

53A1 DATA UNIT

DESCRIPTION, OPERATION, AND TESTS

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1. GENERAL

1.01 This section contains information to enable telephone company (telco) personnel to use the 53A1 data unit (DU). The section contains a physical and functional description of the data unit, and information on testing the data unit.

1.02 When this section is reissued, the reason for reissue will be presented in this paragraph.

1.03 The 53A1 DU provides a comparatively simple and inexpensive method of performing dynamic start-up tests for a group of synchronous data sets, as follows:

- 201C (2400 bps, DDD & PL)
- 208A (4800 bps, PL)
- 208B (4800 bps, DDD)
- 209A (9600 bps, PL)

1.04 The unit is compact, self-contained, and powered by the data set under test. The unit is recommended for use on customer premises to aid in isolating causes of start-up errors between data set, terminal, and line. It provides a nearly complete test of the data sets and facility because it simulates the typical customer terminal operation on an end-to-end basis over the same facilities that the customer uses.

1.05 The data unit can perform a start-up test on these typical data set applications:

- Point-to-point private line and switched network. An exception is that the data unit cannot be used on 4-wire applications where both ends are continuous carrier.
- Multipoint private line.

1.06 In using the data unit to test the above applications, the test can be made using exactly the same options that the typical customer uses. An exception is that where the customer externally times the data set, the data unit cannot be used unless the data set option is changed to internal timing. The exception does not apply when testing data sets (DSs) 201C and 208A that are remote stations of a 209A extension service. For these sets, no option change is necessary as long as the data unit connects at the same point

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that the customer's terminal previously connected (through an M23B cord).

1.07 The data unit can also be used in analog loopback and digital loopback testing, remote testing of a 208B, and in certain end-to-end tests with a 914B or 914C data test set (DTS).

2. PHYSICAL DESCRIPTION

2.01 The 53A1 DU (Fig. 1) measures 24 cm long by 13 cm wide by 1 cm high (9 1/2 in. by 5-1/4 in. by 3/8 in.), and is contained in a plain aluminum housing. The unit with cables weighs about 0.45 kg (1 pound). The width is narrow enough to fit between the feet of a 201-type DS and the height is sufficiently low to fit between a shelf and a data set or between stacked data sets.

2.02 A three-connector cable is attached to the unit to provide connections to customer and telco connectors of the data set under test. The third connector provides a feedthrough of the telephone interface to allow connection of the data channel for switched network or private line data sets.

2.03 The data unit derives its power from the data set under test. Power requirements are as follows:

- 12 volts @ < 14 mA
- +12 volts @ < 10 mA
- +5 volts @ < 100 mA.

2.04 Operating temperature range of the 53A1 DU is 0 to 70° Celsius (32 to 158°F) with a relative humidity range of 20 to 95 percent.

2.05 The front panel of the data unit (Fig. 2) contains four bat-handle toggle switches, two slide switches, a green (CO) light emitting diode (LED), a red (ER) LED, and an ER jack for connection to an external counter.

2.06 Because of its small size, the 53A1 DU may be stored in the maintenance kit for DSs 208 and 209.

3. FUNCTIONAL DESCRIPTION

Basic Operation

3.01 The data unit is designed to perform a start-up test on the data sets listed in paragraph 1.03. Both registered and unregistered versions of these data sets may be tested with the 53A1 data unit. In general, each test is performed with field-installed options on the data set under test, especially for those options that have been chosen according to channel conditions, such as transmit level and equalizer setting. ***In no case should the external timing option be installed on a data set while the data set is being exercised by a 53A1 DU, except as noted for extensions off a DS 209A.***

3.02 In analog loopback tests of DS 209A, each port of the customer interface may be tested

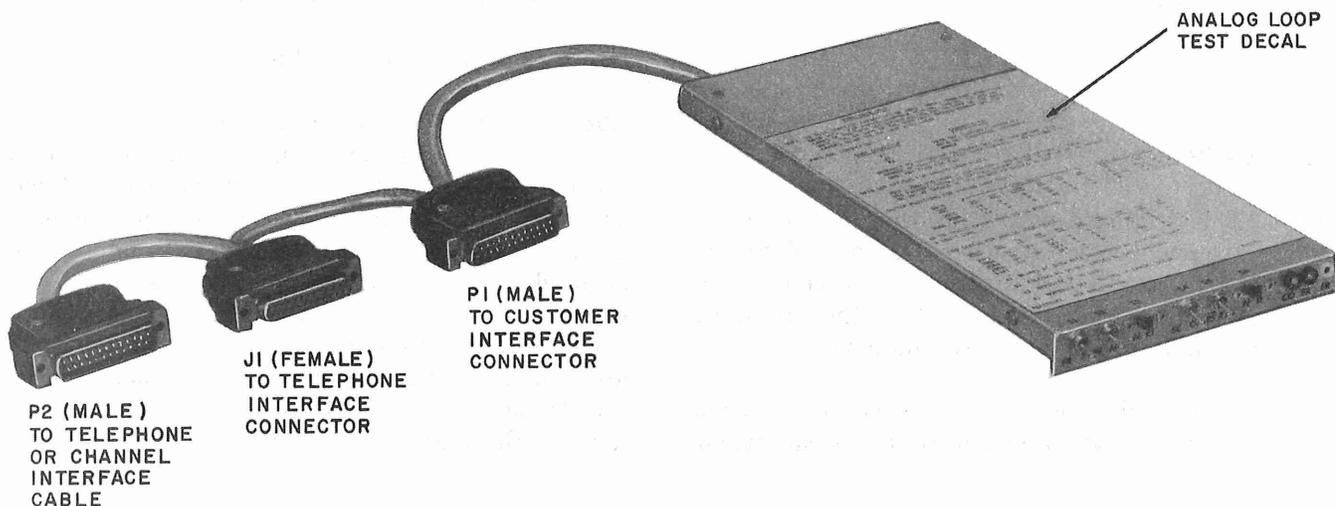
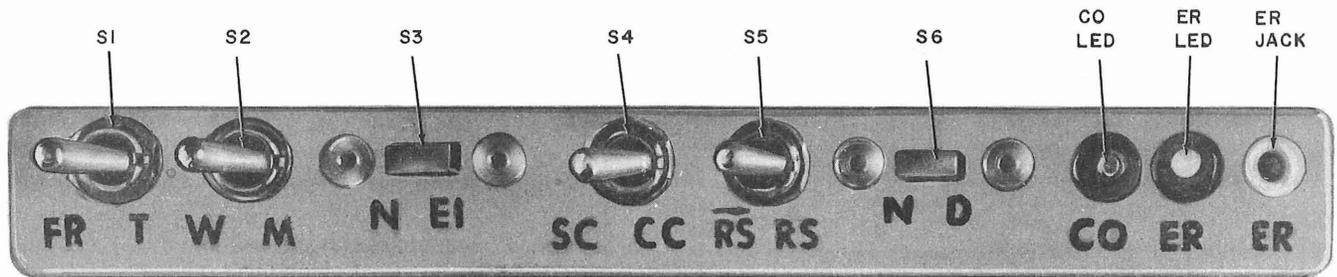


