the SU-2 module. It will be noted in this schematic that the first part of the filter network of this unit is comprised of choke L201 and shunt capacitor C201A. The second part of the filter network consists of resistor R205 and shunt capacitor C201B. Resistor R204 is used as a bleeder resistor. Resistors R206 and R207 are used as a voltage divider network to provide the required oscillator plate voltage for TU modules. Resistors R201 and R202 in the B+ supply serve as voltage-dropping resistors for the buffer amplifiers of DTU-12 (Dual Transmitter Unit) TU-1 modules. (See figure 2.) Resistor R201 is used as the voltage dropping resistor only for the buffer amplifier of the TU-1 module. See the schematic diagram for Dual Transmitter Unit DTU-11 and Single Transmitter Unit STU-11 (figures 1 and 3 respectively).

5-8. SU-3 Module: The SU-3 module is used only in duplex signaling units (DSU). Refer to figure 7 for the schematic diagram of a typical duplex signaling unit using the SU-3 module. The filter network of the SU-3 module is identical to the filter network of the SU-1 module. In the SU-3 module however, as in the SU-2 module previously discussed, resistors R206 and R207 function as a voltage divider network to provide the necessary oscillator plate voltage to the TU module; and resistor R201 in the B+ supply acts as a voltage-dropping resistor for the buffer amplifier of the TU-1 module.

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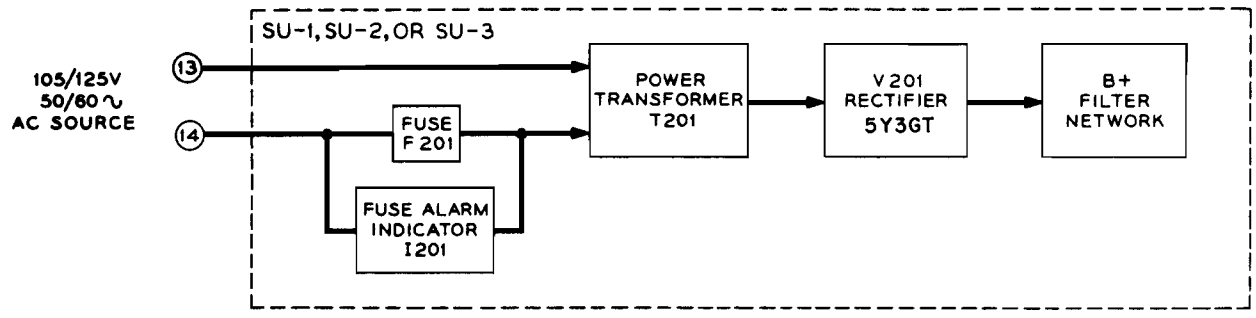

FIG. 5-1

5-9. TRANSMITTER MODULES.

5-10. Transmitter modules TU-1 and TU-2 each consist of a Frequency Determining Unit Z03- , and the tone generator TG-2 plug-in package. (See figure 5-2.) Module TU-1 also includes an output coupling network.

5-11. The Z03-XXXX frequency determining unit determines the tone frequency of the module section of which it is a part. The numbers indicated on the nameplate following the "Z03-" indicate the frequency in cycles per second. Stock units of Z03- are available for any of the 48 standard Hammarlund frequencies. In addition, frequency determining units are also available for A.T. and T. frequencies and other special frequencies within the range of 425 to 6025 cps. Available frequency ranges are indicated in Section III, Table IV.

5-12. The TG-2 tone generator is a plug-in type package. Its 12-terminal connector plug fits into a matching socket. Two captive screws lock the package in place.

5-13. Specific functions of the transmitter module (TU) are outlined in the following paragraphs. (See figures 1, 2 and 3.)

5-14. The limiter (½ of V1) serves to limit the A-C voltage input to the tank circuit. Bias of the limiter is obtained in part through the voltage drop across R8, and in part from the grid leak bias developed across R3 and R4.

5-15. The frequency determining unit Z03- permits only the frequency to which it is tuned to pass through to the phase-inverter grid (½ of V1). Capacitor C2 is the coupling capacitor to the phase-inverter.

5-16. The phase inverter provides a double-ended output to the push-pull amplifier V2. The energy required to sustain oscillations is fed back from the plate of the phase inverter, through coupling capacitor C3, to the grid circuit of the limiter. Bias for the phase-inverter is developed across resistor R6. Resistors R2 and R7 are the phase-inverter load resistors. The audio tones across these two resistors are capacitively coupled into the grids of the push-pull amplifier V2.

5-17. Push-pull amplifier V2, when keyed to ground (at J1-P1 terminal 9), functions to provide amplified tone output across the secondary of output transformer T101. Unit output level adjustment is available with the LEVEL ADJUST control R114. Resistors R116 and R117 limits the minimum bridging impedance to 6K ohms. The push-pull amplifier sections are biased by resistors R11 and R12. The amplifier is keyed by grounding the cathode circuits of the amplifier at the junction of R11 and R12, through pin 9 of the module plug. Voltage between cathode and filament of V2 is limited to a safe maximum value by having the junction of R11 and R12 connected to the cathode, pin 8 of V1, through resistor R13.

5-18. RECEIVER MODULES.

5-19. Receiver modules RU-1 and RU-3 each consist of a Filter Assembly ZF10A, tone receiver TR-1 plug-in package, a GAIN control R19, and, except for certain special applications, integrating Capacitor C7. (See figure 5-3.) Module RU-1 also includes input transformer T1 and an input resistor circuit.

5-20. Input transformer T1 in the RU-1 module may also serve as input transformer for other RU-3 modules present in a particular installation. In such instances the T1 secondary winding is par-

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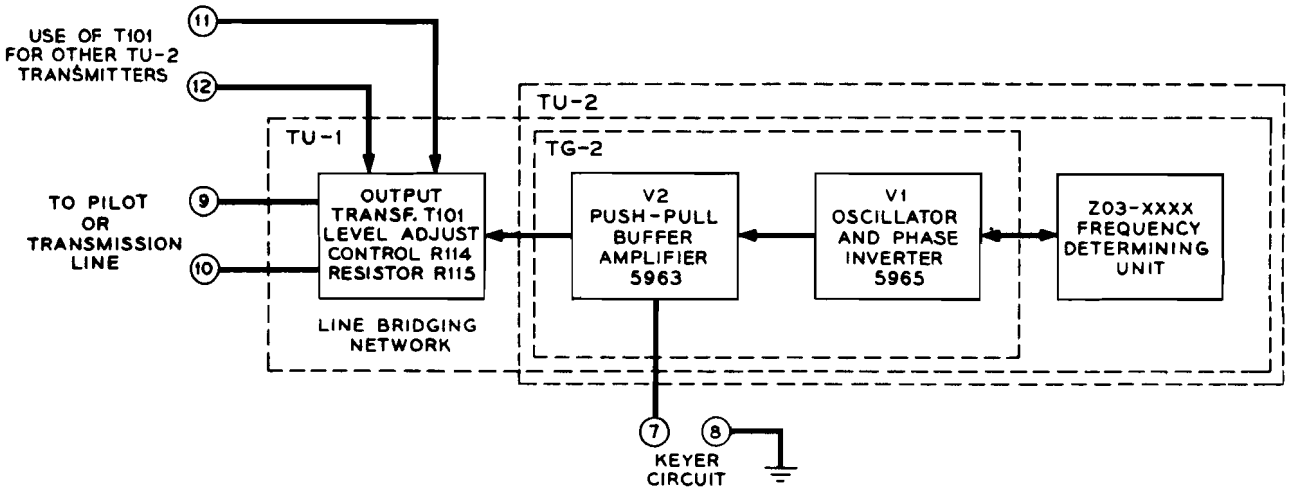

FIG. 5-2 TRANSMITTER MODULE

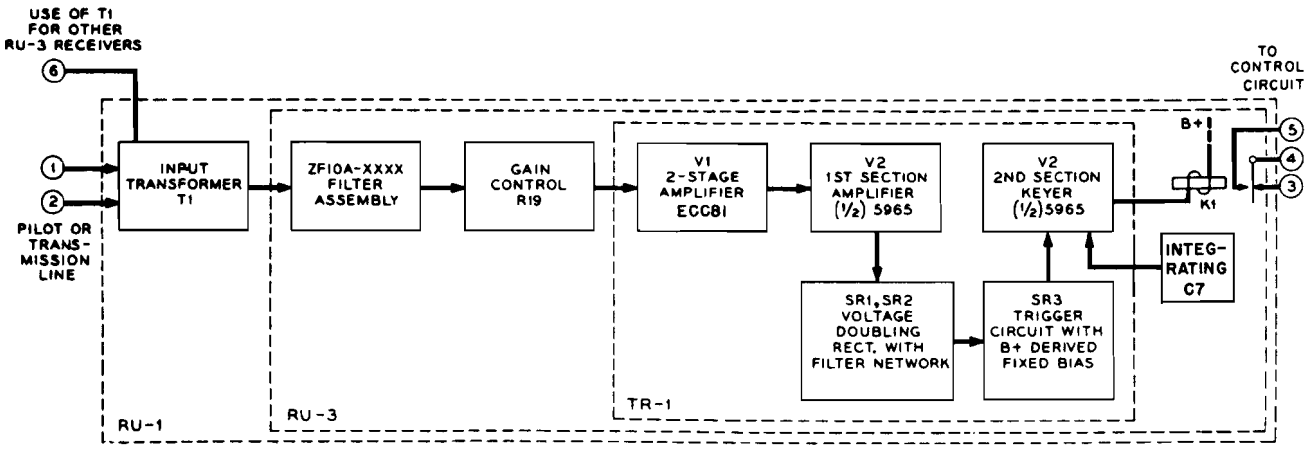

FIG. 5-3 RECEIVER MODULE

allel-connected to the ZF10A input terminals of each RU-3.

5-21. The ZF10A-XXXX filter assembly determines the tone-selective channel of the module section of which it is a part. The numbers indicated on the nameplate following the "ZF10A-" symbol indicates the frequency in cycles per second. Stock units are available for any of the 48 frequencies which are standard to Hammarlund. In addition, filters are also available for A.T. and T. frequencies and other special frequencies within the range of 425 to 6025 cps. The available frequency ranges are indicated in Section III, Table IV.

5-22. The TR-1 tone receiver is a plug-in type package. Its 12-terminal connector plug fits into a matching socket. Two captive screws lock the package in place.

5-23. Specific functions of the receiver module (RU) are outlined in the following paragraphs. (See figures 4, 5 and 6.)

5-24. Tone receiver TR-1 contains a 3-stage resistance-coupled amplifier, a voltage-doubling detector, a low-pass filter network, a fixed-bias source and an output relay. The filter network, composed of choke L1 and capacitors C4, C5 and C6, is designed to permit operating speeds of up to 40 pulses per second and functions to attenuate tone signal components existing in the receiver dc

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output. For minimum bias distortion it is desirable to limit the keying rate to between 10 and 13 pulses per second, dependent upon the frequency.

5-25. The 3-stage, negative-feedback, stabilized amplifier is comprised of both sections of V1 and the first section of V2. The voltage-doubling detector SR1 and SR2 develops a DC output proportional to its applied signal input (through C3) across its load resistor R15.

5-26. The voltage divider network, resistors R17 and R16, develops +29 volts fixed bias for limiting the signal applied to the second section of V2. However, this limit voltage cannot be effective at the grid of V2 (pin 7) unless the selenium rectifier SR3 conducts. SR3 will conduct only when the DC output across R15 is at least +29.0 volts DC.

5-27. Integrating capacitor C7, when required, is used to increase delay of the unit response so that extraneous pulse inputs of short duration cannot simulate signal input. Time delays of controlled length may thus be generated by use of integrating capacitor C7.

5-28. Table XI following, shows the relationship between the various values of capacitor C7 and the actual operate and release times. Operate delay is defined as the time between the application of a signal to the receiver input and the closing of the normally open relay contact. The release delay is defined as the time interval between cessation of receiver input and the opening of the normally open contact. This relationship indicated in this table is valid only when the detector voltage, as measured at the test socket, is approximately 34.0 volts. In addition, for proper correlation, the pulse-on time must be at least five times the delayed-operating time, and the pulse-off time, five times the delayed-on time. Note, from figures 4 thru 8, that capacitor C8 is connected across the same electrical points as those intended for C7. Thus a small amount of integration is incorporated in all standard units. If necessary to eliminate the delay caused by this capacitor, C8 may be removed provided that precautions are taken to keep other services and devices from producing short transients at the tone receiver input. With C8 removed, the "Operate Delay" will be 19 milliseconds, and the "Release Delay" will be 24 milliseconds.

TABLE XI.
INTEGRATING CAPACITANCE DELAY CHART

Capacitor C7 (mfd)	Operate (millisec.)*	Release (millisec.)*
0	22	28
0.01	23	31
0.02	24	35
0.05	30	49
0.10	37	69
0.20	62	114
0.50	115	250
1.00	200	460

* The characteristics of units and components designed for particular requirements may be at variance with the above table.

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SECTION VI

MAINTENANCE AND TROUBLE-SHOOTING

6-1. The following steps are suggested in trouble-shooting tone signaling equipment.

a. Visual Inspection: Inspect the unit for discoloration, charring, pitting, or other evidence of malfunction. In the event that fuse F201 has blown, neon lamp I201 of the fuse alarm will glow.

b. Check the vacuum tubes using a tube checker, or by substitution with a known good tube if no tube checker is available.

NOTE

As a temporary expedient, tube types 5965, 12AT7, and ECC81 may be interchanged. Also, a type 12AU7 may be substituted for type 5963 tubes.

c. Using the test socket X202, monitor the B+ power supply voltage, transmitter output, and receiver input levels as applicable to the specific unit under test. Use the Hammarlund TM– Test Meter if available. A V. T. V. M. or 20,000 ohms-per-volt meter is satisfactory if a Test Meter is not available. Refer to Table XII for test meter connections necessary to trouble-shoot the tone signaling units. Proper switch positions of the Test Meter for monitoring of the circuits are covered in a chart that is supplied with each Test Meter. Refer to this chart for the proper switch positions applicable to the unit under test.

d. Substitute suspected faulty plug-in packages with "known good" packages to localize the faulty component. A plug in package from a channel operating properly, may be considered "known good".

e. To pin-point the defective component or part, refer to the applicable trouble-shooting procedure as covered in the following paragraphs for each of the three modules. Use a V. T. V. M. or 20,000-ohms-per-volt meter for all measurements.

6-2. POWER SUPPLY MODULES (SU).

6-3. Remove the applicable tone generator TG-2 or tone receiver TR-1 package from the tone signaling unit under test and perform the following voltage measurement as indicated in Table XIII.

