

**407-TYPE MULTIPLE DATA STATION
SUPPLEMENTARY INFORMATION**

CONTENTS	PAGE	CONTENTS	PAGE
1. GENERAL	2	B. Tone and Voice Answer-Back Circuits	19
2. PHYSICAL INFORMATION	4	C. Hybrid and Voice Receive Circuits	20
A. 407-Type Multiple Data Station	4	D. Customer Interface Circuits	20
B. Power and Grounding Requirements	4	E. Automatic Call Distributor Interface Circuits	21
C. Customer Interface Connector and Cable Requirements	6	F. Status Lamp Indication Circuits	21
3. OPTION INFORMATION	6	G. AGC Amplifier	22
A. Data Sets 407A and 407B	6	H. Group Separation Filters	22
B. Station Options	6	I. Group Limiters and Divide-by-Three Circuits	22
C. Option Descriptions	6	J. Clocks and Synchronization Circuits	22
4. INTERFACE AND DATA SIGNAL CHARACTERISTICS	6	K. Time-Domain Detectors	25
A. Interface Signal Characteristics	6	L. Logic, Timing, and Inhibit Circuits	25
B. Data Signal Characteristics	11	M. Output Drivers and Lockup Circuits	26
5. SYSTEM CAPABILITIES AND OPERATION	12	DATA SET 407B	26
A. System Operation With a Key Telephone Set	12	A. Special Code Detectors	26
B. System Operation With a 2B or 3A Automatic Call Distributor	15	B. Computer Down Circuits	26
C. Private Line Capability	15	41-TYPE DATA MOUNTING	31
6. THEORY OF OPERATION	16	A. Test Unit of 41A1 Data Mounting	31
DATA SET 407A	16	B. 101A Power Unit	32
A. Line Control Circuit	16	7. MAINTENANCE AND TEST INFORMATION	35

NOTICE

Not for use or disclosure outside the
Bell System except under written agreement

CONTENTS	PAGE
8. GLOSSARY OF ABBREVIATED TERMS	35
9. REFERENCES	36

1. GENERAL

1.01 This practice covers the 407-type multiple data station in greater depth and detail than the description, installation, maintenance, and test (-100, -200, -300, -500) practices, and is intended to supplement them. Before reading this practice, the above standard practices should be read and understood. The contents of this practice are not required for normal installation, operation, and maintenance of the data station. This practice should be a valuable aid in understanding the apparatus associated with the 407-type multiple data station and in clearing unusual trouble conditions.

1.02 This section is reissued to include coverage on data sets (DS) 407B and 407A-L1A. Since this reissue constitutes a general revision, arrows ordinarily used to indicate changes have been omitted.

1.03 The 407-type multiple data station as shown in Fig. 1 is used primarily for Digital Inquiry Voice Answer-Back (DIVA) systems. These systems may be used in such applications as credit checking or retrieving information from a customer-provided terminal. Using a TOUCH-TONE® telephone set dial or a TRANSACTION* telephone as the input device, a customer may call the terminal and receive a voice answer over the telephone handset. This answer may consist of machine-generated or prerecorded phrases or tones. These phrases are under the control of a customer-provided computer equipped with an audio response unit.

1.04 The 407-type multiple data station is compatible with the following apparatus:

- 565HK-type key telephone set, or equivalent
- CALL DIRECTOR® telephone
- 2B or 3A automatic call distributor (ACD).

1.05 The 565HK-type telephone set and the CALL DIRECTOR telephone provide TALK and return to DATA functions as well as normal telephone set functions when associated with the 407-type multiple data station. The ACD, which provides concentration and queuing of incoming calls, as well as the ability to free the data set during referrals, may be used in place of a 565HK-type telephone set or CALL DIRECTOR telephone.

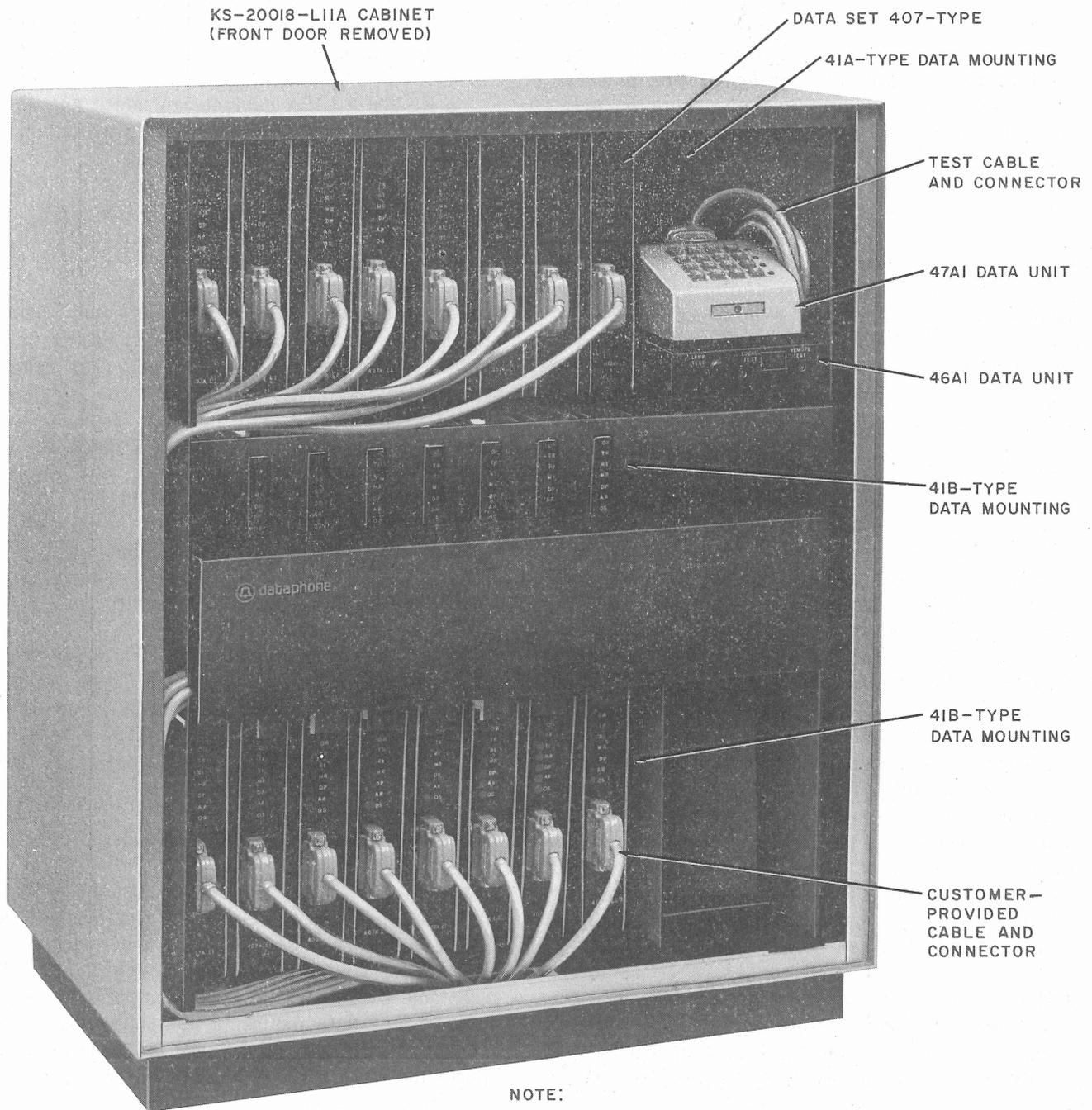
1.06 Data sets 407A-L1 and L1A provide the following:

- Full-duplex 2-wire service.
- Low speed parallel data set that detects two-out-of-eight multifrequency codes.
- Two-way voice channel.
- Reception of data via the switched telecommunications network or unconditioned private line facilities, as required.
- Answer tone (which can be activated from the interface).
- Electronic Industries Association (EIA) voltage (RS-232-C) or contact *equivalent* customer interface, as required.
- Local test capability.
- Remote test capability.
- Status light emitting diodes (LEDs) on the front panel to indicate the state of various functions and customer interface signals.
- DS 407A-L1A provides, in addition, a tighter tolerance on the answer-tone duration, in order to ensure compatibility with the TRANSACTION telephone.

1.07 Data set 407B provides all the features of DS 407A, plus the following three additional features:

- Terminal-initiated referral capability
- Positive automatic call termination

*Trademark of AT&TCO



NOTE:

101A POWER UNIT MOUNTED ON RIGHT SIDE OF 41-TYPE DATA MOUNTING

Fig. 1—407-Type Multiple Data Station Mounted in a KS-20018-L11A Cabinet—Typical

- Limited call-handling capability when customer-provided equipment is out of service.

1.08 The 41-type data mounting will accommodate up to eight data sets 407-type. DS 407A

requires a 41A1 or 41A2 data mounting for the first eight data sets and a 41B1 or 41B2 data mounting for each additional eight data sets; DS 407B requires a 41A2 data mounting for the first eight data sets and a 41B2 data mounting for each additional eight data sets. The 41A1 and 41B1

data mountings are rated Manufacture Discontinued Not Orderable (MD/NO), and are replaced by the 41A2 and 41B2 data mountings, respectively. The 41A1 and 41A2 data mountings contain a 101A power unit, one 46A1 data unit, and one 47A1 data unit. The 41B1 and 41B2 data mountings are the same as the 41A1 and 41A2 data mountings but do **not** contain the 46A1 and 47A1 data units (test unit).

1.09 The 46A1 data unit (Fig. 1) is provided with 41A1 and 41A2 data mountings and enables local or remote testing of any data set 407-type in the cabinet. The 47A1 data unit is also provided with 41A1 and 41A2 data mountings and enables local testing by a telephone company (telco) employee or customer of any data set housed in the cabinet.

1.10 Functionally the 407-type multiple data station (Fig. 2) receives incoming TOUCH-TONE signals and translates the signals into either parallel EIA voltages or contact closure equivalents. The digital signals are then applied to the customer-provided terminal. Voice answer-back is provided from the terminal. Tone answer-back is also available in the data set and is under control of the customer terminal. The data set also provides an answer tone to acknowledge incoming calls.

1.11 The received signals are all in the voice-frequency range and consist of pairs of tones, one A-group frequency and one B-group frequency (Fig. 6). The tones are received at a rate of up to ten pairs of tones (ten characters) per second. Line impedance of the 407-type data set is either 900 ohms (option A—switched network) or 600 ohms (option B—private line).

1.12 Answer tone and tone answer-back signals are attenuated before being applied to the telephone line by option strapping to provide no greater than -12 dBm at the serving central office.

1.13 The 407-type multiple data station may be housed in a KS-20018-L11A or -L12A cabinet, or equivalent, or any mounting rack arrangement that will accept the 23-inch, 41-type data mountings. Each KS-20018-type cabinet listed above may house the following number of 41-type data mountings and data sets.

- KS-20018-L11A cabinet can house one 41A1 or 41A2 and up to two 41B1 or 41B2 data mountings with a maximum of twenty-four

DS 407As. Only sixteen DS 407Bs can be housed in this cabinet, due to thermal limitations.

- KS-20018-L12A cabinet can house one 41A1 or 41A2 data mounting with a maximum of eight data sets.

2. PHYSICAL INFORMATION

A. 407-Type Multiple Data Station

2.01 The 407-type multiple data station will operate in an ambient temperature range from 40 to 120°F. The relative humidity operating ranges for the data station are as follows:

TEMPERATURE, °F	HUMIDITY RANGE, %
40 to 75	20 to 95
100	20 to 70
120	20 to 40

2.02 Refer to Section 594-800-100 for physical information on data sets 407-type, 41-type data mountings, and 46A1 and 47A1 data units. Refer to Table A for an abbreviated version of the physical information contained in Section 594-800-100.

B. Power and Grounding Requirements

2.03 Electrical power is supplied to the 407-type multiple data station from a customer-provided 117 volts ± 10 percent, 60 Hz ± 5 percent source through a 3-wire grounded receptacle. The receptacle should **not** be under control of a switch. Each 41-type data mounting containing eight data sets (served by a single power supply) consumes approximately 110 watts of ac power.

Note: If fewer than eight data sets are used in the 41-type data mounting, the power consumption is reduced but **not** linearly. For example, four data sets consume 60 watts of ac power while one data set consumes 28 watts of ac power at 117 volts (line voltage).

