

**DATA SET 401-TYPE RECEIVERS  
THEORY OF OPERATION AND  
SUPPLEMENTARY INFORMATION**

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<b>4. THEORY OF OPERATION</b> . . . . .	13	<b>1.01</b> This section provides theory of operation and supplementary information on Data Set 401-type receivers. This section briefly describes Data Sets 401B and 401F, which were earlier model receivers, and provides detailed description, operation, and test procedures for Data Set 401J-type. The information contained in this section supplements the information in other sections and is not required for installation, maintenance, or service under normal circumstances.	
<b>A. Power Supply</b> . . . . .	13	<b>1.02</b> Data Set 401-type receivers are suitable for the reception of low-speed voice-frequency 2-out-of-8 parallel numeric or 3-out-of-14 parallel alphanumeric data signals, such as those produced by 401-type transmitters and used over the DDD network or in private line service.	
<b>B. Line Control</b> . . . . .	17	<b>1.03</b> Received data is translated from multifrequency tones into contact closures for delivery to various classes of business machines. The rated speed is up to 20 characters per second (50 ms per character), or approximately 130 bits per second.	
<b>C. AGC Amplifier</b> . . . . .	19	<b>1.04</b> Data Set 401-type receivers find applications in data-gathering activities where a great	
<b>D. Band Separation Filter</b> . . . . .	19		
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many transmitters send data at low speeds and in parallel form to a centralized location. Remote metering and control signaling are examples of these activities. Another application is in the card-reader systems such as the IBM 024 or 026 system. Brief examples of Data Set 401-type receiver applications are as follows:

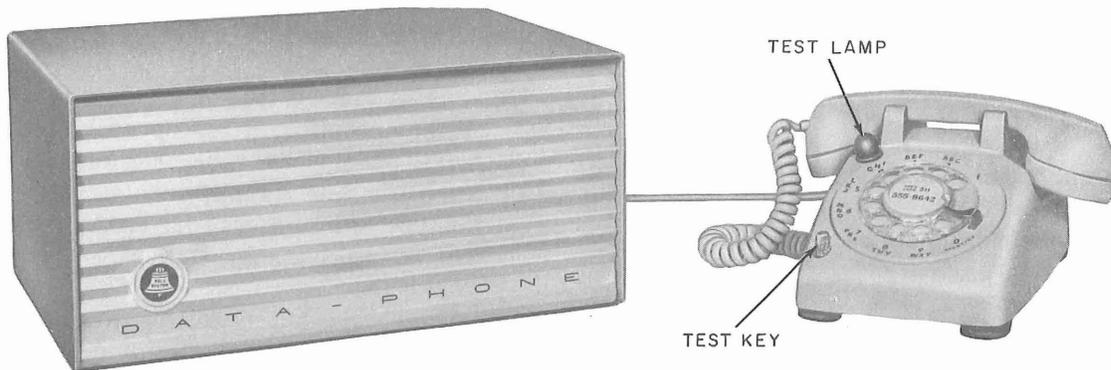
- A city sewage department receives data on possible malfunctions at a remote pumping station.

- A power company receives reports of abnormal conditions affecting customer outage at an unattended substation.
- An oil company receives information on the amount of oil stored at a remote storage facility.

**1.05** Data Sets 401B, 401F, and 401J-type are shown in Fig. 1, 2, and 3, respectively, and are summarized in 1.06 through 1.09.



**Fig. 1—Data Set 401B**



**Fig. 2—Data Set 401F**



**Fig. 3—Data Set 401J-Type**

#### **Data Set 401B**

**1.06** Each character received consists of two tones which Data Set 401B converts into contact closures. When the data set is used on the switched telephone network, a modified 502BR-61 telephone is required to establish connections and for voice communication. Attended and unattended answering features are provided. In private line service, no telephone is required but the modified 502BR-61 may be used for voice communication. Data Set 401B can be arranged to transmit one of two answer-back frequencies to the sending data set.

#### **Data Set 401F**

**1.07** Each character received consists of three tones which Data Set 401F converts into contact closures. When the data set is used on the switched telephone network, a 513BR-61 telephone is required to establish connections and for voice communication. In private line service, no telephone is required but the modified 502BR-61 may be used for voice communication. Data Set 401F can be arranged to transmit one of two answer-back frequencies to the sending data set. Automatic answering is available.

TABLE A  
DATA SET 401J-TYPE FEATURES

DATA SET	RATING	DIAL	ANSWER-BACK
J1D401J	MD	Rotary	Tone
401J1	MD	Rotary	Tone
401J2	MD	Rotary	Tone
401J3	MD	Rotary	Tone & Voice
401J4	MD	TOUCH-TONE®	Tone
401J5	MD	TOUCH-TONE	Tone & Voice
401J6	Standard	Rotary	Tone
401J7	Standard	TOUCH-TONE	Tone & Voice
401J8	Standard	TOUCH-TONE	Tone
401J9	Standard	Rotary	Tone & Voice

#### Data Set 401J-Type

**1.08** This set combines a data receiver, an answer-back oscillator, and a standard telephone in one housing. Each data character received consists of three tones, or optionally two tones, which the data set converts into contact closures. Automatic answering is available and an external automatic calling unit can be used with the data set. Facility for voice or tone answer-back is provided.

**1.09** Refer to Table A for various models of Data Set 401J-type and their features.

## 2. EQUIPMENT CHARACTERISTICS

**2.01** Table B lists the major characteristics of the 401-type receivers, including compatible data sets, business machines, physical characteristics, and power requirements. For information on operating controls and cords supplied with the Data Set 401-type receivers, refer to the applicable description and operation sections listed in Part 6 of this section.

### A. General Interface and Line Signal Characteristics

**2.02** General interface and line signal characteristics for the 401-type receivers are given in 2.03 through 2.07. Detailed information on the conditioning of the various interface leads will be given under the appropriate data set headings.

**2.03** The cord used to connect the data sets to the customer business machine should be supplied by the customer. The cord should not exceed 50 feet in length (capacitance between any signal interchange lead and its signal ground must not exceed 2500 picofarads).

**2.04** The maximum current through any interconnecting lead should not exceed 100 mA steady state with 500 mA permissible on a surge. On open, the maximum potential between any two pins in the connector should not exceed 50 volts with 200 volts permissible on a surge less than 10 milliseconds in duration.

**2.05** Data Set 401-type receivers provide either 8 (Data Set 401B) or 14 (Data Sets 401F

TABLE B

## DATA SET 401-TYPE RECEIVERS—OPERATING CHARACTERISTICS

DATA SET	TYPE TRANSMISSION	INTERFACE	BIT RATE	LINE FACILITY	OPERATION	WORKS WITH		UNATTENDED ANSWER	AUTOMATIC DIALING	REVERSE CHANNEL	TELEPHONE HANDSET AND DIAL	REMOTE TESTING	POWER	SIZE	TEMPERATURE AND HUMIDITY RANGE
						DATA SET	BUSINESS MACHINE								
401B	2 signals parallel—serial by character. Max. of 16 characters	Contact 8 data leads	Up to 20 characters per second or approximately 130 bits per second. Non-synchronous	DDD network or 2-wire private line	Half-duplex 2-wire	401A	IBM 1001  Raytheon "Dataray"	Yes	No	1017- and 1785-Hz answer-back	Separate (502BR-61)	No	105-120 Vac 30 watts	Width 14" Depth 11" Height 4" Weight 21 lbs.	40 to 120°F 20 to 95%
401F	3 signals parallel—serial by character. Max. of 99 characters	Contact 14 data leads	Up to 20 characters per second or approximately 130 bits per second. Non-synchronous	DDD network or 2-wire private line	Half-duplex 2-wire	401A 401E 401H 401L		Yes	No	1017- and 1785-Hz answer-back	Separate (513B-61) for switched network	Yes	105-120 Vac	Width 13" Depth 11" Height 6" Weight 23 lbs.	40 to 120°F 20 to 95%
401J	3 signals parallel—serial by character. Max. of 99 characters	Contact 14 data leads	Up to 20 characters per second or approximately 130 bits per second. Non-synchronous	DDD network 2001-type channel—private line alternate voice/data  3002-type channel—private line data only	Half-duplex 2-wire	401A 401E 401H 401L	IBM 024 or 026  Dashew DC 1000  Raytheon "Dataray" 401	Yes	Can be provided with 801-type ACU	Control of answer-back tones is available	Integrated rotary or TOUCH-TONE dials available	Yes	105-120 Vac 10 watts	Width 10-3/4"  Depth 14-1/2"  Height 5-1/2"  Weight 22 lbs.	40 to 120°F 20 to 95%

and 401J) channels divided into two or three frequency groups, respectively. Data is presented to the business machine in the form of contact closures between a group common lead and one of the leads in the group. The data contacts are electrically isolated from each other and the other circuits. Contact protection is furnished by a series RC network consisting of 470 ohms resistance and 0.5 microfarad capacitance connected in parallel with the contacts.

**2.06** Data contact characteristics for the 401-type receivers are as follows:

- (a) If only one contact closure is presented to the transmitting data set or if the skew (time interval between contact closures that nominally should occur simultaneously) in the business machine contacts is too great, only one closure will be presented to the receiving business machine.
- (b) If more than one contact closure in a group is presented to the transmitting data set, no closure from that group will be presented to the receiving business machine.
- (c) If a character is improperly timed (duration, rest interval, or total period is too short) the entire character may be lost.
- (d) If the transmitting business machine holds the data contacts closed after releasing the keying contacts, interference caused by transmission echoes may be encountered. This will usually appear in the form of a repeated closure of the data contacts in the 401-type receivers.

**2.07** Certain types of noise may introduce errors, which appear to the receivers as follows:

- Closure of contacts may occur in addition to those which represent the character being transmitted.
- A legitimate contact closure may not occur due to cancellation of the signal.

#### **B. Data Set 401J Interface Characteristics**

**2.08** Table C lists Data Set 401J-type interface lead designations. The characteristics of the interface leads are as follows:

**TABLE C**

#### **DATA SET 401J-TYPE**

#### **INTERFACE LEAD DESIGNATIONS**

PIN NO.	LEAD DESIGNATION
1	Frame ground
2	A0 (600 Hz)
3	A1 (697 Hz)
4	A2 (770 Hz)
5	A3 (852 Hz)
6	A4 (941 Hz)
7	A Common
8	B0 (1098 Hz)
9	B1 (1209 Hz)
10	B2 (1336 Hz)
11	B3 (1471 Hz)
12	B4 (1633 Hz)
13	B Common
14	C1 (2050 Hz)
15	C2 (2150 Hz)
16	C3 (2250 Hz)
17	C0 (1950 Hz)
18	C Common
19	Electrical answer-back (1017 Hz)
20	Electrical answer-back (1785 Hz)
21	Data receive (squelch)
22	Data terminal ready (line control)
23	Data set ready (line status)
24	Signal ground
25	Ringin indication (W option) or out-of-service (X option)

#### (a) *Data Contacts*

- A0, B0, and C0 are rest channels and are used as intercharacter separators.
- When a Data Set 401A transmitter serves as a transmitting input to the 401J receiver, the business machine should be arranged to ignore any "C" group data contacts.
- Each character will be delivered to the business machine approximately 13 ms after the incoming signal has been detected and will be removed approximately 13 ms after the incoming signal has been removed. If simultaneous signals are presented to the 401J receiver input, a maximum skew of 4 ms can be expected in the contact closures.

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(b) **Data Receive (Squelch):** The data receive (squelch) lead should be connected to signal ground when the business machine is ready to accept data. The lead should be held open when the business machine is not ready to receive data or when electrical answer-back signals are being generated.