Fig. 1—53A1 Data Unit—Overall View



SWITCH	POSITION		FUNCTION
	LEFT	RIGHT	
S 1	FR	T	FREE RUN - TRIGGERED WORD-MARK
S 2	W	M	
S 3	N	EI	NORMAL-ERROR INJECT
S 4	SC	CC	SWITCHED-CONTINUOUS CARRIER * RS OFF - RS ON †
S 5	RS	RS	
S 6	N	D	NORMAL-DISCONNECT
LED			FUNCTION
CO ER			CARRIER ON ERROR DETECTED
JACK			FUNCTION
ER			BLOCK ERROR PULSE (FOR EXTERNAL COUNTER)

* SC ALLOWS COMPARATOR TO START WHEN COD GOES HIGH.
CC ALLOWS CHOICE OF \overline{RS} OR RS TO START COMPARATOR.

† INSTRUCTS 53A1 DU TO START COMPARATOR WHEN
RS IS OFF OR ON. ONLY ENABLED WHEN S4 IS IN CC POSITION.

Fig. 2—53A1 Data Unit—Front Panel

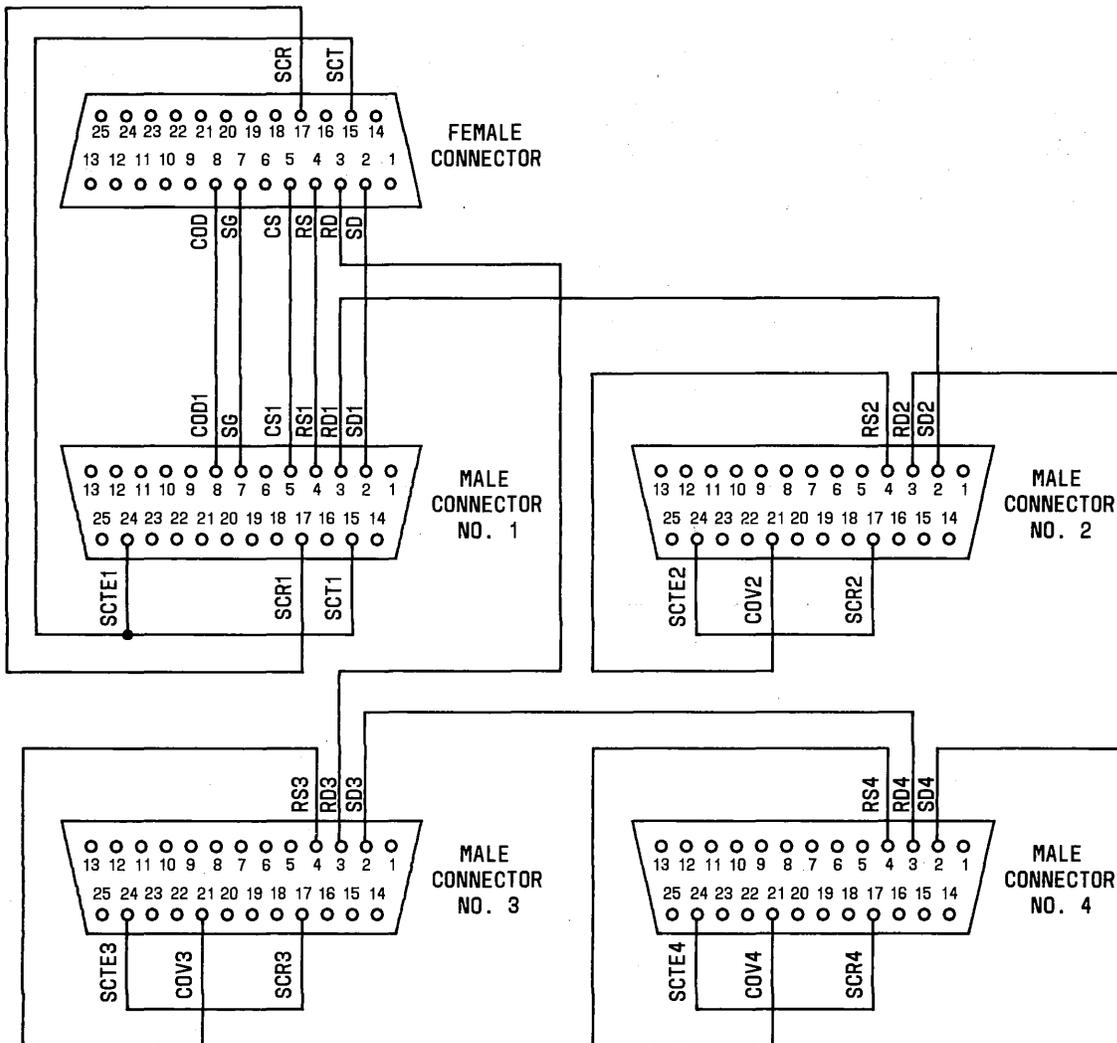
individually, or all four ports may be jumpered together using a special cable shown in Fig. 3. When end-to-end or digital loopback tests are made with selected DS 209A ports, take care to use the same port at each end and select the proper speed of operation for each port. The 53A1 DU will test all multiplex combinations of DS 209A as long as the correct speed and port are chosen at each end of the channel. For the analog loopback test using the special jumper cable shown in Fig. 3, each of the four ports must operate at 2400 bps (bits per second).

