DATA SET 401-TYPE TRANSMITTER THEORY OF OPERATION AND SUPPLEMENTARY INFORMATION

CONTENTS PAGE

1. GENERAL

1.01 This section provides theory of operation and supplementary information for data set 401-type. This section also provides a functional description of the input and output characteristics of the data set, and gives the input characteristics the data set will accept from compatible business machines. This information is presented in enough detail to provide engineering background knowledge required to design the station arrangements necessary to provide different types of services. It also provides special tests of the data set that may be useful for special investigation of unusual data set problems (ie, normal tests have shown no problem, but repeated trouble is indicated). The information contained in this section supplements information in other sections and is not required for installation and servicing of the data set under normal conditions.

1.02 This section is reissued:

- To include option M, which permits substitution of data set 401E-type for data set 401A-type
- To correct the oscillator circuit (Fig. 8)
- To add component designations to the talk mode circuit (Fig. 3).

1.03 The data set transmits data signals in the form of a composite of three frequencies. The chief advantage of this type of modulation is that relatively inexpensive transmitters can be used to supply data to a more complicated receiver. The data set is intended to be used over the switched network. It can also be used on private lines.

1.04 Data set 401-type is an integrated set, combining in one housing the data transmitter, audible answer-back circuit, remote testing circuits, and a telephone set. Dimensions are shown in Fig. 1. The height of the data set with the handset in place is 4-1/2 inches.

1.05 The data set is designed for horizontal installation in an environment that provides an ambient temperature range of 40 to 120°F with a relative humidity of 20 to 90 percent.

1.06 Data set 401-type is installed on the customer premises instead of the usual telephone subscriber set. In addition to the usual telephone services, it provides a means for low-speed parallel transmission of alphameric data. Data is received from the originating business machine in the form of contact closures. The data set can transmit at a rate of up to 20 characters per second. A restricted 3-out-of-14 multifrequency code is used to provide a usable alphabet of 99 data characters, plus an intercharacter separator.

2. EQUIPMENT ARRANGEMENT

2.01 *Equipment Layout:* A typical arrangement of equipment consists of the business machine, the data set, transmission facilities, a data set 401-type receiver, and a receiving business machine. A typical arrangement of equipment is shown in Fig. 2. An extension telephone can be connected if desired.

The features listed in 2.02 and Table A are prewired at the factory and should not be altered in any way. If for any reason features V or T have been altered, the data set will have to be returned to Western Electric for adjustment before it will operate properly. The data sets are ordered with the desired features installed. The description included here is for information only.