2.04 Ground is provided for the data station through the ground wire of the power cord. A signal ground is provided, optional at the 101A power unit, for customer use as a signal level

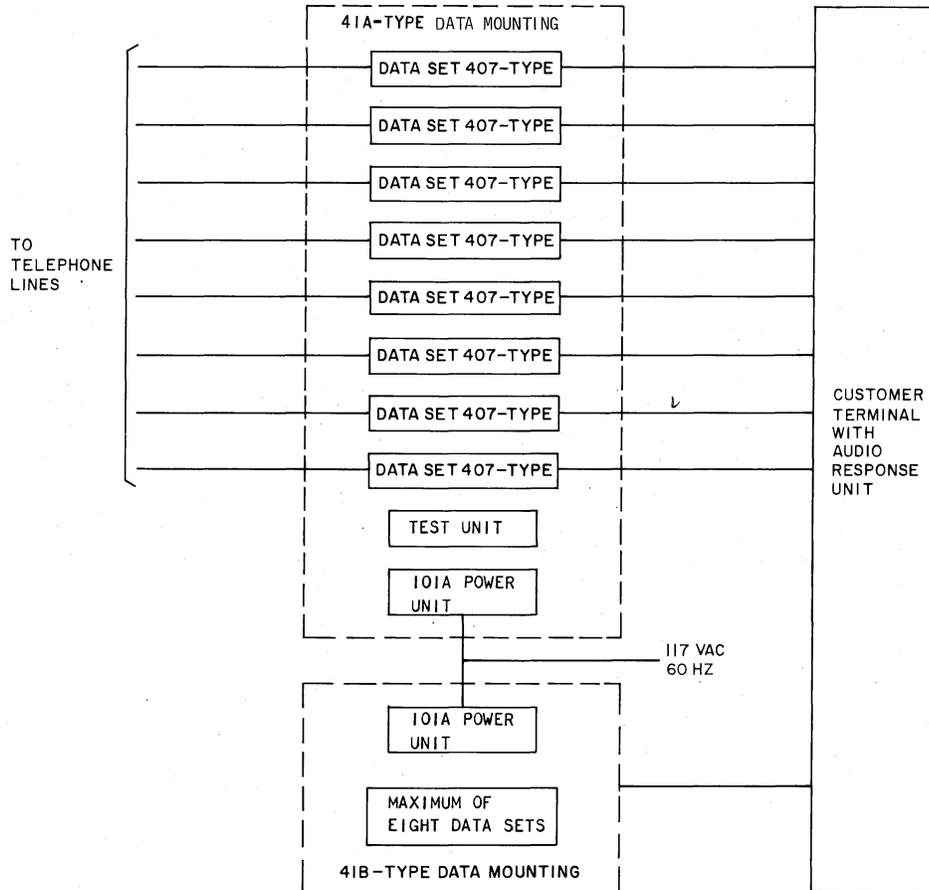


Fig. 2—407-Type Multiple Data Station Functional Block Diagram—Typical

TABLE A

PHYSICAL INFORMATION

CODE	DIMENSIONS (INCHES)			WEIGHT (POUNDS)
	WIDTH	HEIGHT	DEPTH	
DS 407A	1.45	8	12.1	2.5
DS 407B	1.45	8	12.1	2.75
41A1 DM (MD)	23	8.67	16.5	42
41A2 DM	23	8.67	16.5	42
41B1 DM (MD)	23	8.67	16.5	38
41B2 DM	23	8.67	16.5	38
46A1 DU	5.2	2	4.2	1.5
47A1 DU	4.5	2.5	4.5	1.5

reference point. Means are provided in each data mounting for optionally disconnecting signal ground from frame ground. If signal ground is not connected to frame ground, signal ground reference between data mountings must be provided by external wiring.

C. Customer Interface Connector and Cable Requirements

2.05 The customer must supply a Cinch DB-19604-432 connector or equivalent, terminated on a 25-conductor cable for interface connections. If the cable used has a 1.125-inch maximum bending radius, such as that obtainable from Alpha Wire Company 1181/25-22 AWG, then a Cinch DB-51226-1 straight molded hood may be used. If the cable has a larger bending radius, a right-angle hood, Cinch 239-13-99-140 or equivalent, must be used. Cables with a bending radius greater than 4 inches are *not* recommended.

3. OPTION INFORMATION

A. Data Sets 407A and 407B

3.01 Option strapping is done by means of small 2-pronged plugs (Fig. 3) on DS 407A and DS 407B. These plugs fit into numbered jacks on the JU1B circuit board of the data set. Additional options apply to DS 407B only (Fig. 4) and are made by means of small rectangular jacks which fit over lettered prongs on the option block on

circuit module CM1 (daughter board). Refer to Table B for option strapping and functional information.

B. Station Options

3.02 There are nine options made external to the data set; seven are made at the connecting block or intermediate distribution frame (IDF), and two are made on the power supply.

C. Option Descriptions

3.03 Refer to Section 594-800-200 for a description of options and for details of installation.

4. INTERFACE AND DATA SIGNAL CHARACTERISTICS

A. Interface Signal Characteristics

4.01 Interface pin numbers, lead designations, abbreviations, and functions for data set 407-type are shown in Table C. Twenty-three of the twenty-five leads on the customer interface connector have functions assigned. The two unassigned leads are spares.

4.02 Data set 407-type provides two interfaces, an EIA or a contact equivalent interface. These interfaces are discussed separately below.

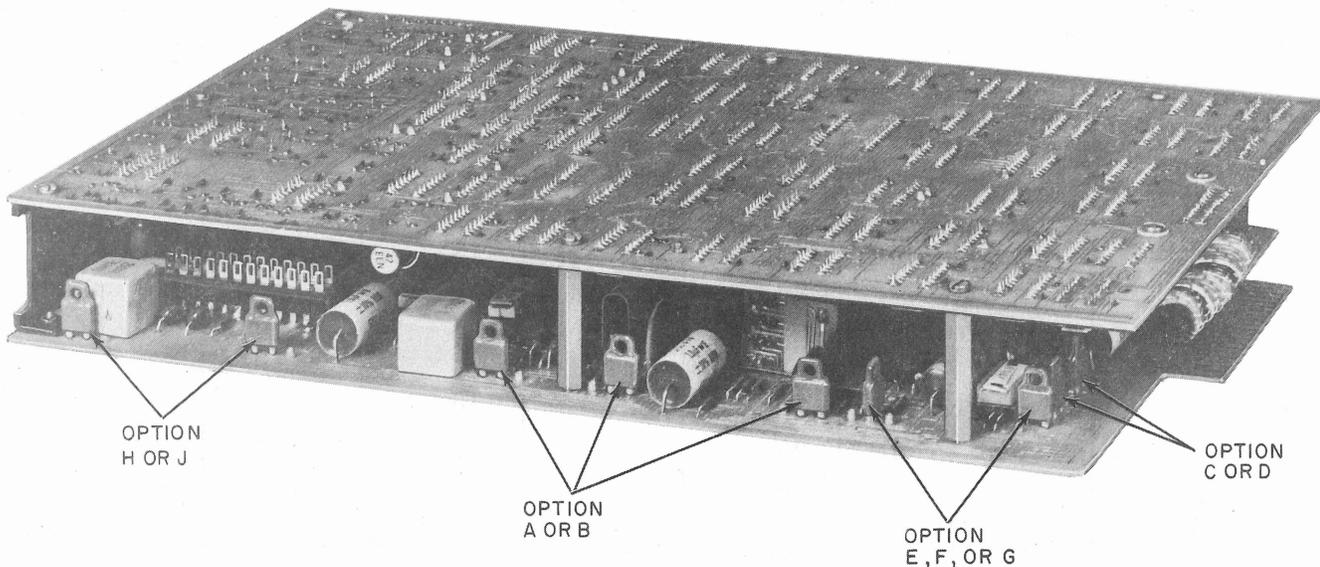


Fig. 3—Data Set 407A or 407B—Option Plug Locations

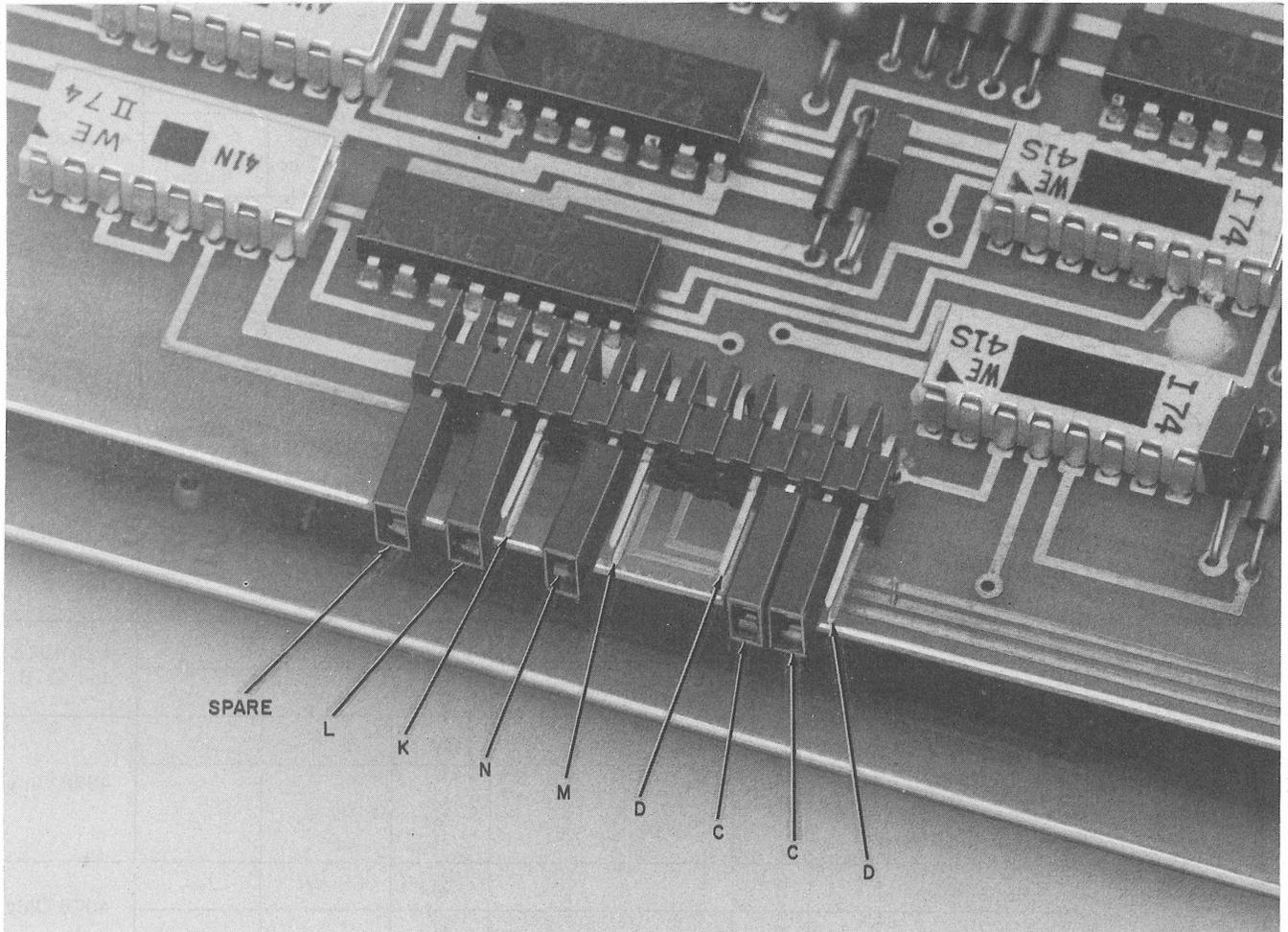


Fig. 4—Data Set 407B—Additional Option Jack Locations

EIA Interface

4.03 All leads in the EIA interface except the voice answer-back and voice receive leads conform electrically to the voltage characteristics specified in EIA Interface Standard RS-232-C. The voice answer-back leads are terminated within the data set in 600 ohms balanced to ground. The voice receive leads provide a 600-ohm balanced pair on which the line signals are passed to the customer.