(c) **Electrical Answer-Back (1017 Hz or 1785 Hz):** The electrical answer-back signal is initiated by the business machine opening the data receive (squelch) lead and placing a contact closure between one of the electrical answer-back leads and signal ground.

(d) **Data Terminal Ready (Line Control):** A contact closure between the data terminal ready lead and signal ground enables the data set to answer incoming calls and maintain existing ones. The data terminal ready lead should be held open for at least 50 ms to initiate a disconnect. The time interval allows the data set to remove the contact closure between the data set ready lead and signal ground.

(e) **Data Set Ready:** The data set ready lead is closed to signal ground by the data set when it is ready to receive data. If the call is answered manually (data terminal ready lead open), the data set will be in the voice mode and the data set ready lead will be open; it will close to signal ground when the DATA key is depressed.

(f) **Signal Ground:** Signal ground is connected to the frame of the data set which is grounded through the power cord. The frame of the business machine must also be grounded. If required, signal ground may be connected to the frame of the business machine but it must not be used to derive the main ground for the frame of the business machine.

(g) **Frame Ground:** The frame ground lead may be used to connect the frame of the data set to the frame of the business machine but must not be used to derive the main ground for the business machine. With all power cords removed, the resistance between the ground terminals of the two power outlets must be less than 1 ohm when measured by a typical volt-ohmmeter.

(h) **Ring Indicator or Out of Service:** This lead can be used either to give the business machine a ringing indication or under certain conditions and limitations, to allow the business machine to signal the line that the station is out of service.

**C. Data Set 401B Interface Characteristics**

**2.09** Table D lists Data Set 401B interface lead designations. The characteristics of the interface leads which differ from Data Set 401J-type interface leads are as follows:

(a) **Data Contacts:** Each character will be delivered to the business machine for 20- to 27-ms duration, independent of the length of the character presented to the transmitting data set, with the skew reduced to 3 ms or less.

**TABLE D**

**DATA SET 401B-TYPE**

**INTERFACE LEAD DESIGNATIONS**

INTERFACE LEAD	EARLY MODEL	LATER MODEL
A1 (697 Hz)	A	3
A2 (770 Hz)	B	4
A3 (852 Hz)	C	5
A4 (941 Hz)	D	6
A Common	K	7
B1 (1209 Hz)	E	9
B2 (1336 Hz)	F	10
B3 (1477 Hz)	H	11
B4 (1633 Hz)	J	12
B Common	Z	13
Start or Ans-Back	T	19
Check or Aud Answer-Back	P	20
Squelch	L	21
Line Control	S	22
Line Status	R	23
Line Status	U	24
Frame Ground	N	1
Ground	M	

TABLE E  
DATA SET 401F

## INTERFACE LEAD DESIGNATIONS

INTERFACE LEAD	DESIGNATION
Frame Ground	1
A0 (600 Hz)	2
A1 (697 Hz)	3
A2 (770 Hz)	4
A3 (852 Hz)	5
A4 (941 Hz)	6
A Common	7
B0 (1098 Hz)	8
B1 (1209 Hz)	9
B2 (1336 Hz)	10
B3 (1477 Hz)	11
B4 (1633 Hz)	12
B Common	13
C0 (1950 Hz)	17
C1 (2050 Hz)	14
C2 (2150 Hz)	15
C3 (2250 Hz)	16
C Common	18
Answer-Back (1017 Hz)	19
Answer-Back (1785 Hz)	20
Squelch	21
Line Control	22
Line Status	23
Signal Ground	24

(b) **Start or Answer-back:** A contact closure between frame ground and the start or answer-back lead causes Data Set 401B-type to transmit a 1017-Hz answer-back signal.

(c) **Check or Audible Answer-back:** A contact closure between frame ground and the check or audible answer-back lead causes Data Set 401B-type to transmit a 1785-Hz answer-back signal.

(d) **Line Control:** Closure of the line control lead to the frame ground lead allows the data set to accept incoming calls and maintain existing calls. The line control lead should be opened when the business machine wants to terminate the call or have incoming calls ignored.

(e) **Line Status:** The line status leads are closed together by the data set when a telephone connection has been established and the data set is ready to receive data. If an incoming call is answered manually (line control open), the data set will be in the voice mode and the line status leads will be shorted together only when the data switch is operated to place the data set into the data mode. Once the line status leads are closed they will remain closed until the call is terminated, regardless of the changes in operating mode. When a call is terminated, the line control lead must be held open until the line status leads are opened by the data set. The two leads are electrically isolated from the rest of the receiver.

#### D. Data Set 401F Interface Characteristics

2.10 Table E lists Data Set 401F interface lead designations. The characteristics of the interface leads which differ from the Data Set 401J-type interface leads are as follows:

(a) **Answer-Back (1017 Hz):** Closure of this lead to signal ground causes Data Set 401F to transmit a 1017-Hz answer-back signal to the transmitting data set.

(b) **Answer-Back (1785 Hz):** Closure of this lead to signal ground causes Data Set 401F to transmit a 1785-Hz answer-back signal to the transmitting data set.

#### E. Options

2.11 The purpose of options is to adapt the data set to specific conditions encountered in a particular installation. The options are applied by strapping or unstrapping specified terminals in the data set.

2.12 Options are divided into two categories: customer options, which are provided to allow the customer to operate in a manner consistent with his particular application; and Telco options, which are primarily for the purpose of adapting the data set to the parameters of the switched network or private line facilities.

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**2.13** Data Sets 401B and 401F do not have customer options. The only Telco option which may be required is an external pad to ensure that the level of the answer-back tones does not exceed -12 dBm at the serving central office.

**2.14** The following paragraphs summarize customer and Telco options shown for Data Set 401J-type in Tables F and G.

**Customer Options**

**(1) Attended or Unattended Answering**

(a) **Attended (Option H):** With this option, an attendant must answer all incoming calls and manually place the data set in the data mode. If option W is also specified, a ringing indication is passed to the business machine.

(b) **Unattended (Option G):** With this option, the data set automatically answers all incoming calls and places itself off-hook in the data mode. If option W is also specified, a ringing indication is passed to the business machine. Option G is normally used, especially for installations with high calling rates.

**(2) With or Without Automatic Calling Unit (ACU)**

(a) **With ACU (Option F):** The ACU allows calls to be dialed automatically under control of the business machine. This option enables the spare No. 1 button to furnish momentary ground to the ring side of the line in order to signal the central office for dial tone if the ACU is disabled.

(b) **Without ACU (Remove Option F):** This removes the ground-start feature from spare No. 1 button if an ACU is not provided.

**(3) Ringing Indication to Customer or Out-of-Service (OOS) Control by Customer**

(a) **Ringing Indication (Option W):** With this option, an indication is given to the business machine that the line is being rung by a contact closure between ring indicator lead (pin 25) and signal ground in either the attended or the unattended mode.

**TABLE F**

**CUSTOMER OPTION DECISIONS**

OPTION	DESIGNATION
1. Attended operation	H*
2. Unattended operation	G
3. Used with ACU	F
4. Used without ACU	
5. Ring indication to customer	W*
6. Out-of-service controlled by customer	X

\* Factory wired.

**(b) Out-of-Service Control (Option X):**

With this option, the customer can present an "out-of-service" or "make-busy" condition to incoming calls. It is useful when the business equipment must be removed from service to prevent "ring-no-answer" conditions, etc. The business machine presents a contact closure between the out-of-service interface lead (pin 25) and signal ground. This causes the data set to go off-hook and pass a "line-occupied" indication back to the serving central office.

**Caution:** This option can be used only if the data set is on a "receive only" central office line equipped with a special line circuit. Coordination with the Engineering Department is required.

**Telco Options**

**(1) Terminal Impedance 600 or 900 Ohms**

(a) **600 Ohms (Option N):** This option provides dc isolation and line matching impedance for private line service.

(b) **900 Ohms (Option Q):** This option provides dc isolation and line matching impedance for the switched network.

(c) **Answer-Back Tone Level (Option J, K, T, or M):** This option sets the level of the answer-back tone. The level of the tone reaching the serving central office should not exceed -12 dBm.

TABLE G  
TELCO ENGINEERING OPTIONS

OPTION		DESIGNATION	
Terminal impedance	600 ohms	N	
	900 ohms	Q*	
Answer-back tone level	-3 dBm†	0 dBm	J
	-6 dBm†	-3 dBm	K
	-9 dBm†	-6 dBm	T*
	-12 dBm†	-9 dBm	M
6-dB pad	in	R	
	out	S*	
Mounting cord	10-Conductor (Note 1)		D
	24-Conductor (Note 2)		
	30-Conductor (Note 3)		

\* Factory wired.

† Effective on all Data Sets 401J6, 401J7, 401J8 and 401J9 and also 401J2, 401J3, 401J4, and 401J5 series 3 and above.

**Note 1:** Standard cord shipped with all Data Sets 401J. (Earlier sets were shipped with 6-conductor cord.)

**Note 2:** Required when Data Sets 401J2 through 401J9 are used with 801-type ACU. Order separately.

**Note 3:** Required when Data Set 401J1 is used with 801-type ACU. Order separately.

**Note:** The answer-back tone in Data Sets J1D401J series B and below; 401J1 series 1; and 401J2, 401J3, 401J4, and 401J5 series 3 and below many require external padding to meet the -12 dBm requirement.

(e) **Mounting Cord (Option D)**—Various cords are available for specific applications. Refer to Table G.

(d) **6-dB Pad In or Out**

(1) **In (Option R):** This option provides an attenuator which reduces the gain of the data set by approximately one half. The attenuator should be strapped in on short loops having unusual noise conditions.

(2) **Out (Option S):** This option straps the attenuator out and allows the data set to operate at its normal gain.

**F. Operation**

**2.15** This part discusses the operation of Data Set 401J-type in the attended, unattended answering, and unattended originating modes.

**Attended Operation**

**2.16** Attended operation requires that each call be handled manually and placed in the same manner as a voice call. After agreeing to go into the data mode, each party should depress the DATA button and place the handset on the cradle.

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**2.17** When data transmission is complete, the call may either be terminated or the parties may return to the voice mode by depressing the TALK button and lifting the handset.

**2.18** Call termination may be achieved in one of two ways. If voice communication is not desired after reception of data, the call may be terminated by lifting the handset, depressing the TALK button and returning the handset to the cradle. The second method is to open the closure between the data terminal ready lead and signal ground.

### Unattended Answer

**2.19** When the receiver is arranged for automatic answer, incoming calls will be handled automatically when the business machine provides a contact closure between the data terminal ready lead and signal ground.

**2.20** When the call is answered, a 1.1-second quiet period is provided to allow proper operation of the telephone network control circuits. After the silent interval, a 3-second burst of 2025-Hz answer tone is transmitted. This answer tone signal notifies the calling station and any telephone operators involved that the call has been answered, and disables any echo suppressors. After the echo suppressors have been disabled, signal energy in the 300- to 3000-Hz band in either direction of transmission will keep them disabled provided this power is not interrupted for periods greater than 100 ms.

**2.21** Approximately 30 ms after the transmission of the 2025-Hz answer tone, the business machine is notified that a data call has been set up by a contact closure between the data set ready lead and signal ground. Data transmission may then begin, providing the business machine supplies a contact closure between the data receive (squelch) lead and signal ground.

**2.22** The DATA lamp is lit when the receiver is in the data mode. Transfer to voice mode and back to the data mode or call termination may be accomplished in the same manner as the attended answer mode.

### Unattended Origination

**2.23** Data Set 401J-type can be provided with an 801-type automatic calling unit (ACU) for the unattended origination of data calls. The ACU seizes the telephone line in response to a call request from the business machine and dials the number using information supplied by the business machine.