TABLE XII.
TEST CONNECTIONS AND SPECIFICATIONS

Applicable Tone Units*	Test	Test Socket X202 Terminals	Meter Range	Reading
ALL	B+ Power Supply Voltage	Pin 7 to Pin 1	0-300 V DC	220 V DC ±20%
STU, DTU	TU-1 (Left Hand) Output Level	Pin 3 to Pin 4 (jumper between Pins 2 and 1 for keying)	0-3 V AC	1.0 V AC ±20% (with Gain Control R114 fully clockwise)
DTU, DSU	TU-1 (Right Hand) Output Level	Pin 5 to Pin 6 (jumper between Pins 8 and 1 for keying)	0-3 V AC	1.0 V AC ±20% (with Gain Control R114 fully clockwise)
DTU	TU-2 (Right Hand) Output Level	Pin 3 to Pin 4 of coupled TU-1 module (jumper between Pins 8 and 1 for keying)	0-3 V AC	1.0 V AC ±20% (with Gain Control R114 fully clockwise)

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TABLE XII.
TEST CONNECTIONS AND SPECIFICATIONS (CON'T)

Applicable Tone Units*	Test	Test Socket X202 Terminals	Meter Range	Reading
SRU, DRU, DSU	RU-1 or RU-3 (Left Hand) Input Gain Level	Pin 2 to Pin 1	0-60 V DC	34 V DC with normal input level
DRU	RU-1 or RU-3 (Right Hand) Input Gain	Pin 8 to Pin 1	0-60 V DC	34 V DC with normal input level

* NOTE:
1. To make the desired test for TU modules connect the equipment to a properly terminated 600-ohm transmission line or a 300-ohm dummy load.
2. To make the desired test for RU modules connect the equipment to the transmission line with normal operating signal.
3. After completing transmitter module test, re-adjust the GAIN control R114 of each unit to the desired level.
4. Meter negative lead to Pin 1 (ground).

TABLE XIII. SUPPLY UNIT VOLTAGES

Module	Units	Voltmeter Connection (to Grd)	Voltage (dc ±20%)
SU-1	SRU, DRU	Pin 5 of J1 Pin 6 of J1	275 275
SU-2	STU, DTU	Pin 12 of J1 Pin 6 of J1 Center Tap T101	285 165 320
SU-3	DSU	Pin 5 of J1 (RU-) Pin 6 of J1 (RU-) Center Tap T101 (TU-) Pin 12 of J1 (TU-) Pin 6 of J1 (TU-)	275 270 300 275 155

TABLE XIV. RESISTANCE CHART OF TG-2 PACKAGE
(Removed from Tone Signaling Unit)

Location	Adaptor Pin or Terminal To Grd (ohms ±10%)											
	1	2	3	4	5	6	7	8	9	10	11	12
V1	150K*	570K	820	—	—	10K	481K	11.3K	—	—	—	—
V2	∞	470K	620*	—	—	∞	470K	620*	—	—	—	—
P1	—	—	—	—	—	0	—	—	0	∞	∞	0

* Provide temporary ground connection at P1 terminals 6, 9 and 12 prior to measuring resistance.

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6-4. TRANSMITTER MODULES (TU).

6-5. If a transmitter module is suspected of being faulty, trouble-shoot the module by performing the resistance and voltage measurements indicated in Tables XIV and XV. All voltage and resistance measurements may be taken by interposing a nine-pin adapter socket (Hammarlund Part No. 15555, or equivalent) between the tube V1 or V2 and its mating socket.

6-6. To check potentiometer R114, unsolder one end of it from transformer T101.

6-7. RECEIVER MODULES (RU).

6-8. If the receiver module is suspected of being faulty, trouble-shoot the module by performing the resistance and voltage measurements indicated in Tables XVI and XVII. All voltage and resistance measurements may be taken by inserting a nine-pin adapter socket (Hammarlund Part No. 15555, or equivalent) interposed between the tube V1 or V2 and its mating socket.

TABLE XV.
VOLTAGE CHART OF TRANSMITTER MODULE
(With Unit Oscillating and Not Keyed)

Location	Adaptor Pin or Terminal to Grd (dc unless specified, ±20%)											
	1	2	3	4	5	6	7	8	9	10	11	12
V1	90	1.8	3.7	To pin 9 6.3 AC	To pin 9 6.3 AC	185	34	47	To pin 4 & 5 6.3 AC			
V2	295	0	47	To pin 9 6.3 AC	To pin 9 6.3 AC	295	0	48	To pin 4 & 5 6.3 AC			
J1	To pin 7 6.3 AC	—	—	0	—	124	To pin 1 6.3 AC	—	48	295	295	220

TABLE XVI. RESISTANCE CHART OF TR-1 PACKAGE (Removed from Tone Signaling Unit)

Location	Adaptor Pin or Terminal to Ground (ohms ±10%)											
	1	2	3	4	5	6	7	8	9	10	11	12
V1	51K	∞	1K	—	—	51K	470K	1K	—			
V2	20K	470K	510	—	—	*29K	470K	3K	—			
P1	—	—	—	—	0	0	—	—	0	∞	5.6K	400K
XK1	∞	*29K	24K	∞	∞	∞	∞	∞				

* Provide temporary ground connection at P1 terminals 5, 6, & 9 pin to measure resistance. Relay (std. relay) should remain in socket when making measurements. Reading will be 24.5 for polar-relay.

TABLE XVII. VOLTAGE CHART OF RECEIVER MODULE (With no signal input)

Location	Adaptor Pin or Terminal to Grd (DC unless specified, ±20%)											
	1	2	3	4	5	6	7	8	9	10	11	12
V1	+115	—	+1.95	To pin 9 6.3 AC	To pin 9 6.3 AC	+110	—	+2.12	To pin 4 & 5 6.3 AC			
V2	+140	—	+2.2V	6.3 AC	6.3 AC	+215	+6.2	+12.1	6.3 AC			
P1	—	—	—	—	+225	+210	To pin 8 6.3 AC	To pin 7 6.3 AC	0	—	30	6.7

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SECTION VII

REPLACEABLE PARTS LIST

Ref. Symbol	Applicable Module/Package	Nomenclature	Part No.
	POWER SUPPLY MODULES		
C201	SU-1, SU-2, SU-3	Capacitor, Fixed, 60/60 MFD 400V	K15504-54
E201	SU-1, SU-2, SU-3	Fuse Holder	K35093-1
F201	SU-1, SU-2, SU-3	Fuse 1.0 Amp	K15928-5
I201	SU-1, SU-2, SU-3	Neon Indicating Lamp	(Incl. in E201)
L201	SU-1, SU-2, SU-3	Choke, 15 HY., 85 MA.	K15785-1
R201	SU-2, SU-3	Resistor, Fixed, 5K—5W, ±10%	K19431-46
R202	SU-2	Resistor, Fixed, 5K—5W, ±10%	K19431-46
R203	SU-1	Resistor, Fixed, 900Ω—10W, ±10%	K19430-32
R203	SU-3	Resistor, Fixed, 1.2K—10W, ±10%	K19430-35
R204	SU-1, SU-3	Resistor, Fixed, 16K—10W, ±10%	K19430-59
R204	SU-2	Resistor, Fixed, 22.5K—10W, ±10%	K19430-63
R205	SU-1, SU-3	Resistor, Fixed, 1K—½W, ±10%	K19309-49
R205	SU-2	Resistor, Fixed, 6K—5W, ±10%	K19431-47
R206	SU-2	Resistor, Fixed, 39K—1W, ±10%	K19310-87
R206	SU-3	Resistor, Fixed, 43K—1W, ±5%	K19310-170
R207	SU-2	Resistor, Fixed, 51K—1W, ±5%	K19310-182
R207	SU-3	Resistor, Fixed, 56K—1W, ±10%	K19310-91
T201	SU-1, SU-2, SU-3	Transformer, Power	M15786-1
V201	SU-1, SU-2, SU-3	Vacuum Tube 5Y3GT	K16252
X201	SU-1, SU-2, SU-3	Socket, Octal 8-pin	K15944-15
X202	SU-1, SU-2, SU-3	Socket, Octal 8-pin	K15944-15
	TRANSMITTER MODULES		
C1	TG-2	Capacitor, Fixed .01 MFD 1000V	M23034-8
C2	TG-2	Capacitor, Fixed .01 MFD 1000V	M23034-8
C3	TG-2	Capacitor, Fixed .01 MFD 1000V	M23034-8
C4	TG-2	Capacitor, Fixed .01 MFD 1000V	M23034-8
C5	TG-2	Capacitor, Fixed .01 MFD 1000V	M23034-8
J1	TU-1, TU-3	Jack, 12 Pins; Mates with P1	K16094-1
P1	TG-2	Plug, 12 Terminals; Mates with J1	K16086-1
R1	TG-2	Resistor, Fixed, 150K—½W, ±5%	K19309-289
R2	TG-2	Resistor, Fixed, 10K—½W, ±5%	K19309-278
R3	TG-2	Resistor, Fixed, 100K—½W, ±5%	K19309-288
R4	TG-2	Resistor, Fixed, 470K—½W, ±5%	K19309-293
R5	TG-2	Resistor, Fixed, 470K—½W, ±5%	K19309-293
R6	TG-2	Resistor, Fixed, 510Ω—½W, ±5%	K19309-170
R7	TG-2	Resistor, Fixed, 10K—½W, ±5%	K19309-278
R8	TG-2	Resistor, Fixed, 820Ω—½W, ±5%	K19309-266
R9	TG-2	Resistor, Fixed, 470K—½W, ±5%	K19309-293
R10	TG-2	Resistor, Fixed, 470K—½W, ±5%	K19309-293
R11	TG-2	Resistor, Fixed, 620Ω—½W, ±5%	K19309-205
R12	TG-2	Resistor, Fixed, 620Ω—½W, ±5%	K19309-205
R13	TG-2	Resistor, Fixed, 330K—½W, ±5%	K19309-241
R114	TU-1	Resistor, Variable, 10K	K15369-17
R116	TU-1	Resistor, Fixed, 3.0K—½W, ±5%	K19309-212
R117	TU-1	Resistor, Fixed, 3.0K—½W, ±5%	K19309-212
T101	TU-1	Transformer	M15769-1
TG-2	TU-1, TU-3	Tone Generator	PL37235-G1
V1	TG-2	Vacuum Tube 5965	K16384-1
V2	TG-2	Vacuum Tube 5963	K16383-1
X1	TG-2	Socket, 9-pin miniature	K37307-1
X2	TG-2	Socket, 9-pin miniature	K37307-2
Z03	TU-1, TU-2	Frequency Determining Unit	P37243-G1
	RECEIVER MODULES		
C1	TR-1	Capacitor .01 MFD 1000V	M23034-8
C2	TR-1	Capacitor .01 MFD 1000V	M23034-8
C3	TR-1	Capacitor .022 MFD 500V	M23034-24
C4	TR-1	Capacitor .02 MFD 500V	M23034-7
C5	TR-1	Capacitor .0027 MFD 500V	M23034-6
C6	TR-1	Capacitor .02 MFD 500V	M23034-7
C7	RU-1, RU-3	Integrating Capacitor (if used)	*
C8	RU-1, RU-3	Capacitor .01 MFD 1000V	M23034-8
J1	RU-1, RU-3	Jack, 12 pins; mates with P1	K16094-1
L1	TR-1	Choke, 50HY @ 1 MIL	K15784-1
P1	TR-1	Plug, 12 terminals; mates with J1	K16086-1
R1	TR-1	Resistor, Fixed 51K—1W, ±5%	K19310-182
R2	TR-1	Resistor, Fixed 1K—½W, ±5%	K19309-267

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REPLACEABLE PARTS LIST

Ref. Symbol	Applicable Module/Package	Nomenclature	Part No.
	RECEIVER MODULES		
R3	TR-1	Resistor, Fixed 51K—1W, ±5%	K19310-182
R4	TR-1	Resistor, Fixed 1K—½W, ±5%	K19309-267
R5	TR-1	Resistor, Fixed 470K—½W, ±5%	K19309-293
R6	TR-1	Resistor, Fixed 560K—½W, ±5%	K19309-294
R7	TR-1	Resistor, Fixed 510Ω—½W, ±5%	K19309-170
R8	TR-1	Resistor, Fixed 24K—1W, ±5%	K19310-187
R9	TR-1	Resistor, Fixed 470K—½W, ±5%	K19309-293
R10	TR-1	Resistor, Fixed 2.7 MEG—½W, ±5%	K19309-301
R11	TR-1	Resistor, Fixed 3.3K—½W, ±5%	K19309-273
R12	TR-1	Resistor, Fixed 56K—2W, ±5%	K19304-128
R13	TR-1	Resistor, Fixed 20K—2W, ±5%	K19304-133
R14	TR-1	Resistor, Fixed 270K—½W, ±5%	K19309-171
R15	TR-1	Resistor, Fixed 75K—½W, ±5%	K19309-223
R16	RU-1, RU-3	Resistor, Fixed 39K—2W, ±5%	K19304-139
R17	TR-1	Resistor, Fixed 5.6K—½W, ±5%	K19309-276
R18	TR-1	Resistor, Fixed 51K—1W, ±5%	K19310-182
R19	RU-1, RU-3	Resistor, Var., 1.0 MEG—2W, ±20%	K15369-14
SR-1	TR-1	Selenium Rectifier	M16356-15
SR-2	TR-1	Selenium Rectifier	M16356-15
SR-3	TR-1	Selenium Rectifier	M16356-15
T1	RU-1	Transformer	K15769-3
V1	TR-1	Vacuum Tube ECC81	K16398-1
V2	TR-1	Vacuum Tube 5965	K16384-1
X1	TR-1	Socket, 9-pin miniature	K37307-2
X2	TR-1	Socket, 9-pin miniature	K37307-1
XK-1	TR-1	Socket, Relay, 8-pin Octal	K15944-15
ZF10A	RU-1, RU-3	Filter Assembly	T37352-G1
K1	TR-1	Relay	**

*Part No. depends on value
**Relay used depends on application:
Standard, with dust cover K16669-1
Standard, Hermetically sealed K16670-1
Polar, Hermetically sealed K16678-1

