DATA SET 101C

USED WITH 4-ROW TWX

LOCATING TROUBLE AND TEST PROCEDURES

CONTENTS PAGE

CONTENTS PAGE

1. GENERAL

1.01 This section is being reissued to add tests using 907A data test set and to make major changes in the text. This practice presents some of the methods that may be used to locate trouble at 4-Row TWX stations using data set 101C. It does not cover all possible conditions but discusses some typical troubles and presents a testing procedure to determine which section of the station or associated equipment is causing the trouble. The station is the teletypewriter (TTY), data set, and attendant set. The associated equipment is the line and central office equipment.

1.02 Obvious TTY defects such as nonreversing ribbon, stiff keyboards, and broken copy-holders are not included. These may be cleared by referring to the appropriate Bell System Practices.

1.03 It can be assumed that, where possible, central office equipment trouble has been located and cleared before dispatching to the station. On transmission problems, tests may require coordination between the station and central office or back-up test center. The term "back-up test center" designates the test center

that is arranged to make tests beyond the capabilities of a local test center, automatic data test line (ADTL), and portable station test meter.

1.04 The following precautions should be observed when testing the data set.

Note: When SEND BREAK TIMER is not fully inserted in its slot, the S relay will buzz.

(1) When making voltage readings on the test points (TPs) of data set units, measure to GRD on rectifier, unless otherwise indicated, using Northeast Electronics test set TTS-28 or equivalent.

(2) Never use a 1011-type handset or test picks in the TPs of data set except as specified, as the components of the units in the data set may be damaged.

(3) After operating or working on wire spring relays and/or units check for:

(a) Improper position of contact springs

(b) Broken units

(c) Improper position or seating of units.

(4) When making any tests, data set should be in off-hook condition unless otherwise specified.

(5) Support rear of fiber printed wiring boards on data set units when using inserter-extractor tool to strap wedge-lock terminals. Use only 24-gauge wire.

(6) Data set should be restored to normal or on-hook condition following each complete test.

1.05 Output of rectifier should be measured before making any other tests. Output of rectifier should be +20 ±3 volts and −20 ±3 volts. Disregarding the signs, the difference in numerical values shall not exceed 2 volts.

1.06 Regardless of the reason for visiting a station, a final check of the station should be made with ADTL.

1.07 When a 4-Row TWX station is placed in test mode, certain transmission and performance tests can be made from the nearest back-up station test center. The station can be placed in test mode by depressing the TST key in the attendant set after a call has been originated to the back-up station test center.

1.08 Do not attempt to repair data set units at station location. If trouble is traced to a unit, replace it except for potentiometer adjustments.

1.09 In order to cover as many troubles as possible, they have been grouped under the following headings:

(1) Trouble Originating Calls

(a) TTY does not turn on

(b) No dial tone

(c) Cannot break dial tone

(d) Getting wrong numbers

(e) TTY does not unblind.

(2) Trouble Answering Calls

(a) Bell does not ring

(b) Cannot trip ring

(c) TTY does not turn on

(d) TTY does not unblind

(e) Station disconnects (cut offs).

(3) Trouble Sending

(a) Most stations receive bad copy

(b) One or two stations receive bad copy

(c) Cannot send

(d) Cannot break.

(4) Trouble Receiving

(a) Receiving bad copy from all stations

(b) Receiving bad copy from certain stations

(c) Cannot receive.

(5) TTY Trouble

- Troubles directly connected to the TTY, broken parts, ribbon trouble, line feed troubles, etc.

2. TEST EQUIPMENT

2.01 The following tools, meters, and spare units are necessary for maintenance of data set 101C:

- Teletypewriter Maintenance Tools
- 1011-Type Handset
- Northeast Electronics Test Set Model No. TTS-28
- 164C4 Transmission Measuring Set or Equivalent
- Inserter-Extractor (Wire) Tool, KS-19092, List 1
- Carrying Case for Data Set Units
- Spare Set of Data Set Units
- Maintenance Test Card J70148AA, List 1A
- 907 Data Test Set, J79907A, List 1; Associated List 2 and 3 Connector Cords; and List 5 Test Card
- SD-3D007-01 (Data Set)
- SD-3D009-01 (Attendant Set)

Note: Northeast Electronics Test Set Model No. TTS-28 must be in a vertical position to ensure accurate measurements.

3. TROUBLE ORIGINATING CALLS

3.01 This category includes the troubles in completing a connection to another station. The following tests are checks to aid in sectionalizing the troubles to the major components of the station.

A. TTY Does Not Turn On

STEP	ACTION	RESULT
1	Depress ORIG key.	TTY should turn on; if not, trouble may be defective data set or TTY trouble.
2	Check power using TTS-28 test set or equivalent at ac power outlet.	
3	Depress LCL key.	TTY should turn on; if not, trouble is in TTY.
4	Depress ORIG key.	OR relay operates and ORIG lamp lights, but TTY motor does not start.
5	Ground D32.	Motor should start, indicating trouble in data set wiring. If motor does not start, check wiring to TTY.

B. No Dial Tone (NDT)

STEP	ACTION	RESULT
1	Connect 1011-type handset across D34 and D35.	Dial tone should be heard; if not, trouble is in line or CO equipment. If dial tone is heard, trouble is in data or attendant set.
2	Ground D39 of attendant set and operate ANS key.	ANS and ORIG lamps light, and f_{2m} tone should be heard in speaker, indicating the receive portion of HYBRID unit, LIMITER unit, and loudspeaker are good. Therefore, trouble must be in data set control circuits, dial contacts (rotary dial), line, winding of hybrid coil, or associated wiring.

C. Cannot Break Dial Tone (CBDT)

1	Disconnect loop at connecting block. Place 1011-type handset across loop and attempt to dial.	If unable to dial, trouble is in line or CO equipment.
2	Remove leads on D26 and D27.	
3	Connect 1011-type handset to D26 and D27.	
4	Operate ORIG key. Listen for dial tone, attempt to dial.	If unable to dial, check data set wiring. If able to dial, check attendant set.

D. Getting Wrong Numbers

For Stations Equipped with Rotary Dial —

1	Use dial speed test or operate ORIG key and dial test number.	If results are unsatisfactory, trouble could be in station dial or CO equipment.
2	Bridge 1011-type handset across terminals D34 and D35; dial speed test code.	If results are unsatisfactory, refer to plant service center. If test results are satisfactory, replace station dial.
3	Check customer dialing procedure if all test results are satisfactory.	

For stations equipped with TOUCH-TONE dialer—

STEP	ACTION	RESULT
1	Operate ORIG key.	
2	Dial 900-ohm quiet termination.	
3	After connection is completed, disconnect TIMER unit and operate CON relay.	TTY runs open.
4	Switch TTS-28 test set to O DBM BRDG position.	
5	Connect test probes to TP1 and TP2 of the HYBRID unit.	Note reading on TTS-28.
6	Release CON relay.	TTY runs closed.
7	Simultaneously depress 4 and 5 of the TOUCH-TONE dialer.	Tone can be heard in loudspeaker, and reading should be within 0.0 and −0.5 db of reading in Step 5. If proper reading cannot be obtained, adjust PT potentiometer of TOUCH-TONE dialer.

Note: PT potentiometer is located to the right side, directly under the TOUCH-TONE dialer. Adjustment *MUST* be as follows:

(1) Turn potentiometer to full counterclockwise position.