4.04 The corresponding characteristics of the data circuit interface leads are summarized as follows:

- Binary State.....ONE or ZERO

- Signal Condition...MARK or SPACE

- Voltage State.....NEGATIVE or POSITIVE

4.05 The corresponding characteristics of the control circuit leads are summarized as follows:

- Control Function...OFF or ON
- Voltage State.....NEGATIVE or POSITIVE

Contact Equivalent Interface

4.06 Since proper operation of the contact equivalent interface depends on the circuitry in the customer terminal, equivalent circuits are shown in Fig. 5 for the terminators and drivers

TABLE B
DATA SET 407-TYPE OPTIONS

OPTION	SELECTION	DESIG	STRAPPING				AVAILABLE IN
			ON LINE CONTROL AND INTERFACE BOARD	ON CM1	ON 101A POWER UNIT	ON CONNECTOR BLOCK	
Type of Operation	Switched Network (DDD)	A ¹	E34-E32, E37-E38 E42-E41	—	—	—	Both 407A and 407B
	Private Line	B	E34-E33, E37-E36 E42-E43	—	—	—	
Used With ACD	No	C ¹	E28-E26, E30-E29 ²	C (Two Jacks) ³	—	—	Both 407A and 407B
	Yes	D	E28-E27, E30-E31 ²	D (Two Jacks) ³	—	—	
Answer Back Level	- 3 dBm	E	E54-E56, E60-E58	—	—	—	Both 407A and 407B
	- 7 dBm	F	E54-E53, E60-E59	—	—	—	
	-12 dBm	G ¹	E54-E55, E60-E61	—	—	—	
Customer Interface	EIA	H ¹	E49-E48, E51-E52	—	—	—	Both 407A and 407B
	Contact Equivalent	J	E49-E47, E51-E50	—	—	—	
Terminal Initiated Referral	Always	K	—	K	—	—	407B Only
	During Computer Down Only	L ¹	—	L	—	—	
OS Controlled by DTR	No	M ¹	—	M	—	—	407B Only
	Yes	N	—	N	—	—	
Computer Down Detection	Switch Only	AA	—	—	—	—	407B Only
	All DTR Off Only	BB	—	—	—	—	
	Switch or All DTR Off	CC	—	—	—	—	
	Not Used	DD	—	—	—	—	
Out-of-Service Wiring	Tip-Ring Short	EE	—	—	—	Both 407A and 407B	
	Third Wire Ground	FF	—	—	—		
	Separate Pair Short	GG	—	—	—		
Grounding	Frame Ground Connected to Signal Ground	HH ¹	—	—	E16-E17	—	Both 407A and 407B
	Frame Ground and Signal Ground Not Connected	JJ	—	—	E16-E17 Open	—	

Note 1: Factory Furnished Option.

Note 2: Applies to DS 407A and DS 407B.

Note 3: Applies to DS 407B only.

TABLE C

CUSTOMER INTERFACE LEAD FUNCTIONS

PIN NO.	LEAD DESIGNATION	ABBREVIATION	FUNCTION
1	Frame Ground	FG	Common to ac power service ground.
2	Voice Receive A	VRA	Provides one-half of a 600Ω balanced pair for line signals being passed to customer.
3 4 5 6	A1 Data A2 Data A3 Data A4 Data	A1 A2 A3 A4	Low group outputs from data set when a valid TOUCH-TONE character is present.
7	Spare	—	Not used.
8	Voice Receive B	VRB	Provides one-half of a 600Ω balanced pair for line signals being passed to customer.
9 10 11 12	B1 Data B2 Data B3 Data B4 Data	B1 B2 B3 B4	High group outputs from data set when a valid TOUCH-TONE character is present.
13	Spare	—	Not used.
14	Ring Indicator	RI	An ON condition on this lead indicates that ringing signal is being received.
15	Attendant Request	AR	An ON condition on this lead (data set in data mode) indicates that an attendant is requested on the line.
16	Data Present	DP	An ON condition on this lead indicates that data set is receiving a valid TOUCH-TONE signal.
17 18	Voice Answer-Back A Voice Answer-Back B	VAA VAB	Provides a 600Ω balanced pair for <i>voice only</i> from customer to data set.
19	Data Mode	DM	An ON condition on this lead and DSR lead (pin 23) indicates data set is in data mode. An OFF condition on DM lead and an ON condition on DSR lead indicates data set is in talk mode.
20	Tone Answer-Back	TAB	An ON condition on this lead causes data set to disable voice answer-back port and generate an answer-back tone (2025 Hz).
21	Data Receive	DR	An ON condition <i>must</i> be placed on this lead by the customer to connect TOUCH-TONE receiver to telco line. This enables data set to receive data.
22	Data Terminal Ready	DTR	An ON condition on this lead prepares data set to be connected to telco line. As an option, an OFF condition on this lead can make the data set appear busy to incoming calls.
23	Data Set Ready	DSR	An ON condition on this lead indicates data set is <i>either</i> in data mode and ready to receive data, transmit answer-back signals, or both, depending on condition of DR lead (Pin 21), or is in talk mode (DM lead Pin 19 is OFF).
24	Signal Ground	SG	This conductor establishes common ground for signals referenced to it and is optionally connected to frame ground via a strap located on power unit.
25	Out of Service	OS	An ON condition on this lead makes data set appear busy to incoming calls. When an ACD is employed, this lead is placed in OFF condition at all times.

of the 407-type contact equivalent interface. The conditions that must be met by the customer terminal at the interface are specified in Table D. The specifications given in Fig. 5 and Table D are used to determine whether the customer equipment will function properly with the 407-type contact equivalent interface.

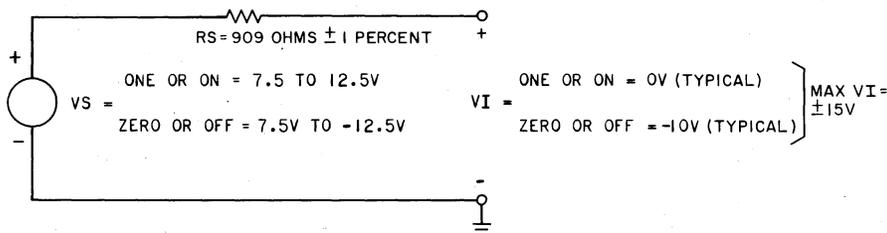
4.07 The optional contact equivalent interface modifies both the driver and terminator circuits of data set 407-type. These modifications enable the data set interface to be used with many customer terminals that are designed to operate with a contact closure-type interface.

4.08 The drivers of the 407-type contact equivalent interface can be represented by an equivalent

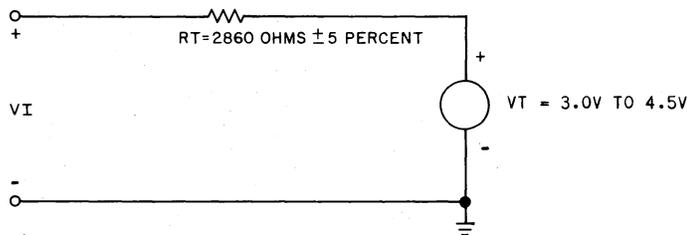
circuit of approximately 1000 ohms in series with a source of approximately 10 volts. The source will be positive to ground for the closed state and negative to ground for the open state.

4.09 Closure sensors in the customer terminal which are the equivalent of 1000 ohms to a negative 10 volts will detect zero volts (simulating a closure) at the interface when the DS 407 driver source is **positive**. The same closure sensors will detect negative 10 volts (simulating an open) at the interface when the DS 407 driver source is **negative**.

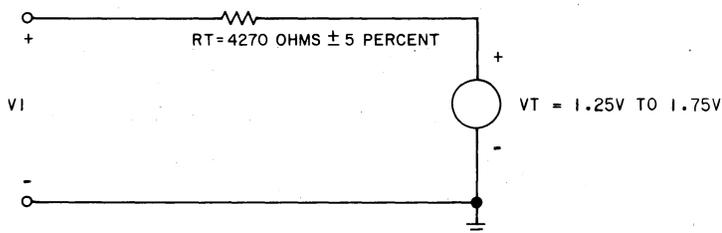
4.10 The contact equivalent interface causes the terminators of the data set to interpret an open (high impedance) to ground on the interface



A. EQUIVALENT CIRCUIT FOR CONTACT EQUIVALENT INTERFACE DRIVER



B. EQUIVALENT CIRCUIT FOR CONTACT EQUIVALENT INTERFACE TERMINATOR (EXCEPT OS)



C. EQUIVALENT CIRCUIT FOR CONTACT EQUIVALENT OUT-OF-SERVICE TERMINATOR ONLY

Fig. 5—Equivalent Circuits for Data Set 407-Type Drivers and Terminators

TABLE D

CUSTOMER TERMINAL DRIVER REQUIREMENTS FOR COMPATIBILITY WITH DATA SETS 407-TYPE CONTACT EQUIVALENT INTERFACE

PASSIVE (METALLIC CONTACT OR TRANSISTOR SWITCH)	ACTIVE (VOLTAGE)
R ON \leq 250 ohms	Vi ON = 0.4V to -15V (same voltage requirement for OS lead)
R OFF \geq 100 K ohms	Vi OFF = 2.0V to 15V (1.20V for OS lead)

lead as an OFF condition and a short (low impedance) to ground as an ON condition.

Note: If solid-state closure devices are used in the customer terminal, they **must** use a positive polarity to ground.

4.11 The corresponding characteristics of the data circuit interface leads are summarized as follows:

- Binary State.....ONE or ZERO
- Signal Condition...MARK or SPACE
- Closure State.....CLOSED or OPEN

4.12 The corresponding characteristics of the control circuit interface leads are summarized as follows:

- Control Function...OFF or ON
- Closure State.....OPEN or CLOSED

Note: In the contact equivalent interface circuit, the **closed** and **open** states are only simulated; there is no metallic contact in the circuit.

B. Data Signal Characteristics

4.13 The frequency assignment of the audio-frequency tones utilized in TOUCH-TONE service is shown in Fig. 6. Eight frequencies are employed and these are arranged in two groups of four, a

low (A) group and a high (B) group. A character is represented by two frequencies, one from each group. This yields 16 possible combinations or characters. Only 12 of the possible 16 combinations are used on standard TOUCH-TONE sets, and these represent the 10 numerals (0 through 9) along with the symbols * (star) and # (number sign).

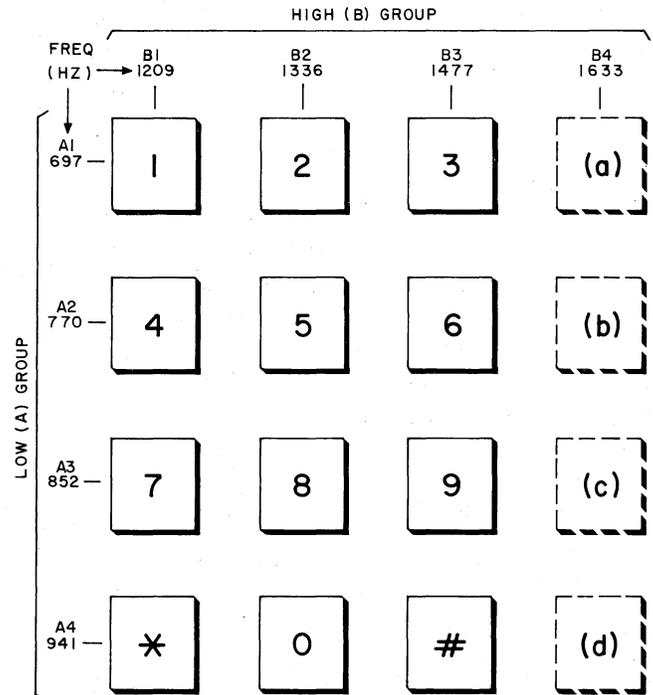


Fig. 6—TOUCH-TONE Dial Frequency Assignments for DS 407-Type Systems

4.14 The other four combinations are presently unassigned for standard telephone service. However, there are card dialers, TRANSACTION telephones, and data sets now available that can send all 16 combinations. The DS 407-type receiver is equipped to receive these 16 characters and pass them to the customer terminal.

4.15 If the customer chooses to provide a tone transmitter to be used with a Bell System protective coupler, the tone signals must meet the following requirements:

- (a) The tone frequencies shall be within ± 1.5 percent of nominal assigned frequencies.

SECTION 594-800-150

- (b) The total power of all extraneous signal components shall be 20 dB or more below the combined tone signal power in the voiceband above 500 Hz.
- (c) If the tone source is a customer-provided telephone used in conjunction with a data coupler, voice signals shall be suppressed at least 45 dB during tone signal transmission (the telephone transmitter shall be muted). In the case of automatic dialing, it is essential that the suppression be maintained until dialing is completed.
- (d) Each of the two tones shall attain at least 90 percent of full amplitude within 5 ms, and preferably within 3 or less ms for automatic dialers, from the time the signal begins.
- (e) The following specifications shall apply to the signaling rate:
- Minimum duration of the 2-frequency signal: 50 ms
 - Minimum interdigital time: 45 ms
 - Minimum cycle time (tone-on plus tone-off): 100 ms.
- (f) The tone leak or nonsignal level shall be less than -55 dBm.
- (g) Peak transient voltages accompanying the tone signal shall be no greater than 12 dB above the zero-to-peak voltage of the composite 2-frequency signal.
- (h) The 3-second average power of the signal pulses (2 tones) shall not exceed the value specified on the protective coupler. The level of each tone shall not be lower than 5 dB below the specified value. It is further required to ensure proper detection that **not more** than 4 dB difference exists between the levels of the high and low frequencies.