**2.24** After the ACU completes the dialing operation and receives an answer tone signal from the called station, the ACU will transfer the line to the data set, cause it to go into the data mode, and present a data set ready indication to the business machine.

**2.25** Independent of the manner in which the call was placed, there are two ways to terminate the call. In both ways the operator at the transmitting station hangs up by placing the telephone handset in its cradle. If an operator is at the receiver, the call may be terminated by removing and replacing the handset with the TALK button depressed. If the receiver is unattended, the transmitting business machine must transmit an end-of-call code before the station hangs up. This code is used to signal the receiving business machine to open the data terminal ready lead and thus disconnect the receiver. This is the standard method of call termination for unattended terminals. In the event that this signal is not sent before the transmitting station hangs up, the central office may eventually recognize that the call has ended and disconnect the receiving station. The customer, however, may be annoyed by the unnecessary delay and by interference caused by transient noise on the line. In addition, lack of proper call termination will place additional loads on the central office equipment and degrade service to other customers, and may result in additional charges on other than flat-rate calls.

## 3. EQUIPMENT SPECIFICATIONS

**3.01** This part discusses some important parameters of the sets including sensitivity, listener echo, and envelope delay distortion, and provides some nominal values.

**3.02** *Sensitivity* is the characteristic of a receiver which determines the minimum input signal strength for a given signal output value (ie, contact closure). The minimum input levels for Data Sets 401B, 401F, and 401J-type are as follows:

- 401B: -39 dBm total or -42 dBm for each tone.
- 401F: -39 dBm below 1950 Hz and -49 dBm above 1950 Hz.
- 401J-type: -48 dBm for each tone in the A and B frequency groups and -53 dBm for the C group frequencies.

**3.03** Impedance irregularities, or mismatch, in the telephone transmission plant produces reflections or echo signals. These echoes are of two types: talker echoes and listener echoes. Talker echoes are produced by a single reflection back to the transmitting station but cause no difficulty in data transmission; therefore, they will not be discussed further here. Listener echoes are produced by a double reflection, causing echo signals to appear to be valid signals some time after the valid signals appear. Listener echoes can interfere directly with receive data if the time delay is significant and the echo is of sufficient amplitude. The minimum listener echo tolerated by 401-type receivers is 12 dB below the received signal in the absence of other transmission impairments.

**3.04** Envelope delay is measured by applying a low frequency amplitude modulated carrier which is varied in frequency over the band of interest. The variations in phase of the low frequency envelope are then measured. The difference between the envelope delay at one frequency and some other frequency is called *envelope delay distortion*. The maximum envelope delay distortion on the line is as follows:

- Data Set 401B—2500 microseconds in the range of 700 to 1600 Hz.
- Data Set 401J-type—2500 microseconds in the range of 700 to 2300 Hz.

**3.05** For further information on factors affecting data communications on the switched communications network, refer to the technical reference entitled Data Communications Using the Switched Telecommunications Network.

#### 4. THEORY OF OPERATION

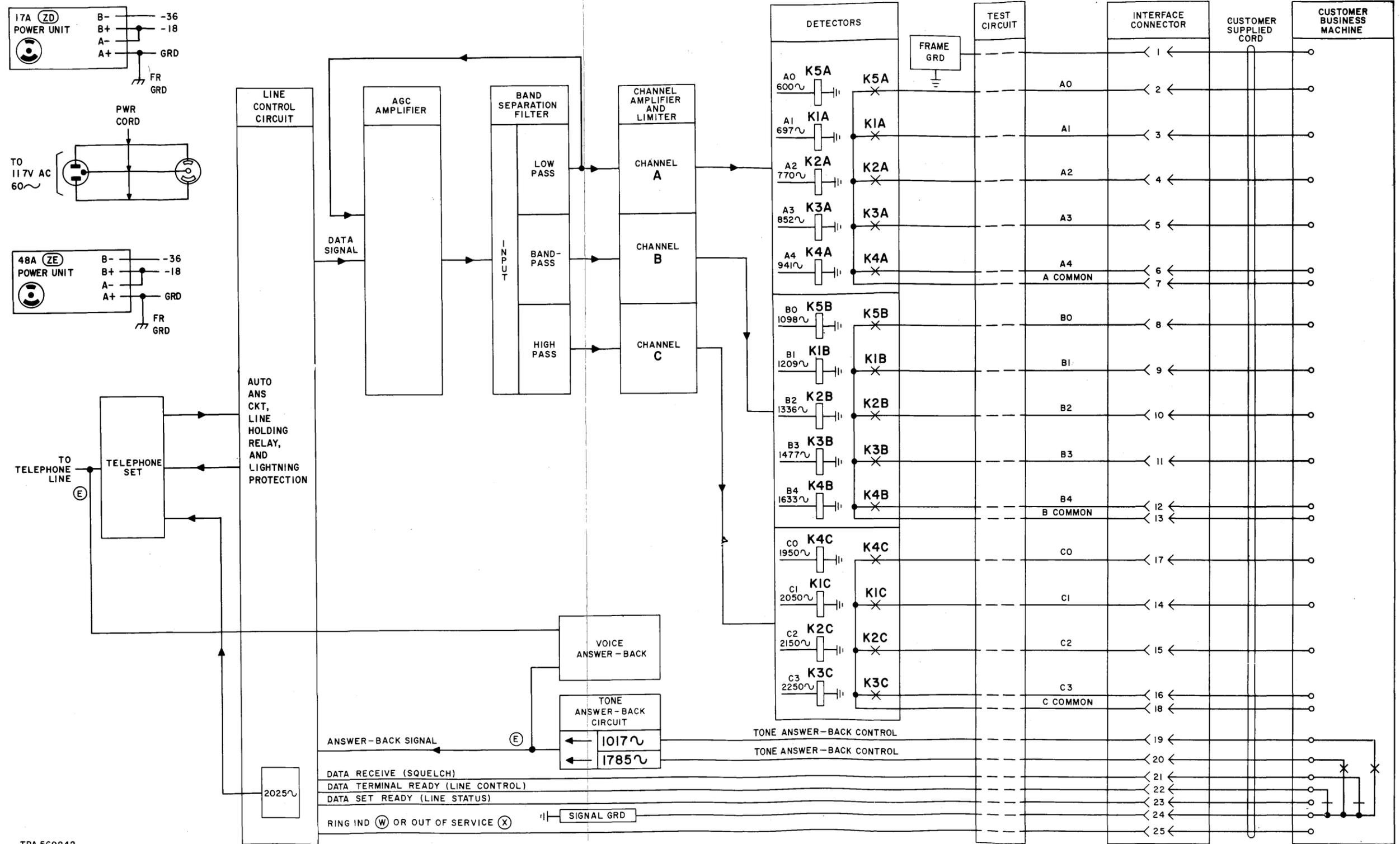
**4.01** A block diagram of Data Set 401J-type is shown in Fig. 4. The following is a description of the functions and interrelationships of the circuits of Data Sets 401J1 through 401J9. Information on Data Set J1D401J is not included; however, the set functions in basically the same fashion as the other series.

**4.02** For descriptive purposes, Data Set 401J-type has been divided into the following sections, with each section covering only one circuit board or functional circuit:

- A. Power Supply
- B. Line Control
- C. AGC Amplifier
- D. Band Separation Filter
- E. Channel Amplifiers and Limiters
- F. Detectors
- G. Tone Answer-Back Oscillator
- H. Voice Answer-Back Amplifier
- I. Remote Testing Circuit

##### A. Power Supply

**4.03** The power supply for the data set may be a ferroresonant-regulated type 17A unit (earlier models) or 48A unit (later models). The 17A power unit provides two dc outputs nominally at +18 volts and -18 volts with a load current of 200 mA on both sides. The required power supply input is from 105 to 129 volts ac at a frequency of  $60 \pm 0.1$  Hz. The 48A power unit is identical to the 17A power supply, except that it delivers a load current of 250 mA on both sides and its power supply input can vary from 105 to 129 volts ac at a frequency of 57 to 63 Hz, and consequently would be suitable where standby power may be used. The outputs of both power supplies are connected to furnish -18 volts, ground, and -36 volts to all parts of the receiver.



TPA 569842

Fig. 4—Data Set 401J-Type—Block Diagram

**B. Line Control**

**4.04** Line control for the data set is provided by an 11C or 11G telephone apparatus network, a 589AA key and a 58A control unit or 3A3 data unit.

*Note:* The 58A control unit found in the older model of the 401J-type is now rated Additions and Maintenance (A&M). The 3A3 data unit makes the data set compatible with No. 1 Electronic Switching System (ESS) central offices and with long Unigauge lines, but will not directly replace the 58A control unit due to wiring incompatibility.

The line control circuit provides a means of placing the set in the desired operating mode (ie, talk mode or data mode). Refer to Fig. 5 for a simplified schematic of the line control circuit and to Fig. 6 for a sequence chart of the relay operations.

**4.05** When option G is installed and the business machine grounds the line control and squelch leads, the set will automatically answer calls and enter the data mode. Ringing current appearing on the line is coupled through a capacitor, resistor, and full-wave rectifier causing the R relay to operate. An R relay contact causes the C relay to operate, placing the H relay across the line. The H relay signals the central office to discontinue ringing and holds the C relay operated. The data mode is indicated by the operation of the DATA lamp across the C relay winding.

**4.06** After approximately 1.3 seconds, the R relay releases and the timing circuit imposes a 1.1-second quiet interval, then places a 2025-Hz answer tone on the line for approximately 3 seconds. Approximately 30 ms after the tone is removed, the LS relay operates and places a contact closure between the line status and signal ground leads to notify the business machine that the data set is ready to receive data. Another LS contact enables the limiters and the receiver is fully operational.

**4.07** To enter the talk mode from the data mode, the operator should depress the TALK key and lift the handset. This action causes the T relay to operate, releasing the H, C, and LS relays and allowing the line current to flow through the telephone apparatus network. The DATA lamp extinguishes with the C relay, and the LS relay

removes the line status closure to the business machine and opens the squelch lead.

**4.08** To transfer from the voice mode to the data mode, the operator must depress the DATA key, which allows line current to flow through the H relay. The H relay operates, causing the C and LS relays to operate. Releasing the DATA key releases the TALK key and T relay, causing the data set to reenter the data mode.

**4.09** For manual answering, the G option is removed and the R relay cannot operate the C relay. The operator answers the call as an ordinary voice call.