Circuit Function

3.03 Start-up capability of the data set under test is determined by transmitting and detecting a data bit sequence through the customer interface (Fig. 4). The test sequence is periodically cycled **on** and **off** by means of a count-down circuit that is driven by the clock of the data set under test to produce the following functions:

- Turn request-to-send (RS) **on** and **off** with a period proportional to transmitter signal

A - CONSTRUCT THE FOLLOWING CONNECTOR ARRANGEMENT



- B - PLUG MALE CONNECTOR NO. 1 INTO CUSTOMER INTERFACE CONNECTOR NO. 1 OF 209A.
 PLUG MALE CONNECTOR NO. 2 INTO CUSTOMER INTERFACE CONNECTOR NO. 2 OF 209A.
 PLUG MALE CONNECTOR NO. 3 INTO CUSTOMER INTERFACE CONNECTOR NO. 3 OF 209A.
 PLUG MALE CONNECTOR NO. 4 INTO CUSTOMER INTERFACE CONNECTOR NO. 4 OF 209A.
 PLUG FEMALE CONNECTOR INTO THE MALE CONNECTOR OF THE 53A1.
 PLUG THE FEMALE CONNECTOR OF THE 53A1 INTO THE TELEPHONE INTERFACE OF 209A.
- C - USING THIS CONNECTOR ARRANGEMENT WILL ENABLE ALL FOUR OF THE ELASTIC STORES TO BE TESTED BY TAKING PD1 AND FEEDING IT TO SD2; TAKING RD2 AND FEEDING IT TO SD4; TAKING RD4 AND FEEDING IT TO SD3; AND TAKING RD3 AND FEEDING IT BACK TO THE 53A1 FOR COMPARISON. THE DATA SHOULD BE PRESERVED AND NO ERROR SHOULD BE DETECTED.

Fig. 3—Special Cable for Analog Loopback Start-Up Tests on Data Set 209A

element timing (SCT) of the data set under test.

- Send on send data lead (SD) the repetitive 5-space, 5-mark pattern0000011111..... after clear-to-send (CS) turns **on**. When CS is **off**, SD is held marking (all 1s).
- Turn on green LED upon detection of the first mark-to-space transition on the received data (RD) lead after the received line signal detector (COD) in the data set turns **on**.
- Check that the RD sequence for the first 224 to 240 word patterns is identical to the SD sequence starting with the first mark-to-space transition. Any difference between the two 5-bit sequences during a fixed interval after COD turns **on** will cause the red ER LED to light momentarily.

3.04 The number of word patterns actually checked is a function of the 53A1 DU; the comparator circuit in the data unit shuts off after 224 to 240 word patterns have been checked. To provide a proper test of each type of data set the minimum test duration (100 cycles of RS lead) should be as follows:

<i>Data Set</i>	<i>Test Time</i>
201C	14 1/2 minutes
208A or 208B	7 1/4 minutes
209A	3 3/4 minutes

Modes of Operation

3.05 Two basic modes of operation are available on the 53A1 DU: free-running (FR) and triggered (T). The unit also can transmit its own 5-space, 5-mark word pattern (W) or send a steady mark (all 1s) pattern (M).

3.06 For private line data set tests, a choice exists between switched carrier (SC) and continuous carrier (CC) operation. Switches are provided on the front of the data unit for each of these functions. CC and SC positions correspond to the state of the carrier received at the near-end data set (except in some digital loop cases). Additional switches are provided for deliberate error inject (EI) and steady space transmission (D) to send a

disconnect signal to the far-end data set for terminating a remote test of DS 208B. Switches N-EI and N-D remain in normal (N) position until needed. The carrier switch remains in SC position except as specified otherwise.

3.07 The remaining switch provides a choice of request-to-send (RS) or the inverse of request-to-send (\overline{RS}) for enabling the error detection comparator. The \overline{RS} -RS switch is not operative during any test unless the SC-CC switch is in the CC position.

Basic Theory of Operation

3.08 Approximately 1000 word patterns (if W is selected) are transmitted in the **on** half-cycle of the unit, and the CO LED on the data unit is lighted during the receive half-cycle. The first 224 to 240 of the received word patterns are checked against the transmitted pattern as they are received, depending on clock synchronization with the received data stream. If any bits are in error, the ER LED will light momentarily. The error checking circuitry is only capable of reporting one error per block, regardless of the number of bit errors in the block. Any error is regarded as a block error. To count block errors, an ER jack is provided, into which a commercial digital counter, or a 914B DTS with high (> 10 kohm) input impedance may be connected.

4. TYPES OF TESTS

Analog Loopback Start-Up Test

4.01 Operate switches on the 53A1 DU to the positions shown in Table A for the particular data set to be tested.

4.02 Connect the data set to be tested to the 53A1 DU per Fig. 5.

4.03 Depress AL switch on data set to begin the test. A good data set should not make any errors in an analog loopback test. Passing the AL test is no assurance that the data set will operate properly end-to-end.

4.04 Although W is recommended since it is a more complete test, the AL test may be performed with an all-mark signal by selecting the M pattern instead of the W pattern. For the M condition, the data unit **on-off** cycle remains the