5. SYSTEM CAPABILITIES AND OPERATION

5.01 Data set 407-type can automatically answer all incoming calls in switched service operation. This means the data set can function in an unattended mode (no manual answering is required). The call handling procedure depends on whether a key

telephone or an automatic call distributor (ACD) is used in conjunction with the data set. The former units provide TALK and return to DATA modes for the data sets.

5.02 In private line service, the call handling procedure is dependent on customer system operation.

A. System Operation With a Key Telephone Set

Data Sets 407A and 407B

5.03 A timing sequence chart is shown in Fig. 7 and is keyed to the following text. Operation of DS 407A and DS 407B is the same in **normal** operation. Added capability of DS 407B in referral situations and during "computer down" operation is given in 5.08.

5.04 The serving central office (CO) indicates an incoming call by applying ringing to the line. The ringing signal is detected by the data set and is indicated to the data terminal by means of an ON condition of the ring indicator (RI) lead. The data terminal must have data terminal ready (DTR) in the ON state in response to RI ON to receive the call. With DTR ON, the set goes off-hook, tripping ringing, and after a 1.5-second silent interval, the data set generates a 2025-Hz answer tone for 1.5 seconds. The tolerance on the duration of answer tone is tighter on DS 407A-L1A and DS 407B than in DS 407A-L1. As the call is answered, the lamp on the key telephone associated with the line lights, indicating that the connection has been made. Approximately 3 seconds after ringing is tripped, data set ready (DSR) and data mode (DM) go to the ON state to indicate the data set is connected to the line and is in the DATA mode. If data receive (DR) is ON, data transmission can then take place.

5.05 If the data set is in the DATA mode and the customer terminal places the attendant request (AR) lead in the ON state, the button on the key telephone corresponding to that line will flash at a rate of approximately one flash per second. This flash indicates that the customer terminal wants to transfer the call from the data set to the referral clerk. The referral clerk should cause the data set to go into the TALK mode by depressing the flashing button and answering the call. Return to DATA mode is accomplished by depressing the DATA (HOLD) button.

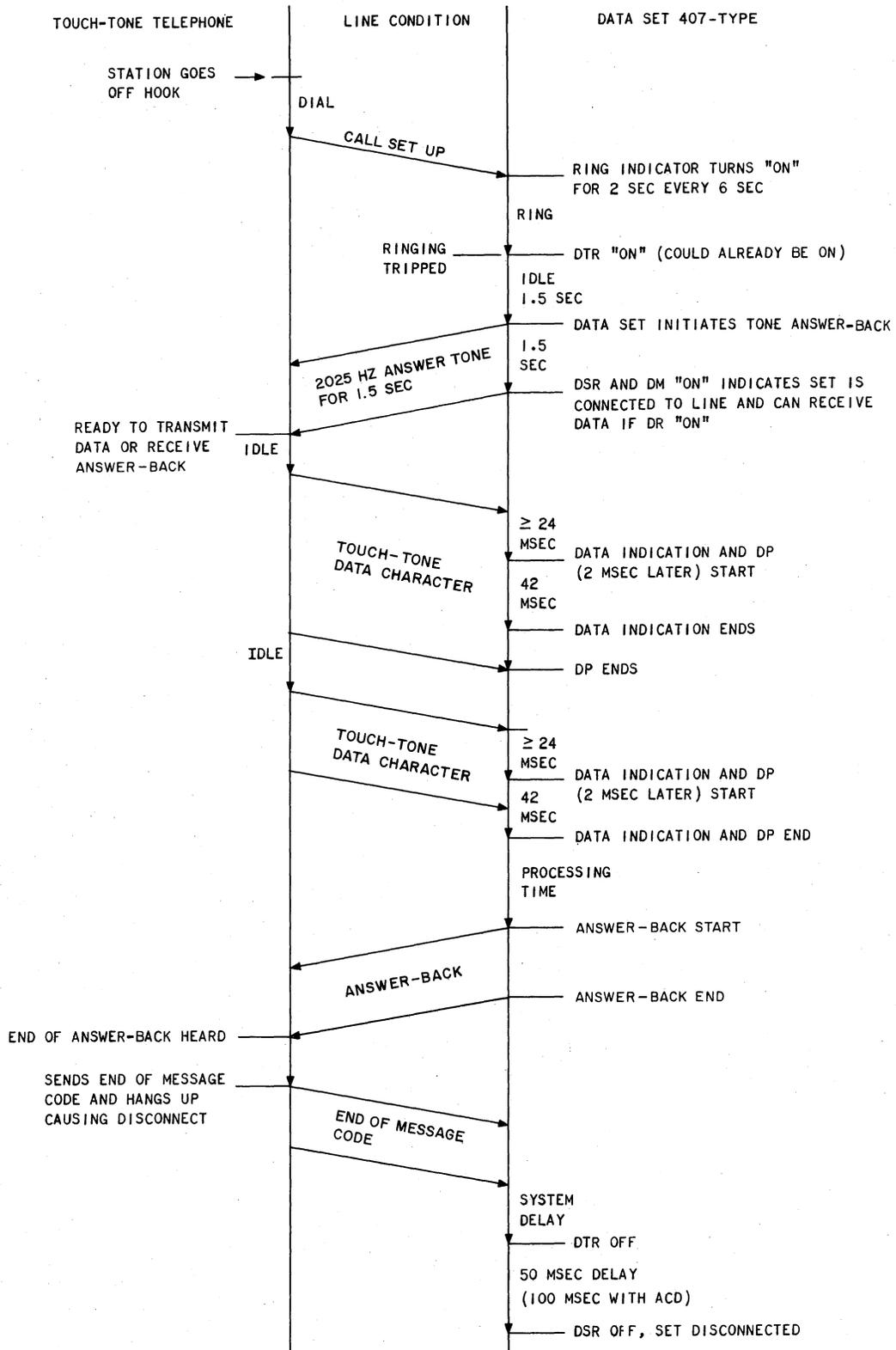


Fig. 7—Timing Sequence Chart for Data Set 407-Type in Normal Operation

5.06 The DM lead can be used by the customer terminal to determine when the referral clerk has gone off-hook following an attendant request. When the referral clerk answers the call, the DM lead goes from ON to OFF. The customer terminal may choose to terminate the call if the referral clerk does not answer the phone (DM does not go from ON to OFF) within a suitable time period as determined by the customer.

5.07 The call is terminated when the calling station hangs up and the data set is in *one* of the following modes:

- In the TALK mode and the handset is returned to the cradle.
- In the DATA mode and the customer terminal turns OFF the DTR lead for a period of at least 50 ms.

Note: DS 407A systems users should employ an end-of-message code to indicate to the business machine that the call is terminated.

Data Set 407B Only

Terminal Initiated Referral

5.08 Data set 407B contains circuitry to detect the TOUCH-TONE sequence * * (double star). By option (option K), this sequence may be used to initiate an attendant request, regardless of the state of the attendant request lead (AR) at the customer interface. This permits terminal-initiated referrals at all times. If this option is not selected, referral may only be initiated by the calling party when the data station is in the "computer down" mode.

Automatic Call Termination

5.09 Data set 407B responds to the TOUCH-TONE sequence * # * (star, number sign, star) by momentarily turning DTR OFF. This causes the data set to immediately return to the on-hook state. This provides faster call termination than the audio response unit (ARU) activity timer; however, the timer is still required, in the event the call termination signal is not received.

Computer Down Operation

5.10 When all ports of the customer computer are out of service, the data station enters the "computer down" mode. DS 407B includes circuitry to detect "computer down" by any one of three ways, as follows:

- Switch closure operated by computer center personnel
- Determining that all DTR leads are simultaneously OFF
- Either of the above (switch closure or all DTR leads OFF).

These modes of "computer down" detection are selected by installer option. In the "computer down" mode, DS 407B responds after the 1.5-second silent interval by sending a 3.5-second answer tone, instead of the usual 1.5-second answer tone. After a call has been answered, a 15-second timer is started. Automatic terminals can recognize the longer answer tone and take appropriate action. For example, the TRANSACTION telephone may light a lamp labeled FOLLOW SPECIAL INSTRUCTIONS, or initiate an attendant referral. The computer down circuitry in DS 407B next examines the first character transmitted by the terminal, if it is other than a *. If that character does not contain the B4 TOUCH-TONE frequency, a 2025-Hz tone is transmitted at a 0.5-Hz rate for the remainder of the 15-second time-out. This is done to provide an audible indication for calling terminals such as the TOUCH-TONE telephone, which cannot automatically respond to the 3.5-second 2025-Hz answer tone. If a * * is not received from the terminal before the timer runs out, the data set terminates the call. If the * * is received within the allotted 15 seconds, the call is referred to an attendant. During "computer down" operation, interface signals from the customer are monitored only by the "computer down" circuitry. This circuitry monitors the state of a customer operated switch and/or the state of all DTR leads. Except for this, all interface leads from the customer are ignored during "computer down" operation. In DS 407B the out-of-service function can be accomplished by turning ON the OS interface lead, as in DS 407A. Alternately, as an option, DS 407B can be taken out of service by turning OFF the DTR interface lead.

B. System Operation With a 2B or 3A Automatic Call Distributor

5.11 When a 2B or 3A ACD is used in place of a key telephone (ACDs are usually used in large systems containing 24 to 48 data sets), several additional functions are introduced into the system:

- Concentration of incoming calls.
- Indication back to the customer terminal of referral clerk line selection.
- Ability to send data to the customer terminal when the referral clerk is on the line.
- Ability to drop the data set from the call during referral to make data set available for next incoming call.

5.12 When a call is placed to the customer terminal through an ACD, ringing is detected by the ACD. This allows the ACD to hunt for an idle terminal port (data set) that has DTR in the ON state. At this time, the call proceeds as shown in the timing sequence chart per Fig. 7 beginning with the *ringing tripped point of the chart*.

Note: In ACD system operation, a ring indication is *not* given on RI lead (14).

5.13 When the AR lead is placed in the ON state by the customer terminal or terminal initiated referral occurs (with DS 407B), the ACD searches for a nonbusy referral clerk line. Upon finding one, the ACD generates two TOUCH-TONE digits and sends them back to the customer terminal through the data set. These digits specify which referral line has been selected. At the same time as the digits are sent, a signal is transmitted to the referral telephone to cause ringing.

5.14 Once the 2-digit code is received by the customer terminal through the data set, the data set can be released from the call by turning DTR and AR OFF [AR will be OFF already if terminal initiated referral (TIR) was employed]. The data set can then be made available (after DTR has been OFF for at least 100 ms) to answer other calls by returning DTR to the ON state. If DTR remains ON after the referral clerk has answered, the data set remains on-line and the referral clerk line is bridged onto the original connection. AR should be turned OFF even though

DTR remains ON. At this time, data can be received by the customer terminal during the course of the conversation. After the clerk hangs up, further data can be received.

5.15 There is *no* TALK mode when a 2B ACD is used with the 407-type multiple data station. Since data can be received during a conversation between the referral clerk and the calling party, there is no requirement for the capability of transferring the data set off-line and later bringing it back on-line. Once the customer terminal turns DTR off, no further data can be received. Connection to the customer terminal is then reestablished by redialing.

5.16 If the data set is not dropped from the line during the conversation, the call is terminated when the calling party and the referral clerk hang up and the customer terminal turns OFF the DTR lead for a minimum of 100 ms. It is recommended that an end-of-message code be sent by the calling party to the customer terminal to indicate when transmission has been completed.

5.17 When a 2B ACD is employed, out of service is accomplished by placing DTR in the OFF state, thereby making that data set appear busy to the ACD. The 2B ACD will then direct the call to the next idle data set. The out-of-service (OS) lead should be OFF at all times when operating with an ACD.

Note: The 407-type multiple data station may also work with ACDs other than the 2B ACD, but local engineering is required.

5.18 In the "computer down" mode using the 2B ACD and DS 407B, the response is the same as given in 5.10.

C. Private Line Capability

5.19 A private line can be used to connect data set 407-type directly to the remote station. In this case, the data set is on-line as long as DTR is ON and no calling procedure is required other than that provided by the customer system. If DTR is kept ON permanently, data or voice can be received by the data set from the remote location at any time. Answer-back signals can also be transmitted by the data terminal via a data set to a remote station. The data set can be taken off the line and out of service by placing DTR in

the OFF state. The OS lead is *not* used in private line operation and is permanently OFF.

5.20 A key telephone set may also be used in private line applications of the 407-type multiple data station if TALK capability is required. Operation of the AR lead (ON and OFF) would depend on the arrangement requested by the customer. A typical arrangement might be to simply bridge the key telephone set to the data line. This would allow data to be received when the referral clerk is on the line. The data set would remain on-line after the clerk hangs up.