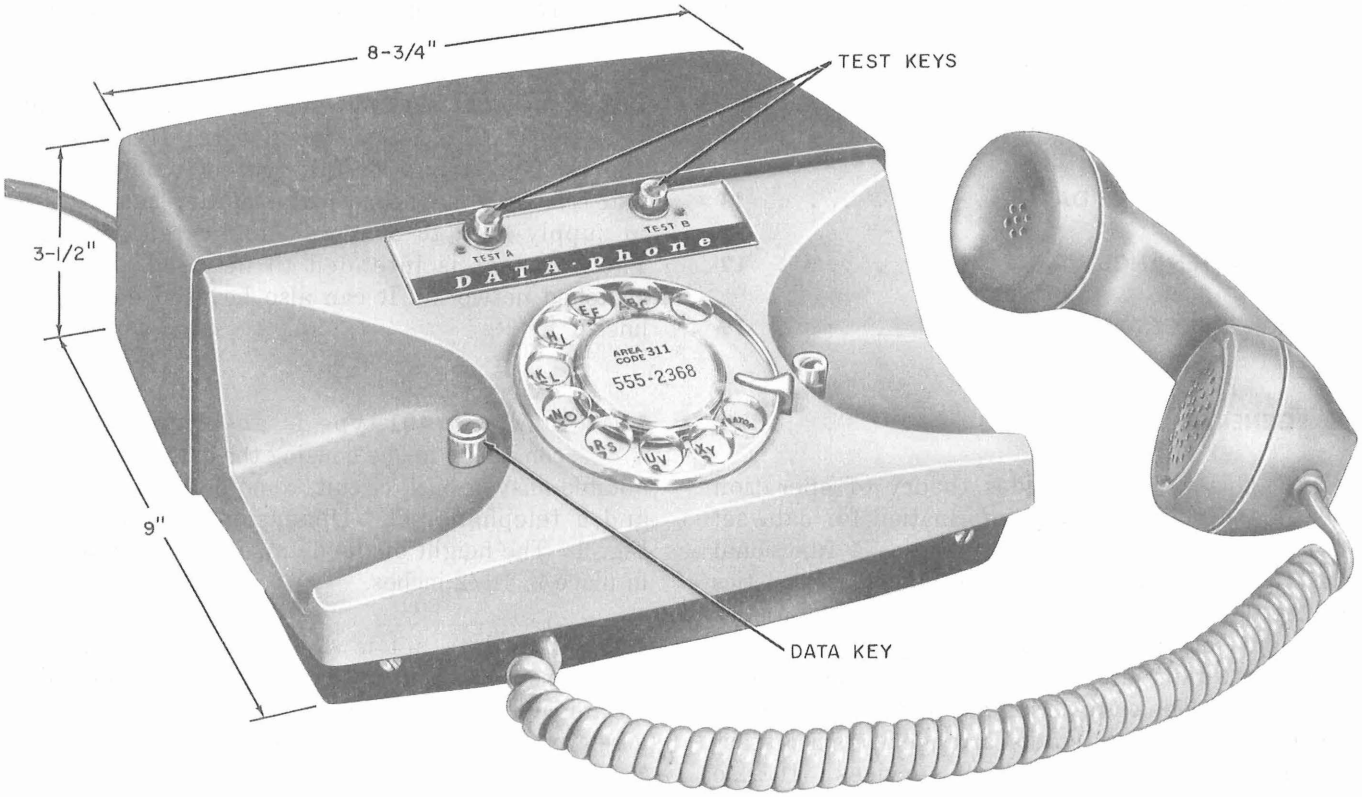


Fig. 1—Data Set 401-Type

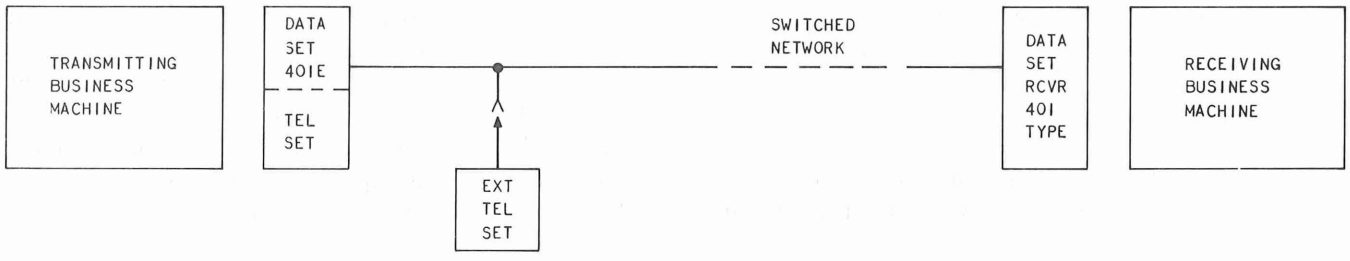


Fig. 2—Typical Equipment Arrangement

TABLE A

FEATURES

<table>
<tr><th colspan="2">FEATURE</th><th>WIRING</th><th>STRAPPING</th></tr>
<tr><td rowspan="2">Oscillator Output Power Pad</td><td>0 dB loss</td><td>V</td><td>Connect the three straps so that the common terminals and the V terminals are connected.</td></tr>
<tr><td>—2 dB loss</td><td>T</td><td>Move the three straps to the right so that the common terminals and the T terminals are connected.</td></tr>
<tr><td rowspan="2">Audible Answer-Back Amplifier</td><td>With</td><td>Z</td><td>Connect wiring to terminals 19 and 20.</td></tr>
<tr><td>Without</td><td>X</td><td>Connect wiring to terminals 19A and 20A.</td></tr>
<tr><td colspan="2">Voice Answer-Back</td><td>Y</td><td>Connect wiring as indicated below:
<table><tr><th>FROM</th><th>TO</th><th>COLOR</th></tr><tr><td>CP3-1</td><td>T4-4</td><td>GR</td></tr><tr><td>CP3-2</td><td>T4-3</td><td>GR</td></tr><tr><td>CP3-3</td><td>626A Key-3</td><td>WH</td></tr><tr><td>CP3-4</td><td>626A Key-4</td><td>BR</td></tr><tr><td>CP3-5</td><td>CP2-25</td><td>SL</td></tr><tr><td>T4-1</td><td>626A Key-1</td><td>BL</td></tr><tr><td>T4-2</td><td>626A Key-2</td><td>OR</td></tr><tr><td>T4-3</td><td>CP2-26</td><td>GR</td></tr></table></td></tr>
<tr><td colspan="2">11D Apparatus Unit (Rotary Dial)</td><td>W</td><td>Connections on 4010B Network
<table><tr><th>COLOR CODE</th><th>TERMINAL</th></tr><tr><td>BL</td><td>F</td></tr><tr><td>G</td><td>RR</td></tr><tr><td>W</td><td>GN</td></tr><tr><td>W</td><td>R</td></tr><tr><td>Y</td><td>Tape & Store</td></tr><tr><td>Y</td><td>Tape & Store</td></tr></table></td></tr>
<tr><td colspan="2">11H Apparatus Unit (TOUCH-TONE Dial)</td><td>S</td><td>Connections on 4010D Network
<table><tr><th>COLOR CODE</th><th>TERMINAL</th></tr><tr><td>G</td><td>F</td></tr><tr><td>BK</td><td>RR</td></tr><tr><td>R-G</td><td>R</td></tr><tr><td>W</td><td>G</td></tr><tr><td>R</td><td>L1</td></tr><tr><td>BL</td><td>L2</td></tr><tr><td>O-BK</td><td>C</td></tr><tr><td>W-BL</td><td>R</td></tr></table></td></tr>
</table>

All wiring is factory supplied and should not be altered. If the straps have been altered, the data sets will have to be returned to Western Electric for adjustment.

2.02 ***Features:*** There are seven features available on data set 401-type, as shown in Table A. These features provide a choice on the output power, audible answer-back or voice answer-back (muting circuit), and TOUCH-TONE® or rotary dial.

(1) ***Output Power Attenuation:*** The output power is fixed at −4 dBm. Sets having the Y feature also use the V wiring to maintain this output power level. Sets having the Z feature use the T wiring.

(2) ***Audible Answer-Back:*** The audible answer-back facilities provide a means for sending acknowledgment signals from the receiver to the transmitter during intervals of no transmission. These signals are applied to the business machine where they may be made audible by a loudspeaker. The circuit can accept any of the voiceband frequencies, but is intended for use with 1017, 1785, or 2025 Hz provided by data set 401-type. The Z feature provides this facility. Data sets with the X feature are without the audible answer-back feature.

(3) ***Voice-Answer-Back (Muting Circuit):*** The voice answer-back facility provides a means whereby full-voice answer-back signals can be received by the transmitting station (X feature). With the Y feature installed, all line signals are coupled directly to the telephone receiver unit. Since this also includes data signals from the transmitter, which are of a higher level, a means must be provided to reduce the data signal level before it is presented to the telephone receiver. The Y feature provides this facility.

2.03 ***Options:*** Installer option M is shown in Table B. This option allows data set 401E2 or 401E4 to be used as a replacement for the data set 401A-type transmitter to work with the data set 403-type receiver. Data set 401E2 or E4 with option M installed has the label OPTION M placed above the customer interface connector at the rear of the data set.

Note: The data set 401E-type transmitter can be used as a replacement for the data set 401A-type transmitter to work with the data set 401J-type receiver with no modification required.

TABLE B

OPTIONS FOR DS 401E-TYPE

FEATURE	WIRING OPTION	STRAPPING
Data set 403-type compatibility	M	Remove strap from rightmost V and T terminal group located between pins 7 and 17 on CP 1 (Fig. 10).

2.04 ***Characteristics:*** The characteristics of the data contacts, timing contacts, keying contacts, answer-back circuit, and interface connector are described in (a) through (e) below.

(a) ***Data Contacts:***

- The data set accepts transmitting data from the customer business machine in the form of contact closures. Each closure is made between the desired data lead and the data common lead (pin 7). The total contact resistance measured from common through the interface connector, data contacts, and interconnecting cable must not exceed 10 ohms.

- The peak ac current flow through the closed data contacts is approximately 0.5 mA. The sum total dc current the business machine may inject into any data lead must not exceed 1.0 mA. The data set may apply 1.5-volts peak ac between pin 7 and an open data lead.

- Leakage resistance from pin 7 to each of the other data leads must be equal to or greater than 400,000 ohms. The data set will present a dc resistance ranging between 50 ohms and 500 ohms between pin 7 and the various data leads.

- Isolation is provided between the data circuit (data leads and common) and ground or other circuits. Data common may be tied to the frame of the business machine or to any other circuit point whose potential difference to ground does not exceed 50 volts peak.

- Contact protection (RC networks) should not be provided for the data contacts because such protection will impair the performance of the data set.

- An allowance of 150 to 450 ($\mu\mu$f) has been made in the data set design for the stray capacitance between the data leads of the business machine.

(b) ***Timing of Contact Operations:*** Characters may be delivered to the data set at any rate up to and including 20 characters per second. Therefore, the duration of a character and adjacent intercharacter rest interval, which together form the character period, must be at least 50 ms. The character must be presented to the data set for at least 20 ms. The adjacent intercharacter rest interval must also be at least 20 ms.

(c) ***Keying Contacts:***

- Data set 401-type provides two interface leads (pins 24 and 25) to be shorted by contacts in the business machine. When closed, these contacts start the data set transmitting, provided the data key has been operated.

- The data set will continue to deliver an output for 40 to 100 ms after the keying contacts have been opened. This delay is used for echo suppression.

- The data set will apply approximately 20 volts between open keying contacts and a surge current of about 250 mA through closed keying contacts. The time constant on the surge decay is about 10 ms. The steady-state current will be no greater than 10 mA through closed keying contacts.

- Series RC contact protection is supplied for the keying contacts by the data set. Additional protection should not be used.

- The keying leads must be electrically isolated from ground or other circuits in the business machine.

(d) ***Answer-Back:*** A loudspeaker may be provided in the customer equipment to detect the answer-back signal. This speaker should have an impedance of 100 to 600 ohms at 1800 Hz and a dc resistance of 0 to 35 ohms. A telephone receiver unit similar to the WECo type U1 receiver is suitable.

(e) ***Interface Connectors:***

- The interface connector should be a Cinch or Cannon connector DB-19604-432 or equivalent fitted with a Cinch hood DB-51226-1.

- The interface cable, terminating in the above connector, should meet the capacitance specification in 2.04(a), (b), and (c) above.

- For the allocation of pins in the interface connector and the data signals associated with each pin, refer to the section entitled Data Set 401E-Type—Transmitter—Description and Operation (594-014-100).

3. FUNCTIONAL DESCRIPTION

3.01 ***General:*** The data set has three modes of operation—talk, data, and test. A brief description of the talk mode is contained in 3.02. A description of the data mode is contained in 3.03 through 3.07. The test mode is described in 3.08.

3.02 ***Talk Mode:*** A simplified schematic of the telephone portion of the data set is shown in Fig. 3. When the data set is conditioned for the talk mode, it functions essentially the same as a standard telephone. Central office battery is applied across tip and ring. The ringer is connected across tip and ring through capacitor C4. Capacitor C4 passes the ringing current but prevents central office battery from being applied to the ringer. A normally closed set of data key contacts connects the ring side of the line to terminal F on the network. The tip side of the line is connected to terminal C of the network through a set of operated switchhook assembly contacts. The "break last" contacts on the switchhook open after the other switchhook contacts have closed. This prevents the noise generated by the switchhook contacts from being applied to the receiver. The "off normal" contacts of the dial assembly also short out the receiver when the dial is in any position other than normal. This prevents the dial pulses from being applied to the receiver. The pulsing contacts are connected between terminals F and RR of the network. Capacitor C1 and resistor R1