(2) Slowly turn potentiometer clockwise until required reading in Step 7 is obtained. If this requirement cannot be met proceed to Step 9.

8	Simultaneously depress 6 and 9 of TOUCH-TONE dialer.	Tone can be heard in loudspeaker and reading should be within −0.5 and +1.5 db of reading in Step 5. If reading does not meet requirement, adjust PT potentiometer and recheck Step 7. Optimum setting may be necessary to meet Steps 7 and 8 requirements. If requirements cannot be met proceed to Step 9.
9	Replace amplifier card in attendant set. Recheck Steps 7 and 8.	Step 7 and 8 requirements should be met; if not proceed to Step 10.

STEP	ACTION	RESULT
10	Disconnect CT capacitor (connected on 8 and 11 of the TOUCH-TONE dialer terminal strip).	
11	Simultaneously depress 4 and 5 of TOUCH-TONE dialer.	Note reading on TTS-28.
12	Simultaneously depress 6 and 9 of TOUCH-TONE dialer.	If reading is 2.0 to 3.0 db more positive than Step 11, change the capacitor; if not replace TOUCH-TONE dialer.

E. TTY Does Not Unblind After Dialing

1	Operate LCL key.	TTY should turn on.
2	Operate ORIG key, and dial ADTL; monitor call.	Should hear ringing tone, silent interval of one second, then receipt of f_{2m} tone. If TTY does not unblind, the trouble is in the data set. Proceed to Step 3.
3	Operate CLR key.	
4	Operate ORIG key.	MCR relay operates, TTY turns on, and dial tone is heard.
5	Operate LCL key.	CY relay operates, and TTY runs open.
6	Operate CLR key.	
7	Block the S relay released.	
8	Ground TP3 of TIMER unit.	
9	Operate ORIG key.	OR, CON, CY, and RB relays operate. BRK-RLS lamp lights, TTY runs open. This checks relay wiring between output of TIMER and relays CON, CY, and RB.

STEP	ACTION	RESULT
10	Unblock the S relay.	Station should go to on-hook condition.
11	Ground TP2 of LIMITER and TP1 of DISCRIMINATOR.	Output of DISCRIMINATOR goes to marking.
12	Operate ORIG key.	CON and CY relays operate, and TTY runs closed and may receive local copy.

Note: This checks TIMER unit. If above tests are satisfactory, trouble is in DISCRIMINATOR or LIMITER unit. See Part 8, Tables C and D or G and H.

4. TROUBLE ANSWERING CALLS

4.01 The following operations are checks of the major sections of the station to aid in isolating typical troubles in the line, station ringer, or data set wiring.

A. Bell Does Not Ring (BDR)

STEP	ACTION	RESULT
1	Operate ORIG key and dial ringback code if office is so equipped. If office is not equipped, back-up test center will have to be contacted for ringback.	
2	Operate CLR key, and then LCL key.	When ringing current is received, ANS lamp should flash; if it flashes and bell does not ring, check station ringer. If lamp does not flash, place 1011-type handset on line at D34 and D35 to listen for audible ring; if ring is heard check data wiring.

B. Cannot trip Ring

To check off-hook condition —

1	Operate ORIG key and dial ringback code, or call back-up test center for ringback.	Connection should be completed.
2	Operate CLR key.	If ANS lamp does not light or is not flashing, check ring-up circuit on HYBRID unit.

To check operation of RU and AN Relays—

STEP	ACTION	RESULT
3	AN relay operates when RU operates.	If AN relay fails to operate, check operating path of AN relay.
4	AN relay operates, machine turns ON, and in 5 seconds times out, and then repeats the cycle.	Ringing is not being tripped.
5	Place 1011-type handset in TALK position across D34 and D35.	If ringing does not trip, trouble is in line or central office. If ringing is tripped with handset, trouble is in wiring or HYBRID unit.

C. TTY Does Not Turn On When Answering

1	Operate LCL key.	TTY should turn on; if not, trouble is in TTY.
2	Operate ANS key.	AN relay operates and ANS lamp lights. If AN relay operates but TTY motor does not start, ground D32, motor should now start indicating trouble in data set wiring. If motor does not start, check wiring to TTY.

D. TTY Does Not Unblind When Answering

This may be due to a bad line, defective data set, TTY trouble, or the TTY station being dialed inadvertantly by a telephone subscriber.

To check data set control circuits with TTY loop disconnected—

1	Operate ANS key.	ANS lamp lights. If TTY motor starts, AN and MCR relays have operated.
2	Ground D39 in data set.	If tone can be heard in speaker or in the handset, this indicates the M relay has operated, and f_{2m} tone is being generated. TTY will time out in 6 seconds.
3	Remove ground from D39.	

STEP	ACTION	RESULT
4	Disconnect HYBRID unit, operate ANS and then LCL keys.	ANS lamp lights. Machine runs open for approximately 6 seconds then will go to local condition and run closed. LCL lamp lights.
5	Depress CLR key and reinsert HYBRID unit.	CLR lamp goes out and TTY goes to on-hook condition.
6	Block S relay released, and connect ground to TP3 of TIMER unit.	
7	Operate ANS key.	AN, M, CON, CY, and RB relays should operate, unblinding TTY. BRK-RLS lamp lights. TTY should run open.
8	Release S relay and remove ground.	TTY goes on hook.
9	Connect loop and operate ORIG key, and dial ADTL.	After f_{2m} tone is heard for an interval of 1 second, CON relay should operate. It can be assumed when f_{2m} tone is heard, that the HYBIRD unit and line are operating in a satisfactory manner. When CON relay operates it indicates the LIMITER, DISCRIMINATOR, and TIMER units are functioning properly. (Units in the receive section of the data set operate identically in response to both tones.)
Flip Operation —		
10	Flip station from call-originating mode to call-terminating mode by depressing the CLR key, then immediately depressing the ANS key. Hold ANS key down until CLR lamp goes out and ANS lamp lights.	
If TTY turns off after flip operation check the following —		
11	Check data set output with TTS-28 test set as described in Part 8, Item G.	
12	Make sensitivity test as described in Part 8, Item N.	

STEP	ACTION	RESULT
13	Check loop loss with TTS-28 test set as described in Part 8, Item 0.	

Note: If customer experiences no trouble answering calls from stations normally contacted but occasionally gets a call that is not completed, suspect that a telephone subscriber has dialed a TWX number. If this occurs frequently, the station may be monitored by the back-up test center.

E. Trouble With Disconnects (Cut Offs)

This trouble, TTY turning off during transmission, is common to both modes. It can be caused by an open on the line of more than 500 msec, receive level of the incoming signal at either station going below the working limits, loss of connections at central office equipment, or a malfunction of the data set. On this type of trouble, determine if the station fails with all stations or just certain stations. If trouble exists with all stations then trouble must be in reporting station equipment (data set, line, or central office). If trouble occurs with only certain stations, then trouble may be located at those stations or in the switching network.

Check Station—

1	Measure data set output with TTS-28 test meter as described in Part 8, Item G.	Compare this reading with station record label. A different result indicates a change in the data set output or an impedance change in the line.
2	Make Sensitivity test as described in Part 8, Item N.	
3	Make loop loss measurement with TTS-28 test meter as described in Part 8, Item 0, and compare results with design values recorded on station record label E-4905.	