5.21 Private line operation requires the customer system to provide any needed signaling. With private line there is no ringing signal provided and the 2025-Hz recognition tone is not generated unless DTR goes from OFF to ON. Usually some type of signal is required so the remote end knows that the data set and customer terminal are on-line. The customer can accomplish this by designating a code that will cause the data terminal to activate the tone answer-back (TAB) circuit. Therefore, the remote end could enter this code and receive the tone response when DTR is ON and data can be sent.

6. THEORY OF OPERATION

6.01 This part discusses the theory of operation of the 407-type multiple data station in more detail than other practices in this series. This part makes possible a more thorough understanding of the functional operation of the data apparatus contained in the 407-type multiple data station. Discussion of the data apparatus is keyed to functional diagrams. Refer to Part 8 of this section for a glossary of abbreviated terms.

DATA SET 407A

6.02 Data set 407A-type consists of two printed wiring circuit packs—the line control and interface circuit (CP JU1B or JU1) and the receiver circuit pack (CP JU2). The line control and interface circuit pack are functionally shown in Fig. 8 and contain the following functional circuits:

- Line control circuit
- Tone and voice answer-back circuits
- Hybrid and voice receiver circuits

- Customer interface circuits
- ACD interface circuits
- Status LED indication circuits.

A. Line Control Circuit

6.03 The line control circuit is the interface between the telephone facility and data set. A line matching transformer (T1) provides impedance matching for either private lines (600 ohms impedance) or switched network lines (900 ohms impedance) on an optional basis. The transformer also provides dc isolation for the data set. Three varistors are connected across the secondary of the line matching transformer to protect against lightning-induced surges on the line. The varistors limit the voltage rise across the transformer secondary to approximately 2.1 volts peak.

6.04 The line control circuit contains the data (DA) relay (contacts 1, 2, and 3) which enables the data set to enter the data mode. The data set is put into the data mode in one of the following *four* ways:

Switched Network (Non-ACD)

When the 20-Hz ringing signal appears on tip and ring (terminals 33 and 17), the R relay operates and releases during each half cycle of ringing. The R relay contacts remain closed for about 50 percent of the time when the ringing signal is present. Closure of the R contact activates the integrator circuit which puts an ON indication on the RI customer interface lead (14).



If the line facility is subjected to dial pulses or other types of sharp transitions, the R relay may operate only momentarily (not activating the integrator circuit) and no ring indication will be given to the terminal.

6.05 When ringing current is present, the data set will answer the call automatically if the A lead is open and the DTR customer interface lead is ON. These three conditions make the DA relay operate, closing the DA contacts shown in Fig. 8. DA 1 and 2 contacts allow the line control (LC) relay to draw line current. After the DA relay operates, there is a 3-second delay to allow call setup within the data set. When the DA 3

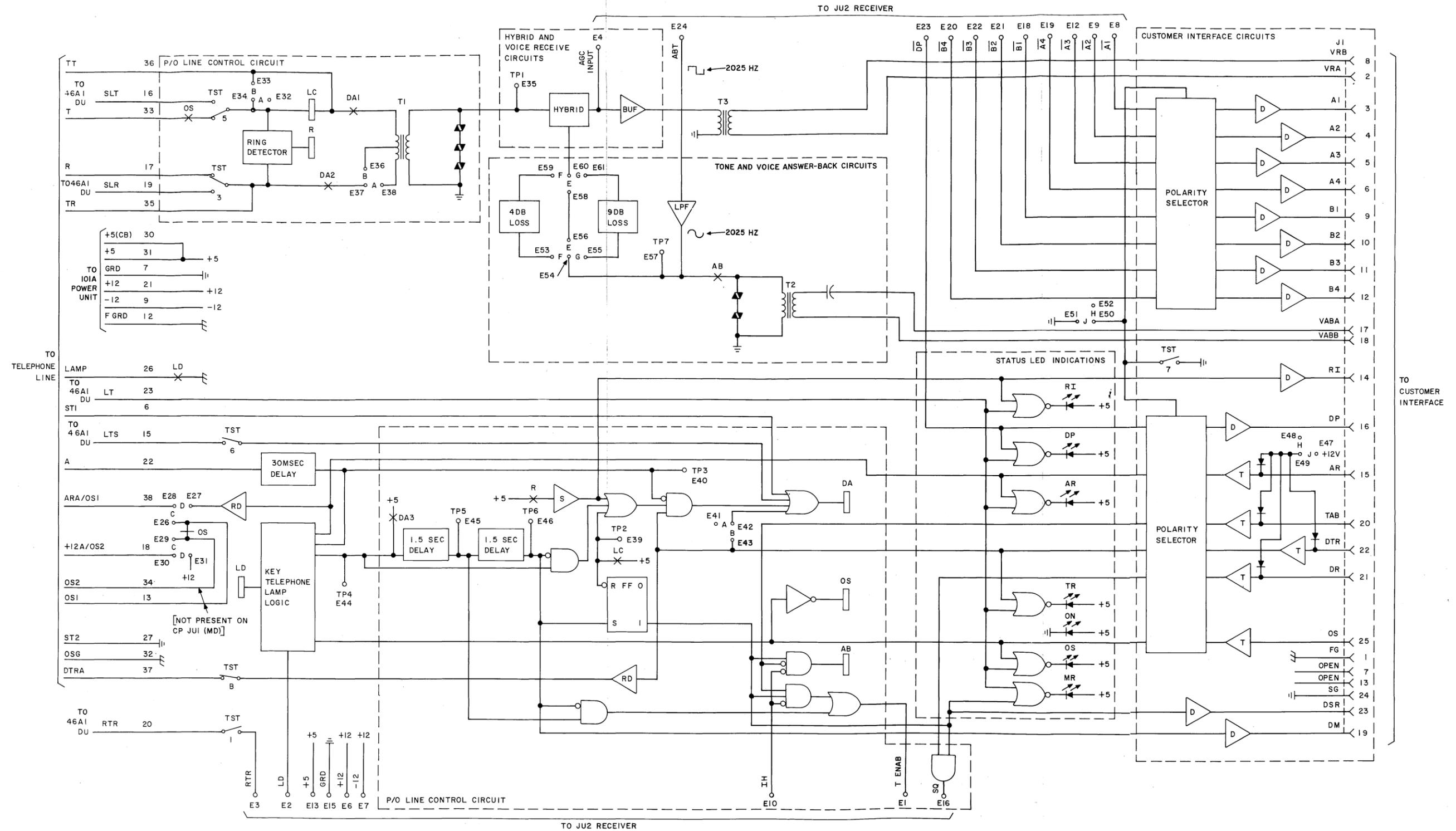


Fig. 8—Line Control and Interface JU1B CP—Functional Block Diagram

contact operates, there is a 1.5 second *quiet* interval. The *quiet* interval is followed by the transmission of 1.5 seconds of 2025-Hz tone answer-back. The 2025-Hz tone is transmitted back to the calling station, acknowledging the answer of the call. At the end of the 3-second period, line current must be present so the LC relay can remain operated. Operation of the LC relay (line holding relay) enables the DA relay to remain operated.

6.06 At the end of the 3-second time interval (6.05), the reset-set (RS) flip-flop shown in Fig. 8 is set, placing an ON indication on the DSR customer interface lead (23). The DSR lead will remain ON until the LC relay releases due to line current loss. The DM customer interface lead (19) comes ON at the same time the DSR lead comes ON. The data set is now in the data mode and ready to receive data.

6.07 When a key telephone set is associated with the data set and goes off-hook, the A lead is made (short to ground). As a result, the DA relay releases. However, line current is still being drawn through the LC relay by a current path through telephone tip (TT) and telephone ring (TR) terminals 35 and 36, respectively. The data set is now in the talk mode. When the data set is in the talk mode, DSR remains ON since the LC relay is still operated and the DM lead goes OFF.

6.08 To go back to the data mode, the HOLD key on the key telephone set is depressed. The A lead then releases. After about 50 ms the DA relay operates again. Since it takes longer than 50 ms for the path between TT and TR to break when the HOLD key is depressed, line current flows through T1 and continues flowing when the path does open. The sequence of a quiet interval followed by the 2025-Hz TAB is repeated. This sequence is repeated every time the data set is put into the data mode. At the end of the 2025-Hz tone, the DM customer interface lead (19) comes back ON. The data set is now back in the data mode.

6.09 The line control circuit will terminate the data call whenever the customer terminal turns the DTR customer interface lead (22) OFF for more than 50 ms. The DA relay will release, opening the line current and dropping the LC relay. At this time the DSR customer interface lead will go OFF informing the customer terminal that the

call has been terminated. The line control circuit is now ready for the next call.

Note: The telephone CO should *not* be relied upon for ending the call. Some COs will open the line causing disconnect, and others will disconnect by means of a time-out circuit, but these are *not* universal features of COs.

Private Line

6.10 In private line operation, the LC relay is shorted and a 600-ohm termination is given to the line facility. The DA relay is operated whenever the DTR customer interface lead is turned ON. At this time the data set is in the data mode.

Switched Network With 2B or 3A ACD

6.11 When an ACD is associated with the 407 multiple data station, the ACD answers all incoming calls. In this system, the ACD provides a short between ST1 and ST2 (terminals 6 and 27, respectively). This short causes the DA relay to operate placing the data set in data mode. When the ACD is used, option D is required in the data set, and no TALK mode is provided. When a referral is requested, the attendant is bridged onto the line. The data set can be dropped during referral and accept another call. Renewal of attendant request requires cycling of the AR lead.

Test Mode

6.12 When the data set is put in test mode, the local test start (LTS) lead (terminal 15) is grounded and the test (TST) switch is closed, operating the DA relay. The data set is now in data mode for testing purposes.

B. Tone and Voice Answer-Back Circuits

6.13 When the data set is in data mode, a 2025-Hz tone answer-back (TAB) can be transmitted from the data set when the TAB customer interface lead (20) is turned ON by the customer terminal. When the TAB lead is turned ON, the T ENAB lead is energized. When the T ENAB lead is energized, a 2025-Hz square wave is generated on the receiver board. The 2025-Hz square wave appears at the answer-back tone (ABT) lead and is coupled to the low-pass filter shown in the tone and voice answer-back circuit in Fig. 8. The low-pass filter converts the square

wave into a sine wave and provides a peak frequency response of 2025 Hz. This 2025-Hz sine wave has a power level of approximately -3 dBm.

6.14 The AB relay controls whether a tone answer-back or a voice answer-back signal is to be applied to the line. If a tone answer-back signal is to be applied to the line, the TAB lead has to be ON and the AB relay contact is *not* operated.

6.15 If a voice answer-back signal is to be applied to the line, the TAB lead has to be turned OFF by the customer terminal, and the AB relay contact is operated. When the AB relay contact is operated, voice answer-back signals can be applied to the line by the customer terminal on the voice answer-back A (VAA) and voice answer-back B (VAB) customer interface leads (17 and 18), respectively). Customer voice answer-back signals should not exceed a maximum level of $+3$ dBm. If this level is exceeded, the data set will limit it.

6.16 One of three attenuation pads can be optionally inserted in the tone and voice answer-back circuit portion of the data set. These pads attenuate the tone and voice answer-back signals which provide transmit levels as follows:

- 0 dB attenuation provides a maximum transmit signal level of -3 dBm
- 4 dB attenuation provides a maximum transmit signal level of -7 dBm
- 9 dB attenuation provides a maximum transmit signal level of -12 dBm.

C. Hybrid and Voice Receive Circuits

6.17 The hybrid network allows the detection of valid TOUCH-TONE signals in the presence of outgoing tone or voice answer-back signals. TOUCH-TONE signals from the line facility are coupled by T1 to the hybrid network and passed to the AGC amplifier unchanged in level. Tone or voice answer-back signals are passed *from* the attenuation pads to the line facility through the hybrid network with *no* change in level.

6.18 When voice signals are received from the line facility, the voice signals are coupled by T1 to the hybrid network and passed to the voice receive buffer amplifier. The voice receive

buffer amplifier passes the voice signals from the hybrid network to voice receive A (VRA) and voice receive B (VRB) customer interface leads (2 and 8, respectively) if DSR is ON. The VRA and VRB customer interface leads provide a balanced 600-ohm pair for the voice signals. If the DSR customer interface lead is OFF, the voice receive ports will be disabled.

D. Customer Interface Circuits

6.19 Twenty-three of the twenty-five leads on the customer interface connector are assigned. The two unassigned leads are spares. The 23 assigned leads are broken down into categories as follows:

- Two leads are used for passing signal and frame grounds to the customer terminal.
- Two leads are for voice answer-back ports.
- Two leads are for voice receive ports.
- Five leads are inputs to *terminators* which convert EIA voltages or contact closures to data set logic levels.
- Twelve leads are outputs of *drivers* which convert data set logic levels to EIA voltages or contact closure equivalents.