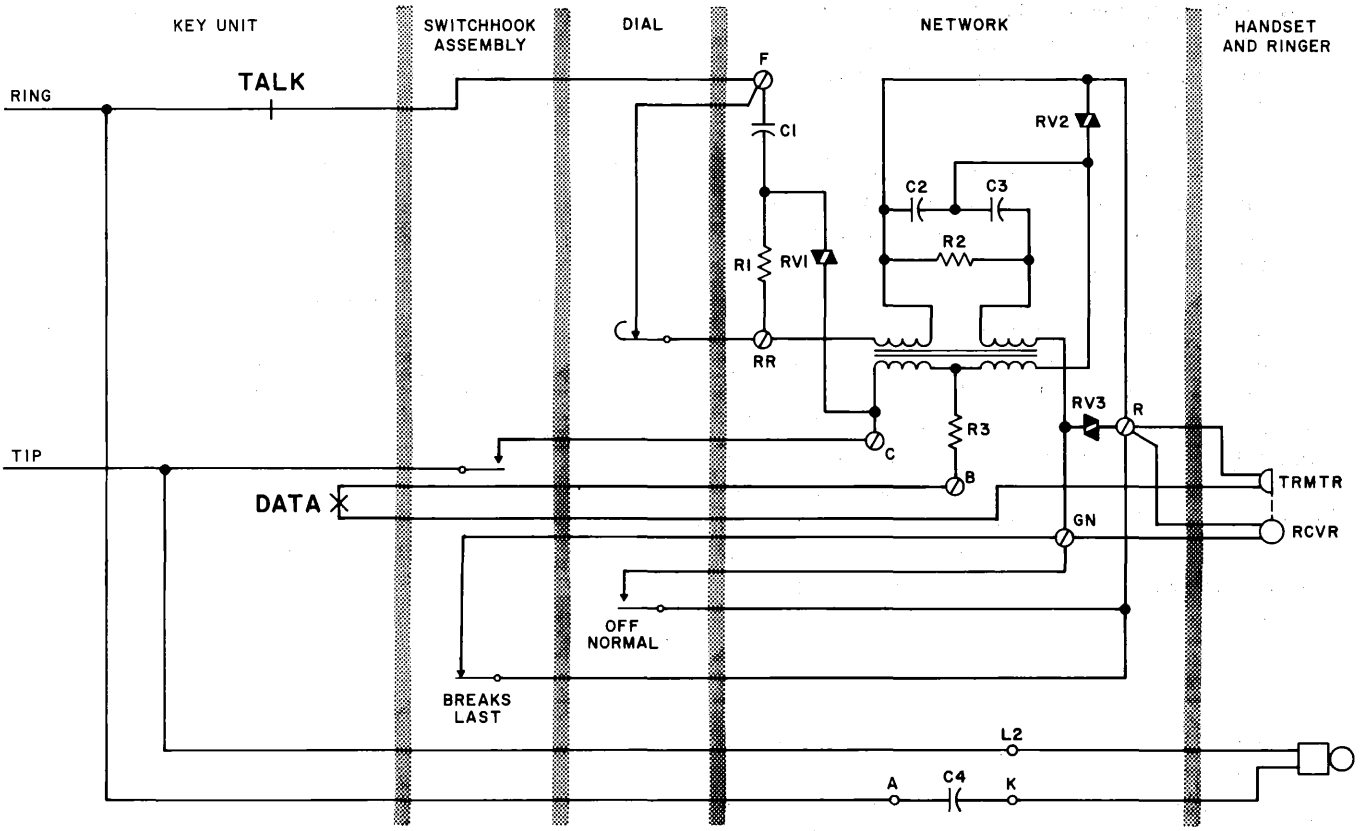


Fig. 3—Talk Mode Circuit

form a network to reduce arcing of the dial pulse contacts. Varistor RV1 in conjunction with R1 provides a shunt across tip and ring. This forms an equalization network that partially compensates for the difference in power loss in long and short telephone lines. Varistor RV2, resistor R2, and capacitors C2 and C3 form a sidetone balancing network. This network functions to maintain the sidetones at the desired level. Resistor R3 is a current limiter. The transformer is a four winding hybrid coil and is wound in such a manner as to deliver as much power as possible to the receiver while suppressing any sidetones. The transformer also delivers maximum power from the handset transmitter to the telephone line.

3.03 ***Data Mode:*** A typical block diagram of the data set is shown in Fig. 4. The data set accepts data from the business machine in the form of contact closures. The contact closure changes the tank circuit of the associated oscillator and causes that oscillator to generate a frequency that represents the contact closure. When there is not a contact closure associated with the oscillator, that oscillator generates a rest frequency. The three frequencies, one from each oscillator, are combined into a multifrequency code and transmitted through the polarity guard to the telephone line. Power for the data set is obtained from the telephone lines or from local battery supply. The correct voltage polarity is ensured by the polarity guard. The standard answer-back facility is provided to notify the attendant that the receiving business machine is ready to receive data. A voice answer-back (muting circuit) is available on a feature basis. Test facilities are provided by a 626A key. This key is equipped with two pushbuttons. When depressed, either of these pushbuttons causes a test signal to be transmitted to the data test center for analysis. The telephone set is an integrated part of the data set; however, the telephone equipment is basically that of a 700-type telephone. The line holding facilities are part of the apparatus unit. Any standard telephone can be used as an extension telephone. A detailed description of the above circuits, except the telephone circuits, is contained in 3.04 through 3.07 below.

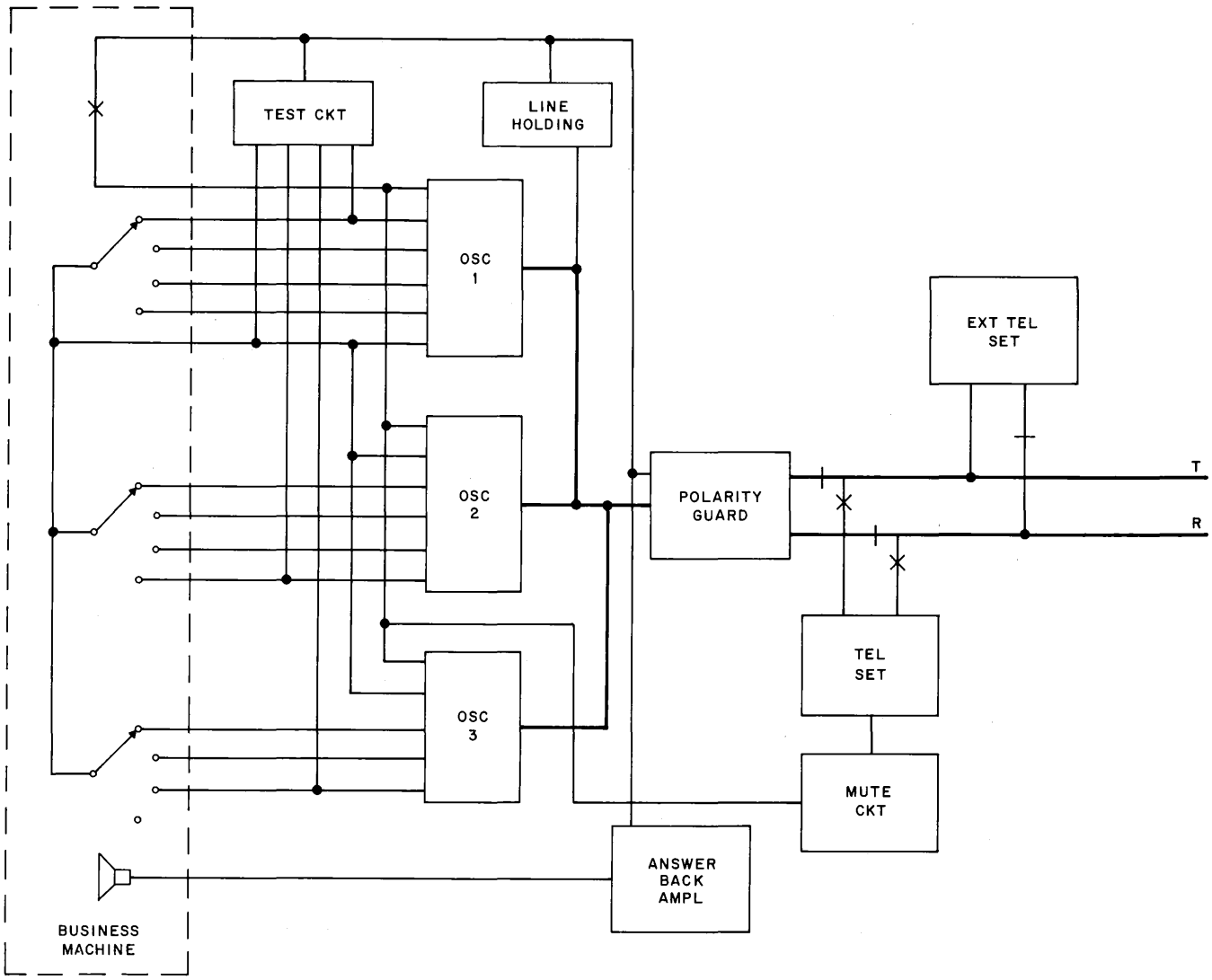


Fig. 4—Typical Block Diagram of Data Set 401-Type

3.04 ***Polarity Guard and Power Supply:*** Refer to Fig. 5 for a simplified schematic of the polarity guard and power supply circuit. Power for the data transmitter is to be derived from the central office battery via the subscriber line. Diodes CR1 through CR4 comprise a full bridge rectifier that functions as a polarity guard. The polarity guard ensures the correct voltage polarity to the data set independent of the line voltage polarity. The voltage potential across this bridge is between 3 and 10 volts, depending upon the subscriber loop resistance. Surge current protection is provided by zener diode CR5 which breaks down at approximately 18 volts. Resistors R16 and R17 limit surge current to protect CR5. Resistors R8 and R15 form a divider network to provide base to emitter bias for the oscillator transistors. Capacitor C7 is in parallel with R15 to reduce low frequency noise between the emitter and the base. Capacitor C7 also supplies bias for the oscillator when the 40- to 100-ms echo suppression signal is sent. In parallel with R8 and R15 is the answer-back amplifier circuit. The major portion of the current flows through this leg. Inductor L4 is in series with the source and the amplifiers. Across the amplifiers are six varistors in series. The regulating property of the varistors maintains collector supply voltage for the amplifiers at a value between 3.6 and 4.8 volts. These varistors also supply the line holding feature. Capacitor C10 acts as a filter