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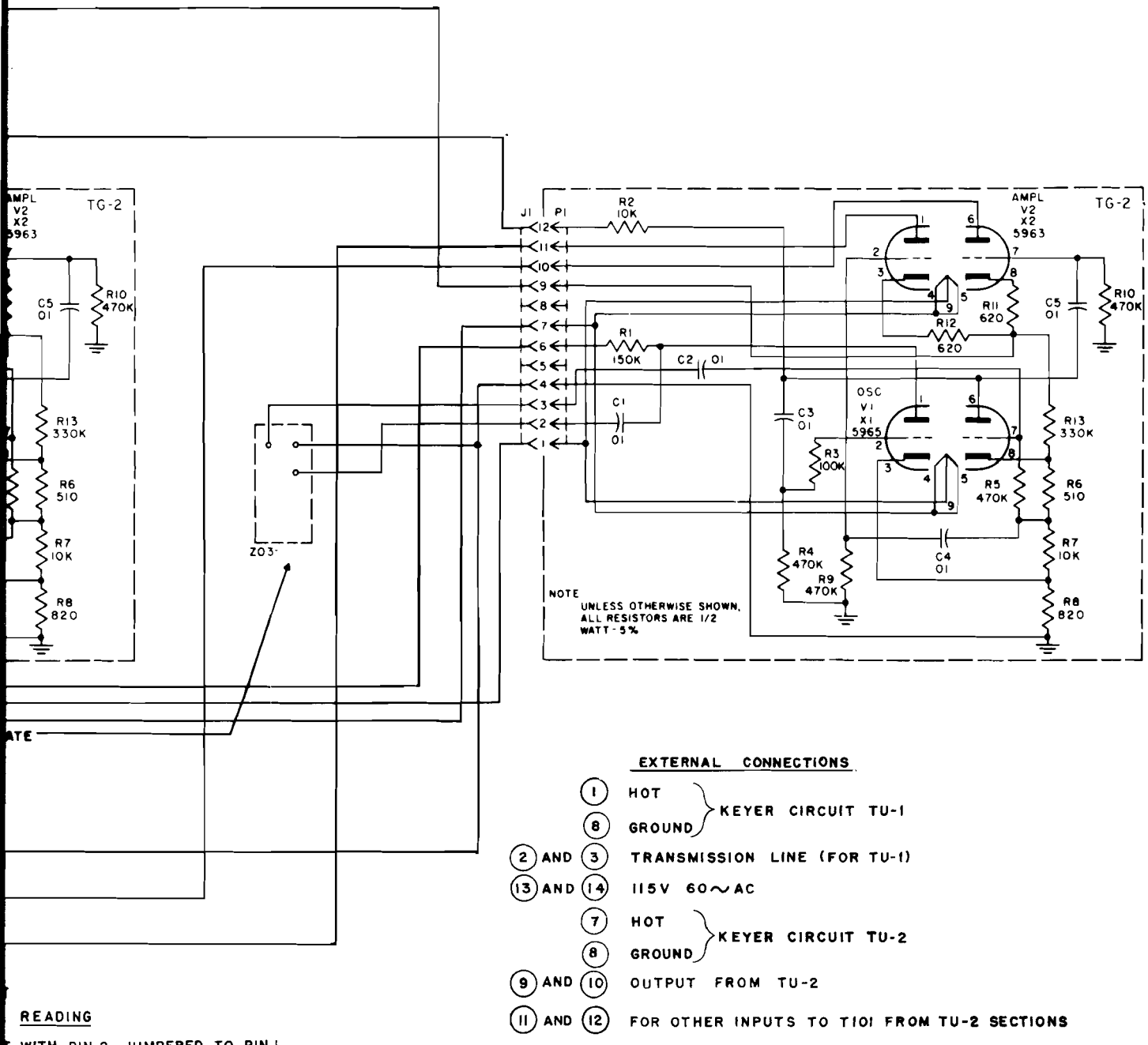

Figure 1. Schematic Diagram of Dual Transmitter Unit DTU-11

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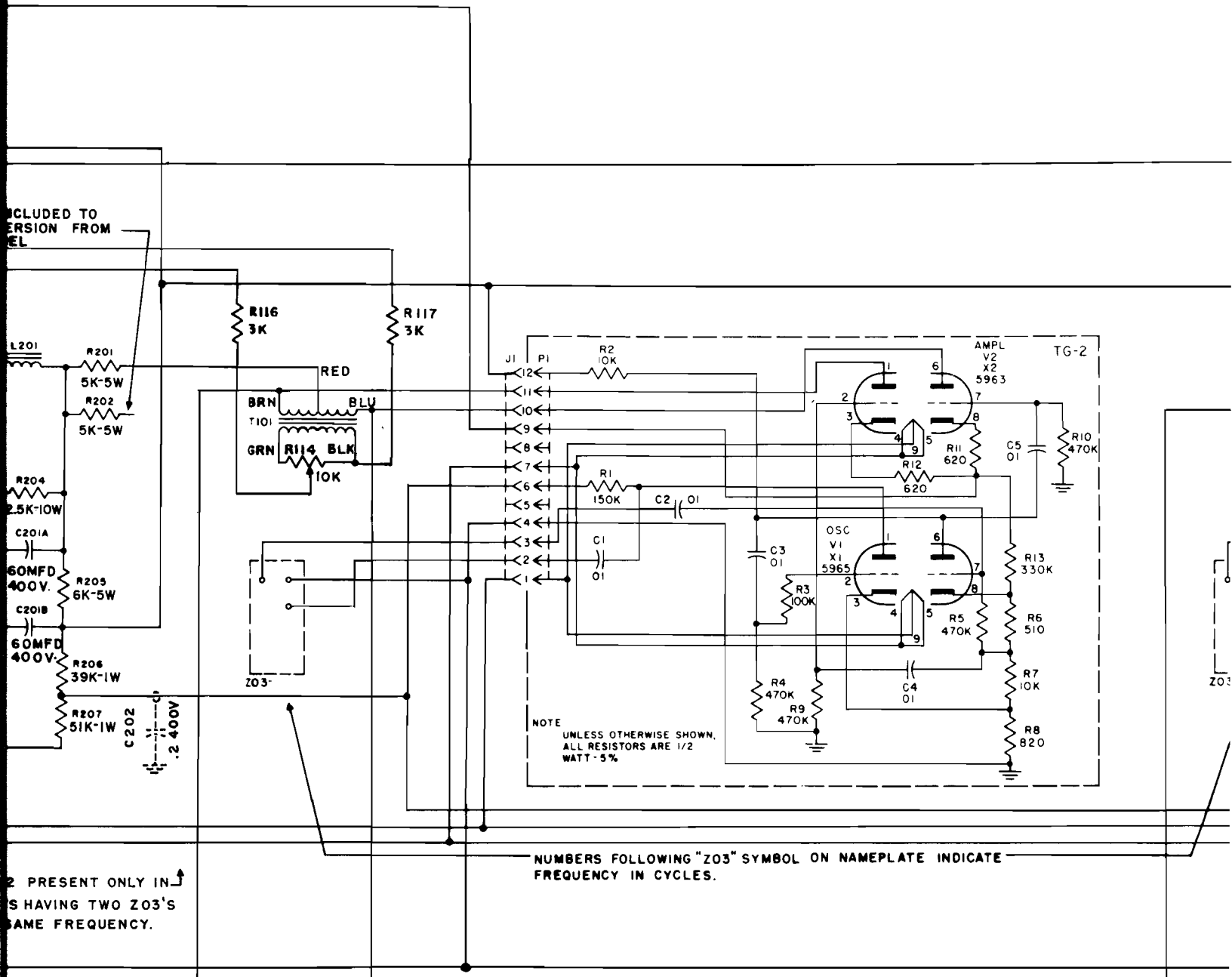
TYPE TU-1



TEST SOCKET

PIN NOS.	READING
3 , 4	TU-1 OUTPUT WITH PIN 2 JUMPERED TO PIN
JUMPER	PIN 8 TO PIN 1 TO KEY TU-2
7+, 1−	B+ VOLTAGE

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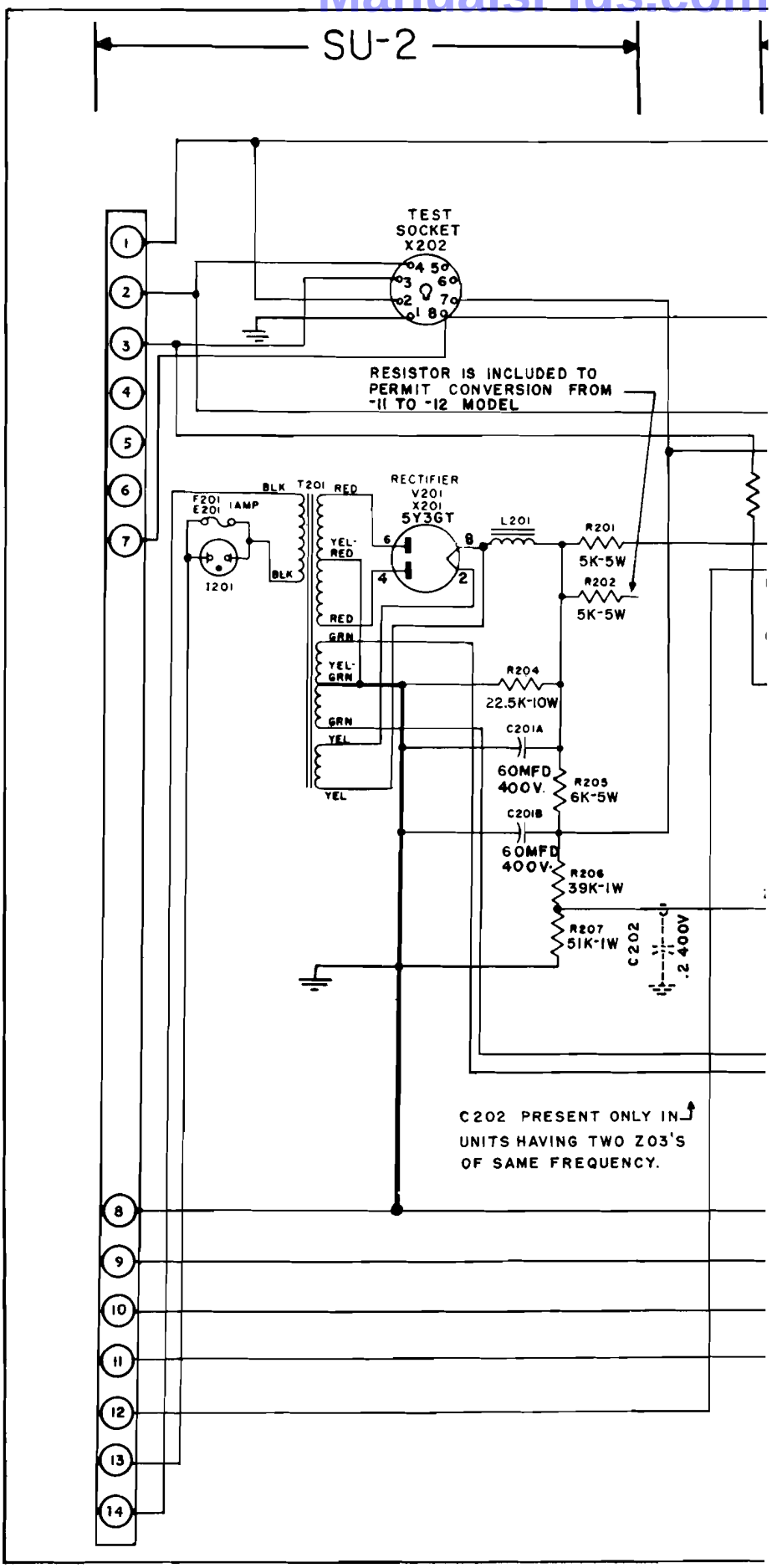

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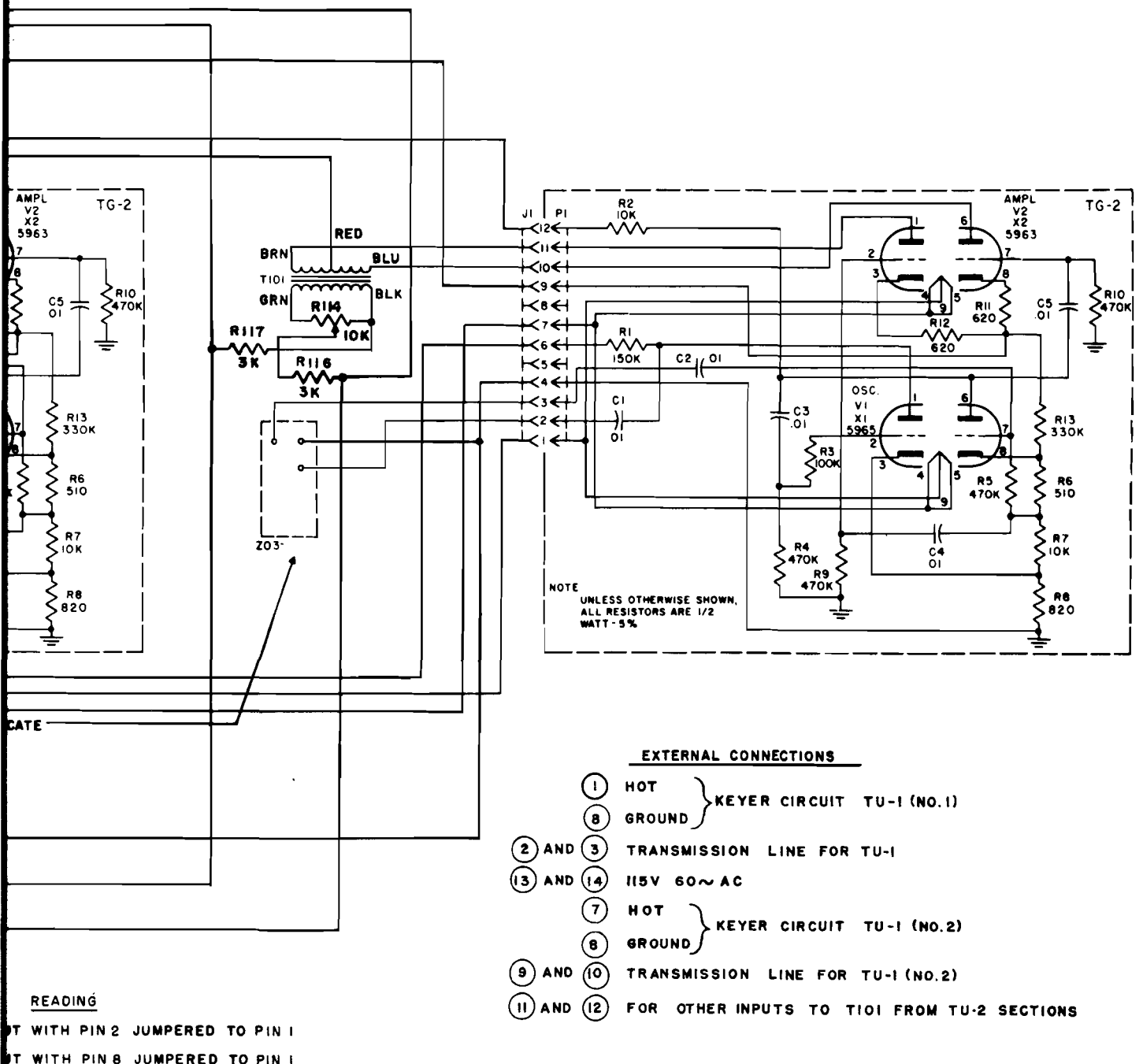
TYPE TU-1
NO. 2



EXTERNAL CONNECTIONS

(1)	HOT	KEYER CIRCUIT TU-1 (NO. 1)
(8)	GROUND	
(2) AND (3)		TRANSMISSION LINE FOR TU-1
(13) AND (14)		115V 60~ AC
(7)	HOT	KEYER CIRCUIT TU-1 (NO. 2)
(8)	GROUND	
(9) AND (10)		TRANSMISSION LINE FOR TU-1 (NO. 2)
(11) AND (12)		FOR OTHER INPUTS TO T101 FROM TU-2 SECTIONS