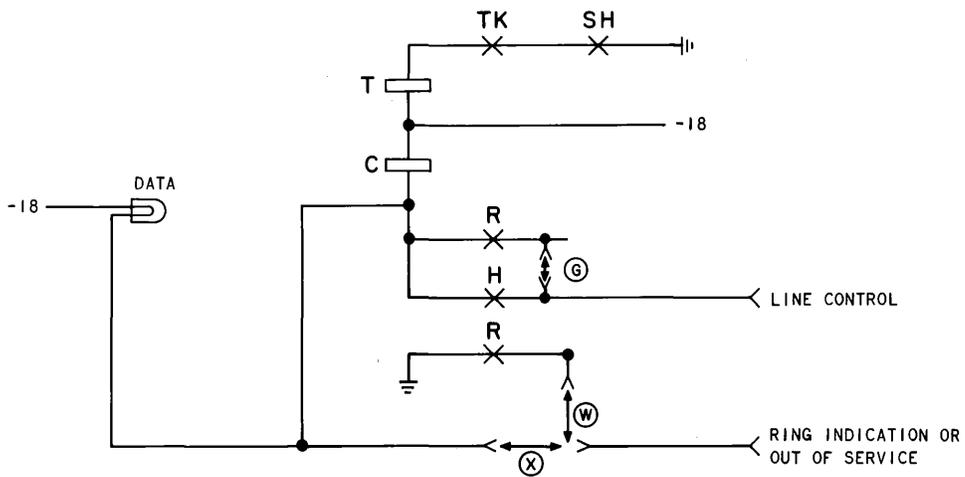
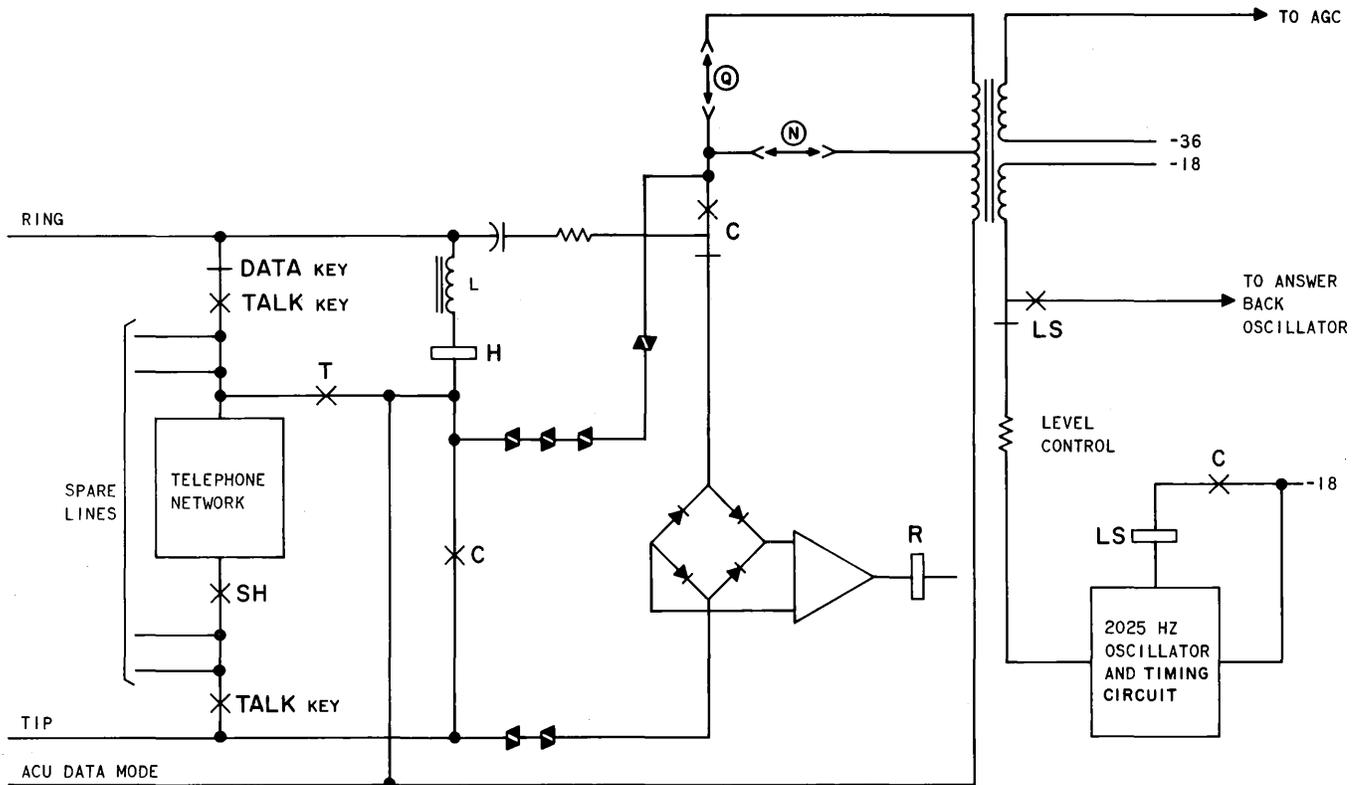
**4.10** Ringing indication to the business machine is provided by an R relay contact between signal ground and the ringing indication lead. This is option W. The ringing indication lead may also be used as an out-of-service indication by the customer. This is option X. When option X is installed, grounding the ringing indication lead causes the C relay to operate and place the H relay across the line, giving a busy indication on receive only lines.

**4.11** An 801-type ACU can place the set into the data mode by transferring the telephone line to the DT and DR terminals and making a temporary contact closure between the DT and ACU data mode leads, thereby bypassing the C relay. The H relay is operated by line current and when the temporary contact closure is removed, the operation of the receiver is the same as previously described for the data mode. Indication that the receiver is in use is given to the ACU by placing a contact closure to ground on the ACU talk indicator or data indicator lead.

**4.12** Three spare lines can be answered at the receiver. With the 1A1 key telephone system, these lines can be placed in the hold mode by depressing the DATA key. The 1A1 system provides power to light the SPARE lamps.

**4.13** The input transformer is used to match the 600-ohm data set to either a 600-ohm (option N) or 900-ohm (option Q) line.

**4.14** Lightning protection for the data set is provided by varistors in the 3A3 data unit.



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Fig. 5—Line Control Circuit—Simplified Schematic

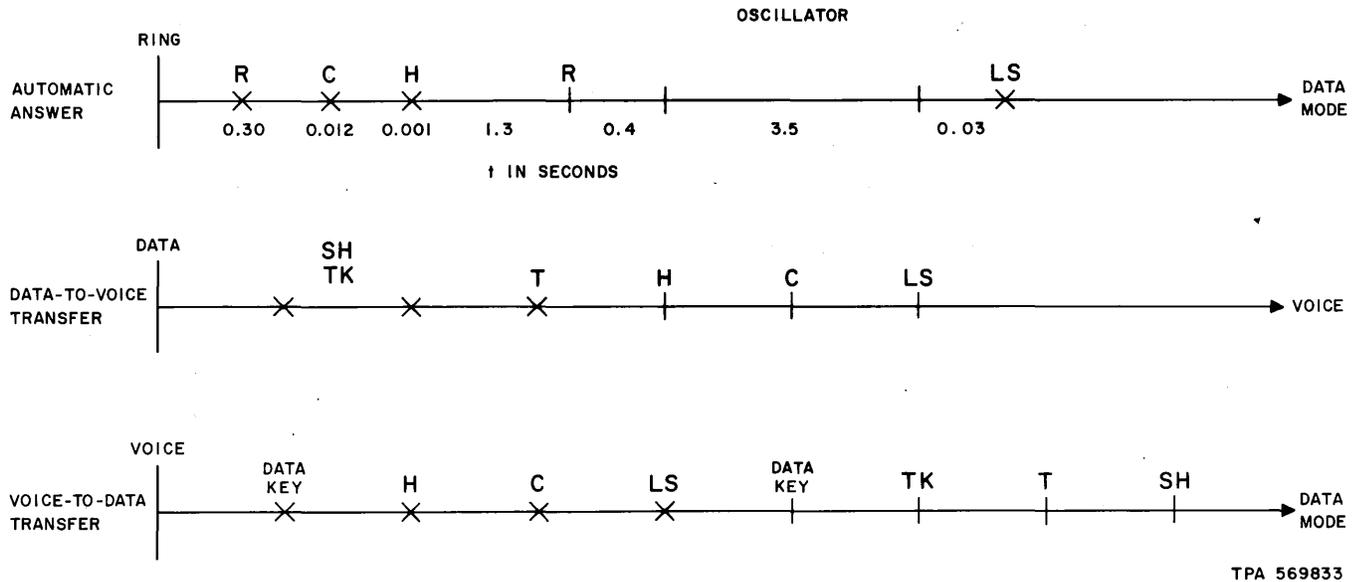


Fig. 6—Line Control Relay Sequence Chart

### C. AGC Amplifier

**4.15** For a functional block diagram of the AGC amplifier, band separation filter, and channel amplifiers and limiters, refer to Fig. 7. The AGC amplifier provides linear amplification of the data signal. The output level is fairly constant over the expected range of input levels.

**4.16** The incoming data signals, after being coupled through the input transformer, are applied to the input of the AGC amplifier. The maximum gain of the receiver may be reduced by one-half by installing option R. Option R places 6 dB of attenuation into the line and should be installed when the receiver is operating on a short loop with unusual noise conditions.

**4.17** After passing through two stages of amplification, the data signals are fed to the band separation filter. The voltage feedback from the band separation filter reduces the amplitude of the signal input, thereby providing automatic gain control. The AGC attack time is determined by the charging rate of C213. Approximately 20

ms are required for adjusting the gain to within 25 percent of its final value. The AGC release time is determined by the discharge time constant of C213 and C214. With a large signal input, the AGC amplifier reaches half of its maximum gain about 300 ms after the signal is removed.

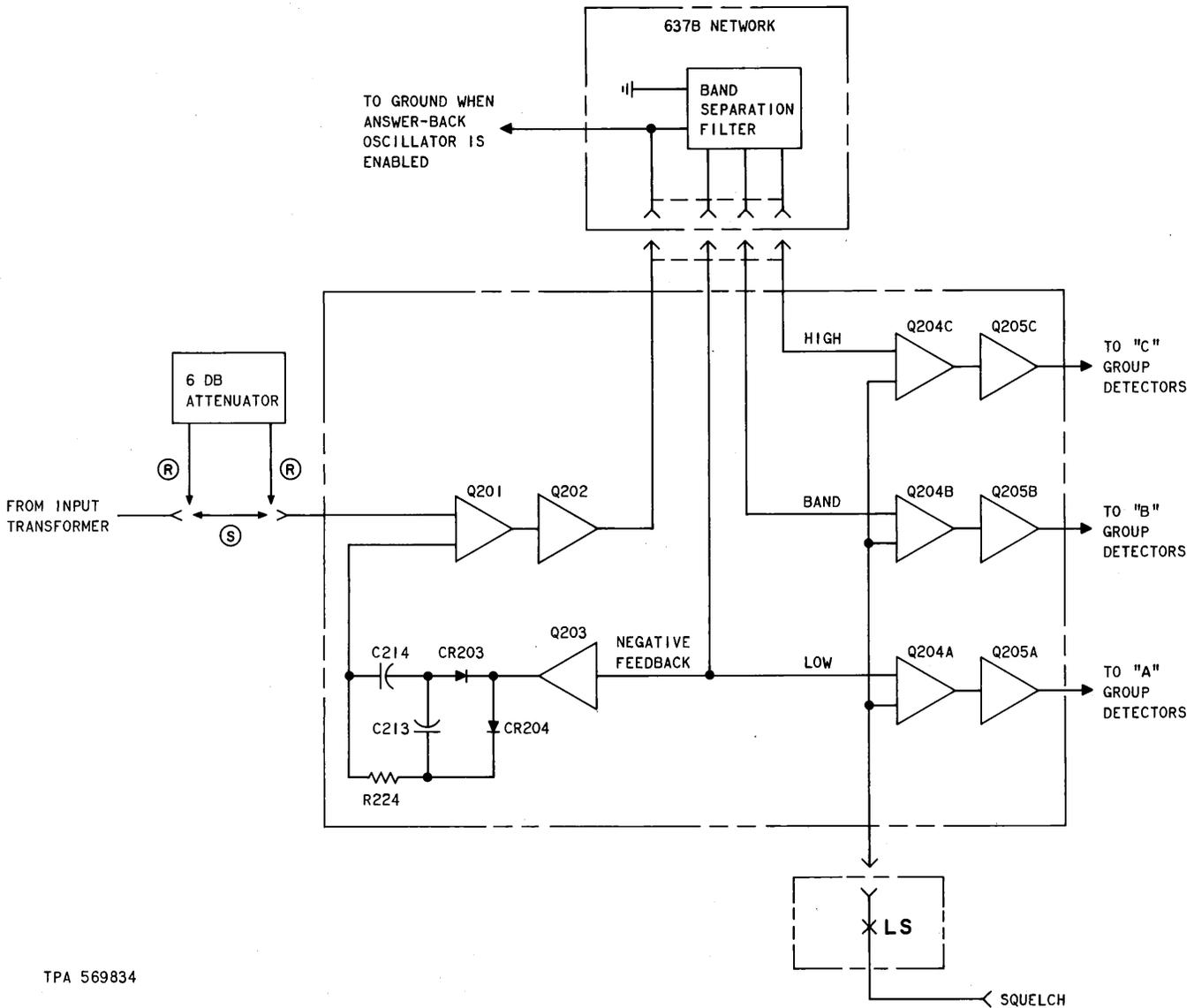
### D. Band Separation Filter

**4.18** The band separation filter (637B network, Fig. 7) consists of one low pass, one bandpass, and one high pass filter with common input terminals. These filters separate the data signal into three frequency bands. The common input is fed by the output of the AGC amplifier unless the answer-back oscillator is enabled. Enabling the answer-back oscillator grounds the output of the AGC amplifier. The output of the low pass filter is connected to amplifier stage Q204A and is also used to control the gain of the AGC amplifier through stage Q203. The output of the bandpass filter is coupled to amplifier Q204B and the output of the high pass filter feeds amplifier stage Q204C. A valid data signal has one frequency component in each of the bands at any given time.