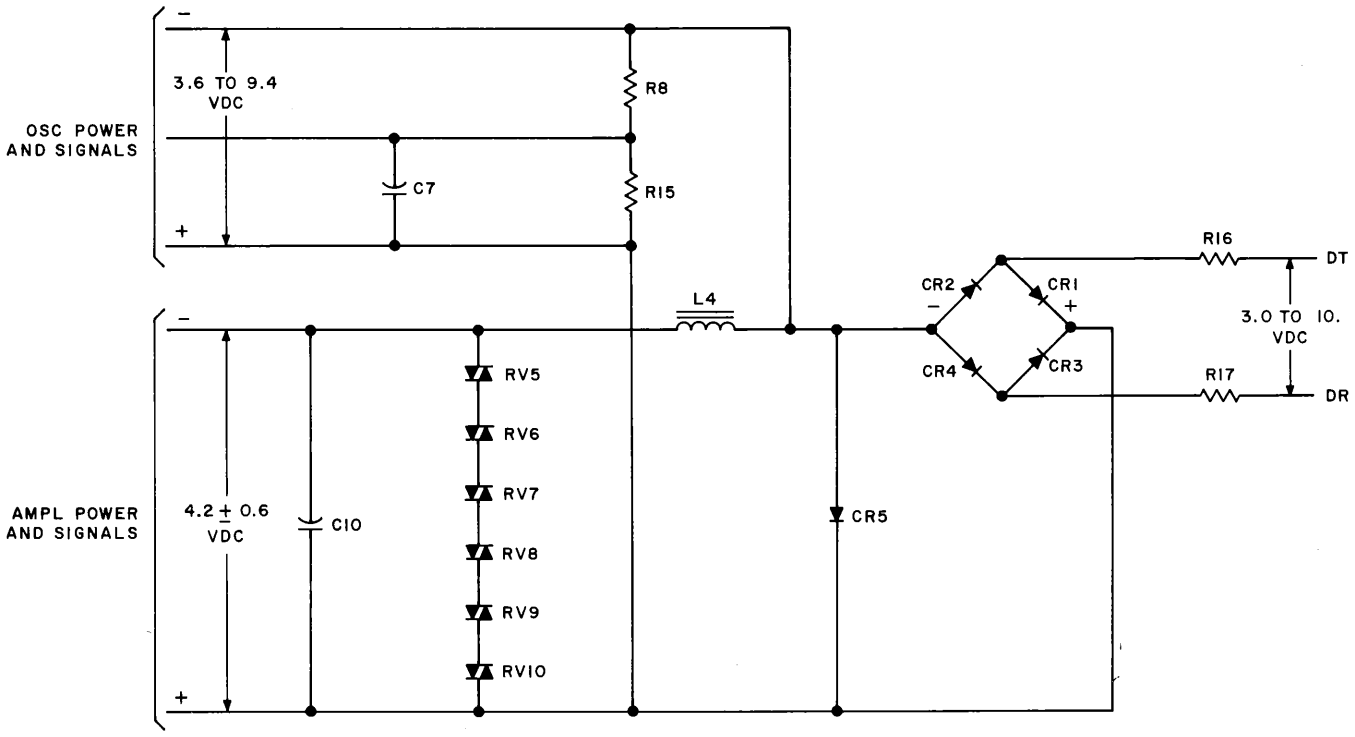


Fig. 5—Simplified Schematic of Polarity Guard and Power Circuit

capacitor for the collector supply voltage. The value of L4 is sufficient to cause little attenuation of signals delivered by the oscillators to the line.

3.05 ***Answer-Back Amplifier:*** Refer to Fig. 6 for simplified schematic of the answer-back amplifier. The answer-back amplifier is a class C amplifier that accepts the acknowledgment or answer-back signals from the telephone line and amplifies these signals before presenting them to the customer. These signals are either 1017, 1785, or 2025 Hz. Due to the dc level in the polarity guard, these signals are passed with little attenuation. Divider network R9 and R12 provides base bias current. The input impedance of the amplifier varies because Q4 saturates on strong input signal. Isolation resistor R10 reduces the effect of these input variations on any of the transmitted signals or the overall transmitter input impedance. Transistor Q4 emitter current is limited by R13 and capacitor C12 reduces degeneration. Input to Q5 is developed across R11. Emitter bias for Q5 is developed across R14 and C13. The output of Q5 is applied across capacitor C11. This output can be made audible by applying to a suitable transducer or receiver. This transducer must pass all the collector current for Q5. A WECo type U1 receiver is suitable. Capacitor C11 is used to reduce excessive spikes across the speaker and to eliminate high frequency oscillation in the amplifier due to capacitance coupling between input and output leads. A shunting volume control may be used across the external speaker if desired. The answer-back circuit will deliver approximately 25 milliwatts into a 150-ohm load. Somewhat less power will be delivered into a higher impedance load.

3.06 ***Voice Answer-Back (Muting Circuit):*** Refer to Fig. 7 for a simplified schematic of the muting circuit. The voice answer-back circuit provides facilities so that the telephone line can be monitored continuously. Since this also includes data signals from the transmitter, a means must be provided to reduce the data signal level before the signal is presented to the handset receiver. When the keying contacts in the business machine are closed, shorting terminals 24 and 25, current flows through resistors R19, R20, and Q6. Sufficient base current is supplied to saturate Q6. This, in essence, places a short across the primary of transformer T4. The make contact on the data key places T4 across the telephone receiver unit and a break contact on the data key removes the telephone transmitter from the circuit. The output of T4 is coupled directly to the telephone network by capacitor C14. The low impedance across T4 is reflected as a low impedance across the handset receiver and thereby reduces the data signals before they are presented to the handset receiver.