To check if intermittent line conditions are suspected —

4	With TTS-28 test set switched to TEL-SET DIAL position, and 1011-type handset connected to TEL-SET terminals, connect TTS-28 test set to D34 and D35.	
5	Dial 900-ohm quiet termination.	
6	When connection is completed, operate TTS-28 test set switch to TEL-SET 150-ma scale.	Observe for any current variations.

To check reporting station —

STEP	ACTION	RESULT
7	Make test with ADTL.	If reporting station equipment is OK, inform plant service center of stations suspected of causing trouble.

5. TROUBLE SENDING

5.01 Exchange of tones between stations necessary to complete the connection would indicate transmission levels are within over-all limits, control circuits of the data set are functioning properly, and central office terminations are OK. Possible causes of sending troubles are distortion or bias of signals from keyboard, transmitter-distributor, or data set hits on the loop, or the wrong code combinations from the keyboard.

A. Most Stations Receive Bad Copy

1	Test in local mode.	Good copy indicates keyboard, and transmitter-distributor are sending proper code combinations. This test will not aid in localizing bias or distortion troubles.
2	Operate ORIG key and dial ADTL.	If ADTL indicates copy was sent out of limits trouble could be in keyboard, transmitter, MODULATOR unit, or loop transmission facilities in transmitting direction.

To sectionalize trouble —

3	Measure bias of send contacts as described in Part 8, Item M.	
4	Replace MODULATOR unit with spare and test with ADTL.	
5	Make transmission tests with back-up test center to measure the "loop-back" distortion of data set and loop.	
6	A station can be placed in a test mode by originating a call to the back-up test center in the normal manner. Upon instructions from the test center, operate the TST key.	Station will receive f_{2m} and f_{2s} signals from the test center.

Note: Station can be "flipped," that is, changed from originate to answer mode, under control of the TST key when requested by the back-up test center.

7	While in the originate mode, depress the CLR key momentarily.	The CLR lamp will light for about 1 second.
8	During this interval depress ANS key and hold.	CLR lamp goes out and the ANS lamp lights.
9	Depress TST key.	Station is now in test mode and will receive f_{1m} and f_{1s} tones from the back-up test center.
10	Depress either ORIG or ANS key.	TST key releases.
11	Operate CLR key.	Station is restored to on-hook condition.

- Arrange to have return loss measurement made on the loop.

B. One or Two Stations Receive Bad Copy

This condition can be caused by the receiving TTY having poor receive margins or an "out of limits" transmission path bteween stations.

1	Measure loop loss as described in Part 8, Item 0.	
2	Make a transmission test with ADTL.	If test is within requirements, inform plant service center of the suspected condition of receiving station.

C. Cannot Send

This trouble is most cases will be in the local equipment because the connections could not have been completed without an exchange of tones.

1	Operate LCL key and print local copy.	This checks TTY send contacts.
2	Operate BREAK key.	TTY should run open for about two characters.

STEP	ACTION	RESULT
If TTY does not run open —		
3	Remove wire on D69.	TTY should now run open for about two characters.
If TTY still does not run open —		
4	Check in the SEND BREAK TIMER or MODULATOR units, or the wiring to the units.	
To check oscillator portion of MODULATOR unit—		
5	Ground D39 in data set and operate ANS key.	When f_{2m} tone is heard in speaker, operate and release BREAK key and listen for modulated f_{2m} tone.

D. Cannot Break

Inability to stop transmission from the sending station can be caused by the trouble described in Part 8, Tables E or I, or BREAK time interval is not long enough.

To check station equipment —

1	Check TTY and data set as described in C.	
2	Operate BREAK key long enough to cause local station BRK-RLS lamp to light.	
3	Ground TP2 of LIMITER unit and TP1 of DISCRIMINATOR unit. Operate ANS key.	ANS-BACK drum triggers.
4	Depress BREAK key.	Machine will run open for about two characters and BRK-RLS lamp will light. If TTY does not run open replace the following, one at a time, SEND BREAK TIMER, LIMITER, and RESTRAINER units.

6. TROUBLE RECEIVING (BAD COPY)

6.01 This section refers to troubles occurring when receiving from a distant station after the connection has been completed. This type of trouble can be caused by high distortion or bias from sending station, poor receive margins at receiving station, a bad line, a faulty connection at central office, or mechanical failure of receiving TTY. Discussing the report with subscriber can help in localizing this type of trouble. Checking the copy in which the errors occurred may indicate a mechanical failure in TTY. When the copy shows a consistent pattern of loss, or gain, of one or more pulses, or the error is always the same, the trouble most likely will be mechanical since a line trouble or a data set trouble generally will not cause the same error continuously.

6.02 Operation of TTY in local mode and repetition of the same sequence of letters or functions, that caused errors in customer's copy will usually show the same errors if this is a mechanical trouble.

A. Receiving Bad Copy From All Stations

This condition indicates trouble must be in local station and can be determined by testing with ADTL.

(1) If TTY will not accept UNDIS trouble could be:

(a) Mechanical or marginal in TTY

(b) In receive portion of data set

(c) In the line

(d) In central office.

(2) If TTY accepts UNDIS, but not SW-DIS, and assuming line is OK, trouble could be:

(a) Margin in TTY

(b) Bias in DISCRIMINATOR unit; check as described in Part 8, Item I.

(3) If TTY accepts UNDIS and SW-DIS but not DIS-PAD, trouble could be:

(a) Poor receiver sensitivity; check as described in Part 8, Item N

(b) Loop loss out of limits.

(4) If TTY accepts UNDIS, SW-DIS, and DIS-PAD in one mode and not the other, suspect the data set.

Note: Results of transmission tests in both modes must be considered when analyzing ADTL results.

To test rotary dial (in ORIG condition line goes through dial contacts)—

STEP	ACTION	RESULT
1	Tap dial while receiving from ADTL.	If contacts are bad, copy will garble.

STEP	ACTION	RESULT
	Note: A momentary short, open, or ground can cause garbling. If unable to prove, or localize trouble to a specific section of equipment, or if loop conditions are suspected, use procedure described in Part 4, Item D.	
	Receive margins —	
2	Make receive margin tests with ADTL.	10-point minimum range is required when testing with 28 per cent distortion.
	Receive bias —	
3	Make tests as described in Part 8, Item M.	
4	Replace LIMITER and DISCRIMINATOR units with spares and recheck margins with ADTL.	

B. Receiving Bad Copy From Certain Stations

Station reporting trouble should be tested with ADTL, and results should be interpreted as in A. If station equipment tests OK, and transmission of distant station is suspected, report trouble to local plant service center.

C. Cannot Receive

1	Operate LCL key and type local copy.	If copy is printed, proceed to Step 4. If no copy is received, proceed to Step 2.
2	Disconnect RESTRAINER unit.	TTY should run open; if it does not, trouble is in TTY.
3	Reinsert RESTRAINER unit.	
4	Disconnect DISCRIMINATOR unit.	TTY should run open; if it does not, trouble is in TTY or RESTRAINER unit.

STEP	ACTION	RESULT
5	Reinsert DISCRIMINATOR unit.	
To check LIMITER unit —		
6	Use Sensitivity test as described in Part 8, Item N.	

If TTY runs open after a completed connection or in local condition, the trouble is in the data set wiring or in the TTY.