6.20 Two options are associated with the five terminators and twelve drivers. When option H is installed in the data set, the electrical interface signals for both data and control functions conform to EIA Standard RS-232-C. If option J is installed in the data set, the outputs of the drivers are also voltages which meet all electrical specifications of EIA RS-232-C except that both data and control functions are positive in the ON condition and negative in the OFF condition. The inputs to the terminators from the terminal (option J installed) may be contact closures to ground for an ON indication.

6.21 The terminators for TAB, AR, DR, and DTR customer interface leads are fail-safe to the OFF condition. This means that the terminators always go to the OFF condition when the signals from the terminal are removed from the inputs of the terminators. The terminator for the OS lead is fail-safe to the ON condition. This means that the terminator always goes to the ON

condition when the signal from the terminal is removed from the input of the terminator.

6.22 Three of the twelve output drivers (RI, DSR, and DM) are for control signals. When either option H or J is installed in the data set, the control signals are positive in the ON state and negative in the OFF state.

6.23 Nine of the twelve output drivers (A1-A4, B1-B4, and DP) are for data signals. When option H is installed in the data set, the data signals are negative in the ON state and positive in the OFF state. When option J is installed, these leads are positive in the ON state and negative in the OFF state.

E. Automatic Call Distributor Interface Circuits

6.24 When DTR comes ON in the data set, a signal is passed to the ACD on the data-terminal-ready to ACD (DTRA) terminal (37) and drives a relay in the ACD. This indication is interpreted by the ACD as a data set and terminal port ready indication. When the ACD wants to direct a call to the terminal port via the data set, the ACD provides a contact closure between ST1 and ST2 (terminals 6 and 27, respectively). This contact closure causes the DA relay to operate.

6.25 When the data set is placed in test mode, the data set and terminal port are made to look busy by opening the DTRA terminal through the TST switch in the data set. The ACD will direct any incoming calls to another idle data set when this busy indication is given.

6.26 An AR indication is given to the ACD when the customer terminal turns ON the AR customer interface lead (15). This indication (attendant request to ACD) is passed to the ACD on the ARA/OS1 terminal (38) and drives a relay in the ACD which causes the ACD to hunt for an idle referral clerk. The +12/OS2 lead (18) of the data set is used to supply +12 volts to the ACD data connecting circuit. Option D must be installed for operation with the ACD.

F. Status Lamp Indication Circuits

6.27 A telephone lamp indication is provided by the data set when a 565HK-type telephone set or a CALL DIRECTOR telephone is associated with the 407-type multiple data station. This

indication is a contact closure to ground on the LAMP terminal (26). Power for the lamp(s) associated with the key telephone sets is *not* supplied by the data set and must be supplied locally by a 412A key telephone unit or equivalent. Only one lamp can be driven directly by this lead. A slave relay must be used to drive more than one lamp. Ten volts ac power is required to power the lamp. The lamp associated with the key telephone set indicates the status of the data set as shown in Table E.

TABLE E

KEY TELEPHONE SET STATUS
LAMP INDICATIONS

MODE	LAMP STATE
Idle	OFF
Data	ON
Data and Attendant Request	Flash
Talk	ON
Out-of-Service	ON

6.28 When the data set is in IDLE mode, the lamp drive (LD) relay is *not* operated. In DATA mode, the LD relay is operated. If an attendant request is made during DATA mode, a 1-Hz square wave will be generated on the LD terminal coming out of the key telephone lamp logic circuit shown in Fig. 8. The associated lamp(s) will flash at this 1-Hz rate.

6.29 When the data set is in talk mode, the LD relay is operated. If the data set is made out of service, the LD relay is operated and the associated lamp is lighted as shown in Table E.

6.30 Seven LEDs on the front panel of the data set indicate both data set and terminal functions and are defined as follows:

- The "ON" LED indicates that power is applied to the data set.
- The terminal ready (TR) LED indicates the status of the data terminal ready signal from the customer interface.

- The ring indicator (RI) LED indicates that ringing is being applied to the data set.
- The modem ready (MR) LED indicates the status of data set ready signal to the customer interface. This LED comes ON 3 seconds after ringing is tripped, if the station is in the data mode and TR is ON. Once it comes ON, it stays ON until termination of the call, whether the line is in the talk or the data mode.
- The data present (DP) LED indicates the status of the data present signal to the customer interface. This signal (DP lamp ON) indicates that the data set is receiving data.
- The attendant request (AR) LED indicates the status of attendant request signal from the customer interface.
- The out-of-service (OS) LED indicates that the data set has been put out of service.

When the lamp test (LT) lead (23) is shorted to ground, all the above LEDs will light.

6.31 The receiver circuit pack (Fig. 9) contains the following functional circuits:

- Automatic gain control (AGC) amplifier
- Group separation filters (A group and B group)
- Group limiters and divide-by-three circuits
- Clocks and synchronization circuits
- Time-domain detectors
- Logic, timing, and inhibit circuits
- Output drivers and lockup circuits.

G. AGC Amplifier

6.32 The AGC amplifier accepts the multifrequency TOUCH-TONE signal from the line facility through the line transformer (T1) and the hybrid circuit (discussed in 6.17). The AGC amplifier provides a variable gain for the input signal to enable a constant level at the output of the amplifier.

The operating range of the AGC amplifier input is from -36 to 0 dB. The output varies a maximum of 2 dB. The AGC circuit is designed so that all the receiver circuits will have time to operate in the minimum character interval and to ignore echo signals which might cause character simulation.

H. Group Separation Filters

6.33 The output of the AGC circuit is passed to the group separation filters. The A and B group frequencies (Fig. 6) which make up the input signal (character) are separated by the two bandpass filters shown in Fig. 9. The A group bandpass filter passes the low frequencies shown in Fig. 6 and rejects all other frequencies, especially the B group frequencies. The B group bandpass filter passes the high frequencies and rejects all other frequencies, particularly the A group frequencies. Both filters provide 6 dB of gain in the bandpass.

I. Group Limiters and Divide-by-Three Circuits

5.34 After the TOUCH-TONE frequencies have been separated by the bandpass filters, each frequency passes through an A or B group limiter, as required. Each group limiter (A and B group) has a threshold in the positive-going direction. A signal which is greater in amplitude than the threshold will produce a square wave with a fixed amplitude, of a frequency which is equal to the input signal. This square wave is then passed through a divide-by-three circuit. The output of the divide-by-three circuit is also a square wave with one-third the frequency of the input square wave. The divide-by-three circuit also allows for averaging out some of the noise and phase jitter present in the signal.

J. Clocks and Synchronization Circuits

6.35 The outputs of each divide-by-three circuit and one shot multivibrator go to a synchronization circuit, which synchronizes the input signal with an A or B group clock, as required. The clocks are derived from crystal oscillators. The output of each crystal oscillator is passed to a divider circuit. The A group clock produces a frequency of 228 kHz which is passed through a divide-by-four circuit. The divide-by-four circuit reduces the A clock frequency to 57.0 kHz. The B group clock produces a frequency of 194.4 kHz which is passed through a divide-by-two circuit. The divide-by-two

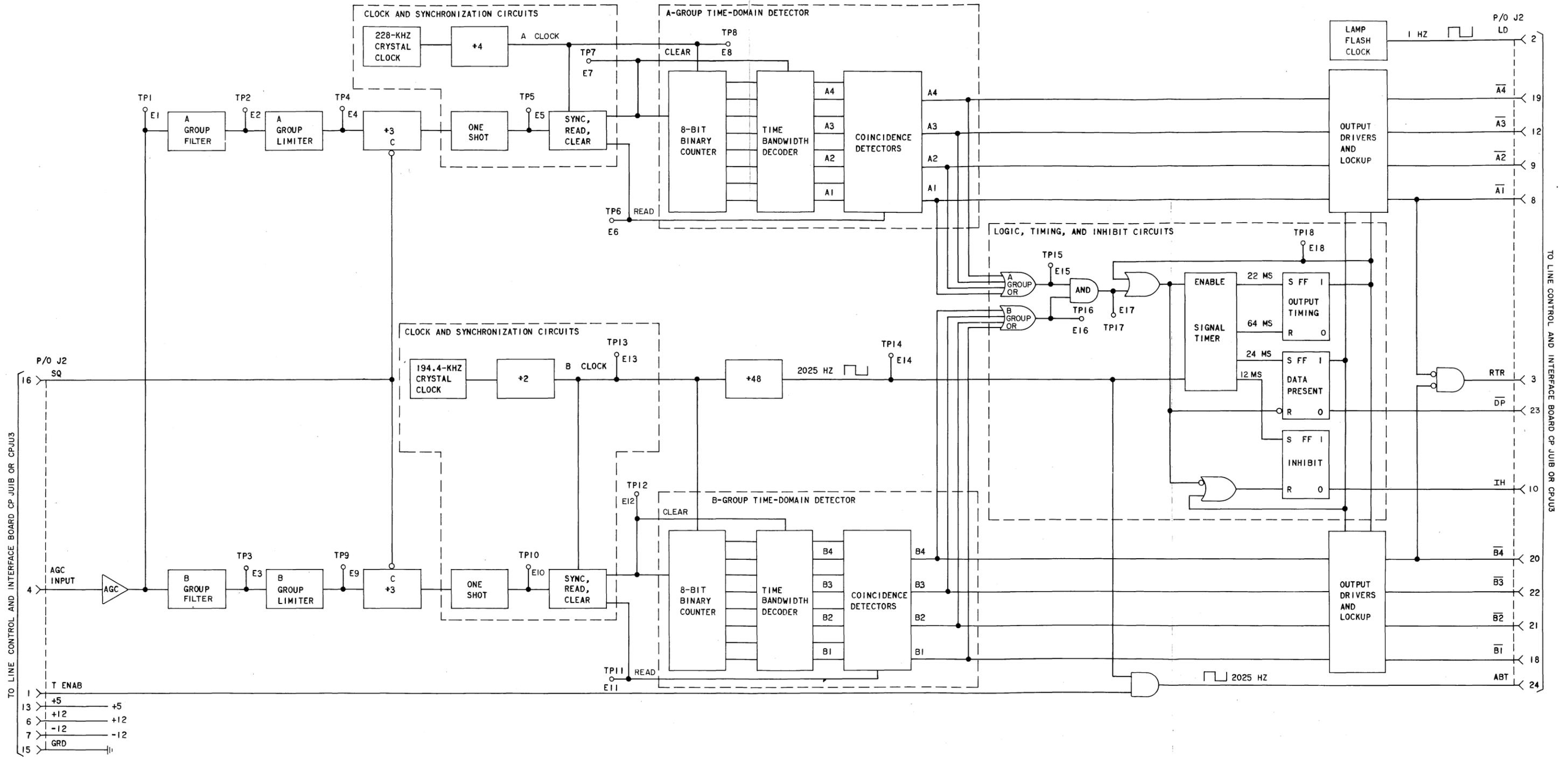


Fig. 9—Receiver JU2 CP—Functional Block Diagram

circuit reduces the B clock frequency to 97.2 kHz. The B clock frequency (97.2 kHz) is then passed through a divide-by-forty-eight circuit which generates a 2025-Hz square wave. The 2025-Hz square wave is used for signal timing and tone answer-back.

6.36 The synchronization circuit produces two pulses, each one clock-period wide. These are the READ and CLEAR pulses. The READ pulse occurs within one clock-period of every third positive-going zero crossing as shown in Fig. 10. The clear pulse starts at the end of the READ pulse.

6.37 A 1-Hz square wave is generated by the lamp flash clock to provide the lamp drive to the lamp circuit on the line control interface board.

K. Time-Domain Detectors

6.38 There are two time-domain detectors, one for each group, which are used to determine if the frequency of the input signal is valid. The READ, CLEAR, and CLOCK pulses of each group are passed to the appropriate group time-domain detector. The time-domain detectors measure the time interval between successive READ pulses in each group and determine if this time falls within one of the four specified ranges of A or B group frequencies shown in Fig. 6.

6.39 The time interval between two consecutive READ pulses corresponds to the period of the signal at the output of the divide-by-three circuit and one-shot multivibrator. The 8-bit binary counter measures the above time interval which indicates if the appropriate A or B group frequencies fall into a valid band.

L. Logic, Timing, and Inhibit Circuits

6.40 The four outputs of each time-domain detector are passed through the appropriate A and/or B group OR gate as shown in Fig. 9. The OR gate determines if any one output from the time-domain detectors has come up. The two group OR gate outputs are passed through an AND gate to determine if both outputs have come up simultaneously. The signal timer starts when an output appears at the AND gate. If the output of the AND gate is present for 22 ms, a valid TOUCH-TONE character has been received.