READING

T WITH PIN 2 JUMPERED TO PIN 1

T WITH PIN 8 JUMPERED TO PIN 1

Figure 2. Schematic Diagram of Dual Transmitter Unit DTU-12

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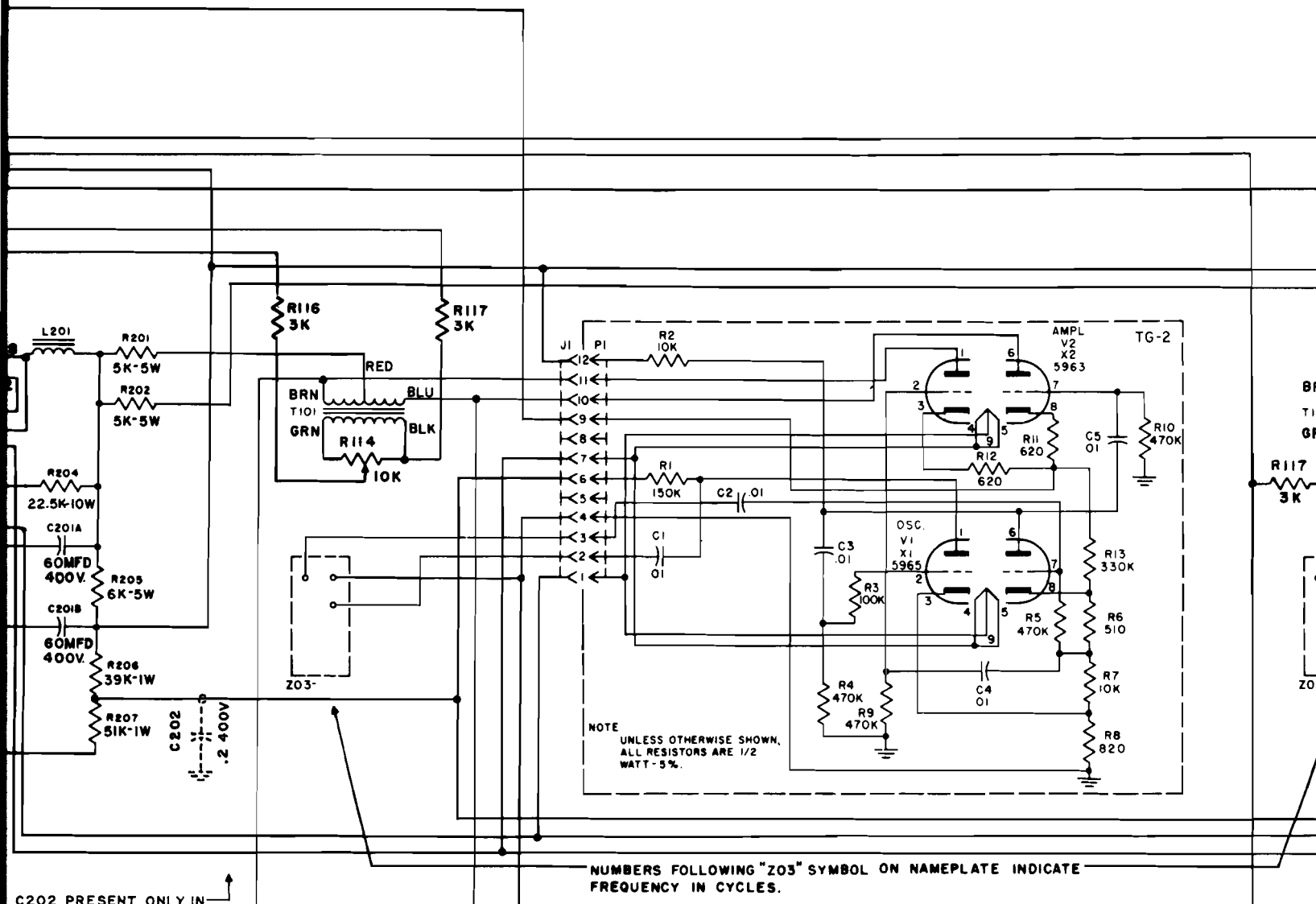
TYPE TU-1
NO. 1



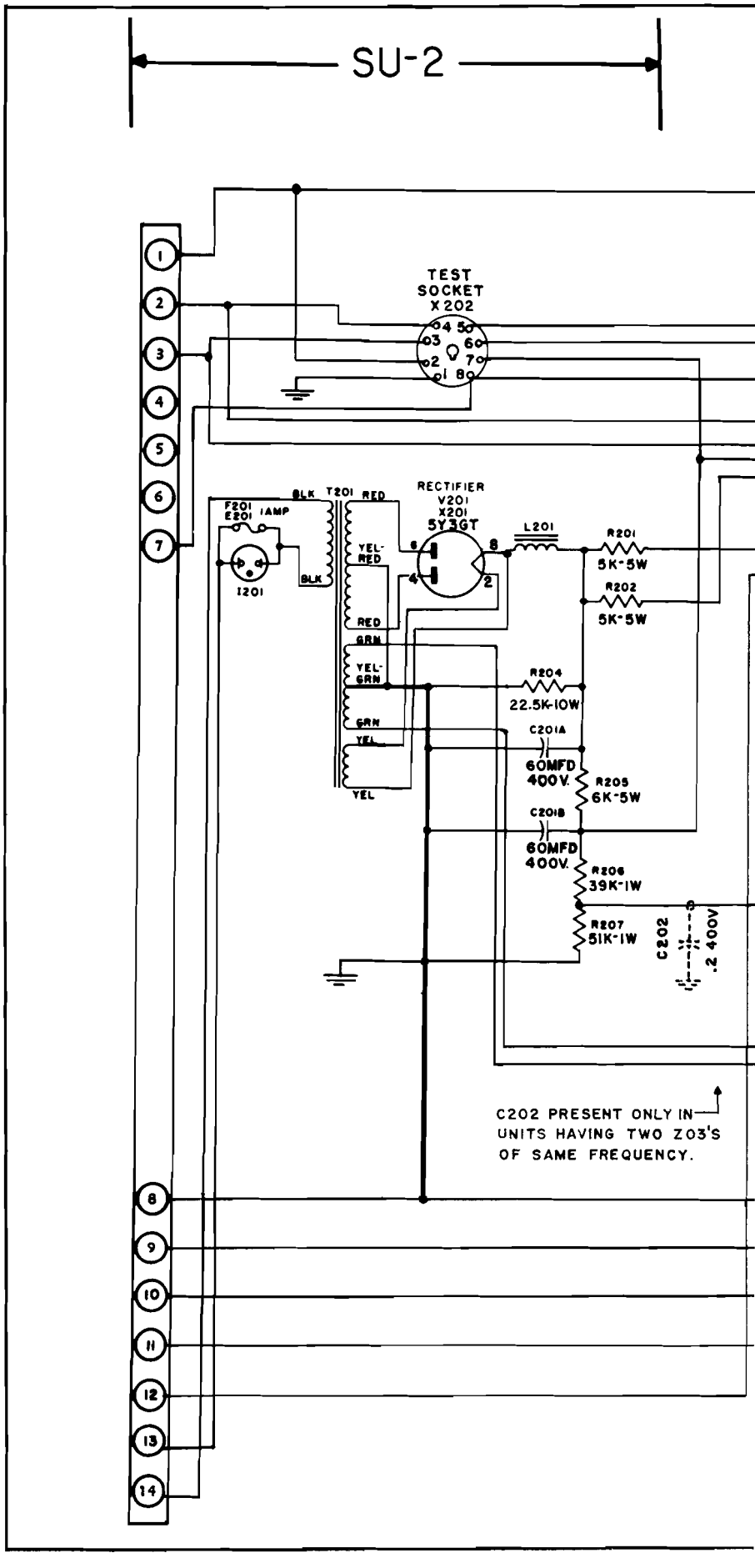
C202 PRESENT ONLY IN UNITS HAVING TWO Z03'S OF SAME FREQUENCY.

NUMBERS FOLLOWING "Z03" SYMBOL ON NAMEPLATE INDICATE FREQUENCY IN CYCLES.

TEST SOCKET

PIN NOS.	READING
3, 4	TU-1 NO.1 OUTPUT WITH PIN 2 JUMPERED TO PI
5, 6	TU-1 NO.2 OUTPUT WITH PIN 8 JUMPERED TO PI
7+, 1−	B+ VOLTAGE

ManualsPlus.com



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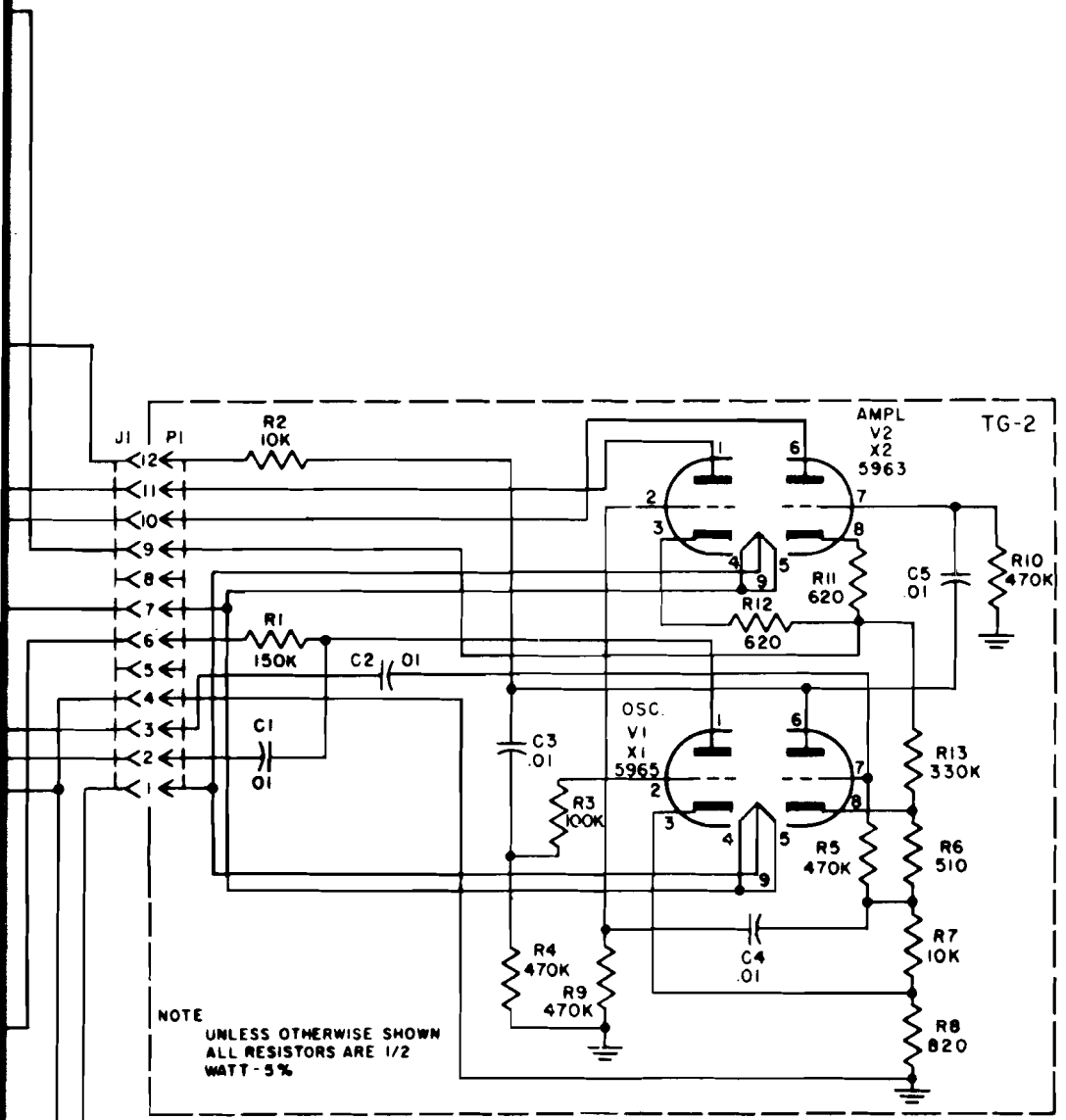

FOLLOWING "Z03" SYMBOL ON NAMPLATE INDICATE
CY IN CYCLES.

EXTERNAL CONNECTIONS

(1) HOT, (8) GROUND	KEYER CIRCUIT
(2) AND (3)	TRANSMISSION LINE
(13) AND (14)	115 V 60~ AC
(11) AND (12)	FOR OTHER INPUTS TO T101 FROM TU-2 SECTIONS

Figure 3. Schematic Diagram of Single Transmitter Unit STU-11

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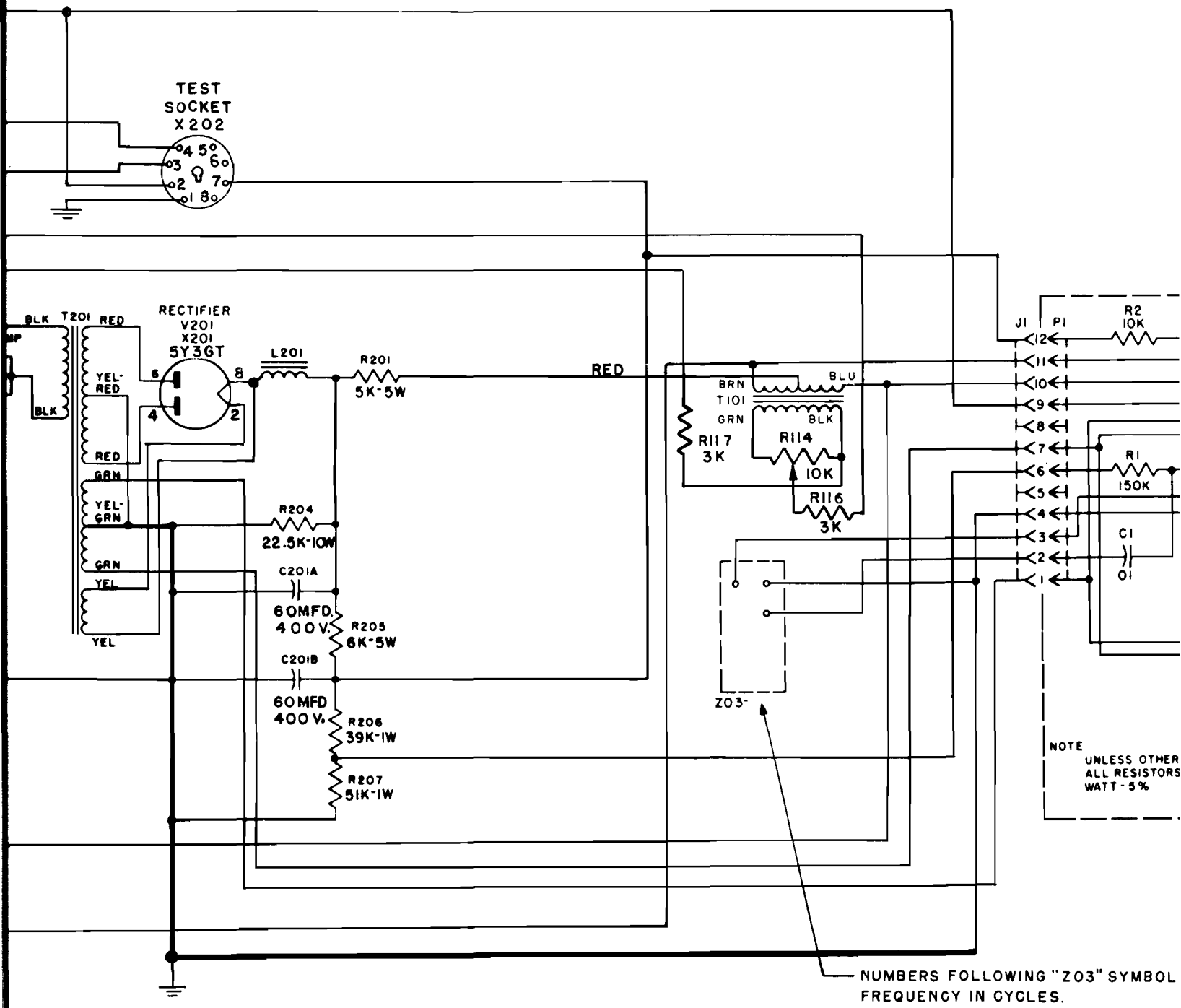