7	Operate LCL key.	
8	Switch TTS-28 test set to 30 VDC position. Connect positive probe to the (−) test point on the rectifier and negative probe to D65.	Reading should be 0 vdc.
9	Remove test probes.	
10	Ground D66.	TTY should run closed; if not trouble is in the TTY or wiring to the TTY.
11	Ground D67.	
If TTY runs closed —		
12	Replace DISCRIMINATOR unit.	
If TTY runs open —		
13	Replace the RESTRAINER unit.	

7. TTY TROUBLE

7.01 This category includes all the mechanical troubles that can occur. Procedures for clearing can be found in the appropriate sections.

8. TEST PROCEDURES

GENERAL

8.01 This section describes, in detail, various tests and test tables that can be used to check the individual units and sections of the data set. If at any time a measured voltage or result deviates from the one indicated in the test, the trouble is likely to be in that part of the circuit being checked. The following test tables are found at the end of this section:

Table	Test
A	Position of B TEST switch
B	RESTRAINER unit test using MTC
C	LIMITER unit test using MTC
D	DISCRIMINATOR unit test using MTC
E	SENSITIVITY test using MTC
F	RESTRAINER unit test using 907A
G	LIMITER unit test using 907A
H	DISCRIMINATOR unit test using 907A
I	SENSITIVITY test using 907A
J	DISTORTION test using 907A
K	BIAS test using 907A
L	TIMING tests using 907A

Note: In each of the tests above, once the TTY connects on the first step the set *SHOULD NOT* be disconnected until that particular test is completed. If TTY does disconnect, in most cases it is an abnormal indication.

A. Data Set Control Circuit

STEP	ACTION	RESULT
1	Disconnect all units from the data set. See 1.04.	
2	Operate ORIG key.	ORIG lamp lights, TTY runs open, OR relay operates and locks.
3	Operate CLR key.	CLR lamp lights, ORIG lamp goes out, RB and S relays operate and lock.
4	Release OR relay manually.	CLR lamp goes out, RB and S relays release. TTY goes to on-hook condition.
5	Operate ANS key.	ANS lamp lights, AN relay operates and locks, and TTY runs open.
6	Operate M relay manually.	M relay locks.
7	Operate RB relay manually.	BRK-RLS lamp lights, and RB relay locks.
8	Operate BRK-RLS key.	BRK-RLS lamp goes out, RB relay releases.
9	Operate CLR key.	CLR lamp lights, ANS lamp goes out, RB and S relays operate and lock.
10	Release AN relay manually.	CLR lamp goes out, RB and S relays release, and M relay releases. TTY goes to on-hook condition.

If the results of the preceding steps differ from those specified —

11	Remove the connections to attendant set and repeat Steps 1 through 10. If trouble is in attendant set or the connections, it can be located by making continuity tests with TTS-28 test set.	
12	Reinsert TIMER unit.	

Note: If trouble is encountered in Steps 13 through 16, proceed to Step 17.

13	Operate ORIG key.	ORIG lamp lights, OR relay operates and locks, and TTY runs open.
14	Operate CLR key.	ORIG lamp goes out, RB and S relays operate momentarily, releasing the OR relay, and TTY turns off.
15	Operate ANS key.	ANS lamp lights, AN relay operates and locks, TTY runs open, and after one second, M relay operates.
16	Operate CLR key.	ANS lamp goes out, RB and S relays operate momentarily, releasing AN and M relays.
17	Ground TP3 on TIMER unit.	

STEP	ACTION	RESULT
18	Operate ANS key.	Relays AN, M, CON, CY, S, and RB shall operate momentarily, and release. In case of trouble check chassis wiring.
19	Reinsert all units in data set. See 1.04.	

B. Space-Hold Circuit (Carrier Fail) on LIMITER and SEND-BREAK TIMER Units

1	Disconnect line from data set at connecting block.	
2	Ground TP1 on DISCRIMINATOR unit.	This isolates the frequency detecting network from the output of the DISCRIMINATOR. After the CY relay operates the output of DISCRIMINATOR unit is now controlled by the space-hold circuit.
3	Operate ORIG key.	ORIG lamp lights, OR relay operates, motor starts, and TTY runs closed.
4	Manually operate the CON relay.	CON relay locks, CY relay operates, and TTY runs open. 150 msec later, RB relay operates and BREAK lamp lights. 350 msec later, S relay operates, and BREAK lamp goes out. CLR lamp lights for 0.75 of a second.
5	If TTY does not run open after CON and S relays have operated, check wiring.	
6	If TTY does not run open after CON relay operates and S relay fails to operate, check LIMITER, DISCRIMINATOR, and SEND-BREAK TIMER units.	
7	If TTY does run open after operating CON relay but S relay fails to operate, check TIMER unit.	

C. RESTRAINER Unit

1	Check RESTRAINER unit using Table B (MTC) or Table F (907A).	

STEP	ACTION	RESULT
To check RESTRAINER unit output circuitry with station in normal on-hook condition —		
2	Ground TP1 of RESTRAINER unit.	After miniature relay in unit operates REST lamp lights.
3	If lamp does not light, ground D7 in the data set.	
4	If lamp still does not light, check lamp and wiring.	
5	Connect TP1 of RESTRAINER unit to TP3 of SEND-BREAK TIMER unit.	REST lamp should light; if not, replace RESTRAINER unit.
To check operation of RESTRAINER circuit using ADTL —		
6	Place call to ADTL.	"GA SEND" received.
7	Begin transmission from station when "GA SEND" is received.	Upon receiving this transmission ADTL sends a restraint followed by a break signal.
8	Transmission is blocked by restraint signal.	REST lamp lights.
9	BREAK signal is received.	BRK-RLS lamp lights.
To check End of Transmission (EOT) —		
10	Connect D75 to D63. Place strap on D75 first.	CLR lamp lights, S relay operates.
11	Disconnect DISCRIMINATOR unit.	CLR lamp goes out, S relay releases.
12	Remove strap from D63 first, then D75. Restore circuit to normal.	

Note: This check will not work if the RESTRAINER unit does not have transistors Q8 and Q9 in its circuit.

D. TIMER Unit

The following test procedure will locate a complete failure in the TIMER unit.

To check input amplifier on TIMER unit in ON condition (station on-hook) —

STEP	ACTION	RESULT
1	Switch TTS-28 test set to 30-VDC position, connect positive probe to TP1 of TIMER unit, negative probe to GRD on rectifier.	Reading should be more than 1.8 vdc.
2	Move positive probe to terminal D13.	Reading should be the same as Step 1.
3	Remove test probes.	

If trouble is encountered in reading at TP1 —

4	Switch TTS-28 test set to 30-VDC position, connect positive probe to GRD on rectifier, and connect negative probe to fixed contact CY1.	Reading should be 9 vdc, ±3 vdc.
5	Remove test probes.	

To check input amplifier in OFF condition —

6	Operate ORIG key.	
7	Disconnect HYBRID unit.	
8	Switch TTS-28 test set to 30-VDC position, connect positive probe to TP1 of the TIMER unit, and negative probe to (−) test point on rectifier.	Reading should be less than 1.0 vdc.
9	TTS-28 test set may be switched to 1.5-VDC position after initial reading for a more accurate result.	
10	Move positive probe to D13.	Reading should be the same as Step 8.

STEP	ACTION	RESULT
11	Remove test probes.	