E. Channel Amplifiers and Limiters

4.19 The channel amplifiers and limiters (Fig. 7) are enabled by a ground on the squelch lead and a contact closure by the LS relay. The output of the low pass part of the band separation filter is amplified by stage Q204A and limited by stage Q205A. For signal amplitudes within the expected

range, the output of the limiter appears as a square wave of approximately 30 volts peak-to-peak amplitude. This signal is coupled to the A group detectors. The amplifier-limiter circuits with B and C component designations drive the band and high channel detectors, respectively, and operate in a manner similar to the amplifier-limiter previously described.



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Fig. 7—AGC Amplifier—Band Separation Filter and Channel Amplifier and Limiters

## F. Detectors

**4.20** Refer to Fig. 8 for a functional block diagram of a typical receiver detector. This description of operation is referenced to Fig. 8 only. The operation of the other detectors is similar except that each is sensitive to a different frequency. Refer to Fig. 9 for a functional diagram showing the interconnection of the receiver detectors.

**4.21** The A channel detectors are driven by the A channel limiters. Initially, detector stages Q401A and Q402A are biased at  $-2.3$  volts, which is 5.5 dB below the peak of the tuned circuits. Relay driver stages Q403A and Q404A are biased at  $-16.8$  volts. When a received signal contains a 697-Hz component, it will be felt by the 697-Hz tuned circuit. Since the 697-Hz tuned circuit has maximum impedance at this frequency, there will be a negligible amount of voltage felt across the 852-Hz tuned circuit. The voltage across the 697-Hz tuned circuit swings above and below ground and

when the negative peaks exceed the  $-2.3$  volts threshold bias, Q401A conducts. When the voltage presented to the base of Q403A swings positive of the  $-16.8$  volts A relay threshold bias, Q403A conducts, pulling in the K1A relay and making a contact closure between the A1 lead and A common. Since the set is in the data mode, test (TE) relays will be nonoperated, the TP relays will be operated, and a contact closure will be delivered to the business machine.

**4.22** When the received signal ends, the voltage on the tuned circuit no longer exceeds the bias threshold voltage and Q401A stops conducting. Once Q401A stops conducting, the A relay threshold bias takes over and Q403A stops conducting, releasing the K1A relay. The contact closure is removed from the interface and all the circuits return to their normal state. After approximately 20 ms the detector is ready to respond to the next signal.

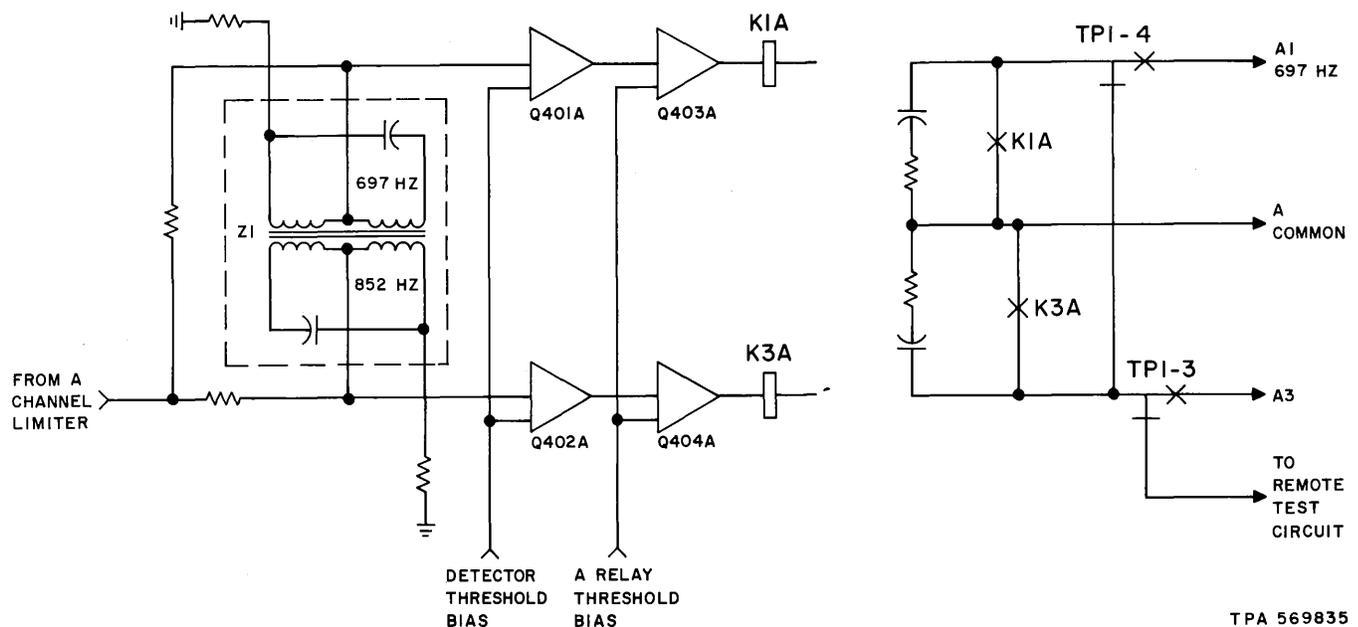
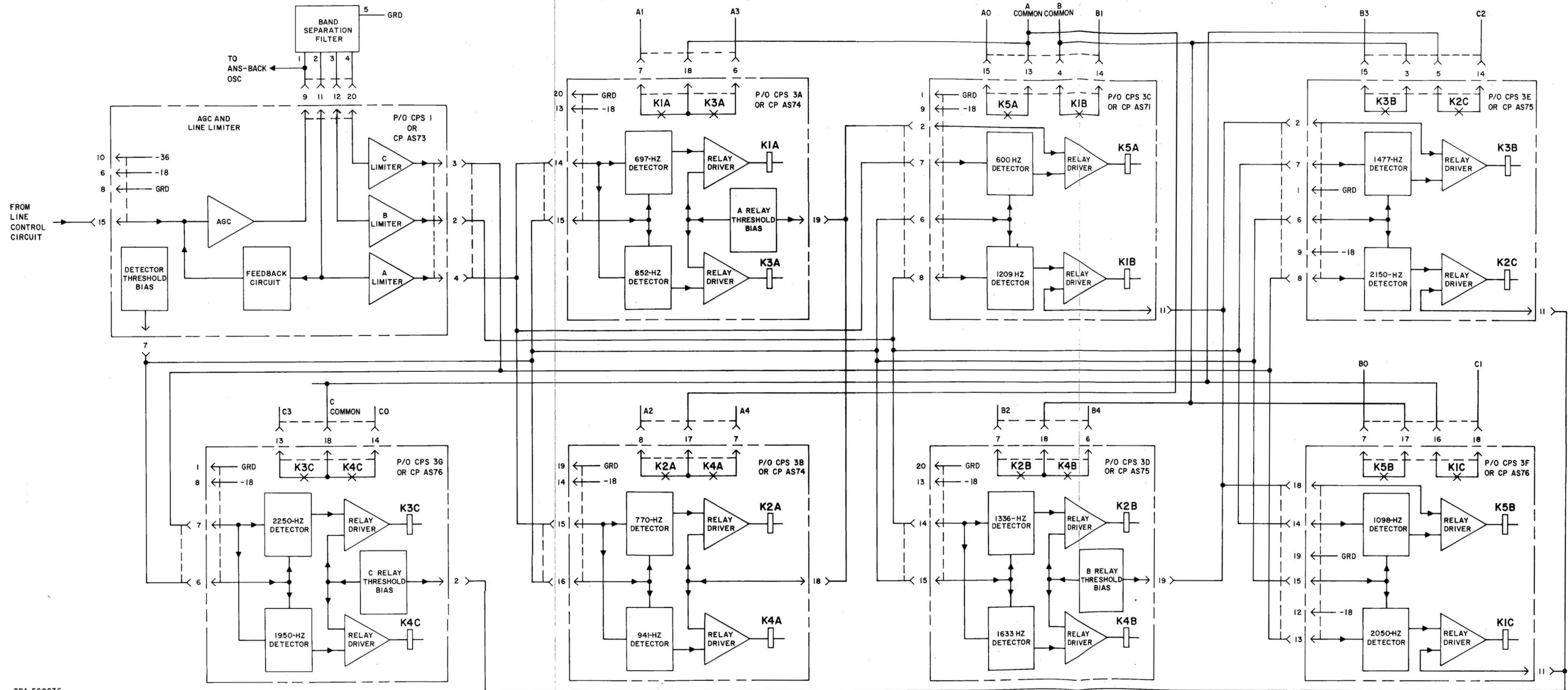


Fig. 8—Detector and Relay Driver—Functional Block Diagram



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Fig. 9—Interconnections of Detector Circuits

### G. Tone Answer-Back Oscillator

**4.23** The tone answer-back oscillator (Fig. 10) allows the customer to switch the mode of the receiver from the receive to the transmit mode and to send one of two possible answer-back tones to the transmitting business machine. When the customer places a contact closure between the AB1 and signal ground leads on the interface (pins 19 and 24), current flows through the E1 and E2 relays, causing them to pick up. A contact of the E1 relay places capacitor C301 across the windings of transformer T301, forming a resonant tank circuit and causing the oscillator to transmit an answer-back frequency of 1017 Hz. Transmission of the 1785-Hz answer-back tone is initiated by a contact closure between the AB2 and signal ground leads on the interface (pins 20 and 24), which cause relays B and E2 to energize. A contact of the B relay places C301 across a portion of T301, causing the oscillator to transmit an answer-back frequency of 1785 Hz. The picking up of the E2 relay in both instances places a ground on the output of the AGC amplifier, disabling the receive portion of the set. The output of the tone answer-back oscillator is sent to the input transformer on the 3A3 data unit. Installer options J, K, T, and M may be used to set the output of the tone answer-back amplifier and the answer tone transmitter to approximately equal levels.