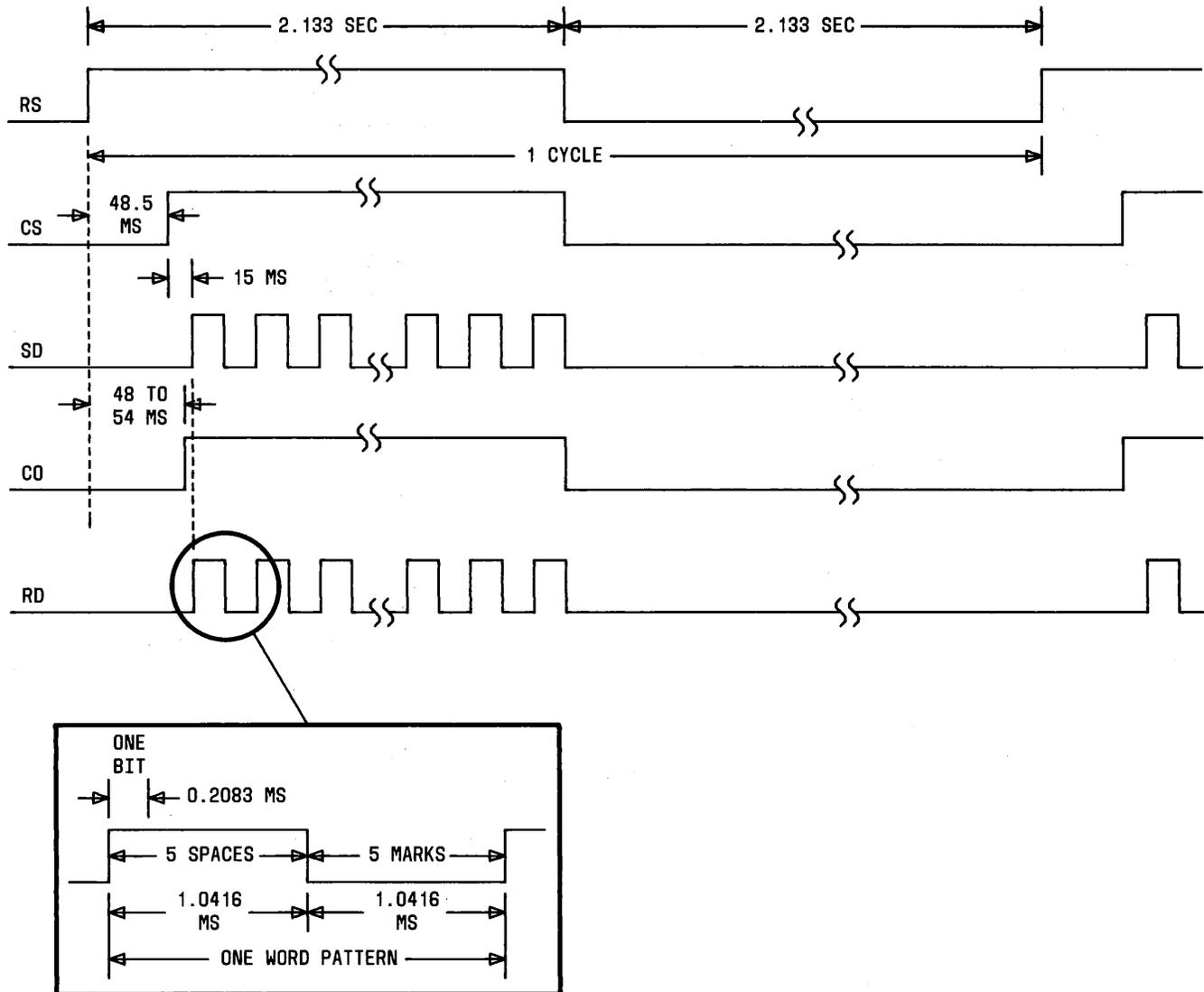


Fig. 4—Waveforms for 53A1 Data Unit/DS 208B in AL Mode—Typical

same as that observed by the LEDs of the data set but the CO LED on the data unit will not light for the *on* half-cycle. Instead, when a space “hit” occurs, both the CO and ER LEDs on the data unit will light momentarily, indicating a block error.

4.05 As shown by the label on top of the data unit, the LED configurations and nomenclature are different for each data set. In general, the RS LED will blink *on* during each *on* half-cycle of the data unit and *off* during the *off* half-cycle. The CS and CO LEDs follow RS after a very short delay. The ER (or MC) LED of the data set should be *off* when CO is *on* and *on* when CO

is *off*. (CO is always *on* in continuous carrier cases). The ER (or MC) LED on the data set is not used as an error indication for the AL test since it will not recognize bit errors in a word pattern test. The ON, TR, and MR LEDs on the data set retain their normal function. The data unit provides the data terminal ready (DTR) signal required to turn TR *on*.

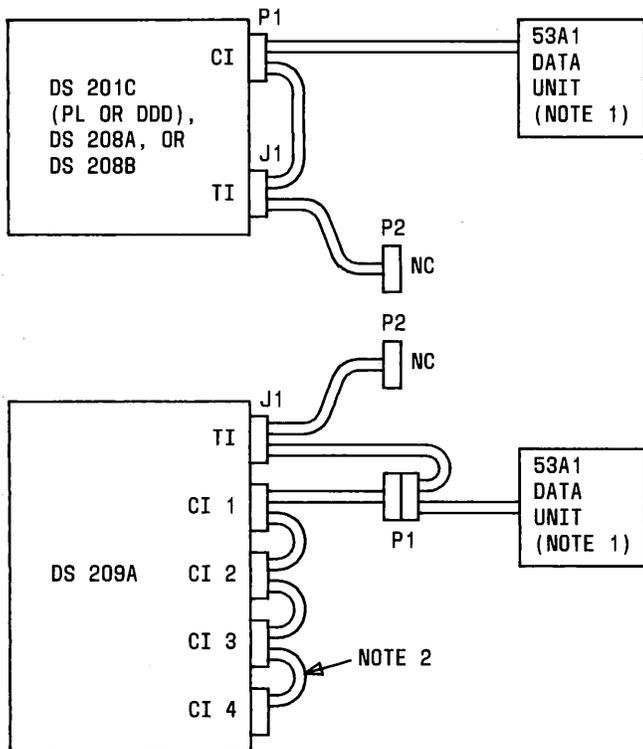
End-to-End Start-Up Tests

4.06 Operate switches on the 53A1 DU to the positions shown in Table A for the particular data sets to be tested.

TABLE A
53A1 SWITCH POSITIONS

TEST	DATA SETS	S1		S2		S3		S4		S5		S6		
		FR	T	W	M	N	E1	SC	CC	RS	RS	N	D	
1 - Analog Loopback	Switched Carrier	X		X		X	*	X		†	†	X		
	Continuous Carrier	X		X		X	*		X		X	X		
SWITCHED NETWORK														
2 - End-to-End (Near End) (Far End)	201C, 208B	X		X		X	*	X		†	†	X		
			X	X		X	*	X		†	†	X		
3 - Far End to 914 (Far End)	201C, 208B	X			X	X	*	X		†	†	X		
4 - Remote Test (Near End)	208B Only		X		X	X	*	X		†	†	X	‡	
PRIVATE LINE														
5 - End-to-End (SC-Near End) (SC-Far End)	 201C, 208A, 209A 	X		X		X	*	X		†	†	X		
				X	X		X	*	X		†	†	X	
6 - End-to-End (CC-Near End) (SC-Far End)			X		X		X	*	X	X	†	†	X	X
				X	X		X	*		X	X		X	X
7 - Far End to 914 (SC-Far End)			X			X	X	*	X		†	†	X	
8 - Digital Loopback (SC-Near End)			X		X		X	*		X		X	X	
9 - Digital Loopback (CC - Both Ends)		X		X		X	*		X		X	X		
10 - Digital Loopback (CC-Near End) (SC-Far End)		X		X		X	*		X		X	X		
		X		X		X	*		X		X	X		
11 - Digital Loopback (SC-Near End) (CC-Far End)	Not Allowed													

* Use for deliberate error inject. (Not operable if local data set is optioned for continuous RS.)
 † Don't care.
 ‡ At end of test.
 SC = Switched Carrier
 CC = Continuous Carrier



NOTES:

1. SWITCH POSITIONS FR, W, N, SC, \overline{RS} , N (SWITCHED CARRIER) FR, W, N, CC, RS, N (CONTINUOUS CARRIER)
2. SPECIAL ANALOG LOOPBACK CABLE (OR TEST EACH PORT INDIVIDUALLY)
3. ERROR INJECT IS NOT OPERABLE IF DATA SET IS OPTIONED FOR CONTINUOUS RS.