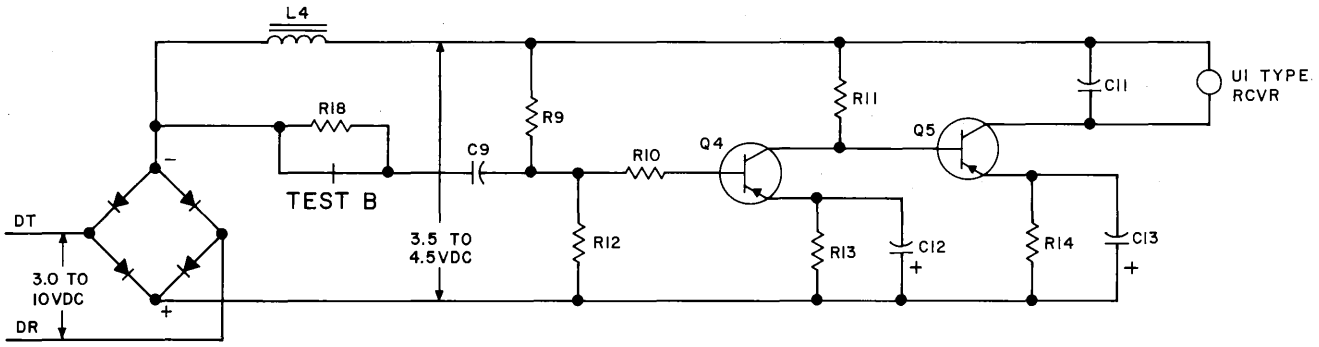


Fig. 6—Answer-Back Amplifier Circuit

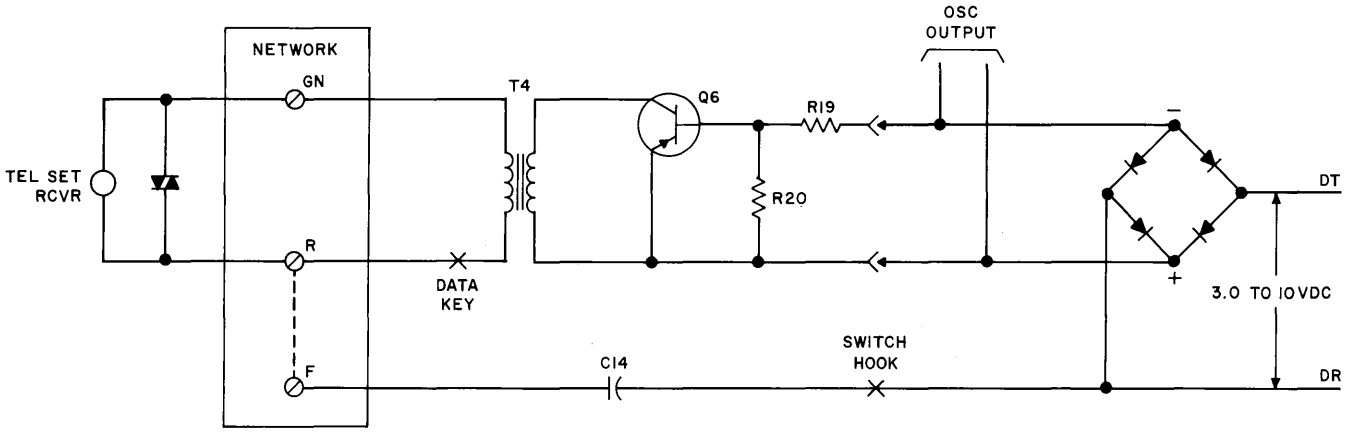


Fig. 7—Voice Answer-Back (Muting Circuit)

3.07 ***Oscillator Circuits:*** For a simplified schematic of the oscillator circuits, refer to Fig. 8. The transmitter circuit of data set 401-type consists of three similar oscillators. Two oscillators can deliver five signal frequencies and the third can deliver four signal frequencies. Since the three oscillators are similar, only the oscillator associated with Q1 will be described. The oscillator section is enabled by shorting contacts 24 and 25 of interface connector J1. Base to emitter bias is provided by the drop across resistor R15. The bias together with the resistor R1 fixes the emitter current. Transformer winding 7-8 is in series with the emitter circuit. The current in winding 7-8 induces current into winding 9-10. Winding 9-10 has more turns than winding 7-8 and is connected to the base of Q1 with polarity such as to cause oscillations. Frequency of the oscillator is controlled by tuning the tertiary winding of the transformer. When the business machine connects the common terminal 7 to one of the terminals 3, 4, 5, or 6 on the interface connector (contact closures), inductor L1 is shunted across part or all the tertiary windings. This in conjunction with capacitor C1 establishes the frequency of the oscillator. Varistor RV1 across the base windings limits the amplitude of oscillations at the base to 0.6-volts peak ac. Resistor R4 and capacitor C4 are connected across the base winding to prevent parasitic oscillation. Opening terminals 24 and 25 terminates transmission. The charging of capacitor C8 permits collector current to flow for a period of 50 to 100 ms after terminals 24 and 25 are opened. When there are no contact closures, this period is spent in the generation of rest frequencies. Resistor R7 and varistor RV4 have little influence on the charging time of C8; however, resistor R7 controls a peak discharge current when the contacts close and varistor RV4 isolates the oscillator from the line during answer-back signal.

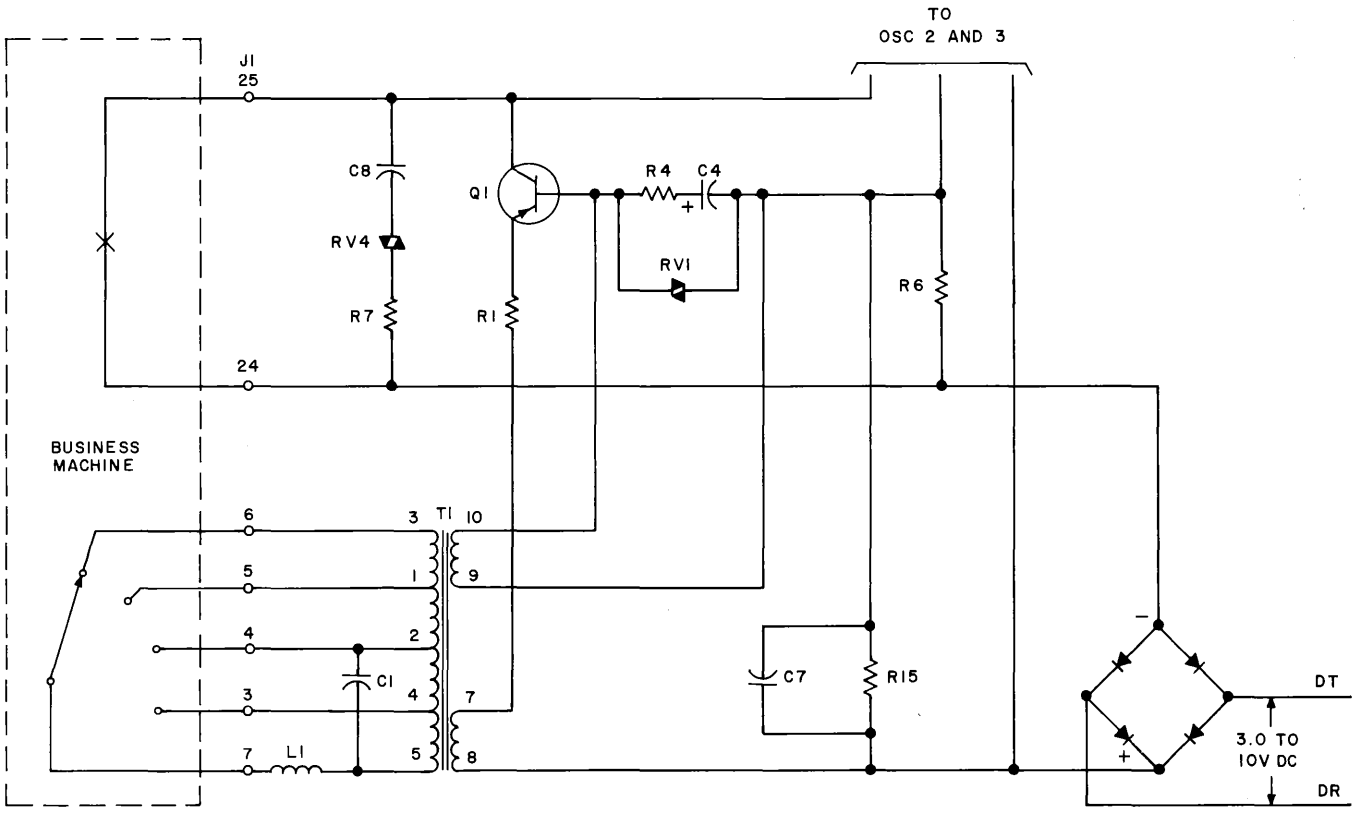


Fig. 8—Oscillator Circuit

3.08 ***Test Key Circuits:*** Refer to Fig. 9 for the simplified schematic of the test key circuits. The remote testing circuit provides facilities for testing the data set on the customer premises. When operated, the test circuits cause test signals to be transmitted to the data test center for analysis. The test circuits operate as follows:

(a) Test A switch (TA) consists of three make-type contacts. When operated, it causes the following conditions to be established:

- Terminals 24 and 25 of the interface connector are connected.
- Terminals 6 and 7 of the interface connector are connected.
- Terminals 7 and 12 of the interface connector are connected.

Therefore, depressing the test A switch will result in transmission of a composite signal consisting of frequencies 941, 1633, and 1950 Hz.

(b) Test B switch (TB) consists of two make-type contacts and one set of transfer contacts. When depressed, test switch TB causes the following conditions to be established:

- Terminals 24 and 25 of the interface connector are connected.
- Terminals 7 and 16 of the interface connector are connected.

This causes the data set to transmit a composite signal of 600, 1098, and 2250 Hz. The transfer contacts bypass resistor R18 during normal operation. Resistor R18 attenuates the input signal to the answer-back receiver (approximately equal to average line loss). This provides a means of testing the sensitivity of the answer-back amplifier.

> ***Note:*** Because certain defects in the customer-provided equipment (CPE) could cause improper test results, the data set should be disconnected from the CPE prior to testing.