### H. Voice Answer-Back Amplifier

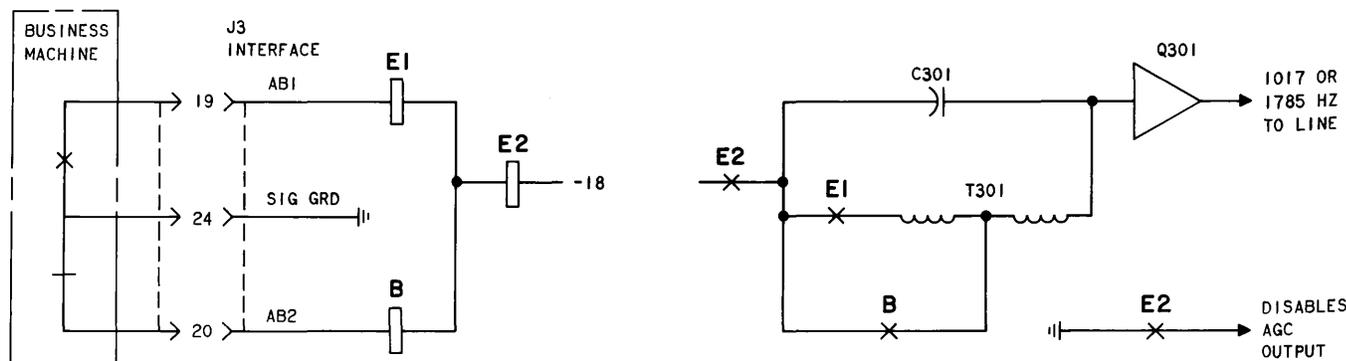
**4.24** Data Sets 401J3, 401J5, 401J7, and 401J9 are equipped with a voice answer-back amplifier (Fig. 11) in addition to a tone answer-back

oscillator. The voice answer-back amplifier accepts voice signals from the business machine at a level of 0 VU and 600 ohms on a pair of balanced leads through transformer T501, and limits their maximum levels to  $-5$  dBm before transmitting them over the telephone lines. Note that the voice answer-back amplifier is always enabled, and therefore it is possible to be receiving data and transmitting voice answer-back or to be transmitting both tone and voice answer-back simultaneously. These are not legitimate operating modes and should be avoided.

**4.25** Varistor RV501 acts as a peak limiting detector, limiting the input signal when the input swings  $+10$  dB above the recommended level. The output of stage Q501 is coupled back to the input through thermistor RT501 and capacitor C503. This feedback loop acts as a soft limiting circuit, limiting the output level between the recommended input level and the point where RV501 begins its limiting action. RT502 is a slow acting thermistor which provides temperature compensation for stage Q501. Q502 is used to provide a high output impedance to the repeat coil to keep from loading down the answer-back oscillator.

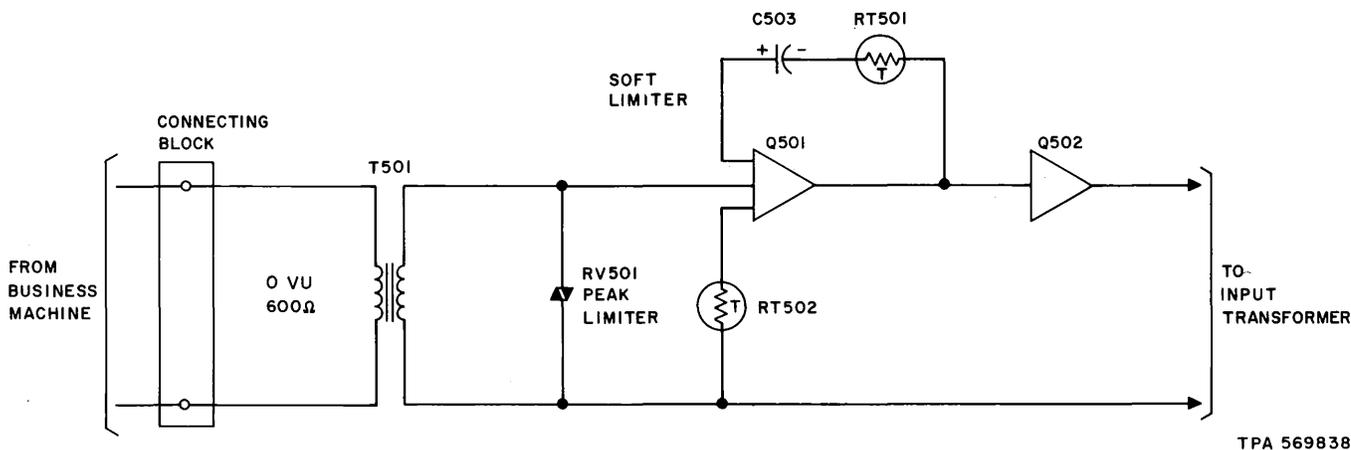
### I. Remote Testing Circuit

**4.26** The remote test circuit allows the receiver to be tested from a data test center (DTC) with the assistance of the customer. After the TEST key is depressed, the DTC can check the operation of the automatic answer circuitry, answer-back amplifiers, and detectors. After the tests are completed, the DTC will release the set from the test mode.



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Fig. 10—Tone Answer-Back Oscillator—Functional Block Diagram



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**Fig. 11—Voice Answer-Back Amplifier for Data Sets 401J3, 401J5, 401J7, and 401J9—Functional Block Diagram**

**4.27** The test mode (Fig. 12) is initiated by depressing the TALK key, lifting the handset (operating the SH contacts), depressing the TEST key, and replacing the handset on the switchhook. A contact of the TEST key causes Q302 to conduct, energizing the TE2 relay. Contact 2 of the TE relay releases the test prime (TP) relays which are operated in the data mode, lights the TEST lamp, and energizes TE1 and TE3. When TE3 operates, the TEST key may be released since it is paralleled by TE3-3. These seven relays (TE1 through TE3 and TP1 through TP4) transfer alternate data contacts into two groups designated OT and ET and also transfer control of the interface from the customer to the test circuit by the following actions:

- Control of the 1785-Hz answer-back tone is switched from the customer (interface lead 20) to the OT and ET data contacts by TP1-1.
- Control of the 1017-Hz answer-back tone is switched from the customer (interface lead 19) to Q305 in the timing circuitry by TP2-2.
- Control of the line status (interface lead 23) lead is switched from the customer to test timing transistor Q303 by TP3-1.
- TP4-1 transfers the squelch (interface lead 21) lead from the customer to ground.
- TP1-2 transfers the line control (interface lead 22) lead from the customer to ground.

- TP3-2 transfers the OOS or RI (interface lead 25) lead from the customer.

**4.28** The data contacts of the OT and ET groups are connected in parallel, with the common side of each group connected to ground and the other side connected to the control relays of the answer-back oscillator. The A, B, and C common leads are connected together and to ground by TE1-1, TE1-2, and TP2-1. The contact protection capacitors of the ET group are connected in parallel along with either C204 or C210 to provide a timing network to control the duration of the answer-back tone.

**4.29** When the DTC places a call to the receiver, the set will answer automatically, making the LS relay. A contact of the LS relay turns off stage Q303, which turns off stage Q304, which turns on stage Q305. Relays E1 and E2, transferred to the output of Q305 by TP2-2, energize, causing a 1017-Hz tone to be transmitted. After about 30 seconds Q303 and Q304 saturate, turning off Q305 and releasing relays E1 and E2, causing the oscillator to stop.

**4.30** To test the detectors for bandwidth and sensitivity, the DTC sets the frequency of the DTC oscillator below the lowest detector frequency of a particular channel and slowly sweeps the frequency up. When the signal first activates a detector (assuming a frequency of 600 Hz or A0 in the ET group) the corresponding relay makes, closing a data contact to ground and causing relays

B and E2 to operate, generating a 1785-Hz answer-back tone. As soon as relay E2 operates, ground is placed on the AGC output, removing the test tone which removes the data contact and releases relays B and E2. The 1785-Hz tone will remain on the line for approximately 20  $\mu$ s due to the capacitance of the ET contact protection capacitors in parallel with C204.

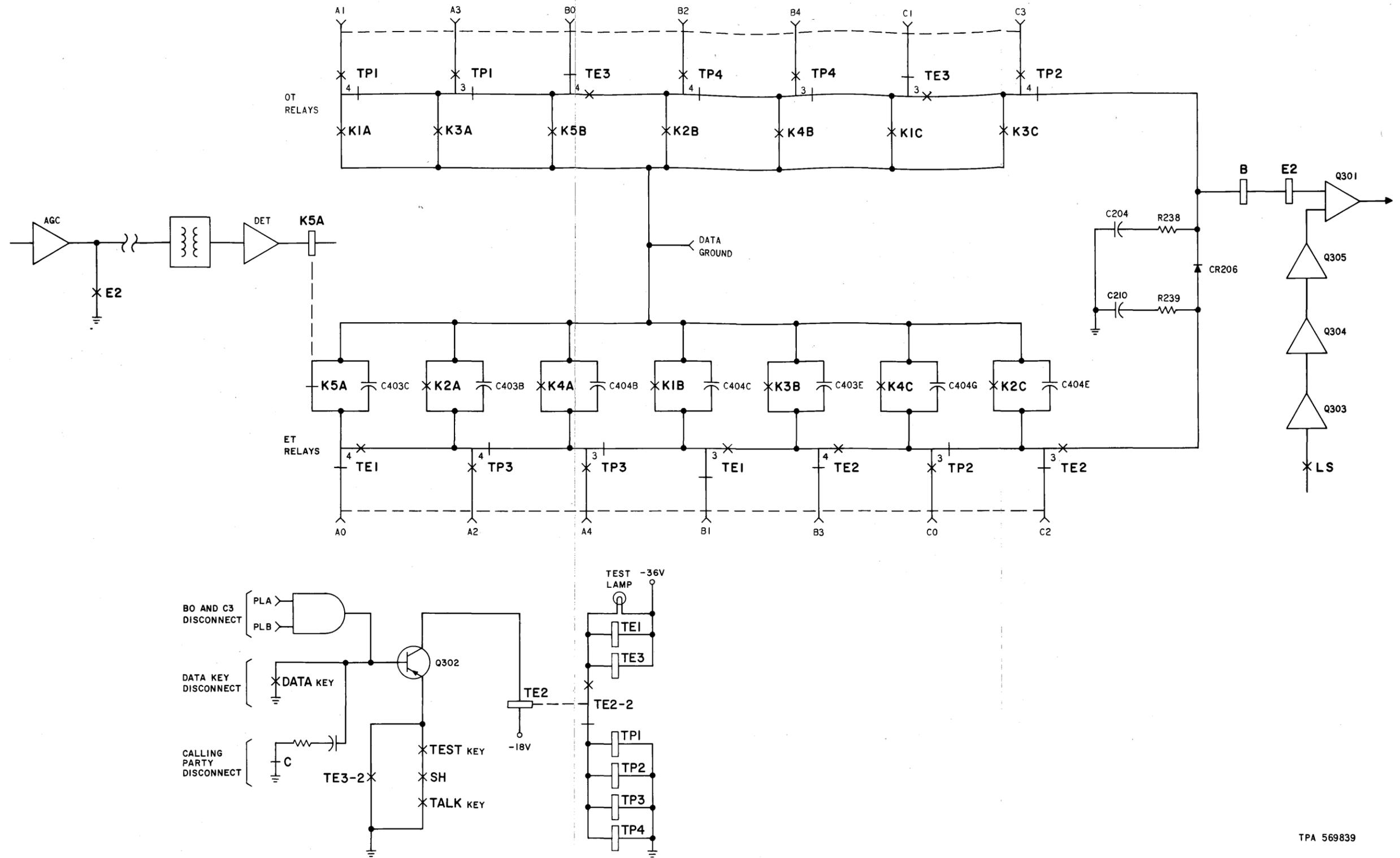
**4.31** When the test frequency causes a detector and therefore a relay in the OT group to operate, ground is applied to relays E1 and E2. Relays B and E2 make, causing the answer tone to be transmitted in the same manner as for the ET group, with the exception that the tone will be on the line for approximately 60 ms due to the capacitance of the ET contact protection capacitors and C210.