6.41 The outputs of the signal timer are fed into the output timing, data present, and inhibit flip-flop circuits. Once a valid signal is present continuously for 22 ms, the output timing flip-flop is set for a period of 42 ms regardless of the AND gate output. The 42-ms time period is accomplished by feedback which locks up the signal timer for 42 ms. If the output of the AND gate is removed during the first 22 ms of timing, the output timing flip-flop will *not* set. After 24 ms of timing, the data present flip-flop is set. This

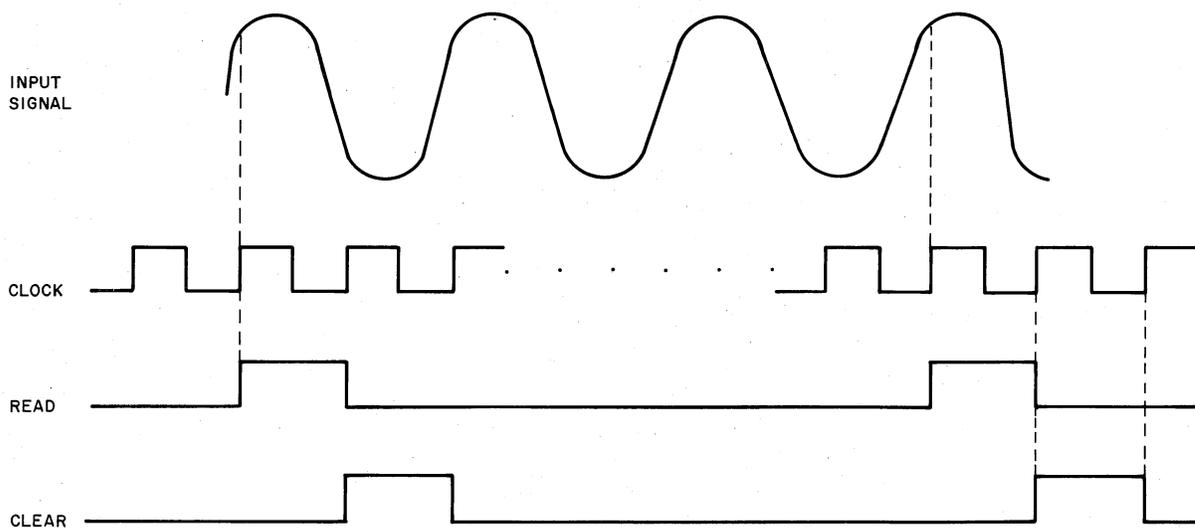


Fig. 10—Relationship of READ and CLEAR Pulses to CLOCK Pulses and Input Signal

flip-flop remains set for 40 ms or for as long as valid signals are present, whichever is longer.

6.42 The inhibit flip-flop circuit gives an output indication after 12 ms of timing. This indication is terminated after 12 ms or upon termination of the AND gate signal, whichever occurs first. The inhibit flip-flop circuit output signal causes momentary interruption of the answer-back signals. If the received signal is an answer-back signal, this interruption prevents character simulation by answer-back signals.

6.43 If the T ENAB lead is ON, the 2025-Hz clock appears at the ABT lead. When the T ENAB lead is OFF, there is no 2025-Hz clock.

M. Output Drivers and Lockup Circuits

6.44 The output of the output timing flip-flop enables the two output drivers associated with the A or B group frequencies which originally started the signal timer. Once the data present flip-flop is set (2 ms later), the drivers are disabled from giving an output so that *no* further output drivers can be activated.

DATA SET 407B

6.45 Data set 407B consists of two printed wiring boards similar to DS 407A; the line control and interface circuit (CP JU3); and the receiver circuit (CP JU2). A circuit module (CM1) is mounted between the line control and interface CP and the receiver CP. The circuit module, also referred to as the daughter board, provides the additional features of DS 407B as given in 1.07.

6.46 All of the functions of DS 407A described in 6.02 through 6.44 are also performed by DS 407B. Only the additional functions performed by DS 407B are described in the following paragraphs.

6.47 The circuits on CP JU1B (used in DS 407A) are the same as CP JU1 (MD) except for six leads which are broken on JU1B and then connected by hard wires. This is done so that the same art master can be used in manufacture of the CP JU1B and CP JU3. CP JU3 consists of a main board and a circuit module (CM1) interconnected by a cable (Fig. 11 and 12). The circuits on the main board are the same as those on CP JU1B except for the six hard wires referenced above. These wires are replaced by the cable

which interconnects the main board and the circuit module. These six wires become inputs to CM1. Other wires in the cable provide outputs from CM1 and power to CM1.

A. Special Code Detectors

6.48 The special code detectors provide for terminal-initiated referral and automatic hang-up. When a TOUCH-TONE * * (double star) appears on leads B1, A4, and DP (Fig. 12), if option K is installed, the data set will initiate an attendant request, regardless of the state of the AR lead at the customer interface. The attendant request signal from the data set can be optioned for operation with or without an ACD. During "computer down" operation, detection of * * causes a referral to an attendant and also disables the time-out feature.

6.49 Detection of the TOUCH-TONE * # * (star, number sign, star) by the shift register and special code detector causes DTR to be momentarily turned off regardless of the state of the DTR lead at the customer interface. This causes the data set to terminate the call.

B. Computer Down Circuits

6.50 The "computer down" mode is entered by a switch manually operated by computer center personnel, and/or by a circuit which monitors the state of all DTR customer interface leads of all data sets in the station. When all DTR leads are simultaneously in the OFF state, the computer is assumed to be "down" (unavailable). Either of these methods of operation may be selected by option, or the feature may be disabled.

6.51 After having determined that the computer is down, the data set automatically answers incoming calls. The computer down circuit also causes the normal 1.5-second 2025-Hz answer tone to be extended to 3.5 seconds. Automated terminals (such as the TRANSACTION telephone) calling into the system can detect this longer answer tone and take appropriate action. The computer down circuitry now examines the first character transmitted by the terminal if it is other than a * (star). If that character does not contain the B4 frequency, a 2025-Hz interrupted tone is transmitted at a 0.5-Hz rate. This provides an audible indication to calling terminals, such as the TOUCH-TONE

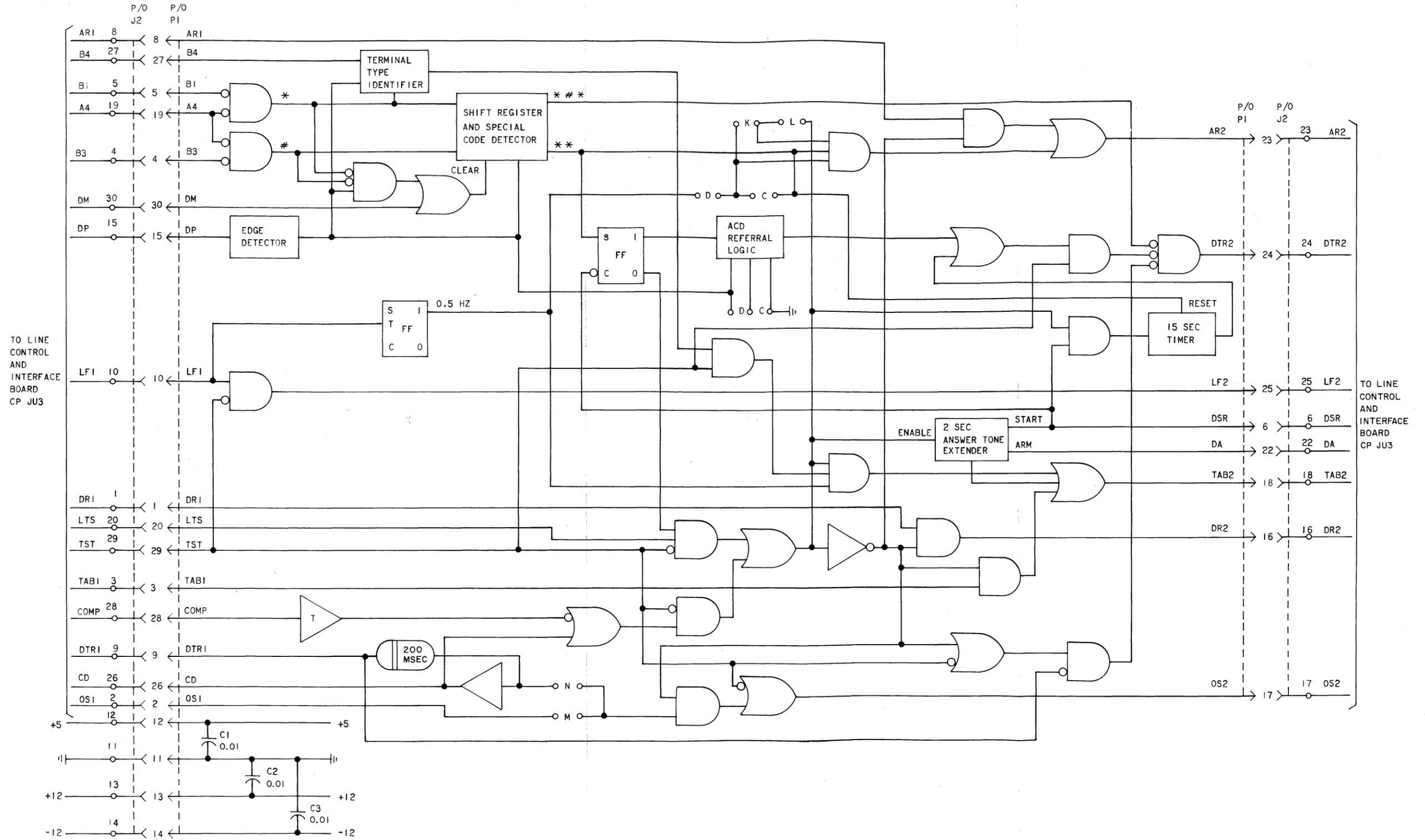


Fig. 12—Daughter Board CM1—P/O Line Control and Interface JU3 CP—Functional Block Diagram

telephone, which cannot automatically respond to the 3.5-second answer tone.

6.52 After a call has been answered as described in 6.51, a 15-second timer (Fig. 12) is started. If a * * is not received within 15 seconds, the timer runs out and the call is terminated by DTR 2 going low. During test, this feature is disabled, so that the 15-second timer can be tested. If a * * is received before the timer times out, a referral to an attendant is initiated. In a system including a 407B data station and an ACD, the data set is automatically dropped from the connection upon receiving the 2-digit attendant identification signal. The attendant then completes the transaction, while the data set is free to handle another call.

6.53 During computer-down operation, all interface control leads from the customer are ignored, except those used for detection of the computer-down condition.

41-TYPE DATA MOUNTING

6.54 The 41-type data mounting is a multiple apparatus housing which will functionally accommodate a maximum of eight data sets. The 41A1, 41A2, 41B1, and 41B2 data mountings are equipped with one 101A power unit. Only the 41A1 and 41A2 data mountings are equipped with a test unit (46A1 and 47A1 data units). The 41A1 and 41B1 data mountings are rated Manufacture Discontinued (MD), and are replaced by the 41A2 and 41B2 data mountings, respectively.

A. Test Unit of 41A1 Data Mounting

6.55 The 46A1 and 47A1 data units and an associated data set in the test mode is functionally shown in Fig. 13. The following text (keyed to Fig. 13) provides a detailed description for both remote and local testing.

Remote Test of DS 407A

6.56 When the test plug is connected to the data set 407A, the TEST switch in the data set is operated by the extension on the test plug. Contact T1 overrides the EIA option (H) if installed in the data set under test and provides the contact equivalent option (J). Contacts T2 and T3 in the data set transfer the input to the data set away from the serving telco line. At this time, the input of the data set is connected to the test circuit

in the 46A1 data unit. If the LOCAL TEST-REMOTE TEST switch is operated to REMOTE TEST, the R contacts are operated and the data set is connected to the service line. The out-of-service (OS) interface lead from the data set is grounded by the test circuit in the 46A1 data unit to make the serving telco line busy to incoming calls. If an ACD is used in the system, contact T4 in the data set opens the READY TO ACD path so no call will be directed to the data set.

6.57 When ringing comes in on the service line, the RS flip-flop in the 46A1 data unit is set (Fig. 13). This flip-flop turns on the DTR lead to the data set and causes the call to be answered. At the end of the normal hand-shaking sequence, the data set turns on the DSR lead causing the remote test LED to light.