Fig. 5—Analog Loopback Start-Up Test Connections

4.07 Connect the data sets to be tested to the 53A1 DU per Fig. 6. Establish a telephone connection over the switched network to the far end, or connect to a 4-wire channel for private line sets. Data sets remain optioned as field installed.

4.08 **On the switched network**, one 53A1 DU is operated in free-run (FR) mode and the other in triggered (T) mode. The data units will fall into push-pull synchronization with each other. During the time synchronization is being established the ER LED should be ignored. Synchronization should occur within 2 cycles of the RS lead (Fig. 4).

4.09 As the near end transmits patterns (W), the far end detects carrier and enables its comparator to begin comparison on the first

mark-to-space transition on the RD lead. The CO LED will light on the far-end data unit when the first transition is detected. When the near end stops transmitting, the carrier goes off; consequently, the far-end CO LED will turn **off**.

4.10 The far-end data unit then turns RS **on**, followed by CS **on**, and begins to transmit its own word pattern back to the near end, where the process is repeated. The data set LEDs should operate in the normal transmit and receive manner.

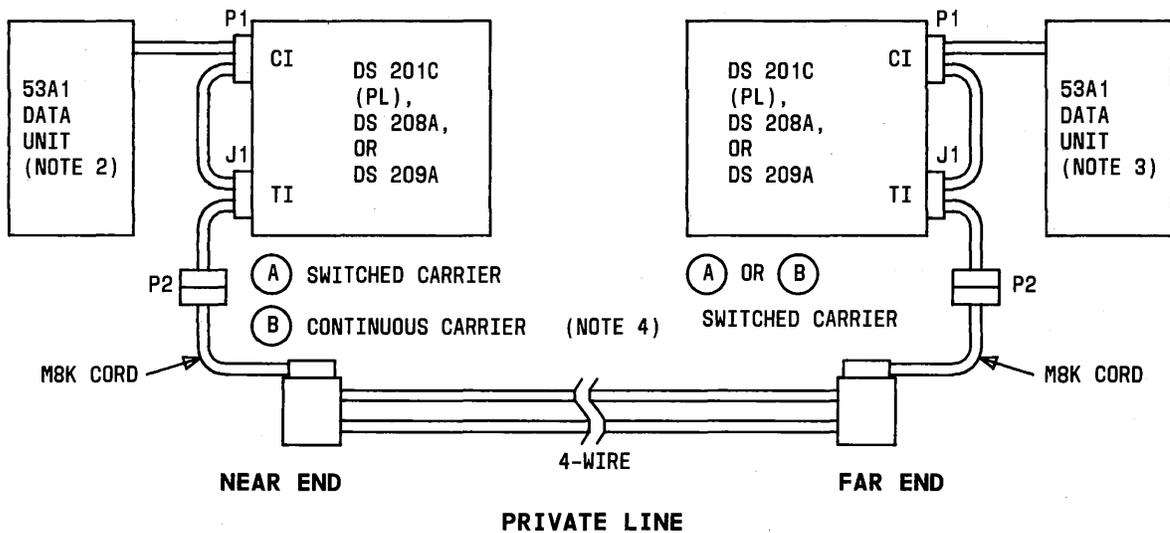
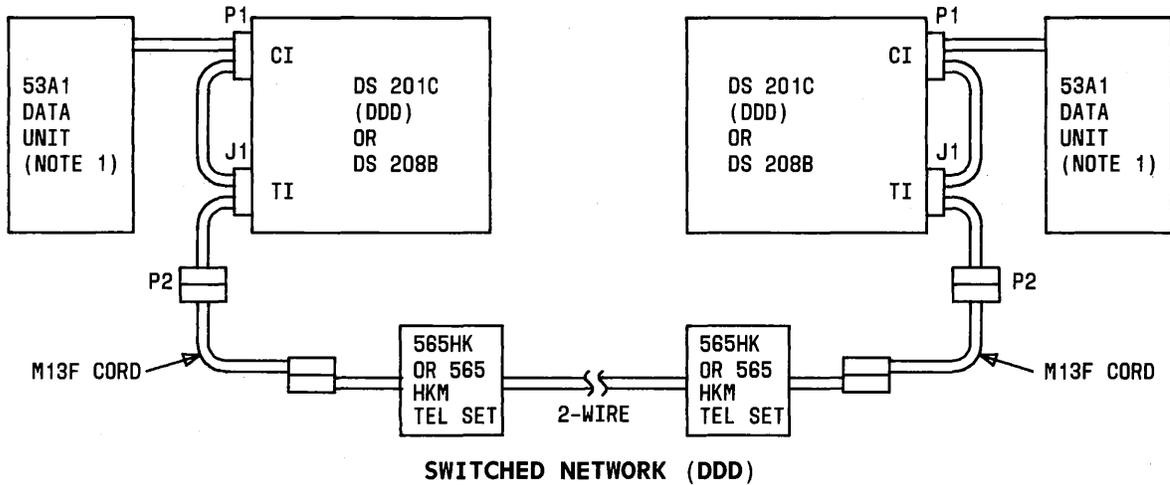
4.11 Both ends must transmit the word pattern (W) in order that proper reception can be determined during the start-up interval at each end. If errors occur in reception at either end, the associated data unit ER LED will blink to indicate a block error.

4.12 **On private lines**, end-to-end tests are divided into two categories: switched carrier at both ends, and continuous carrier at one end. Except for a digital loopback test, the 53A1 DU cannot be used where continuous carrier is employed at both ends.

4.13 Operation of the 53A1 DU on private lines is similar to operation over the switched network, except for the switch positions, as shown in Table A. If data sets at both ends are optioned for switched carrier, the 53A1 DUs will operate in push-pull (as with the switched network) if one data unit is set for triggered mode (T) and the other data unit is set for free running mode (FR). The FR end controls synchronization.