**4.32** When the B and E2 relays release, the test frequency is again allowed to operate the detector and the associated relay, continuing the cycle until the test frequency is swept out of the detector operating range. The two different answer-back pulse rates allow the DTC to distinguish between adjacent data contacts. Diode CR206 isolates capacitor C210 from the ET group. After testing the five low channel detectors, the DTC will test the middle and high channels in the same manner.

**4.33** After the data set has been tested, the test mode can be terminated in several ways:

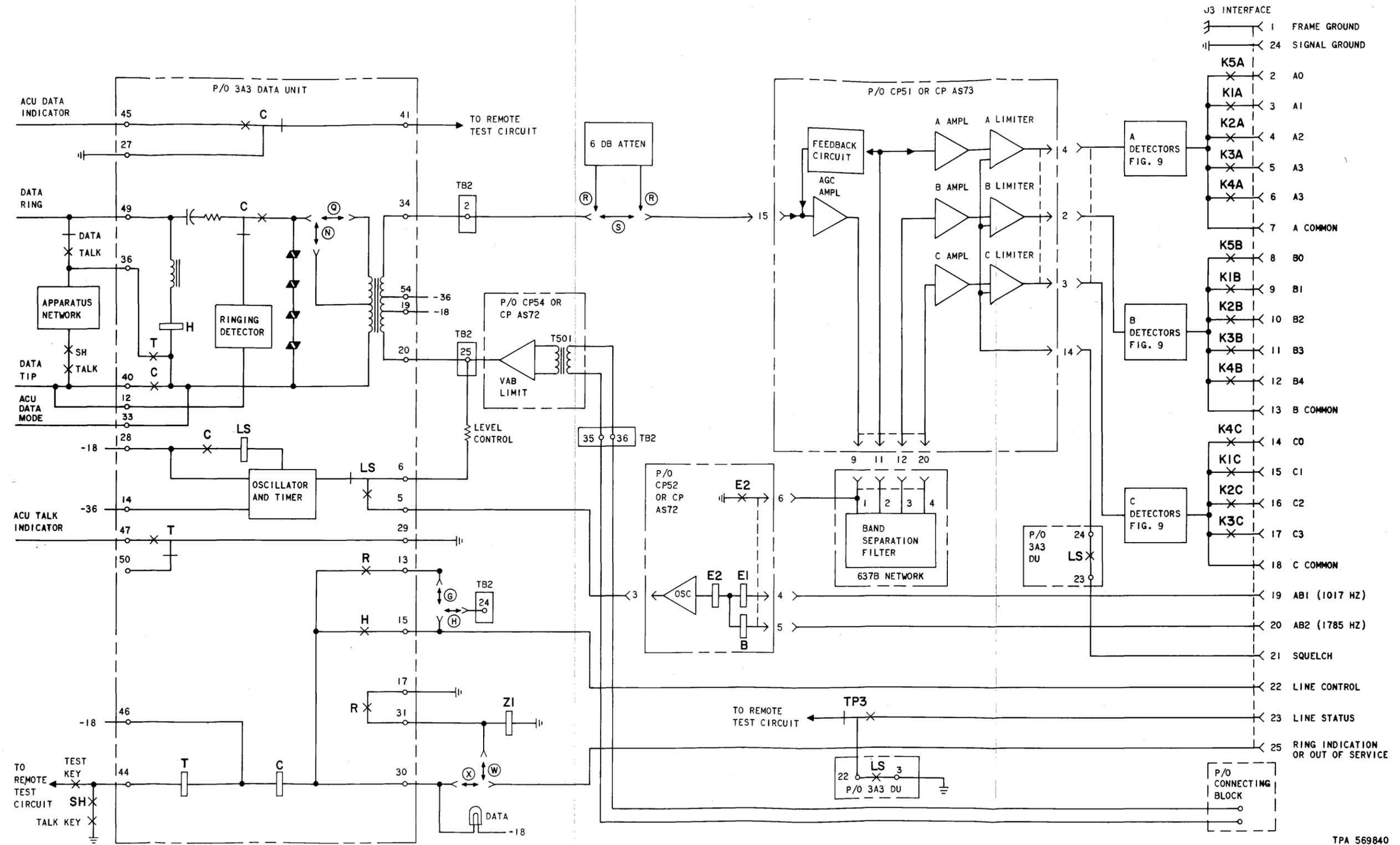
- The DTC can transmit a frequency combination of B0 and C3, which causes ground to be applied to the PLA and PLB leads, causing the TE2 relay to release and removing the receiver from the test mode.
- On the switched network, in some cases when the calling party hangs up, the called party receives a battery interruption which causes the C relay to drop causing Q302 to cut off, releasing the TE2 relay and removing the receiver from the test mode. This is not a recommended method of achieving a disconnect.
- The set can be manually switched out of the test mode by the customer depressing the DATA key, which causes Q302 to cut off, releasing the TE2 relay and removing the receiver from the test mode.

**4.34** For further information on the interrelationships of the circuits in Data Set 401J-type and apparatus designations, refer to Fig. 13.



TPA 569839

Fig. 12—Remote Test Circuit—Functional Block Diagram



TPA 569840

Fig. 13—Data Set 401J-Type—Functional Schematic

## 5. MAINTENANCE AND TESTING

**5.01** Data Set 401-type receivers do not require any routine maintenance.

**5.02** For cover removal and replacement procedures, installation testing, and tests required at the customer premises when clearing trouble conditions, refer to the appropriate section referenced in Part 6 of this section.

**5.03** Maintenance of Data Set 401J-type should be limited to the replacement of circuit packs or other replaceable units. Table H provides the designations and functions of the basic units which make up a Data Set 401J-type.

**5.04** For detailed testing of Data Set 401J-type, refer to the following test and test layout (Fig. 14). This figure shows the test connections and layout or hookup that will be required to test the data set as outlined in the following paragraphs. The entire test or some part of this test may be required when trying to determine the cause of trouble in a malfunctioning data set.

**5.05** The following test equipment or equivalent is required:

2—Muirhead D-695-A/100 Oscillators

1—Frequency Measuring Device capable of measuring frequencies in the range of 600 to 3000 Hz

1—600Ω/600Ω Attenuator

1—Hewlett-Packard 400L Voltmeter

1—107B Frequency Generator

1—Krohn-Hite 440A Oscillator

1—276D Relay

1—45 Volt Power Supply

1—Tektronix 535 Oscilloscope

Various resistors, capacitors, and switches as shown in Fig. 14.

**5.06** Connect the receiver to the test equipment as shown in Fig. 14.

### A. Power Supply Test

**5.07** Connect the power cord to a source of 105 volt 60 Hz ac power. With the input voltage adjusted to 105 volts and the handset on-hook, check that all GRD points on the plug-in boards are at ground potential. All the -18 filtered voltage supply test points should be  $-18 \pm 1.5$  volts dc with respect to frame ground, and the -36 filtered voltage supply test points should be  $-18 \pm 1.5$  volts dc with respect to the measured value at the -18 test points; the readings should not change more than 0.4 volts or exceed the limits when the input voltage is increased to 130 volts. If these requirements cannot be met, replace the 17A or 48A power unit.

### B. Unattended Answer Test

**5.08** The purpose of this test is to check the unattended answer circuits in Data Set 401J-type. The 20-Hz ringing generator should be adjusted to  $65 \pm 2$  volts between points A and B. Perform the following procedure:

- (1) Connect tip and ring to terminals 2 and 4 of the telephone cable.
- (2) Ground the following terminals on connector J3: 7, 13, 18, 21, and 22.
- (3) Close switches S1, S2, and S6. Open switches S3 and S4.
- (4) Adjust the output of signal generator No. 1 to  $1633 \pm 3$  Hz at a level of  $-20 \pm 3$  dBm on the voltmeter.
- (5) Close switch S4 and open switch S6.
- (6) Operate S3 for approximately 2 seconds.

**Requirement:** Telephone bell rings and after a 3.3- to 7-second delay, a single interval of ground potential 40 to 60 ms in duration appears on the scope for each pulse of the input signal. Terminal 23 of connector J3 and terminal 1 of the telephone cable is shorted to ground. DATA lamp lights.

TABLE H

## DATA SET 401J-TYPE BASIC UNITS AND FUNCTIONS

DESIGNATION	DATA SET	FUNCTION
11A Apparatus Unit	401J1	Telephone network—rotary dial
11C Apparatus Unit	401J2, 401J3, 401J6, & 401J7	Telephone network—rotary dial
11G Apparatus Unit	401J4, 401J5, 401J8, & 401J9	Telephone Network—TOUCH-TONE dial
58A Control Unit	401J1 thru 401J5	Provides ring detection, automatic answer, lightning protection, impedance matching, and 2025-Hz answer tone.
3A3 Data Unit	401J6 thru 401J9	Same as 58A Control Unit but is compatible with No. 1 ESS CO and Unigauge lines.
17A Power Unit	401J1, 401J2 thru 401J5, Series 3 and below; 401J6 thru 401J9 Series 1	Provides power for data set.
48A Power Unit	401J2 thru 401J5 Series 4 and above; 401J6 thru 401J9 Series 2 and above	Replaces 17A Power Unit.
589AA Key	All Sets	Provides 6 buttons for controlling talk, data, test, and spare button functions.
G1B Ringer	401J1	Provides audible ringing signal on the data line.
M1A Ringer	401J2 thru 401J9	Replaces G1B Ringer.
CPS 1 ED-1D122	401J1	AGC amplifier, channel amplifier, and limiter and detector threshold bias.
CP AS73		
637B Network	All Sets	Separates data signal into low, middle, and high frequency bands.
CPS 3A ED-1D114	401J1	A1 and A3 detector and relay driver. Relays K1A, K3A, and TP1.
CPS 74	401J2 thru 401J9	
CPS 3C ED-120	401J1	A0 and B1 detector and relay driver. Relays K5A, K1B, and TE1.
CP AS71	401J2 thru 401J9	
CPS 3D ED-1D117	401J1	B3 and C2 detector and relay driver. Relays K3B, K2C, and TE2.
CP AS75	401J2 thru 401J9	B2, B3, B4, and C2 detector and relay driver. Relays K2B, K3B, K4B, K2C, TE2, and TP4.
CPS 3G ED-11D119	401J1	C3 and C0 detector and relay driver. Relays K3C, K4C, and TP2.

TABLE H (Cont)

DESIGNATION	DATA SET	FUNCTION
CPS 76	401J2 thru 401J9	B0, C1, C3, and C0 detector and relay driver. Relays K5B, K1C, K3C, K4C, TP2, and TE3.
CPS 3B ED-1D115	401J1	A2 and A4 detector and relay driver. Relays K2A, K4A, and TP3.
CPS 3D ED-1D116	401J1	B2 and B4 detector and relay driver. Relays K2B, K4B, and TP4.
CPS 3F ED-1D118	401J1	B0 and C1 detector and relay driver. Relays K5B, K1C, and TE3.
CPS 4	401J3 and 401J5 Series 1	Provides voice-answer-back.
CP CA3	401J3 and 401J5 Series 2 and above; 401J7 and 401J9, all series	
CPS 2	401J2 thru 401J5 Series 1	Provides tone answer-back (1017- and 1785-Hz) and remote testing circuitry. Relays B, E1, and E2.
CP AS72	401J2 thru 401J5 Series 2 and above; 401J6 thru 401J9, all series	

(7) Depress TALK key; lift handset.