TEST SOCKET

NOS.	READING
5	TU-1 NO.1 OUTPUT WITH PIN 2 JUMPERED TO PIN 1
1-	B+ VOLTAGE

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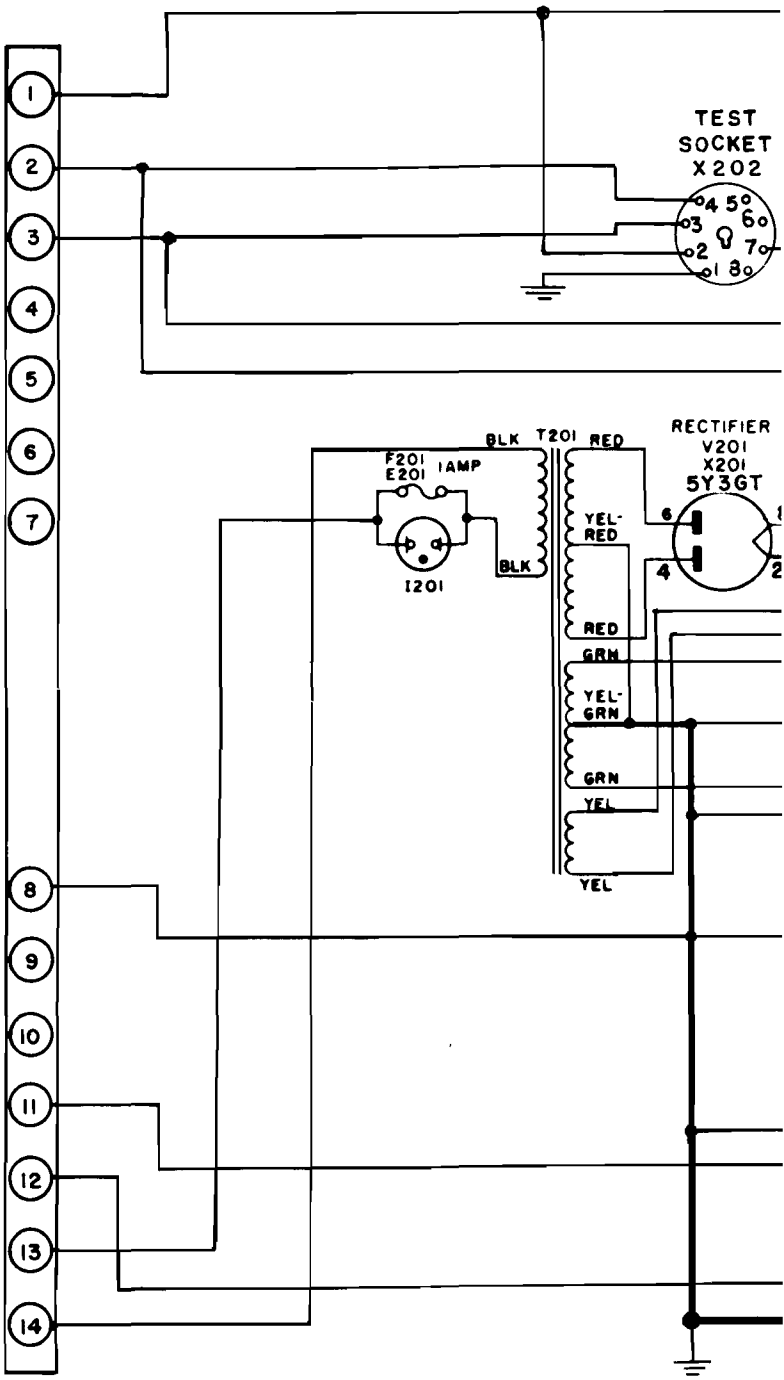
TYPE SU-2



TEST SOCKET

PIN NOS.		REA
3, 4	TU-1 NO.1 OUTPUT WITI	
7+, 1−	B+ VOLTAGE	

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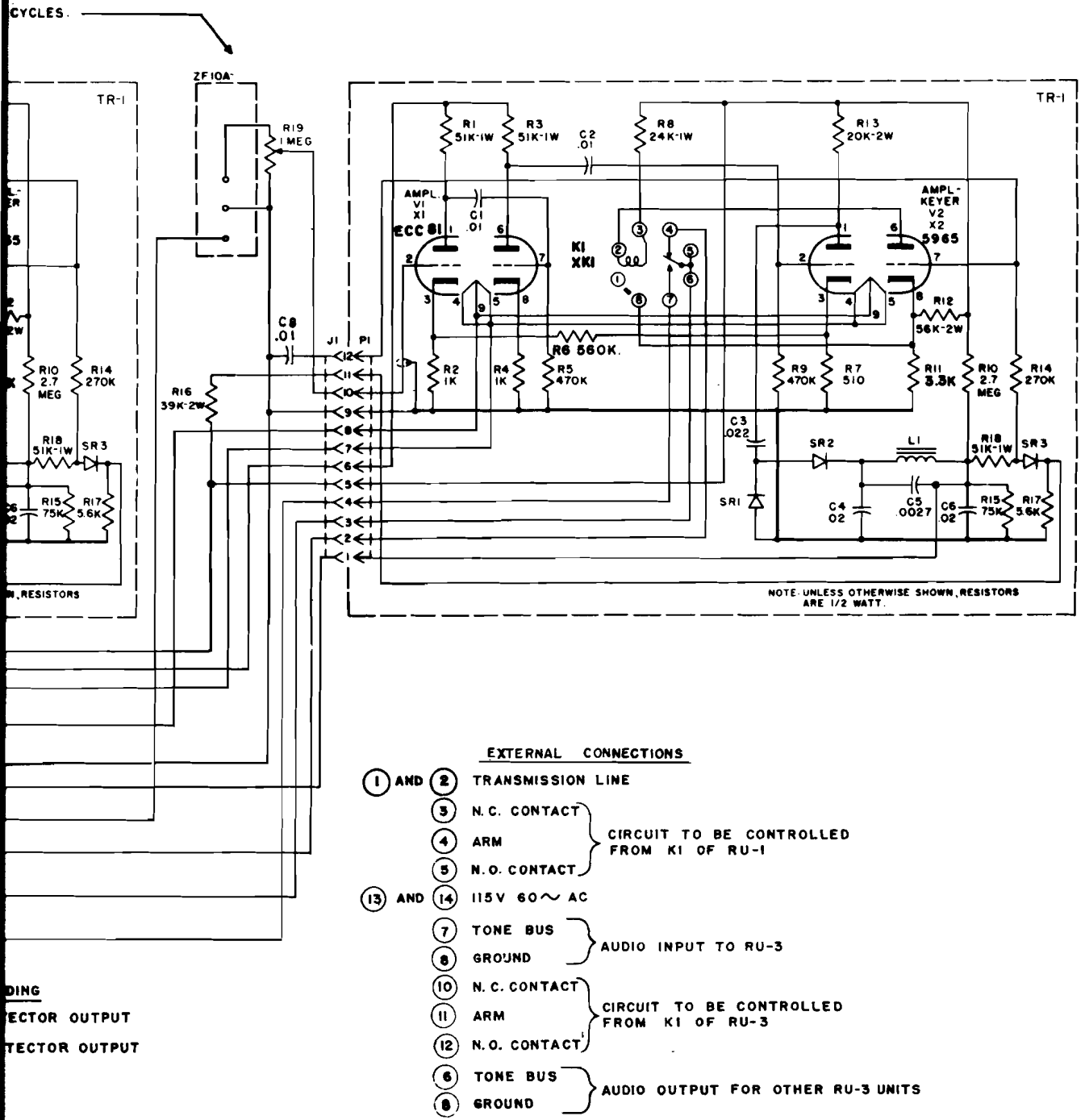

EXTERNAL CONNECTIONS

(1) AND (2)	TRANSMISSION LINE	
(3)	N. C. CONTACT	CIRCUIT TO BE CONTROLLED FROM K1 OF RU-1
(4)	ARM	
(5)	N. O. CONTACT	
(13) AND (14)	115 V 60 ~ AC	
(7)	TONE BUS	AUDIO INPUT TO RU-3
(8)	GROUND	
(10)	N. C. CONTACT	CIRCUIT TO BE CONTROLLED FROM K1 OF RU-3
(11)	ARM	
(12)	N. O. CONTACT	
(6)	TONE BUS	AUDIO OUTPUT FOR OTHER RU-3 UNITS
(8)	GROUND	

Figure 4. Schematic Diagram of Dual Receiving Unit DRU-11

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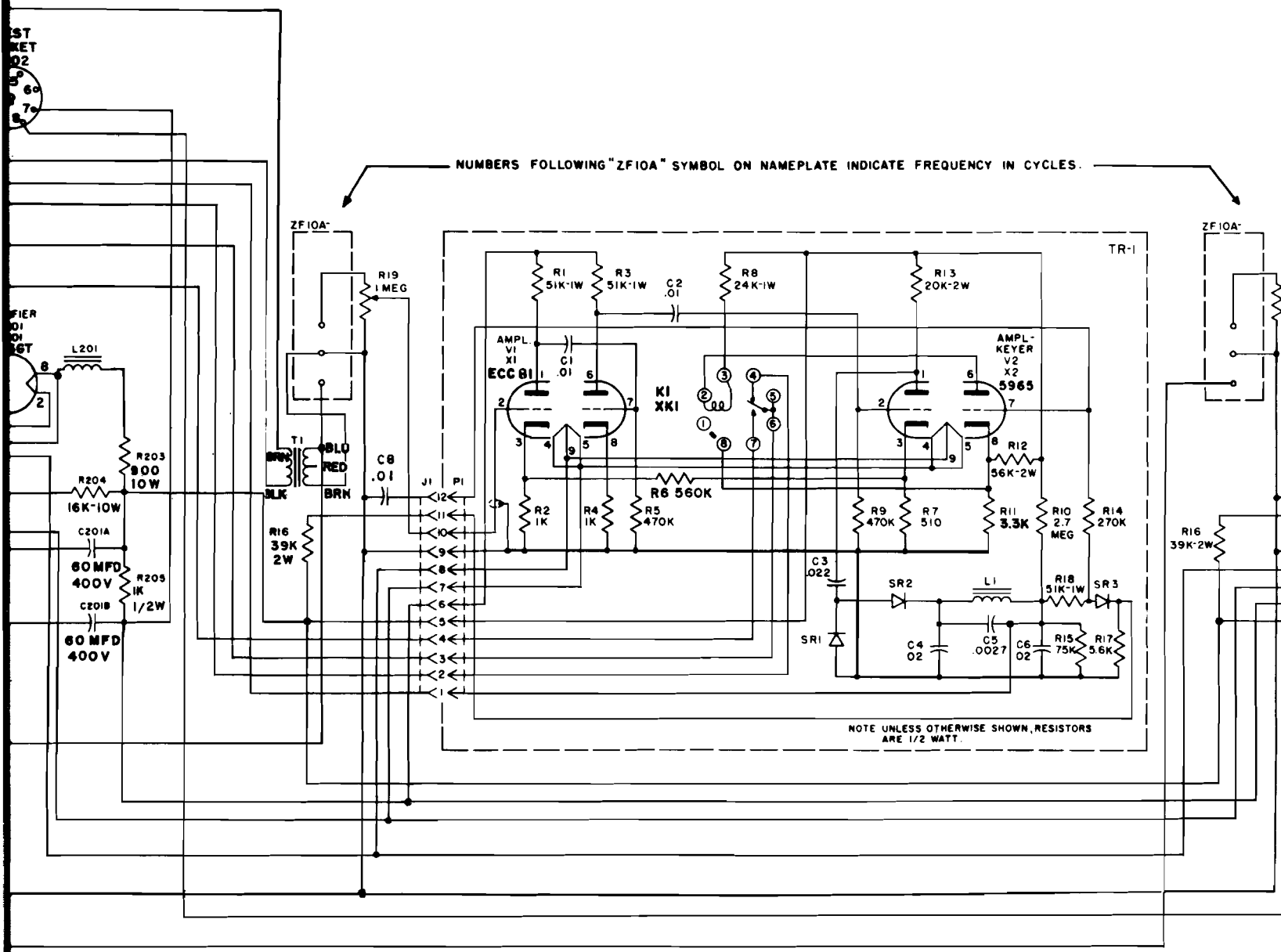

TEST SOCKET	
PIN NOS.	READING
2+, 1-	TR-1 NO.1 DETECTOR OUTPUT
8+, 1-	TR-1 NO.2 DETECTOR OUTPUT
7+, 1-	B+ VOLTAGE

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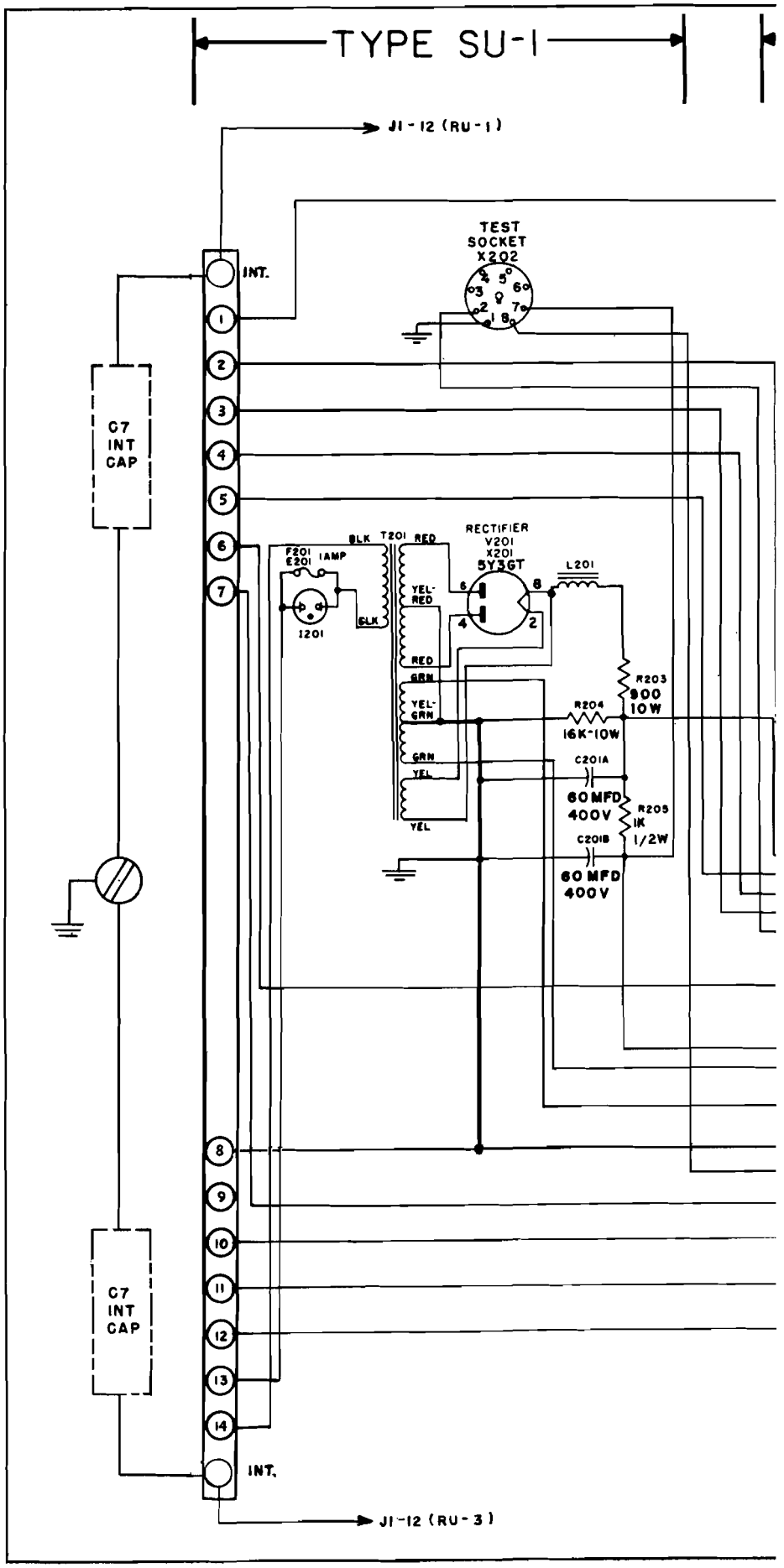