4. PERFORMANCE DATA

4.01 ***Power:*** Data set 401-type obtains its operating power from the telephone line.

4.02 ***Oscillators:*** The operating characteristics of the oscillators are as follows:

(a) Minimum of 4 volts dc and 6 mA is required to power the oscillators.

(b) The dc impedance between terminals 24 and 26 is approximately 1300 ohms.

(c) The T and V features (strapping) affect the power output of the oscillators. When audible answer-back is used, the T feature is factory-strapped (reduced oscillator output power) to maintain the desired power output. If signals (data set output and answer-back) are to be monitored in the telephone handset, the V feature is strapped allowing approximately 2 dB higher output level. This compensates for the loss in bridging the handset to the data set output. At the output of the data set, the power level of the individual oscillator signals into a 600-ohm load is approximately −9 dBm. The level of the combined oscillator outputs is approximately

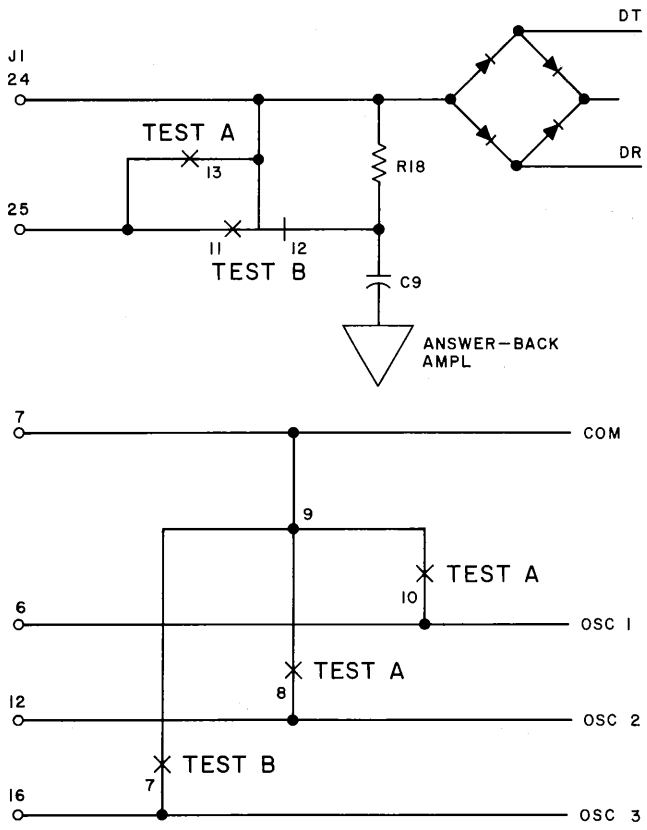


Fig. 9—Test Key Circuits

−4 dBm. External pads may be required to comply with the −12 dBm signal level requirement at the serving central office.

4.03 ***Polarity Guard and Power Supply Circuit:*** The dc voltage drop across the polarity guard is negligible and there is an outgoing loss of 0.1 dB.

4.04 ***Voice Answer-Back (Muting Circuit):*** The voice answer-back circuit power requirements are 4 volts dc at 0.5 mA.

4.05 ***Answer-Back Circuit:***

(a) The answer-back circuit will deliver approximately 25 mW into a 150-ohm load. through pin 19 and return to the data set through pin 20.

(c) The answer-back leads must be electrically isolated from ground and other circuits in the business machine.

5. MAINTENANCE

5.01 ***General:*** This part presents testing requirements and specifications on each functional unit. Enough detailed information is included so that specific tests can be written when desired.

5.02 ***Equipment Required:*** The following test equipment or its equivalent is required.

(a) 1—oscilloscope (Tektronix 535, or equivalent)

(b) 1—true RMS meter (Ballantine)

(c) 1—frequency counter

(d) 1—oscillator (balanced output)

(e) 1—attenuator

(f) 1—ohmmeter (VOM)

(g) 1—battery, resistor, capacitor, and switch (DPDT)

(h) 1—L-R network

(i) 1—pulser

(j) 1—resistor, 600 ohms ±1%, 4 watts

(k) 1—resistor, 100 ohms ±5%, 1/2 watt

(l) 1—resistor, 430 ohms ±5%, 1/2 watt

5.03 ***General Notes:***

- Units with long interface connecting cables (5-foot 6-inch) shall be loaded with a capacitance of 150 pf from each data lead to common. Units without cables or with short (6-inch) cables shall be loaded with 300 pf from each data lead to common.

- This capacitive network shall be located as close to the cable connecting plug as possible to minimize stray wiring capacitance. Stray wiring capacitance from any lead to common must be measured by connecting all other data leads to common. This stray capacitance will be limited to less than 10 pf.

- Care must be exercised not to ground any portion of the data set, especially that portion inside the polarity guard. External ground references are not maintained through the polarity guard, therefore, voltage measurements within the polarity guard should be accomplished on a differential basis only, using two probes with neither probe being ground.

- The connections indicated in the following tables are temporary connections only.

5.04 ***Bell System Repair Specification:*** For detail maintenance of the circuit packs, refer to Bell System Repair Specifications (BSRS) 480.002.

5.05 ***Circuit Pack Identification (Fig. 10, 11, and 12):*** The information necessary to locate the individual components on the circuit packs is given in Table C. Table C gives the circuit pack assembly number, circuit pack features, and a reference to the figure illustrating the circuit pack. This information in conjunction with the information in Parts 2, 3, and 4, should aid in isolating trouble within the data set.