If trouble is encountered in reading at TP1—

12	Switch TTS-28 test set to 30-VDC position, connect negative probe to GRD on rectifier, and connect positive probe to fixed contact CY1.	Reading should be 8 vdc, ±3 vdc.
13	Remove test probes.	

To check output amplifier of TIMER unit in OFF condition —

14	Operate ORIG key.	
15	Disconnect HYBRID unit.	
16	Switch TTS-28 test set to 30-VDC position, connect negative probe to (−) test point on rectifier, positive probe to TP2 of the TIMER unit.	Reading should be less than 1.5 vdc.
17	Move positive probe to TP3 of TIMER unit.	Reading should be less than 1.0 vdc.
18	TTS-28 test set may be switched to 1.5-VDC scale for a more accurate reading.	
19	Restore HYBRID unit, remove test probes, and operate CLR key.	

To check output amplifier in the ON condition —

20	Block M relay released.	
21	Operate ANS key.	
22	Switch TTS-28 test set to 30-VDC position, connect positive probe to TP2 of TIMER unit and connect negative probe to GRD on rectifier.	Reading should be more than 0.5 vdc and less than 3 vdc.

Note: If reading is greater than 3 vdc, replace TIMER unit. If less than 0.5 vdc, proceed to next step.

STEP	ACTION	RESULT
23	Remove test probes.	
24	Switch TTS-28 test set to 1.5-VDC position, connect negative probe to TP3 of TIMER unit, positive probe to GRD on the rectifier.	Reading should be less than 0.2 vdc.

Note: If trouble is encountered in Step 24, check for continuity between terminal D16 and GRD. Then check chassis wiring to control relays.

25	Remove test probes and unblock M relay.	

To check control relay contacts associated with TIMER unit —

26	Disconnect TTY at connecting block. Connect ground to TP1 of DISCRIMINATOR unit.	
27	Connect ground to TP2 of LIMITER unit.	
28	Switch TTS-28 test set to 30-VDC position, connect positive probe to GRD, negative probe to TP2 of TIMER unit.	With all relays released, reading should be 20 vdc, ± 3 vdc.
29	Block CON relay released, and operate ORIG key.	OR relay operates. Reading of less than 0 vdc should be indicated.

Note: Meter will not be damaged since only a small reverse voltage is present.

30	Allow CON relay to operate.	Reading should be 19 vdc, ± 3 vdc.
31	Block RB relay released, and remove ground from TP2 of LIMITER unit.	Reading of less than 0 vdc should be indicated, and TTY runs open.
32	Block S relay released, allow RB relay to operate.	Observe a momentary meter movement upscale, and BRK-RLS lamp lights.
33	Block OR relay operated, and allow S relay to operate.	Observe an upscale kick, TTY runs closed, BRK-RLS lamp goes out, CLR lamp lights.

STEP	ACTION	RESULT
34	Release OR relay and restore circuit to normal.	TTY returns to idle condition.
To make same test in answer mode —		
35	Repeat Steps 26, 27, and 28.	
36	Block M and S relays released.	
37	Operate ANS key.	AN relay operates and reading of less than 0 vdc should be indicated.
38	Remove ground from TP2 of LIMITER. Block CON released and allow M to operate.	Reading should be 19 vdc, ±3 vdc.
39	Block AN operated and allow S to operate.	Reading is less than 0 vdc and CLR lamp lights.
40	Operate CON relay.	Observe upscale kick on meter, answer back triggers.
41	Allow AN to release.	TTY returns to idle condition.

E. LIMITER Unit

To check sensitivity of data set (mainly determined by the LIMITER unit), refer to Part 8, Item N. There are two basic modes of operation for LIMITER unit, signal or no signal and weak signal.

1	Check LIMITER unit using Table C (MTC) or using Table G (907A).	

F. SEND BREAK TIMER Unit

To test SEND BREAK TIMER circuit —

1	Operate LCL key and type local copy.	In case of trouble, proceed to check input to SEND BREAK TIMER, Steps 2 through 6.
2	Switch TTS-28 test set to 150-VDC position.	
3	Connect positive probe to (+) point on the rectifier and negative probe to terminal D70.	Reading should be 40 vdc, ±2 vdc.

STEP	ACTION	RESULT
4	Move negative probe to terminal D69.	Reading should be 40 vdc, ±2 vdc.
5	Hold BREAK key operated.	Reading should be 0 vdc.
6	Move positive probe to GRD on rectifier, switch test set to 30-VDC position. Send repeated Y character from keyboard.	Test set needle vibration should be centered at 3.5 vdc, ± 1.5 vdc.
7	Remove test probes	

To check output of BREAK TIMER circuit of MODULATOR unit —

8	Operate LCL key.	
9	Switch TTS-28 test set to 30-VDC position, connect negative probe to D74 and connect positive probe to GRD.	Reading should be 0 vdc.
10	Operate BREAK key.	Reading should deflect toward, but not quite reach, 20 vdc.
11	Restore circuit to normal.	

G. MODULATOR Unit

To check output of MODULATOR unit —

1	Operate ORIG key.	
2	Dial the 900-ohm quiet termination.	
3	After connection is completed, disconnect TIMER unit.	
4	Switch TTS-28 test set to 0 DBM BRDG position.	
5	Connect test probe to TP3 on MODULATOR unit and test probe to GRD on rectifier.	
6	Manually operate the CON relay.	F_{1m} tone will be generated, and reading should be between −1.0 and +2.5 dbm. TTY runs open.

STEP	ACTION	RESULT
7	Manually operate RB and S relays.	F_{1s} tone will be generated, and reading should be between −1.0 and +2.5 dbm. TTY runs closed and CLR lamp lights.
8	Release RB and S relays.	
9	Block AN relay operated.	
10	Manually operate CON relay.	F_{2m} tone is generated. Reading should be between +2.0 and +5.5 dbm. TTY runs open.
11	Manually operate RB and S relays.	F_{2s} tone is generated. Reading should be between +2.0 and +5.5 dbm. TTY runs closed.
12	Restore circuit to normal.	

To check output of MODULATOR unit through the filter and send pads (HYBRID unit must be strapped for 0.0 dbm output for this test) —

13	Strap 1 to 2, 3 to 4, and disconnect all but the original strapping on these terminals.	
14	Operate ORIG key.	
15	Dial the 900-ohm quiet termination.	
16	After the connection is completed, disconnect TIMER unit.	
17	Switch TTS-28 test set to +10 DBM BRDG position, connect test probe to TP2 on MODULATOR unit and test probe to GRD on rectifier.	
18	Repeat Steps 6 through 12.	Readings for all tones should be between −0.5 and +2.0 dbm.

To check input to the oscillator control circuit on the MODULATOR unit —

STEP	ACTION	RESULT
19	Operate ORIG key.	
20	Disconnect TIMER unit.	
21	Switch TTS-28 test set to 30-VDC position, connect positive probe to GRD on the rectifier and connect negative probe to TP1 on the MODULATOR unit.	Reading should be more than 0.10 vdc.
22	Test set can be switched to 1.5-VDC scale, after initial reading, for a more accurate result.	
23	Remove test probes.	
24	Switch TTS-28 test set to 30-VDC position, and connect positive probe to TP1 on MODULATOR unit and negative probe to GRD on the rectifier.	
25	Manually operate RB and S relays.	Reading should be greater than 4.0 vdc.
26	Restore circuit to normal.	