4.14 If the near-end data set is optioned for continuous carrier, the local data unit must be set for triggered (T) mode. The far-end data unit must be set as follows: FR, CC, \overline{RS} . The far-end data set must be optioned for switched carrier. Data set lamp operation will follow the normal send-receive cycle, except that the CO LED at the end **receiving** continuous carrier will remain **on**.

4.15 The number of repetitions of the word pattern (0000011111) transmitted per RS cycle by each 53A1 DU in end-to-end tests is dependent upon options selected for the test and inherent data set and data unit delays. As with the analog loopback test, only the first 224 to 240 word patterns of each cycle received at either end are checked by the comparator. An allowable block



NOTES:

1. SELECT SWITCH POSITIONS FR, W, N, SC, \overline{RS} , N, FOR NEAR END; T, W, N, SC, \overline{RS} , N FOR FAR END.
2. FOR (A), SELECT SWITCH POSITIONS FR, W, N, SC, \overline{RS} , N
FOR (B), SELECT SWITCH POSITIONS T, W, N, SC, \overline{RS} , N
3. FOR (A), SELECT SWITCH POSITIONS T, W, N, SC, \overline{RS} , N
FOR (B), SELECT SWITCH POSITIONS FR, W, N, CC, \overline{RS} , N
4. ERROR INJECT IS NOT OPERABLE IF DATA SET IS OPTIONED FOR CONTINUOUS RS.

Fig. 6—End-to-End Start-Up Test Connections

error rate is one block error per 100 cycles of the RS lead (see 3.04).

Digital Loopback Start-Up Test

4.16 Operate switches on the 53A1 DU to positions shown in Table A for the particular data set to be tested.

Note: This test applies only to 4-wire private line data sets. This test cannot be used when the near end (with 53A1 DU) is switched carrier and the far end (in DL mode) is continuous carrier.

4.17 Connect the data set at the near end to the 53A1 DU as shown in Fig. 7. Connect the data set to a 4-wire private line using an M8K cord. At the far end, have the same type data set connected to the far-end 4-wire private line channel, using an M8K cord (Fig. 7). Have the person at the far end depress the DL switch. No other switches should be depressed.

4.18 When the switches are properly set and the line connections are made, the test automatically begins immediately. Disregard any ER LED indication that occurs during the first 2

cycles after connection is made. During this period, synchronization is being established. The error count for a normal channel should not exceed one block error in 100 cycles of the RS lead.

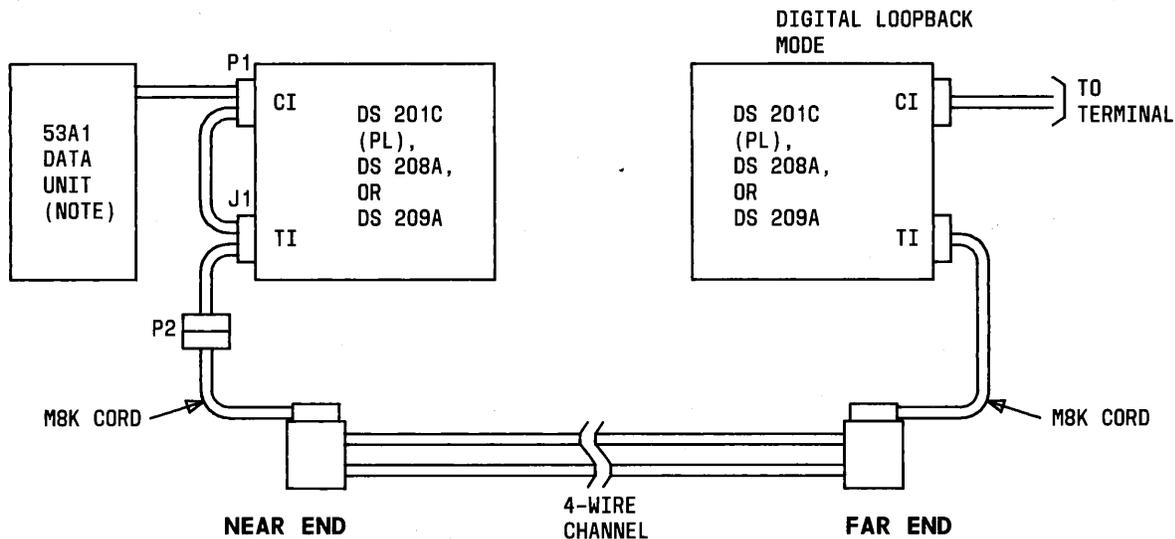
Remote Start-Up Test (DS 208B-Type Only)

4.19 Operate switches on the 53A1 DU to the positions shown in Table A for the particular data sets to be tested (ie, DS 208B-type).

4.20 Connect the data set at the near end to the 53A1 DU as shown in Fig. 8. Connect the 53A1 DU P2 connector to the 565HK telephone set via an M13F cord. At the far end, have the DS 208B connected as shown in Fig. 8, and have the RT switch depressed.

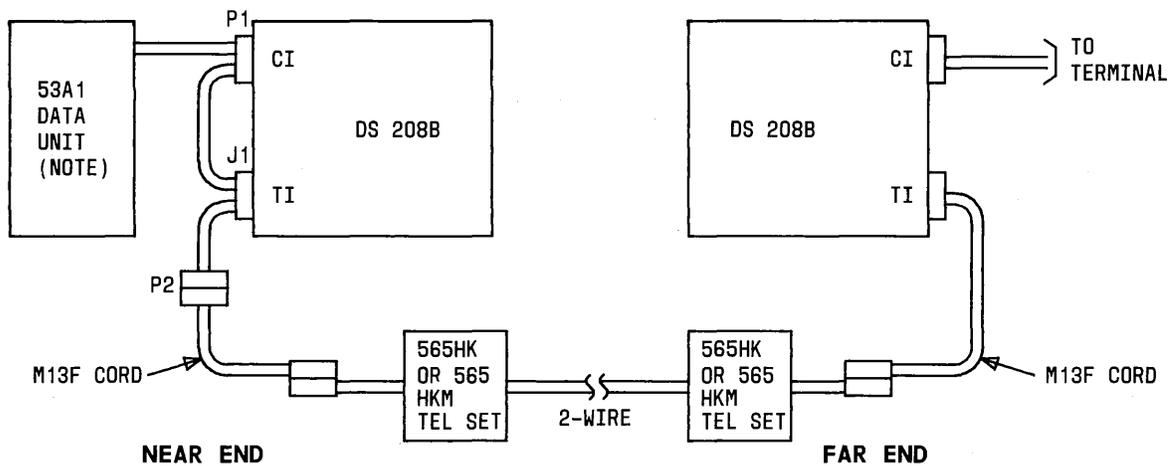
4.21 The mark pattern must be transmitted from the 53A1 DU, since the far end can only detect errors for a steady MARK condition. The 53A1 DU functions only to cycle the RS lead and produce continuous MARK on the SD lead. The test will begin automatically when connections have been established.