6.58 If a valid TOUCH-TONE signal is received by the data set, detection of the signal takes about 30 ms after which the 40-ms 2-out-of-8 output signal is given. The 46A1 data unit verifies that a valid output signal has been given by means of the six EXCLUSIVE OR gates plus the 5-input AND gate followed by an inverter. When no data is present, the two inputs to the AND gate from the EXCLUSIVE OR gates are not satisfied and the output of the AND gate is OFF. This OFF condition is inverted to an ON condition which turns ON the TAB and DR leads. When TAB and DR leads are ON, the data set transmits the 2025-Hz answer-back tone and is ready to receive TOUCH-TONE signals.

6.59 When valid TOUCH-TONE signals are received, one lead in the A group and one lead in the B group should turn ON. If a failure occurs in the data set (two leads in the A or B group come up together), the EXCLUSIVE OR gates will determine that the output from the data set is invalid. In this situation, the EXCLUSIVE OR gates will *not* pass the output indications to the AND gate.

6.60 If one A and one B group frequency from the data set are present at the EXCLUSIVE OR gates (Fig. 13) and DP, DM, and DSR leads are all ON, the AND gate is satisfied and turns ON. The output of the AND gate is then inverted, turning OFF the data receive (DR) and TAB leads. The data receiver is now disabled and the 2025-Hz tone is no longer sent. This state will remain for a total of approximately 70 ms (40 ms while the

timed data output occurs and 30 ms for the delay line in the 46A1 data unit). During this time, a path to the voice answer-back port (VAA and VAB) causes the TOUCH-TONE signal sent by the data test center to be looped back to the data test center. The looped back TOUCH-TONE signal passes through the voice answer-back port during the time the 2025-Hz tone is turned OFF. When the 30-ms delay line times out, the data set is once again enabled and the answer-back tone is turned back ON.

6.61 The data test center is instructed to send TOUCH-TONE character A1-B4 last. When this character is received by the data set, the remote test release (RTR) lead is turned ON. This resets the RS flip-flop in the 46A1 data unit causing the DTR lead to be turned OFF and the data set drops the test call.

Remote Test of DS 407B

6.62 The remote test of DS 407B is similar to that of DS 407A. Additional steps are required, however, at the beginning and end of the test. After the data set is conditioned for remote test, it is called from the data test center on the service line. When ringing is detected, the test circuit causes the data set to answer in the data mode. A 2025-Hz tone is then transmitted by the data set for 3.5 seconds, followed immediately by an interrupted 2025-Hz tone which is 1 second on and 1 second off for 12 seconds. At the end of this tone the testperson generates the TOUCH-TONE sequence * *. The data set responds by sending a continuous 2025-Hz tone. At this point the test procedure for DS 407A is followed until end of test. At the end of test, the testperson sends the TOUCH-TONE sequence * # * (A₄ B₁, A₄ B₃, A₄ B₁) instead of A1-B4, and the data set terminates the call.

6.63 The local test makes use of the same test circuitry as the remote test. The 47A1 data unit (16-button TOUCH-TONE pad) is used to input signals to the data set. When the LOCAL TEST-REMOTE TEST switch is operated to LOCAL TEST, the L contacts in the 46A1 data unit are operated and the telephone line input to the data set is connected through a 20-dB loss pad to the 47A1 data unit. The 20-dB pad is inserted to check the data set's ability to operate at the low end of its dynamic range. Since no ringing is available to bring the data set up, access to the line control

circuit of the data set is provided by the LTS lead coming from the data set. The LTS lead is grounded causing the answering sequence to start. At the same time, the local LED is connected to the DSR lead of the data set to indicate when the answering sequence has been completed.

6.64 When the buttons on the 47A1 data unit are depressed and held, the same sequence takes place in the data set and 46A1 data unit as in remote test. As each TOUCH-TONE button is depressed and held, the A and B group LEDs mounted on the 47A1 data unit flash at a 10-Hz rate. The LEDs are arranged to coincide with the horizontal and vertical coordinates of the button being depressed and held.

Note: When testing DS 407B with option K installed, the AR lamp will light or flash when the * (star) key is depressed on the 47A1 data unit. If option K is *not* installed (ie, option L *is* installed), test of DS 407B is identical to the test of DS 407A.

6.65 The local test is primarily used as an installation check and as an aid to isolate a data set problem. The local test checks the ability of the data set to detect valid TOUCH-TONE signals. This means that the local test checks the receiver portion of the data set and part of the line control circuit. The local test does *not* check response to ringing of the data set. Therefore, the local test is *not* as comprehensive a test as the remote test.

B. 101A Power Unit

6.66 The ac line voltage is reduced to three lower voltages which are rectified and filtered. The three reduced voltages are used to drive a series of regulators that provide eight +5V, +12V, and -12V outputs. These eight regulators are independent of each other. This means that one regulator could malfunction and not affect the output of the other seven regulators. The test set is powered by the regulator associated with data set No. 4. Also, one regulator could malfunction (no +12V or -12V) and the ON (power) LED on data set 407-type under test would still be lighted. The ON LED indicates only the presence of +5V.

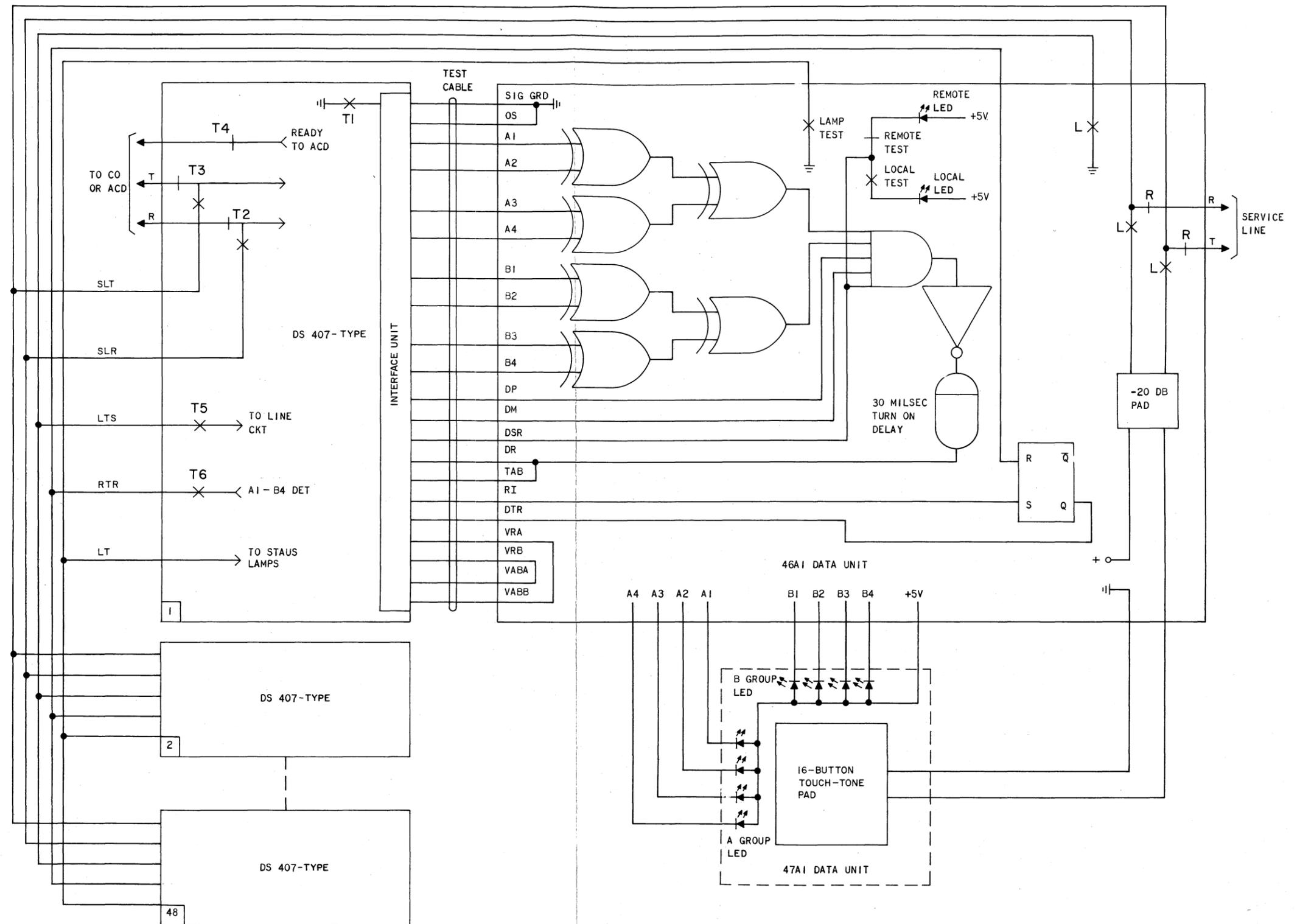


Fig. 13—407-Type Multiple Data Station Test Arrangement—Functional Block Diagram

7. MAINTENANCE AND TEST INFORMATION

7.01 Since the 407-type multiple data station is provided with a service line and an on-station test unit (46A1 and 47A1 data units), maintenance of the data station is limited to detection and replacement of defective apparatus. There are two types of test procedures, local and remote. Both tests isolate the appropriate data set (data channel) from the customer terminal and transmission facility. This isolation procedure enables the telco employee at the station to determine if a data set is satisfactory or defective. The isolation procedure is also helpful in determining if trouble exists in the terminal, hunting group, or transmission facility and thereby assists in solving system trouble. Refer to Sections 594-800-500 and 594-800-501 for test information.

7.02 If the 46A1 and 47A1 data units are suspected of malfunctioning, check the data units against a known good data set.

8. GLOSSARY OF ABBREVIATED TERMS

8.01 Abbreviations and meanings are defined as follows:

ABBREVIATION	MEANING
AB	Answer-Back
ABT	Answer-Back Tone
ACD	Automatic Call Distributor
AGC	Automatic Gain Control
AR	Attendant Request
ARA	Attendant Request to ACD
ARU	Audio Response Unit
CO	Central Office
DA	Data
DDD	Direct Distance Dialing
DIVA	Digital Inquiry Voice Answer-Back
DM	Data Mode

ABBREVIATION**MEANING**

DP	Data Present
DR	Data Receive
DS	Data Set
DSR	Data Set Ready
DTR	Data Terminal Ready
DTRA	Data Terminal Ready to ACD
EIA	Electronic Industries Association
ESS	Electronic Switching System
IDF	Intermediate Distribution Frame
IH	Inhibit
LC	Line Control
LD	Lamp Drive
LED	Light Emitting Diode
LT	Lamp Test
LTS	Local Test Start
MR	Modem Ready
OS	Out of Service
OSG	Out-of-Service Ground
PL	Private Line
R	Ring
RI	Ring Indicator
RS	Reset-Set (Flip-Flop)
RTR	Remote Test Release
SG	Signal Ground
SLR	Service Line Ring
SLT	Service Line Tip

SECTION 594-800-150

ABBREVIATION	MEANING	SECTION	TITLE
SQ	Squelch	590-000-100	Implementation of Data Services—Interdepartmental Coordination
ST1	Start 1 From ACD		
ST2	Start 2 From ACD	590-004-109	407-Type Multiple Data Station—Reference Guide
T	Tip	590-100-132	46A1 Data Unit—Identification
T ENAB	Tone Enable	590-100-133	47A1 Data Unit—Identification
TAB	Tone Answer-Back	590-102-132	41-Type Data Mounting—Identification
TELCO	Telephone Company		
TIR	Terminal Initiated Referral	594-030-100	Data Set 407-Type—Identification
TR	Telephone Ring	594-800-100	407-Type Multiple Data Station—Description
TST	Test (Relay)		
TT	Telephone Tip	594-800-101	407-Type Multiple Data Station Using 2B Automatic Call Distributor—Description
VAA	Voice Answer-Back A		
VAB	Voice Answer-Back B	594-800-200	407-Type Multiple Data Station—Installation and Connections
VRA	Voice Receive A	594-800-300	407-Type Multiple Data Station—Maintenance
VRB	Voice Receive B		
9. REFERENCES			
9.01	The following documents pertain to the 407-type multiple data station.	594-800-500	407-Type Multiple Data Station—Test
NUMBER	TITLE	SECTION	TITLE
SD- & CD-1D240-01	Data System Station—Data Set 407-Type	594-800-501	407-Type Multiple Data Station Using 2B Automatic Call Distributor—System Test
SD- & CD-1D241-01	Power Unit 101A	668-104-540	Data Test Center 904A- and 904C-Types—407-Type Multiple Data Station—Loop-Back Test
SECTION	TITLE	SECTION	TITLE
476-270-203	2B Automatic Call Distributing System—Cabling and Cross Connects	981-235-101	2B Automatic Call Distributor—General Description Information