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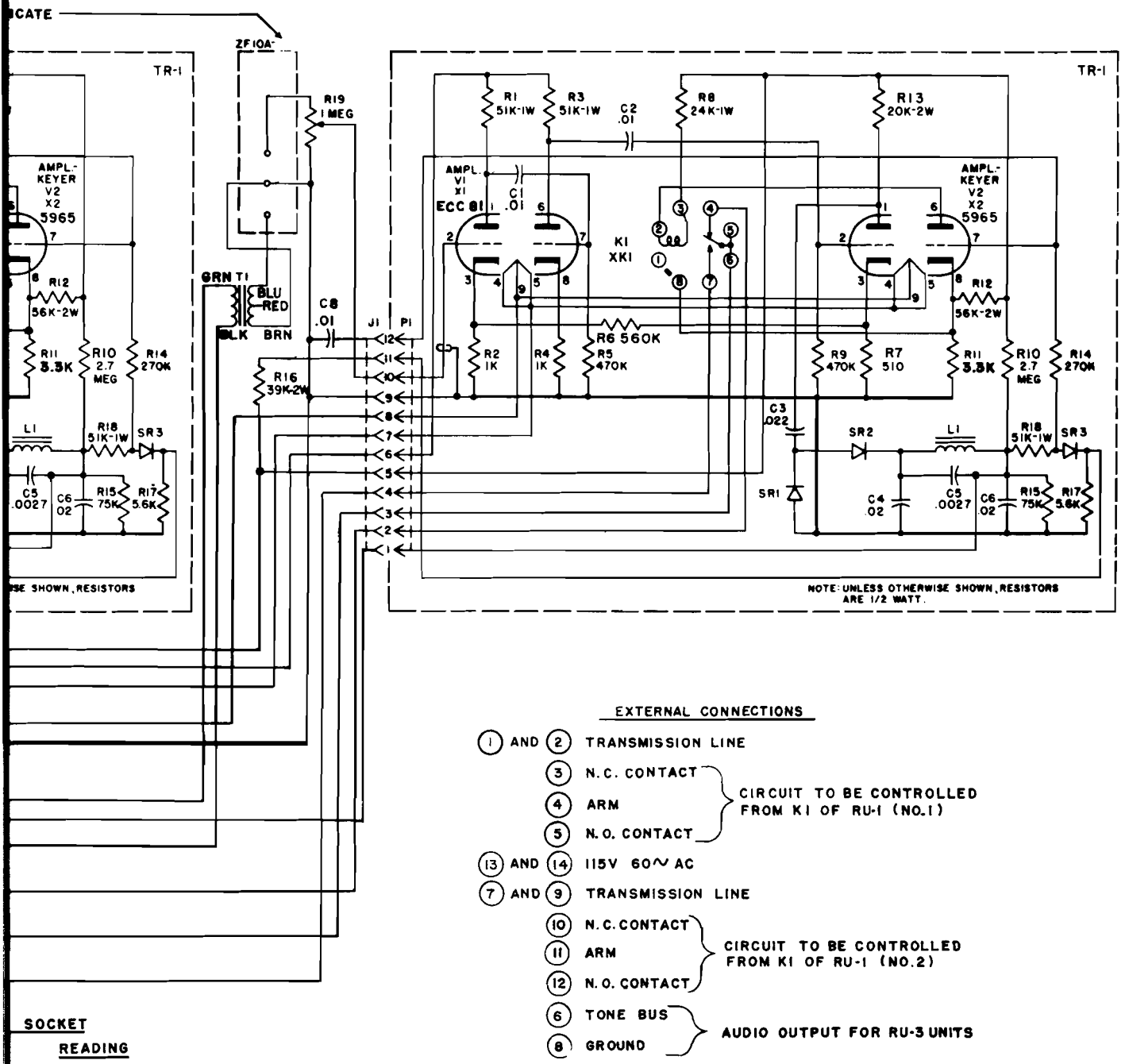
TYPE RU-1 NO. 2



EXTERNAL CONNECTIONS

(1) AND (2)	TRANSMISSION LINE
(3)	N.C. CONTACT
(4)	ARM
(5)	N.O. CONTACT
	CIRCUIT TO BE CONTROLLED FROM K1 OF RU-1 (NO.1)
(13) AND (14)	115V 60~ AC
(7) AND (9)	TRANSMISSION LINE
(10)	N.C. CONTACT
(11)	ARM
(12)	N.O. CONTACT
	CIRCUIT TO BE CONTROLLED FROM K1 OF RU-1 (NO.2)
(6)	TONE BUS
(8)	GROUND
	AUDIO OUTPUT FOR RU-3 UNITS

SOCKET READING

NO.1 DETECTOR OUTPUT

NO.2 DETECTOR OUTPUT

VOLTAGE

Figure 5. Schematic Diagram of Dual Receiving Unit DRU-12

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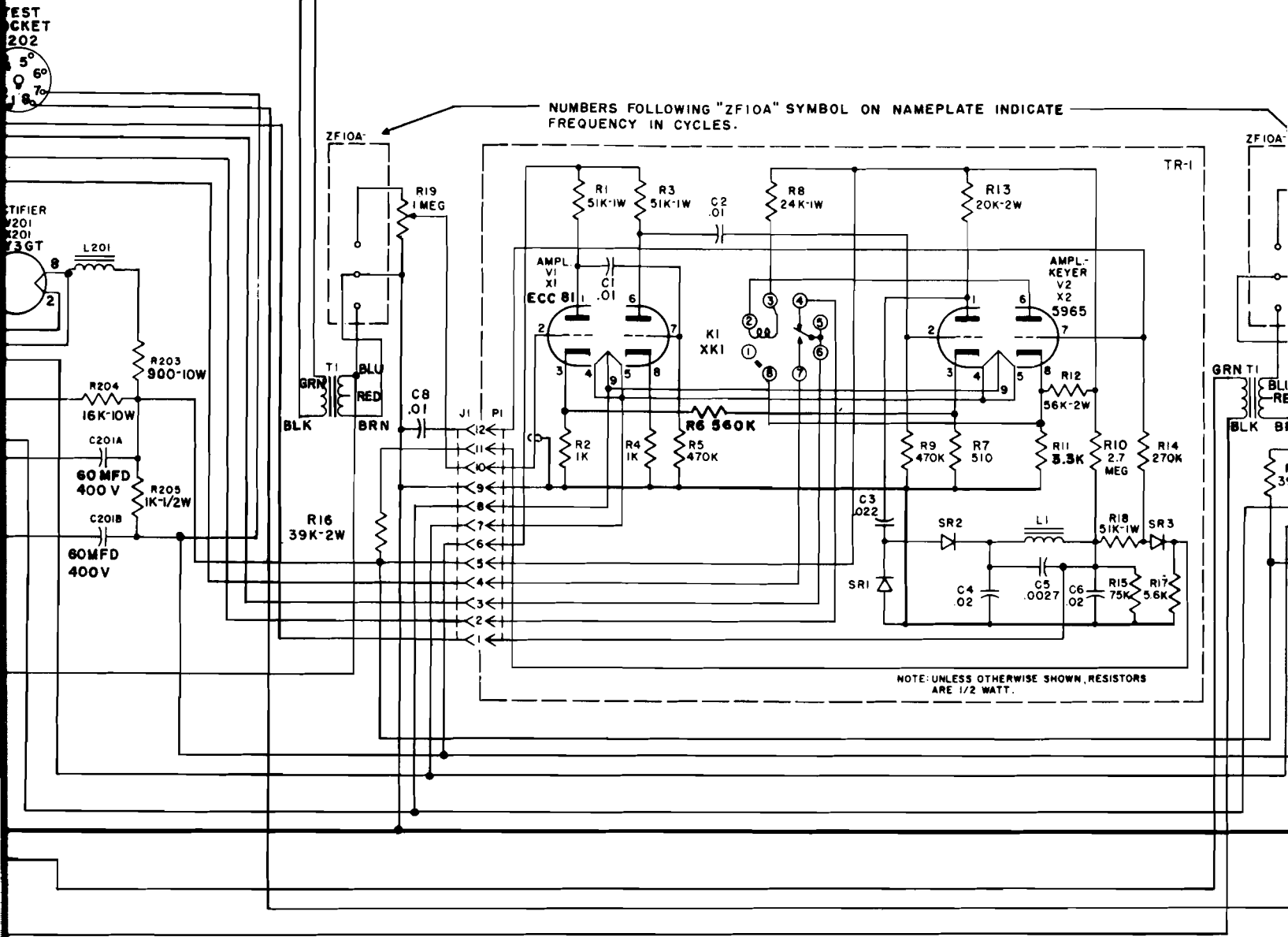
TYPE RU-1
NO. 1



TEST SOCKET	
PIN NOS.	READING
2+, 1−	TR-1 NO.1 DETECTOR OUTPUT
8+, 1−	TR-1 NO.2 DETECTOR OUTPUT
7+, 1−	B+ VOLTAGE

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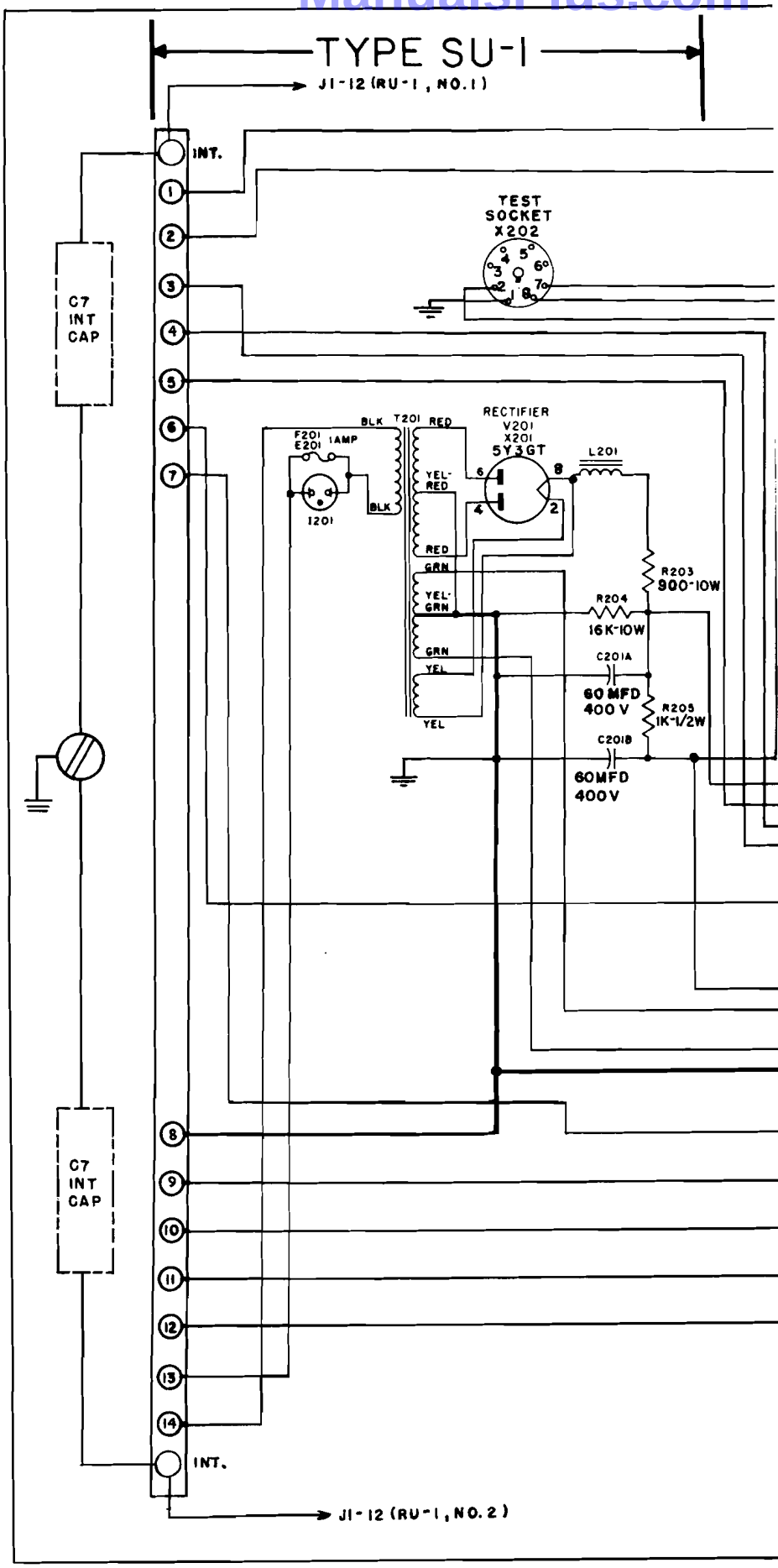