4.22 At the far end, DS 208B monitors the MARK signal and responds by returning a MARK



- NOTES:
1. SWITCHED CARRIER (NEAR END), CONTINUOUS CARRIER (FAR END) NOT ALLOWED.
 2. SELECT SWITCH POSITIONS FR, W, N, CC, RS, N FOR ALL TESTS.
 3. ERROR INJECT IS NOT OPERABLE IF DATA SET IS OPTIONED FOR CONTINUOUS RS.

Fig. 7—Digital Loopback Start-Up Test Connections



NOTE:
SELECT SWITCH POSITIONS T, M, N, SC, \overline{RS} , N
(MARK PATTERN ONLY)

Fig. 8—Remote Start-Up Test Connections (DS 208B Only)

signal if no errors (SPACE hits) occur. In the event an error does occur, the remote data set will return a SPACE signal for 1 full second, which is interpreted by the near-end 53A1 DU as a block error.

4.23 To accommodate DS 208B-L1B or 208BR-L1C, which has a 1.25-second monitor period, the half-cycle of test signal from the 53A1 DU is 2.13 seconds in length. Since transmission is normally all MARK, the CO and ER LEDs on the 53A1 DU will remain *off* unless a block error occurs. When a block error does occur, the CO and ER LEDs will briefly illuminate simultaneously.

4.24 Occasionally the CO LED may blink as the CO lead of the receiving data set turns *off*. This is a normal occurrence and should not be considered an error. An error (SPACE) will cause the ER LED to illuminate. A block error rate of 1 in 100 cycles of the RS lead is allowable.

Far End to 914 DTS Start-Up Test

4.25 When a 914 DTS is available at the near end, tests may be performed on both private lines and the switched network using a 53A1 DU at the far end.

4.26 Have the far end set switches on the data unit as shown in Table A for the particular data set to be tested. Set the matrix and switches on the 914 DTS as shown in Table B.

4.27 Make connections at each end as shown in Fig. 9 for the particular data sets to be tested. The test will start automatically when all connections are made. The 914 DTS will monitor errors in the MARK pattern, and individual errors will be counted, rather than block errors as in all the other tests described herein. Take care to ignore counts that occur as CO turns *off* at the local data set. On private line installations, the far-end data set must be operated in switched carrier mode; the near-end data set may be operated in either switched carrier or continuous carrier mode.

Note: This test is used to test the start-up capability from the far-end data set through the channel to the near-end data set connected to the 914 DTS.

4.28 A block error rate of 1 in 100 cycles is allowed. A block error is one or more hits occurring as CO turns *on*.

TABLE B

914 DTS MATRIX AND CONTROLS FOR FAR-END TEST

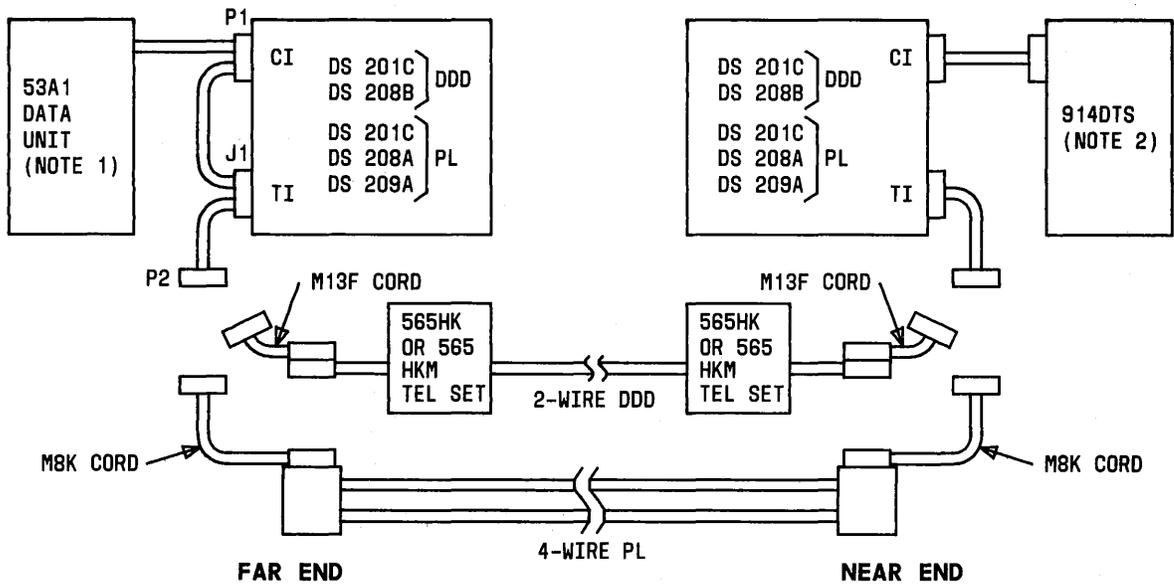
HORIZONTAL	VERTICAL	PIN	FUNCTION
GRD	1, 7	RED	
S1	4	RED	RS (DOWN = OFF)
DS1	4	RED	
S2	2	RED	SD (DOWN = MARK)
DS2	2	RED	
DS3	3	RED	RD (OFF = MARK)
TP1	3	WHITE	(DIODE)
TP1	17	YELLOW	(RESISTOR)
TP1	13	RED	
S4	14	RED	NS (DOWN = OFF)
SCR	13	RED	
S6	20	RED	DTR (UP = ON)
DS6	20	RED	
DS8	8	RED	COD (OFF = CARRIER OFF)
CONTROL		SETTING	
TEST SET MODE BIT RATE COUNTER SIGNAL LEVEL INTERFACE MODE RS SD DTR NS		RCV SER EXT + (RECEIVE) BIT ERRORS ± 4V VOLTAGE DOWN DOWN UP DOWN	

5. MAINTENANCE

5.01 No routine maintenance or adjustments are required on the 53A1 DU. In the event that a data unit is suspected of malfunctioning with a known good data set, the suspect data unit may be returned to Western Electric Co. for analysis and repair. No attempt should be made to repair the data unit in the field.