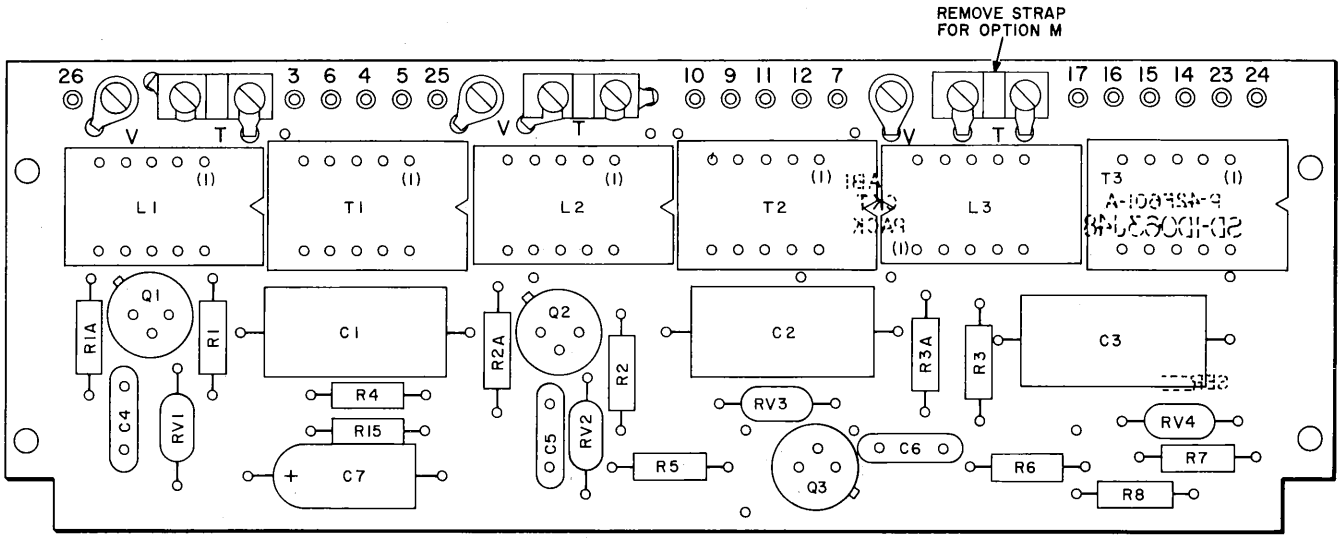


Fig. 10—CP 1 Component Arrangement

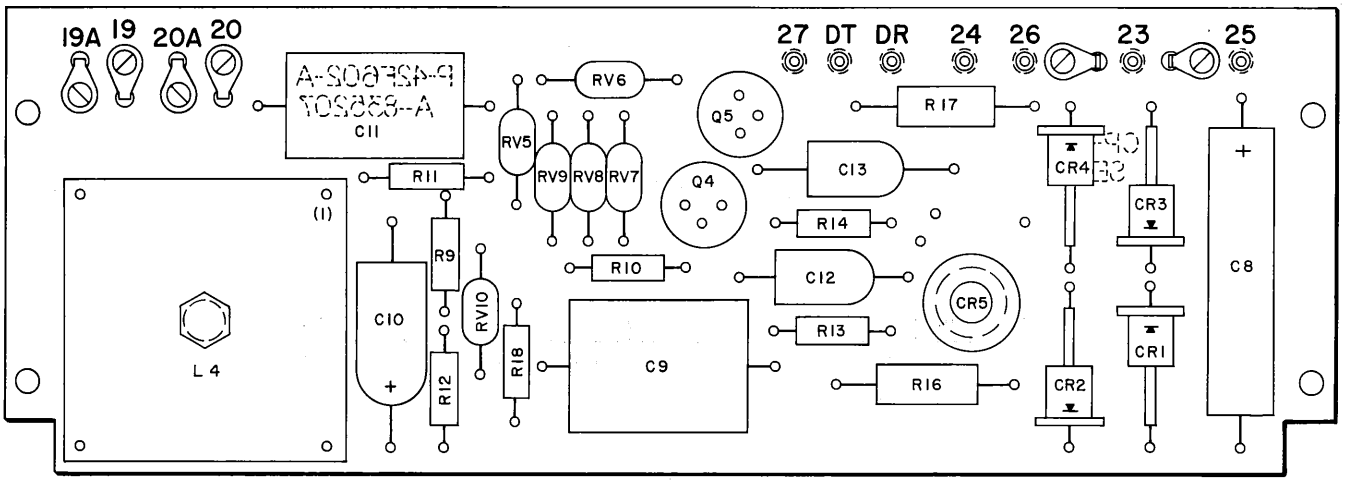
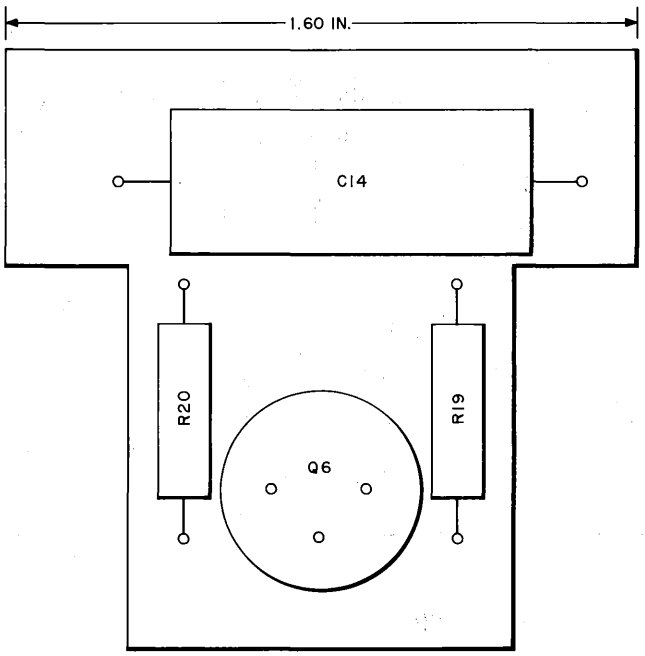


Fig. 11—CP 2 Component Arrangement



NOTE:
REFERENCE DESIGNATORS C14, R19, ETC ARE NOT PANEL STAMPED.

Fig. 12—CP 3 Component Arrangement

TABLE C

CIRCUIT PACK IDENTIFICATION

DESIGNATION	FEATURE	ASSEMBLY NO.	FIG. NO.	CIRCUIT PACK CODE
CP 1	Contains 3 oscillator circuits	A-835206	10	AB1
CP 2	Contains polarity guard, power supply, and audible answer-back circuits	A-835207	11	AB3
CP 3	Contains voice answer-back or muting circuit	A-835208	12	EE1

5.06 ***Preliminary Checks:*** Visually check that resistors R7, R10, R13 R14, R16, R17, and R18 are of the correct value and that zener diode CR5 is connected to the proper terminals.

5.07 ***Power supply Check:*** Connect power as shown in Fig. 13 and perform the operations in Table D.

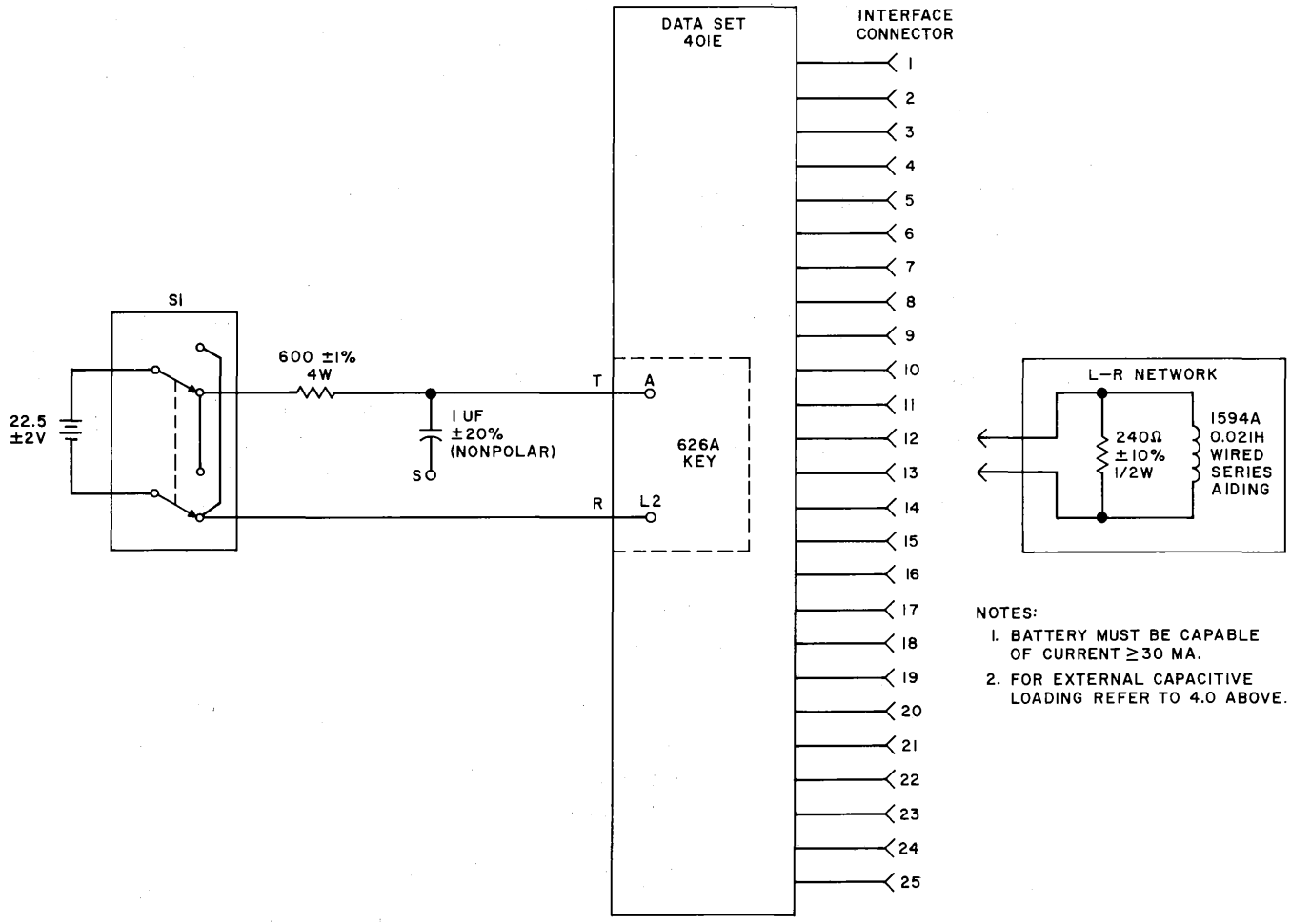


Fig. 13—Test Arrangement for Audible Answer-Back Check

TABLE D

POWER SUPPLY CHECK

EQUIPMENT	CONNECT TO	DATA SET	OPERATIONS	OBSERVATIONS
Oscilloscope (Tektronix 535 or equivalent)	T and R	401E	Short 24 to 25	No oscillations
			Pull data key Short 24 to 25	Transmitter oscillates
			Pull data key Operate S1 Short 24 to 25	Transmitter oscillates

Note: Leave data key operated.

5.08 ***Audible Answer-Back Check:***

(1) Connect the circuit as shown in Fig. 13. Connect the test oscillator to the attenuator and connect 430 ohms across the output terminals of the attenuator. Connect the L-R network across terminals 19 and 20.

(2) Perform the operations in Table E.

5.09 ***Fall Time Check:*** Connect the equipment as specified in Table F and perform the operations indicated. The pulser circuit is shown in Fig. 14.