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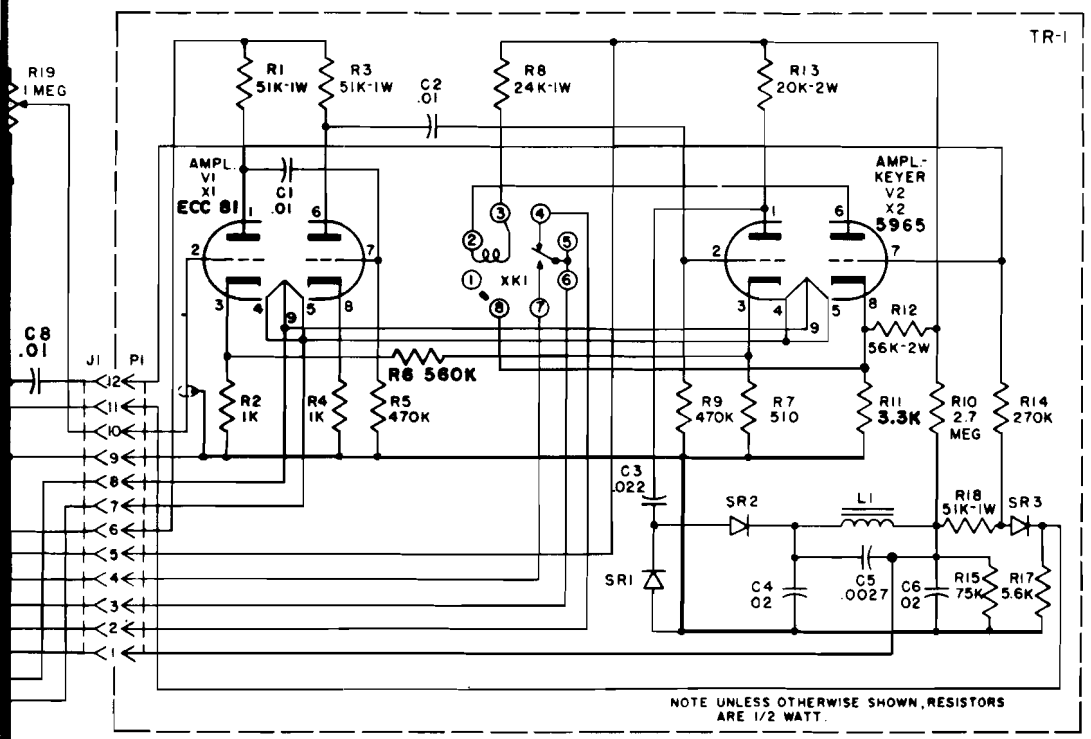
NUMBERS FOLLOWING "ZF IOA" SYMBOL ON NAMEPLATE INDICATE FREQUENCY IN CYCLES



EXTERNAL CONNECTIONS

(1) AND (2)	TRANSMISSION LINE	
(3)	N. C. CONTACT	CIRCUIT TO BE CONTROLLED FROM K1 OF RU-1
(4)	ARM	
(5)	N. O. CONTACT	
(13) AND (14)	115 V 60~ AC	
(6)	TONE BUS	AUDIO OUTPUT FOR RU-3 UNITS
(8)	GROUND	

Figure 6. Schematic Diagram of Single Receiving Unit SRU-11

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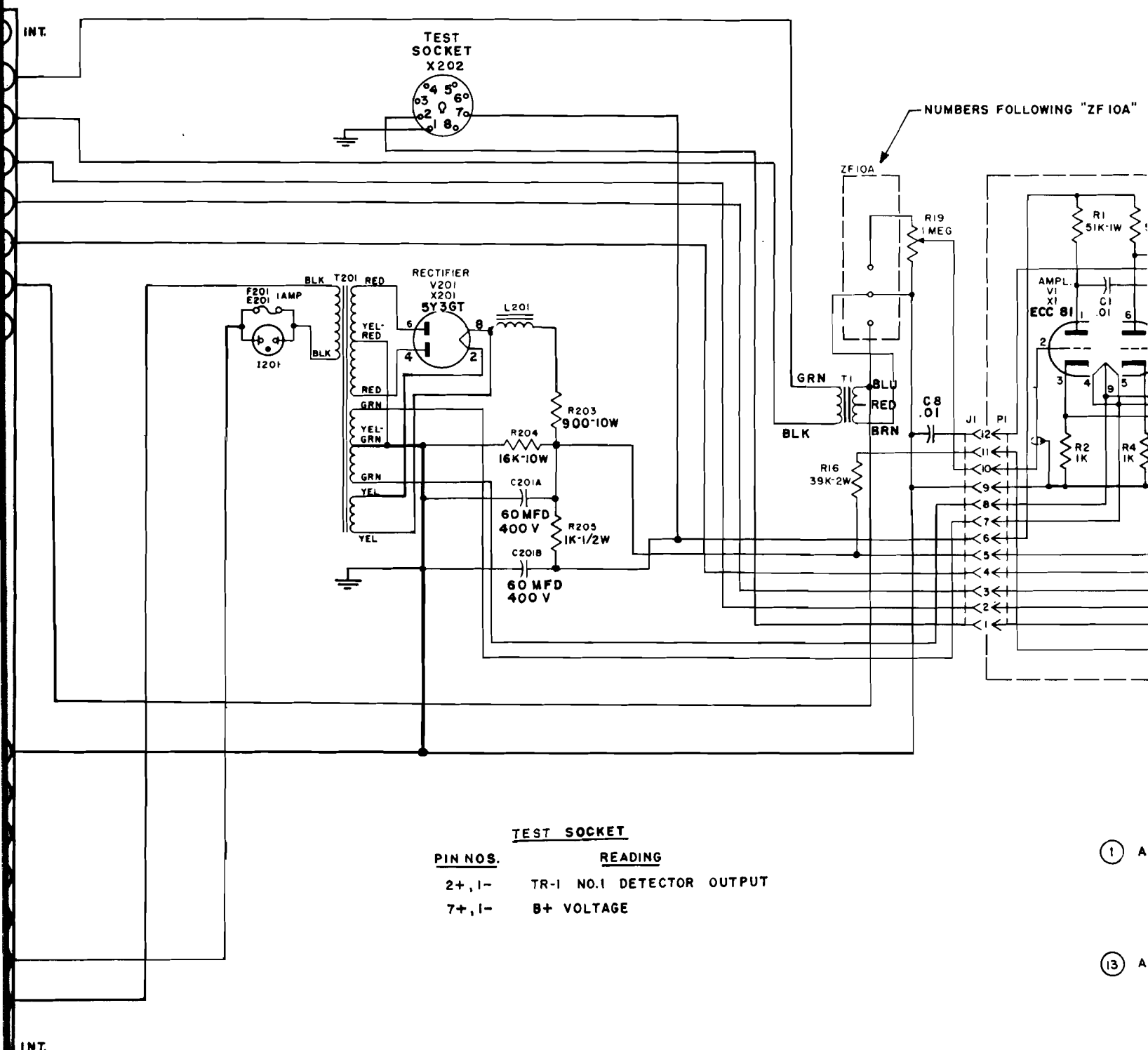
TYPE SU-1

J1-12



TEST SOCKET	
PIN NOS.	READING
2+, 1−	TR-1 NO.1 DETECTOR OUTPUT
7+, 1−	B+ VOLTAGE

(1) A

(13) A

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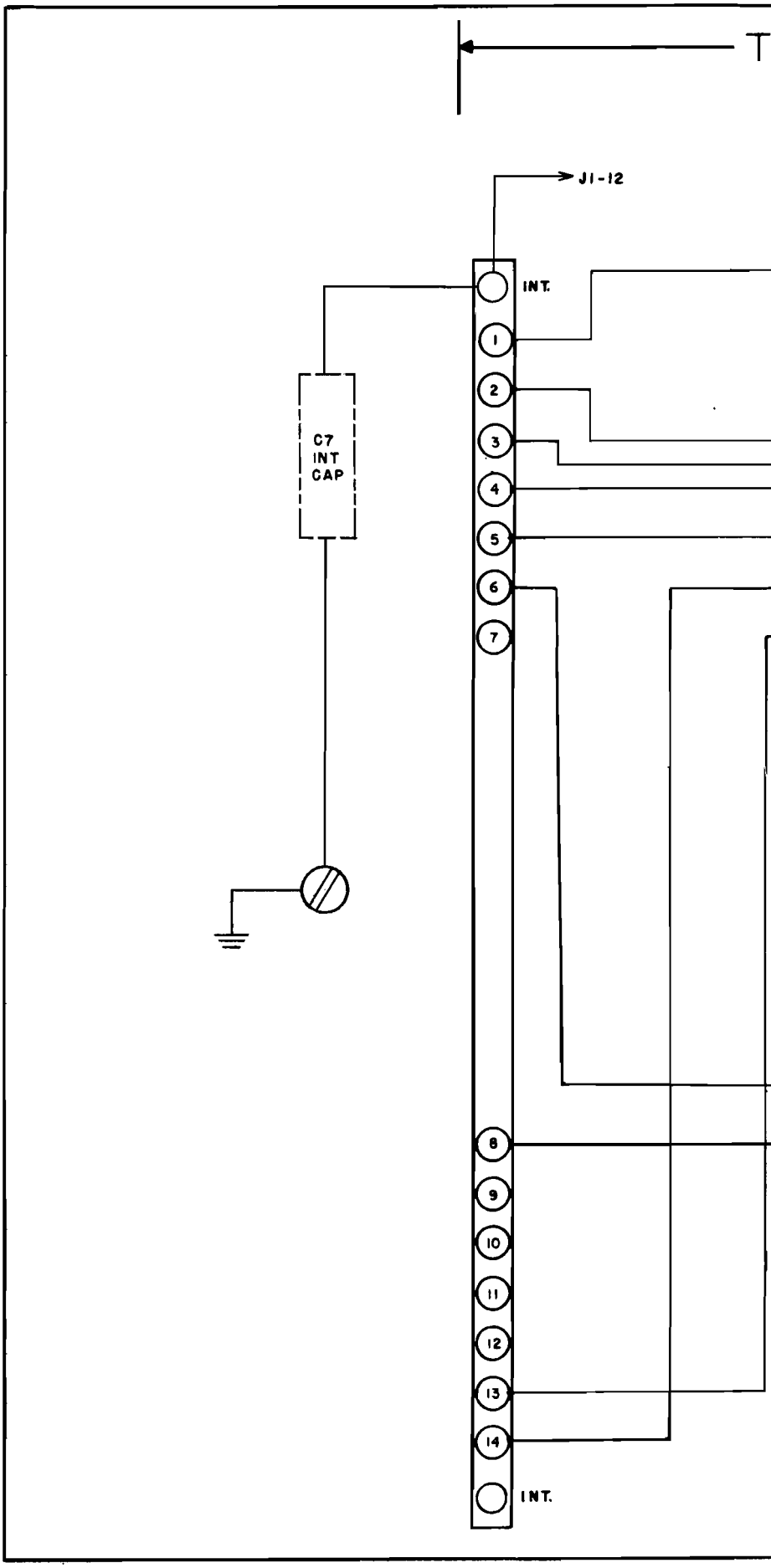

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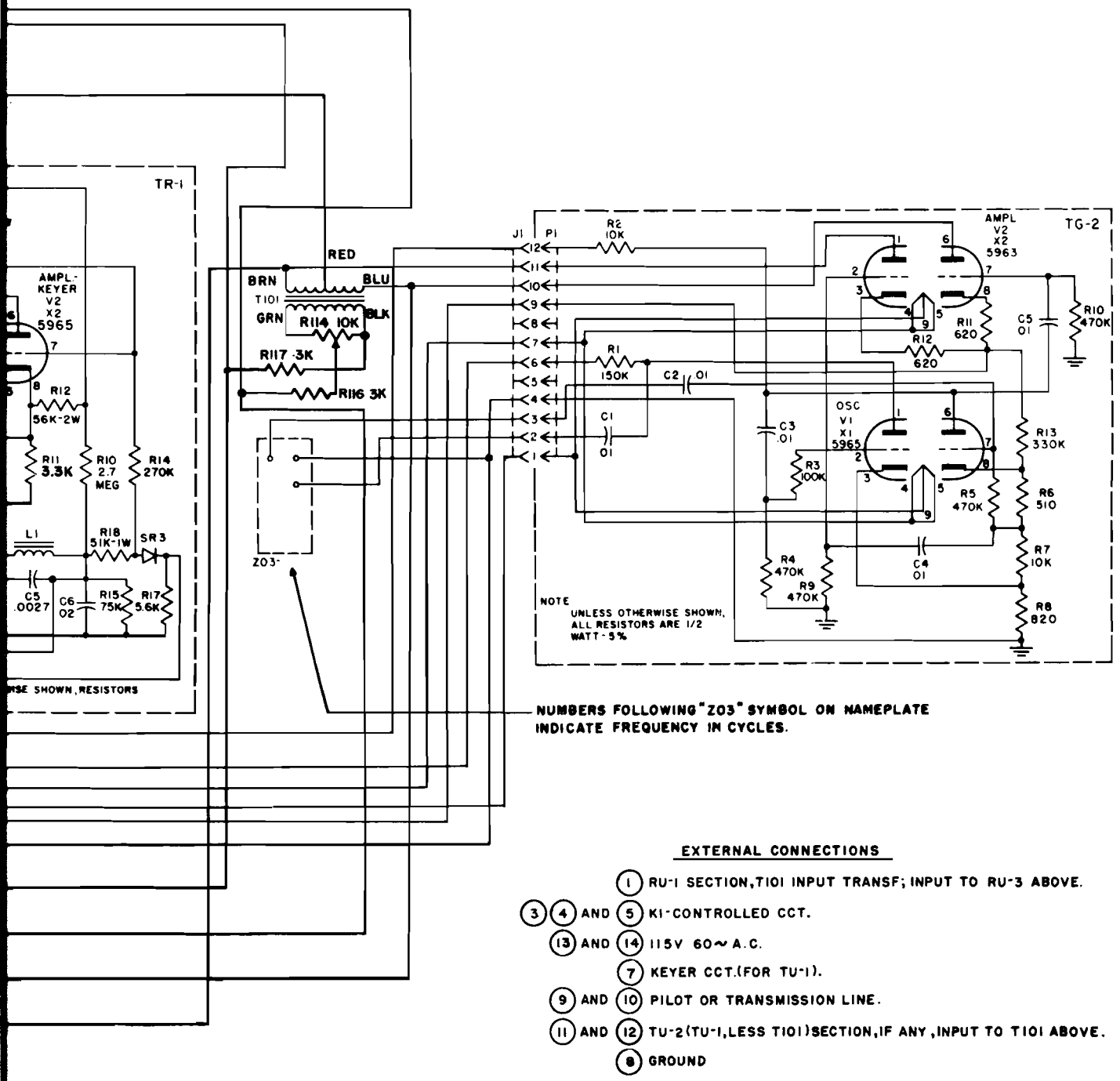