Note: To measure the four data set frequencies, call the back-up test center.

H. HYBRID Unit

To check output of the HYBRID unit, the input to the MODULATOR unit must be OK, filters must be OK, and the attenuation added per the prescription design. (Refer to station label.)

1	Disconnect line at connecting block.	
2	Switch TTS-28 test set to DBM 900-OHM TERM position.	
3	Connect test probes to TP1 and TP2 of the HYBRID unit.	
4	Disconnect TIMER unit.	
5	Manually operate the OR and CON relays.	TTY runs open.

STEP	ACTION	RESULT
6	See Note. Measure F_{1m} tone.	Reading should equal the send pad value strapped in, within −1.0 to +1.5 db.
7	Manually operate RB and S relays.	TTY runs closed.
8	Measure F_{1s} tone.	Reading should be same as Step 6, ±0.5 db.
9	Manually operate AN relay.	CON and OR relays release.
10	Manually operate CON relay.	TTY runs open.
11	See Note. Measure F_{2m} tone.	Reading should equal the send pad value strapped in within −1.0 to +1.5 db.
12	Manually operate RB and S relays.	TTY runs closed.
13	Measure F_{2s} tone.	Reading should be the same as Step 11.
14	Restore circuit to normal.	

To check receive portion of HYBRID coil —

15	Operate ORIG key.	
16	Dial 900-ohm quiet termination.	
17	Disconnect TIMER unit and operate CON relay.	
18	Switch TTS-28 test set to 0 DBM BRDG position, connect probes to TP3 on HYBRID unit and GRD on rectifier.	Reading should not be more positive than −5.0 dbm. −4.0 dbm is unacceptable.

Note: If an E7 repeater is used in the loop, reading for F_{1m} and F_{2m} should not be more positive than 0.0 dbm.

Transhybrid loss should be checked with all four frequencies. This can be done by operating relays as described in Part 8, Item G.

I. DISCRIMINATOR Unit

1	Check DISCRIMINATOR operation using Table D (MTC) or Table H (907A).	

J. Answer-Back Circuit (SEND BREAK TIMER Unit)

Six second timing circuit test —

STEP	ACTION	RESULT
1	Operate ANS key.	M relay operates 1 second later.
2	Block CON relay released.	After M relay operates, S relay should operate within 6 seconds, ±3 seconds. If S relay does not operate, proceed to Step 3. If S relay operates, proceed to step 10.
3	Switch TTS-28 test set to the 30-VDC position.	
4	Connect negative probe to TP3 of SEND BREAK TIMER unit and positive probe to the (+) test point on the rectifier.	With no relays operated, reading should be less than 1.0 vdc.
5	Remove test probes.	
6	Block S relay released.	
7	Operate ANS key.	
8	Connect negative probe to TP3 of SEND BREAK TIMER unit and positive probe to GRD on the rectifier.	With CON relay released, reading should be less than 1.0 vdc.
9	Remove test probes, and restore circuit to normal.	

Drum Answer-Back Test —

10	Operate LCL key.	
11	Manually operate the M and CON relays momentarily.	Drum should trigger and answer-back should be printed on TTY.

K. Adjustment of R4A for Balancing of DISCRIMINATOR Unit

Note: This adjustment shall be made if DISCRIMINATOR unit is replaced.

Potentiometer adjustment R4A is a means of balancing voltages in the discriminator circuit. It determines at what voltage level (from the discriminator coil) the output changes from mark to space. A factory adjustment aligns the discriminator coils and the potentiometer, so the midfrequency of the mark and space frequencies provides an output voltage that is equal to this

threshold voltage. Since the discriminator is a frequency-to-voltage converter, the potentiometer also adjusts the frequency characteristic of the receiver. Therefore, the balance potentiometer can also alter the received teletypewriter signal bias, measured at the output of the discriminator.

STEP	ACTION	RESULT
1	Disconnect LIMITER and TIMER units.	
2	Switch TTS-28 test set to the 30-VDC position.	
3	Connect the positive probe to GRD on the rectifier and the negative probe to TP2 on the DISCRIMINATOR unit.	
4	Manually operate AN and CON relays.	
5	Adjust R4A to provide -10 ± 1 volt at TP2 of DISCRIMINATOR unit (See Note).	

Note: This voltage may change from 0 to -20 volts with only a slight unbalance of the DISCRIMINATOR. A subsequent reading may differ greatly and does not necessarily indicate trouble with the DISCRIMINATOR unit.

6	Restore circuit to normal.	

L. Check of DISCRIMINATOR Tuning with MTC

Note: This test should be performed only after completing the adjustment specified in Part 8, Item K.

1	Remove HYBRID and MODULATOR units.	
2	Insert MTC into HYBRID unit slot in data set.	
3	Plug MODULATOR unit into MTC.	
4	Set MAINTENANCE TEST CARD switches at ANS, CONN +3, and MARK.	
5	Operate ANS key.	Data set will connect.

STEP	ACTION	RESULT
6	Disconnect TIMER unit.	
7	Set MTC switches at ANS, CONN +3, and DOT.	TTY will print meaningless copy.
8	Switch TTS-28 test set to 30-VDC position.	
9	Connect positive probe to GRD on the rectifier and the negative probe to the (−) test point on the rectifier.	Note the −20 volt power supply voltage.
10	Move negative probe to TP1 on the MTC.	Reading should be one-half ±1.0 volt of the result of Step 9.
11	Move negative probe to TP2 of the DISCRIMINATOR unit.	Reading must be within one volt, ±, of result of Step 10. If not replace DISCRIMINATOR unit.
12	Remove test probes.	
13	Connect negative probe to the test point, either TP1 on the MTC or TP2 on the DISCRIMINATOR unit, that gave the highest reading in Steps 10 and 11, and connect the positive probe to the test point that gave the lowest reading.	This connection should operate the meter properly upscale, thereby checking its polarity. It should read less than 1.0 volt.
14	Switch TTS-28 test set to the 1.5-VDC position.	A reading of less than 1.0 vdc indicates a satisfactory DISCRIMINATOR unit.
15	Replace TIMER unit and operate the CLR key.	
16	Test should now be repeated in ORIG mode by setting the MTC switches at ORIG, CONN +3, and MARK, and operating the ORIG key. With this and a similar change in Step 7, Steps 6 through 15 should be repeated.	

M. Distortion Measurement

Preparation of the 164C4 (or equivalent)

STEP	ACTION	RESULT
1	Connect TMS test cord by plugging 359A plug into input jacks of test set and the 347A plug into jack J2. Connect plug of the 2W44A cord, provided with the set, into jack J3.	

Send and receive bias measured at the DISCRIMINATOR unit —

2	Remove strap between D67 and D68.	
3	Switch 164 TMS to 20 MA and to proper speed.	
4	Connect alligator clip with black wire of 2W44A cord to terminal D67 of data set.	
5	Connect alligator clip with red wire of 2W44A cord to terminal D68.	

To check bias of send contacts —

6	Operate LCL key and transmit from the keyboard or any other signal generator at the station.	Read distortion on TMS; it shall be less than 5 per cent marking or spacing.

To check receive bias at DISCRIMINATOR unit —

7	Establish a connection to a source of telegraph signals via the telephone network.	
8	Read distortion on the 164 TMS.	Reading should be less than 7.5 per cent.
9	Restore circuit to normal.	