5.10 ***Oscillator Feedback Margin:*** Connect equipment as specified in Table G and perform the operations indicated.

5.11 ***Frequency Adjustment and Output Power:*** Connect equipment as specified in Table H and perform the operations indicated.

5.12 ***Individual Circuit Board Test:***

(1) Verify correct value of components mentioned in preliminary check. Set switch S1, Fig. 13 to the position that makes T negative and R positive. Leave switch S1 in this position throughout the test. Connect R to 26 on CPS 2. Short terminals 24 and 25, then connect T to either 24 or 25.

(2) Connect equipment as specified in Table I and perform the operations indicated.

(3) Verify correct value of components on the answer-back amplifier circuit board as mentioned in preliminary checks. Connect T to DT and R to DR on circuit board. The answer-back amplifier must satisfy the requirements of 5.08. For 19 and 20, use studs 19 and 20 on the circuit board. Reverse S1 and repeat readings.

TABLE E

AUDIBLE ANSWER-BACK CHECK

EQUIPMENT	CONNECT TO	OPERATIONS	OBSERVATIONS
True RMS Meter (Ballantine)	T and R	Set frequency to 1785 ±20 Hz. Set level to −31.5 ±0.5 dBm across 430 ohms, then connect the output terminals of the attenuator to S and R, Fig. 13.	−32 ±2 dBm at T and R
	19 and 20		≥ −1.0V rms at 19 and 20

TABLE F

FALL TIME CHECK

EQUIPMENT	CONNECT TO	OPERATIONS	OBSERVATIONS
Oscilloscope (Tektronix 535)	T and R	Set scope to 10 ms/cm, using negative external trigger.	Fall time to reach 0.4V peak-to-peak must be ≥40 ms
	B1 to 25, J1 B3 to 24, J1 B5 to external trigger	Short 3 to 6, 14 to 16 on J1, and operate S2.	

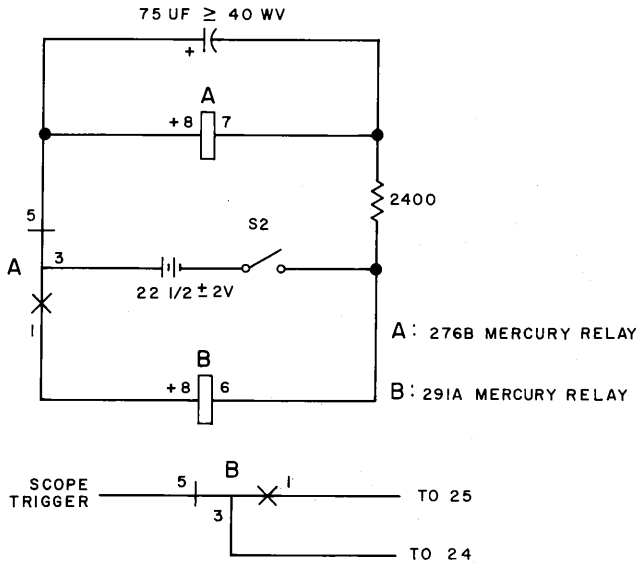


Fig. 14—Pulser Circuit

5.13 *Test Circuit Checks:*

(1) Transfer contacts of test button TB. Connect equipment as specified in Table J and perform the operation indicated.

(2) Test circuit measurements. Connect equipment as specified in Table K and perform the operations indicated.

5.14 *Telephone Apparatus Tests:*

(1) Examine switchhook assembly to ensure that spring and operating arms are properly aligned. Check plunger operation for freedom from binding. Check operation of data key.

(2) Using the circuit of Fig. 13, pick up the telephone handset and speak or whistle into the transmitter. Sidetone should be heard in the receiver. Repeat with S1 reversed.

TABLE G

OSCILLATOR FEEDBACK MARGIN CHECK

EQUIPMENT	CONNECT TO	OPERATIONS		OBSERVATIONS	
		CLOSE	SHORT	FREQ HZ	LEVEL DBM
Oscilloscope (Tektronix 535)	T and R	6 to 7 through 430 ohms	9 to 12, 14 to 16, 24 to 25	≤941	≥−12
Meter (Ballantine)	T and R	12 to 7 through 100 ohms	3 to 6, 14 to 16, 24 to 25	≤1633	≥−12
Counter (H-P 523)	Vertical output terminal of scope	17 to 7 through 100 ohms	3 to 6, 9 to 12, 24 to 25	≤2250	≥−12

TABLE H

FREQUENCY ADJUSTMENT AND OUTPUT POWER CHECK

EQUIPMENT	CONNECT	OPERATIONS			OBSERVATIONS	
		SHORT	CLOSE	TUNE	FREQ HZ	LEVEL DBM
Oscilloscope (Tektronix 535)	T and R	9 to 12, 14 to 16, and 24 to 25		T1	600 ±1	—9 ±2
			6 to 7	L1	941 ±1	
			5 to 7	Note 1	852 ±2	
			4 to 7		770 ±2	
			3 to 7		697 ±2	
Meter (Ballantine)	T and R	3 to 6, 14 to 16, and 24 to 25		T2	1098 ±1	
			J to K or 12 to 7	L2	1633 ±1	
			H to K or 11 to 7	Note 2	1477 ±3	
			F to K or 10 to 7		1336 ±3	
			E to K or 9 to 7		1209 ±3	
Counter (H-P 523)	Vertical output terminal of oscilloscope	3 to 6, 9 to 12, and 24 to 25		T3	1950 ±1	
			17 to 7	L3	2350 ±1	
			16 to 7	Note 3	2250 ±3	
			15 to 7		2150 ±3	
			14 to 7		2050 ±3	

Notes:

1. T1 and L1 may be readjusted to bring all the frequencies within the ±2 Hz tolerance.
2. T2 and L2 may be readjusted to bring all the frequencies within the ±3 Hz tolerance.
3. T3 and L3 may be readjusted to bring all the frequencies within the ±3 Hz tolerance.

TABLE I

INDIVIDUAL CIRCUIT BOARD TEST

EQUIPMENT	CONNECT TO	401 OSC BOARD (CPS 1)	OBSERVATIONS
Oscilloscope (Tektronix 535)	T and R	Short stud 9 to 12 and stud 14 to 17	Frequency 540 <Freq <680 Hz −9 ±2 dBm
Meter (Ballantine)	T and R	Short stud 3 to 6 and stud 14 to 16	Frequency 1010 <Freq <1200 Hz −9 ±2 dBm
Counter (H-P 523)	Vertical output of scope	Short stud 3 to 6 and stud 9 to 12	Frequency 1830 <Freq <2900 Hz −9 ±2 dBm

TABLE J

TEST CIRCUIT CHECK

EQUIPMENT	CONNECT TO	OPERATIONS	OBSERVATIONS
VOM	24 and 27 on CPS 2	Set VOM to R X 1000 scale	Short circuit
		Set VOM to R X 1000 scale Press test button B	20,000 ohms

(3) In the circuit of Fig. 13, replace the 22.5-volt battery with a 90-volt 20-Hz ringing signal source in series with 400 ohms. With the telephone on-hook, connect T and R. The telephone ringer should operate.

6. REFERENCES

6.01 The following documents provide additional information data set 401-type.

SECTION	TITLE
594-014-100	Data Set 401E-Type Transmitter—Description and Operation
594-014-200	Data Set 401E-Type Transmitter—Installation and Connections
594-014-300	Data Set 401E-Type Transmitter—Maintenance
594-014-500	Data Set 401E-Type Transmitter—Test Procedure

NUMBER	TITLE
CD&SD-1D063-01	Data Set 401E-Type Transmitter Circuit
P.E.L	6794
P.E.L	7922
B.S.R.S.	480.002
Tech. Ref.	Manufacturing Testing Requirements and Specification X77353 Bell System Data Communications

TABLE K

TEST CIRCUIT MEASUREMENTS

EQUIPMENT	CONNECT TO	OPERATIONS		OBSERVATIONS	
		PRESS	SHORT	FREQ HZ	VOLTAGE AT 19 & 20
Oscilloscope (Tektronix 535)	T and R	Test button A	9 to 12 14 to 16	941 ±2	≥1.0 VRMS
Meter (Ballantine)	19 and 20		3 to 6 14 to 16	1633 ±3	
			3 to 6 9 to 12	1950 ±3	
		Test button B	9 to 12 14 to 16	600 ±2	≥0.4 VRMS
Counter (H-P 523)	Vertical output of scope		3 to 6 14 to 16	1098 ±3	≥1.0 VRMS
			3 to 6 9 to 12	2250 ±3	