Figure 7. Schematic Diagram of Duplex Signaling Unit DSU-11T

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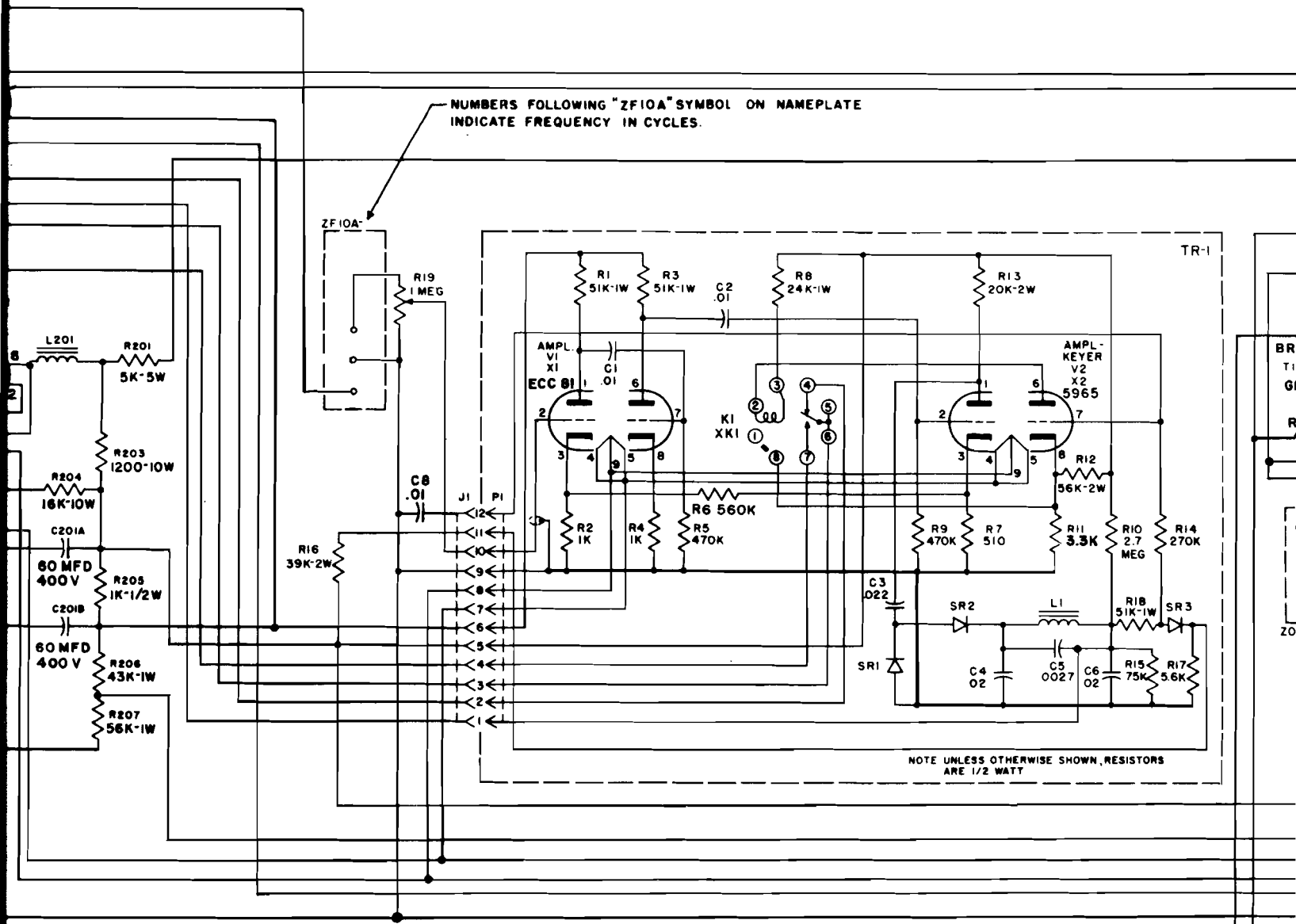

TEST SOCKET PIN NOS.	READING
2+, 1−	TR-1 DETECTOR OUTPUT
7+, 1−	B+ VOLTAGE
5 , 6	TU-1 OUTPUT WITH PIN 8 JUMPERED TO PIN 1

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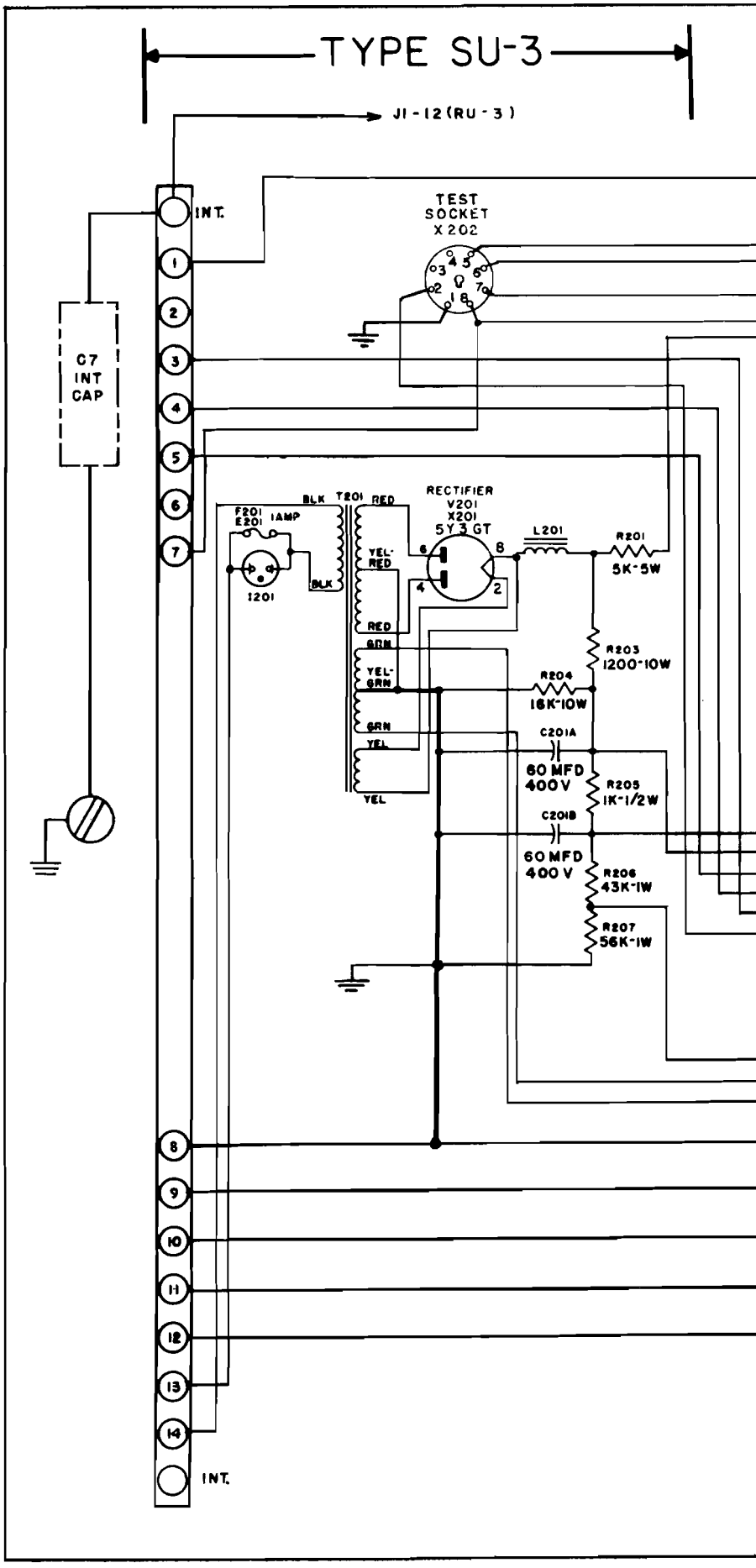

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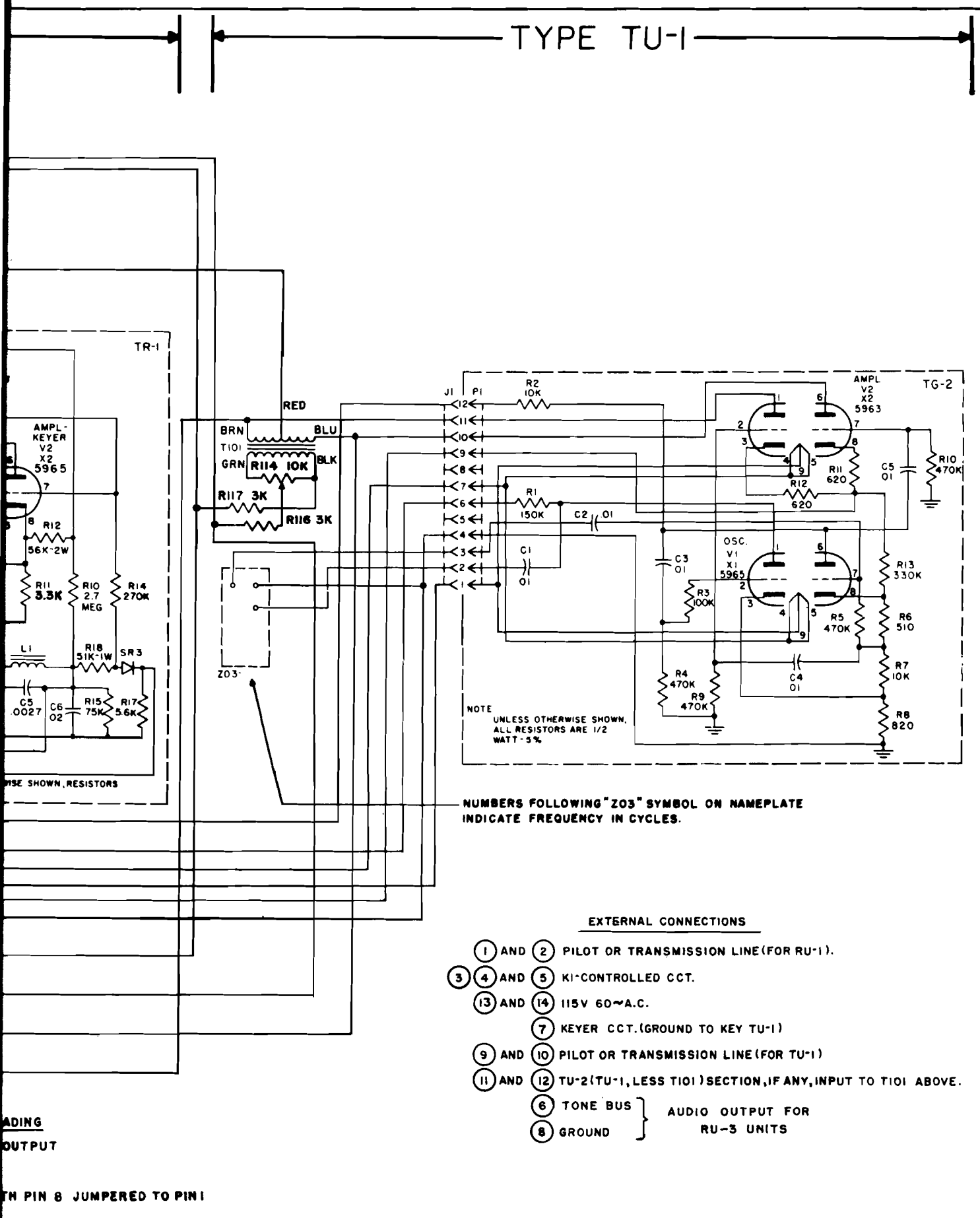

Figure 8. Schematic Diagram of Duplex Signaling Unit DSU-12

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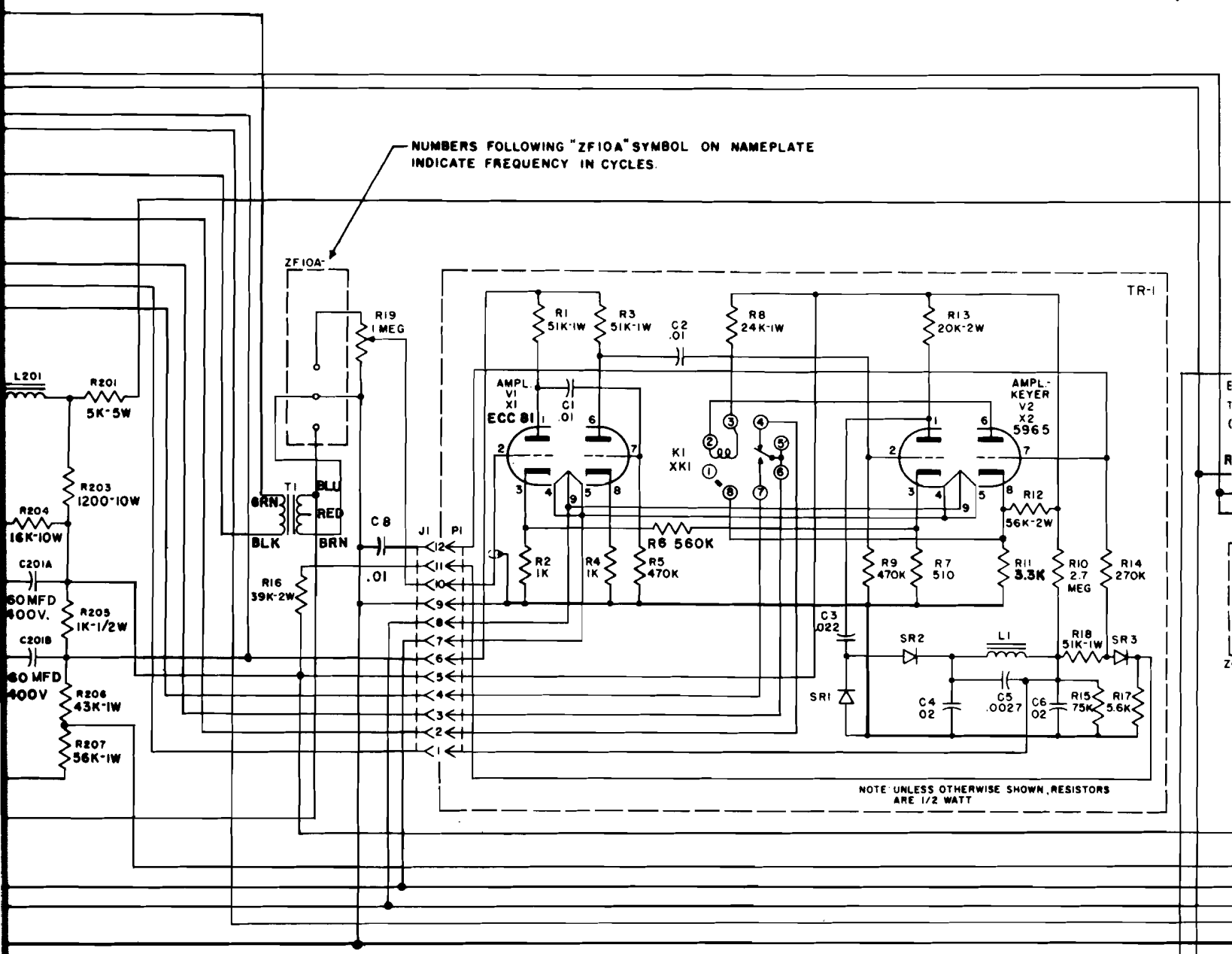

TEST SOCKET PIN NOS.	READING
2+, 1−	TR-1 DETECTOR OUTPUT
7+, 1−	B+ VOLTAGE
5 , 6	TU-1 OUTPUT WITH PIN 8 JUMPERED TO PIN 1

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