Bias of send contacts —

STEP	ACTION	RESULT
10	Switch 164C4 TMS to 62.5 MA and to proper speed.	
11	Disconnect SEND BREAK TIMER unit.	
12	Connect alligator clip with black lead of 2W44A cord to terminal D49, and with a 180-ohm resistor in series with the red lead, clip red lead to terminal D69.	
13	Operate LCL key.	
14	Type on keyboard or generate signals from any other source.	Observe distortion on 164 TMS. It shall be less than 5 per cent marking or spacing.
15	Restore circuit to normal.	
16	To make bias and distortion tests, use the 907A per Tables J and K.	

N. Sensitivity Tests

Data set 101C contains a "signal fail" feature that permits a potentiometer adjustment of circuit sensitivity, determining the minimum signal level that will keep the station connected to the line. This is intended to be a factory adjustment. With wedge-lock terminals A and B on LIMITER unit strapped, it is initially set to require incoming signals above −51 dbm in filter band pass for the connect sequence to be operative. After station has connected, the same adjustment will also detect a reduction of signal below −56 dbm producing a spacing signal to TIMER unit, which initiates disconnect sequence. This feature is included to assure circuit continuity to the user during transmission of his message.

Some types of customer trouble reports might indicate changes in circuit sensitivity due to component changes. This section describes how the MAINTENANCE TEST CARD enables limiter and associated circuitry to be isolated from the line to determine whether the sensitivity is within acceptable limits.

When making Sensitivity test with MAINTENANCE TEST CARD, MODULATOR unit will send f_{1m} signals via MAINTENANCE TEST CARD to LIMITER unit. These signals are reduced by pads on MAINTENANCE TEST CARD to ac voltages that are equivalent to the required Limiter input test levels. Their value depends upon the position of the switches.

For a meaningful test, a MODULATOR unit within ±0.75 db of nominal output level is required.

The various switch settings of the MAINTENANCE TEST CARD, with ANS-ORIG switch in ANS position, provide equivalent signal levels, relative to power into 900 ohms across tip and ring, as indicated below. The SPACE position provides pure spacing signals that are useful for testing and trouble shooting. TST key may be depressed to prevent data set from disconnecting in SPACE position.

Position	Mark	Dot	Space
CONN	−51	−41	−41
CONN +3	−48	−38	−38
DISCONN	−58	−58	−58

All readings are in dbm.

Note: The dbm values in ORIG mode, F_{2m} band, are approximately 2 db higher.

Make sensitivity tests per Table E (MTC), or Table I (907A).

O. Loop Loss Measurement

STEP	ACTION	RESULT
1	Switch TTS-28 test set to TEL-SET DIAL position.	
2	Connect 1011-type handset to TEL-SET terminals of TTS-28 test set, and connect test set to D34 and D35.	
3	Dial 1000-cycle, 1-milliwatt test number.	
4	After connection is completed, switch TTS-28 test set to DBM 900-OHM TERM position.	Note reading. This result should be compared with the figure recorded on station record. If loop losses are not within limits of the expected measured loss (EML), as indicated on station label, loop should be turned back for repair. Table M gives the permissible variations from EML.

P. Timing Tests

Table L contains tests of timing functions of the data set using the 907A data test set. These are not a series of tests but individual timing checks and are not numbered. These tests are intended to be performed on a data set only where incorrect timing intervals are suspected; any other data set trouble should be cleared before these tests are made.

TABLE A

POSITION OF B TEST SWITCH TO CORRESPOND TO WEDGE LOCK TERMINAL STRAPPED VALUE

*Preparation**

1. Connect EXTENDER card to 907A using connecting cord assembly ED-71287-20G1 (FS 2).
2. Remove HYBIRD and MODULATOR units.
3. Position EXTENDER card into HYBIRD unit slot and carefully insert MODULATOR unit into EXTENDER card.

Data Set 101C Arrangement			907 Data Test Set			TTS-28				Normal Indication and Procedure	Abnormal Indication and Procedure
Gain Reduction	Wedge Lock Terminal Strapping		Sw-A	Sw-B	ANS-ORIG	Function Switch	Probe		Reading†		
	Limiter	Send Break Timer					+	−			
0	A-B	G-K	5	1	ANS or ORIG	−10 DBM BRDG	M-1 907A	M-2 907A	ANS −6.3 db ORIG −6.0 db	Reading should be within ±1.5 db	Check output of MODULATOR unit per Part 8, Item G
2	A-B	G-H J-K	5	2	ANS or ORIG	−10 DBM BRDG	M-1 907A	M-2 907A	ANS −4.5 db ORIG −4.1 db	Reading should be within ±1.5 db	
4	A-C	G-K	5	3	ANS or ORIG	−10 DBM BRDG	M-1 907A	M-2 907A	ANS −2.5 db ORIG −2.1 db	Reading should be within ±1.5 db	
6	A-C	G-H J-K	5	4	ANS or ORIG	−10 DBM BRDG	M-1 907A	M-2 907A	ANS −0.3 db ORIG +0.2 db	Reading should be within ±1.5 db	
8	A-D	G-K	5	5	ANS or ORIG	−10 DBM BRDG	M-1 907A	M-2 907A	ANS +1.7 db ORIG +2.2 db	Reading should be within ±1.5 db	

* Before connecting 907A to EXTENDER card, set ADJ at 500 or higher to prevent damage to pot.

† Actual reading on TTS-28.

TABLE B

RESTRAINER UNIT TEST USING MAINTENANCE TEST CARD

Step	Preparation	MTC			TTS 28			Atnd Set	Normal Indication and Procedure	Next Step	Abnormal Indication and Procedure	Next Step
		ORIG ANS	MARK DOT SPACE	DISCONN CONN CONN +3	Function Switch	Probe (+)	Probe (−)					
1	Remove HY-BRID and MODULATOR units. Insert MTC into HY-BRID slot and plug MODULATOR into MTC.	ORIG	MARK	CONN +3				ORIG	Set connects	2	If set does not connect make SENSITIVITY test per Table E	
2		ORIG	DOT	CONN +3	−10 DBM BRDG	GRD	TP-3 RE-STRAINER unit	ORIG	TTY prints meaningless copy. Reading on TTS 28 should be between 0 and +3 dbm.	3	Replace RESTRAINER unit.	1
3	Remove test probes	ORIG	DOT	CONN +3	−10 DBM BRDG	GRD	TP-4 RE-STRAINER unit	ORIG	Reading on TTS 28 should be between −1.5 and +0.5 dbm Reading should be more positive at TP-3 than TP-4.	4	Replace RESTRAINER unit.	1
4	Remove test probes	ORIG	MARK	CONN +3	30 VDC*	GRD	TP-2 RE-STRAINER unit	ORIG	Reading should be less than 0.85 vdc.	5	Replace RESTRAINER unit.	1
5		ORIG	DOT	CONN +3	30 VDC*	GRD	TP-2 RE-STRAINER unit	ORIG	TTY prints meaningless copy. Reading should be less than 0.85 vdc.	End of Test	Replace RESTRAINER unit.	1

* Switch can be moved to 1.5 VDC scale after initial reading.