**Requirement:** Interrupted tones audible in handset, output indications removed from scope, DATA lamp extinguishes, and TK of TB1 is shorted to ground.

(8) Depress DATA key and replace handset.

(9) Open S4 for approximately 1 second.

**Requirement:** Open circuit between terminals 23 and 24 of connector J3.

(10) Remove ground from terminal 22 of connector J3 and operate S3.

**Requirement:** Telephone bell rings and terminal 25 of J3 is shorted to ground.

(11) Open S3 and install option H. Operate S3.

**Requirement:** Same as Step 10.

(12) Open S3 and install option X. Ground terminal 25 of J3.

**Requirement:** Output indication appears on the scope, DATA lamp lights, and terminal 23 of J3 is shorted to ground.

(13) Remove ground from terminal 25.

(14) Install options W, J, N, and G.

(15) Open S2. Operate S3 for 2 seconds and release.

**Requirement:** A 2025  $\pm$ 10 Hz tone at a level of  $-2 \pm 2$  dBm appears at test point C.

**5.09** If the requirements of 5.08 cannot be met, replace the 58A control unit or 3A3 data unit and repeat the tests.

## SECTION 594-018-150

### C. Detector Tests

**5.10** The purpose of this test is to check the bandwidth of the detectors. Perform the following procedure.

- (1) Install options N, S, and W.
- (2) Close switches S1, S2, and S6. Open S3 and S4.
- (3) Adjust the level of each oscillator to  $-20 \pm 3$  dBm on the voltmeter.
- (4) Close S4 and open S1 and S6.
- (5) Set the interruption rate to  $10 \pm 1$  Hz. Depress TALK key, lift handset, and depress DATA key.
- (6) Set oscillator No. 1 frequency to the nominal frequency for the detector to be tested and switch S5 to the appropriate terminal of J3 as shown in Table I. Set oscillator No. 2 frequency to  $1336 \pm 10$  Hz when testing A0 through A4 and to  $770 \pm 10$  Hz when testing detectors B0 through B4 or C0 through C3.
- (7) Slowly decrease the frequency of oscillator No. 1 from the nominal value until the output indications disappear from the scope and then increase the frequency until they reappear.

**Requirement:** The frequency at which output pulses reappear on the scope meets the F low limits outlined in Table I.

- (8) Slowly increase the frequency of oscillator No. 1 from the nominal value until the output indications disappear from the scope and then decrease the frequency until they reappear.

**Requirement:** The frequency at which the output pulses reappear on the scope meets the F high limits outlined in Table I.

- (9) Repeat Steps 8 and 9 for each of the detector frequencies.
- (10) Set switch S5 to 12 and set oscillator No. 1 to  $1633 \pm 3$  Hz.
- (11) Set oscillator No. 2 to  $770 \pm 10$  Hz and set the interruption rate to  $22 \pm 1$  Hz.

- (12) Set the oscilloscope for an indication of 20 output pulses appearing on each trace.

**Requirement:** No output pulses missing for at least 5 seconds.

**5.11** If the above requirements cannot be met, refer to Table H and replace the circuit pack associated with the particular detector(s) which fail to meet requirements. Retest after replacing the suspected faulty circuit pack.

### D. Sensitivity Test

**5.12** The purpose of this test is to check the ability of the detectors to respond to a frequency having a minimal signal strength. Perform the following procedure:

- (1) Install options N and S.
- (2) Set up the equipment as described in the detector test.
- (3) Set oscillator No. 1 to the nominal frequency and sensitivity as shown in Table I.

**Requirement:** Regular output indications appear on the scope at the corresponding S5 positions as shown in Table I.

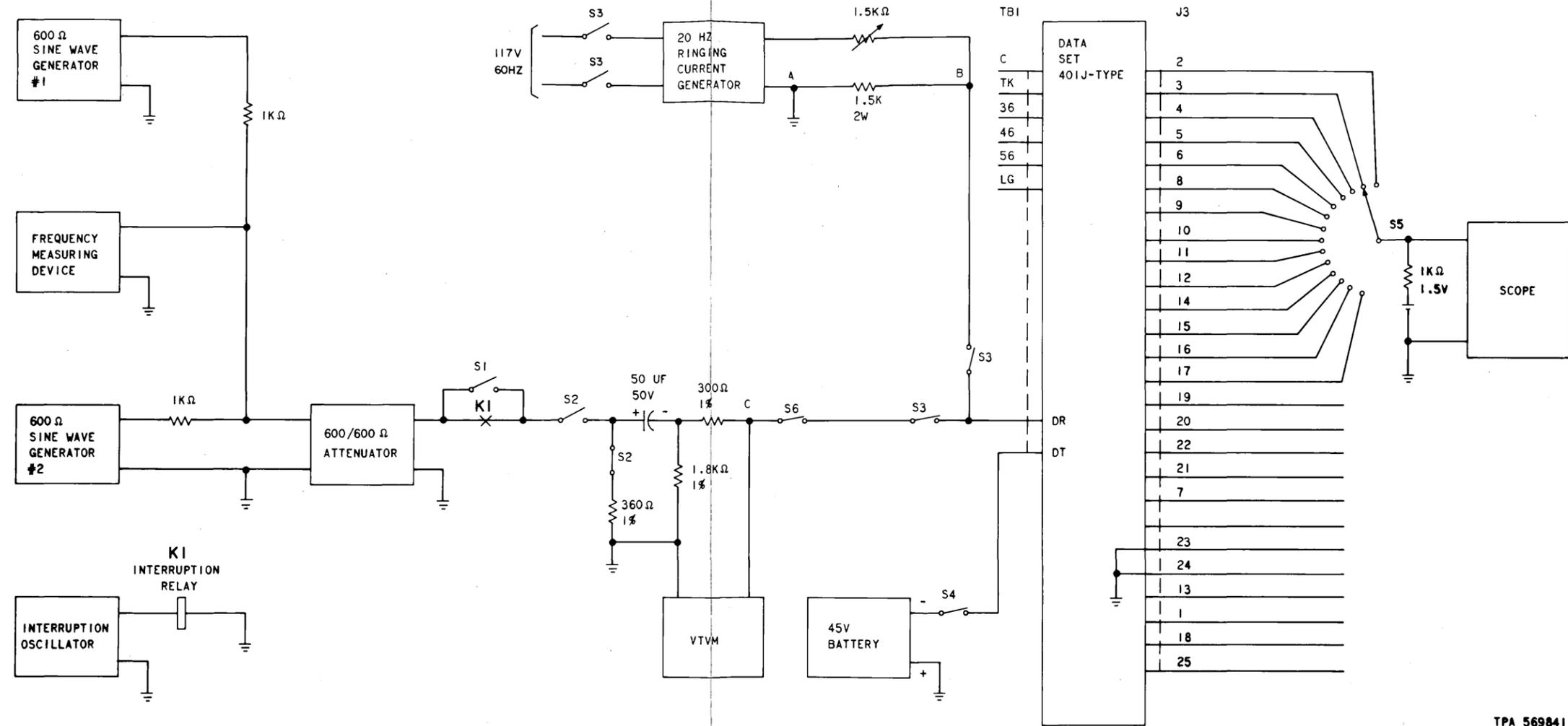
- (4) Repeat the test for each of the nominal frequencies as shown in Table I.

**5.13** If the requirements in 5.12 are not met, refer to Table H and replace the circuit pack associated with the particular detector(s) which fail to meet requirements. Retest after replacing the faulty circuit pack.

### E. Automatic Gain Control Test

**5.14** This test checks the operation of the automatic gain control circuitry of the receiver. Perform the following procedure:

- (1) Install options N and S and set up the equipment as described in the detector test.
- (2) Set oscillator No. 1 to a frequency of  $770 \pm 10$  Hz at a level of  $-10 \pm 1$  dBm.
- (3) Set the interruption rate at  $0.3 \pm 5$  Hz.



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Fig. 14—Data Set 401J-Type Test Setup

TABLE I  
DETECTOR BANDWIDTH AND SENSITIVITY TEST

DETECTOR	S5 POSITION	NOMINAL FREQ (Hz)	F <sub>LOW</sub> (Hz)	F <sub>HIGH</sub> (Hz)	SENSITIVITY (dBm)
A0	2	600	560-571	629-640	-48
A1	3	697	657-668	726-737	-48
A2	4	770	730-741	799-810	-48
A3	5	852	812-823	881-892	-48
A4	6	941	901-912	970-981	-48
B0	8	1098	1065	1131	-48
B1	9	1209	1176	1242	-49
B2	10	1336	1303	1369	-50
B3	11	1477	1444	1510	-50
B4	12	1633	1600	1666	-51
C0	17	1950	1917	1983	-53
C1	14	2050	2017	2083	-54
C2	15	2150	2117	2183	-54
C3	16	2250	2217	2283	-55
C4	17	2350	2317	2383	-

(4) Using the scope, measure the signal on terminal 1 of the band separation filter (637B network).

**Requirement:** The time required from the beginning of the signal until the amplitude drops to  $0.45 \pm 0.05$  volts peak-to-peak is no greater than 20 ms.

(5) Set the interruption rate to  $2.5 \pm 0.1$  Hz.

**Requirement:** The ratio of the amplitude of the transient to the steady state signal is  $2.5 \pm 0.25$ .

**5.15** If the above requirements cannot be met, replace the AGC circuit pack and repeat the test.

#### F. Answer-Back Test

**5.16** This test measures the level of the answer-back oscillator for the various possible options. Perform the following procedure:

(1) Install options N or Q, and T (option L on 401J1).

(2) Ground terminals 20 and 22 of J3.

(3) Close S4 and open S1, S2, S3, and S6.

(4) Depress TALK key, lift handset, and depress DATA key.

(5) Connect an oscilloscope and frequency counter between test point C and ground.

(6) Adjust the tuning slug of the oscillator transformer until the frequency counter indicates  $1785 \pm 3$  Hz. The output power level should be  $-7.5 \pm 2$  dBm.

(7) Remove ground from terminal 20 and ground terminal 19 of J3.

**Requirement:**  $1017 \pm 3$  Hz at a level of  $-5 \pm 2$  dBm.

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(8) Install option J in place of option T.

**Requirement:** Level of tone is  $-0.5 \pm 2$  dBm.

(9) Install option K in place of option J.

**Requirement:** Level is  $-4 \pm 2$  dBm.

(10) Install option M in place of option K.

**Requirement:** Level is  $-11.5 \pm 2$  dBm.

**5.16** The oscillator unit should not be replaced unless an adjustment is reached which causes one of the frequencies to be too high and the other frequency too low.

**6. REFERENCES**

**6.01** The following is a list of reference information relative to the 401-type receivers:

***Data Set 401B-type***

- CD-& SD-1D002-01
- BSP 594-011-ZZZ Series

***Data Set 401F-type***

- CD-& SD-1D018-01

- BSP 594-015-ZZZ Series

***Data Set 401J-type***

- CD-& SD-1D022-01 (J1D401J1)
- CD-& SD-1D064-01 (401J2 through 401J9)
- Data Set 401J Interface Specification
- BSP 594-018-ZZZ Series
- PEL 7340, 7383
- PEM 9197, 9992
- EM 131
- BSRS 480.003, 480.061
- Reference Guide 590-004-103

***General Information***

- Technical Reference—Data Communications Using The Switched Telecommunications Network
- Technical Reference—Transmission Specifications for Voice Grade Private Line Data Channels