5.02 If it is desired to test the 53A1 DU in the field independent of a data set, a test setup may be made as shown in Fig. 10. A 10 kHz square wave with frequency accuracy of ±10 percent and amplitude of 10 to 20 volts peak to peak is required as the external clock source. A power source of +12V, -12V, and +5V is also required.

5.03 Perform the tests outlined in Table C.



NOTES:

1. SELECT SWITCH POSITIONS FR, M, N, SC, \overline{RS} , N (MARK PATTERN ONLY)
2. SET MATRIX AND SWITCHES ON 914DTS PER TABLE B.

Fig. 9—Far End to 914 DTS Start-Up Test Connections

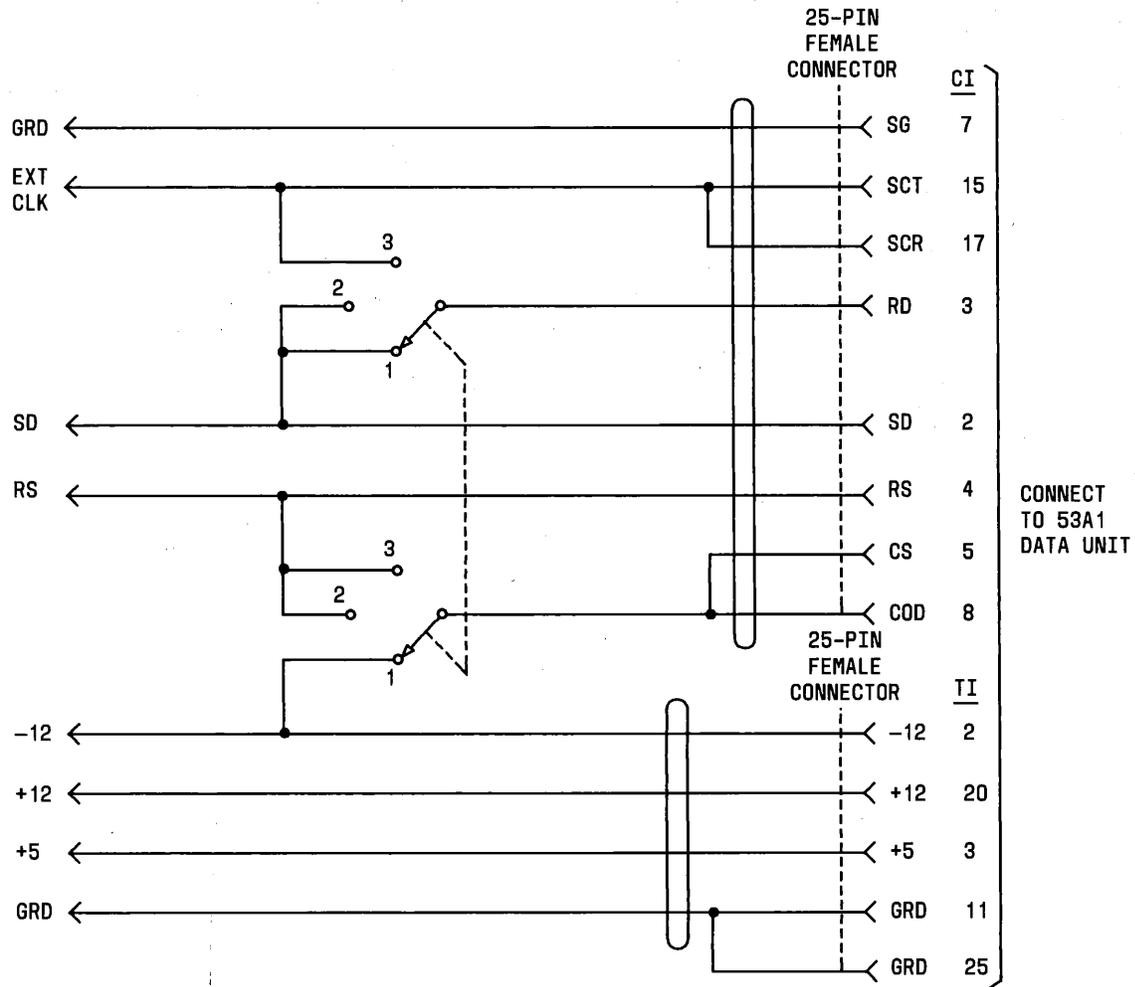


Fig. 10—Test Fixture for 53A1 Data Unit

TABLE C

TEST DATA FOR 53A1 DATA UNIT

TEST NO.	TEST FIXTURE SW POSITION	53A1 SWITCH POSITIONS						OUTPUT (NOTE)			
		FR	W	N	SC	\overline{RS}	N	SD	RS	CO LED	ER LED
1	1							LOW	A	OFF	OFF
2	1						D	HIGH	HIGH	OFF	OFF
3	2			↓			N	B	A	*	OFF
4	2		↓	EI				B	A	*	†
5	2		M	N				LOW ‡	A	OFF	OFF
6	2		↓	EI	↓			LOW	A	*	†
7	2		W	N	CC	↓		B	A	OFF	OFF
8	2				↓	RS		B	A	*	OFF
9	3				SC	↓		B	A	*	†
10	3	↓			↓	↓	D	HIGH	HIGH	ON	OFF
11	3	T			↓	\overline{RS}	N	LOW	≈ GRD	ON or OFF	OFF
12	3				CC	↓		B	HIGH	OFF	OFF
13	3	↓	↓	↓	↓	RS	↓	LOW	LOW	ON	OFF

Note: High = +8 to +12 Vdc; low = -8 to -12 Vdc.

A = ½ Hz square wave, ±8 to ±12V amplitude.

B = 1 kHz square wave, ±8 to ±12V amplitude when RS is positive and -8 to -12V when RS is negative.

* Blinks *on* and *off* with RS (ON for ≈ 1 sec when RS is positive).

† Blinks for short duration (<240 ms) as CO turns ON.

‡ SD is LOW except for a 3 ms error inject pulse about 200 ms from start of RS cycle.