TABLE C

LIMITER UNIT TEST USING MAINTENANCE TEST CARD

Step	Preparation	MTC			TTS 28			Atnd Set	Normal Indication and Procedure	Next Step	Abnormal Indication and Procedure	Next Step
		ORIG ANS	MARK DOT SPACE	DISCONN CONN CONN +3	Function Switch Position	Probe (+)	Probe (−)					
1	Remove HYBRID and MODULATOR units. Insert MTC into HYBRID unit slot and insert MODULATOR unit into MTC. This test checks LIMITER operation under signal condition.	ORIG	MARK	CONN	0 DBM BRDG	GRD	TP-1 LIMITER unit	ORIG	Set will connect and reading should be more positive than −1.0 dbm. This reading indicates LIMITER is clipping and receive level at station is −50 dbm or better.	3	Set does not connect and reading is more negative than −1.0 dbm.	2
2		ORIG	MARK	CONN +3	0 DBM BRDG	GRD	TP-1 LIMITER unit	ORIG	Set will connect	3	Set does not connect. Refer to SENSITIVITY test Table E. Replace LIMITER unit.	1
3	Remove test probes.	ORIG	MARK	CONN	30 VDC*	TP-4 SEND BREAK TIMER unit	GRD	ORIG	Reading should be greater than 0 vdc. This indicates that space-hold circuit is inactive when receiving a proper signal.	4	Replace SEND BREAK TIMER unit	3
4	Remove test probes. To check LIMITER for a weak signal operation make the following measurements.	ORIG	MARK	DISCONN	0 DBM BRDG	GRD	TP-1 LIMITER unit	ORIG	Reading should be more negative than −1.0 dbm. This indicates LIMITER is not receiving an acceptable tone.	5	Replace LIMITER unit.	1
5	Remove test probes.	ORIG	MARK	DISCONN	30 VDC	GRD	TP-4 SEND BREAK TIMER unit	ORIG	Reading should be greater than 0.25 vdc. This indicates that space-hold (carrier fail) circuit is operating properly.	End of Test	Replace SEND BREAK TIMER unit.	5

* Switch may be moved to 1.5 VDC scale after initial reading.

TABLE D

DISCRIMINATOR UNIT TEST USING MAINTENANCE TEST CARD

Step	Preparation	MTC			TTS 28			Atnd Set	Action	Normal Indication and Procedure	Next Step	Abnormal Indication and Procedure	Next Step
		ORIG ANS	MARK DOT SPACE	DISCONN CONN CONN +3	Function Switch	Probe (+)	Probe (−)						
1	Remove HYBRID and MODULATOR units. Insert the MTC into the HYBRID unit slot and plug MODULATOR unit into MTC.	ANS	MARK	CONN +3				ANS	When CON relay operates, remove TIMER unit.	CON relay operates and TTY runs closed.	2	If CON relay does not operate make SENSITIVITY test per Table E. If machine runs open make voltage tests beginning with Step 3.	3
2		ANS	SPACE	CONN +3				ANS		TTY runs open.		TTY runs closed.	3 *
3	Reinsert TIMER unit.	ANS	MARK	CONN +3	30 VDC	TP-1 DISCRIM-INATOR	GRD	ANS	When CON relay operates, remove TIMER unit.	Reading should be more positive than −0.5 vdc.	4 †	Replace DISCRIMI-NATOR unit.	1
4	Remove test probes.	ANS	SPACE	CONN +3	30 VDC	GRD	TP-1 DISCRIM-INATOR	ANS		TTY runs open. Reading should be more than 2.6 vdc.	5	Replace DISCRIMI-NATOR unit.	1
5	Remove test probes.	ANS	MARK	CONN +3	1.5 VDC	GRD	TP-2 DISCRIM-INATOR	ANS		TTY runs closed. Reading should be less than 0.2 vdc ‡	6	Replace DISCRIMI-NATOR unit.	1
6	Remove test probes.	ANS	SPACE	CONN +3	30 VDC	TP-2 DISCRIM-INATOR	(−) Test point on rectifier	ANS		TTY runs open. Reading should be less than 2.6 vdc.	End of Test	Replace DISCRIMI-NATOR unit.	1

* If all readings are correct but machine did not run open in Step 2, check wiring and selector magnet driver.

† Voltage readings in Steps 3 and 4 are the output of the DISCRIMINATOR network. Voltage readings in Steps 5 and 6 are the output of the DISCRIMINATOR unit.

‡ Do not hit any characters at this time.

TABLE E

SENSITIVITY TEST USING MAINTENANCE TEST CARD

Step	Preparation	MTC			Atnd Set	Normal Indication and Procedure	Next Step	Abnormal Indication and Procedure	Next Step
		ORIG ANS	MARK DOT SPACE	DISCONN CONN CONN +3					
1	Remove HYBRID and MODULATOR units. Insert MTC into HYBRID unit slot, plug MODULATOR unit into MTC.	ANS	MARK	CONN	ANS	AN, M and then CON relays should operate. TTY connects.	3	CON relay does not operate. TTY does not connect.	2
2		ANS	MARK	CONN +3	ANS	AN, M and then CON relays should operate. TTY connects. LIMITER unit potentiometer should be adjusted clockwise just enough to permit proper relay operation under condition specified in Step 1.	1	TTY does not connect. Check LIMITER unit per Table C. Check DISCRIMINATOR unit per Table D.	1
3	To ensure data set is not overly sensitive.	ANS	DOT	CONN	ANS	TTY types meaningless copy.	4		
4		ANS	DOT	DISCONN		S relay should now operate and data set will go to on-hook condition indicating LIMITER unit is not overly sensitive.	End of Test	S relay does not operate. Replace LIMITER unit.	1

TABLE F

RESTRAINER UNIT TEST USING 907A DATA TEST SET

STEP	Preparation*	907A Data Test Set			TTS-28			Atnd Set	Action	Normal Indication and Procedure	Next Step	Abnormal Indication and Procedure	Next Step
		Sw-A	Sw-B	ANS-ORIG	Function Switch	Probe (+)	Probe (−)						
1	Connect EXTENDER card to 907A with connecting cord assembly ED-71287 -20G1. Remove HYBRID and MODULATOR units. Slide EXTENDER card into HYBRID unit slot and carefully insert MODULATOR unit into EXTENDER card.	6	†	ORIG				ORIG	Depress ORIG key on attendant set.	TTY turns on and data set connects.	2	If TTY does not connect make SENSITIVITY test per Table I.	1
2		8	†	ORIG	−10 DBM BRDG	GRD	TP-3 RE-STRAINER unit	ORIG		Reading on meter should read between 0 and +3 dbm. TTY will print meaningless copy.	3	Replace RESTRAINER unit.	1
3	Remove test probe.	8	†	ORIG	−10 DBM BRDG	GRD	TP-4 RE-STRAINER unit	ORIG		Meter should read between −1.5 and +0.5 dbm. ***Note:*** Reading at TP-3 should be more positive than TP-4.	4	Replace RESTRAINER unit.	1
4	Remove test probe.	6	†	ORIG	30 VDC	GRD	TP-2 RE-STRAINER unit	ORIG		Reading should be less than 0.85 vdc.	5	Replace RESTRAINER unit.	1
5		8	†	ORIG	30 VDC	GRD	TP-2 RE-STRAINER unit	ORIG		Reading should be less than 0.85 vdc. TTY prints meaningless copy.	6	Replace RESTRAINER unit.	1
6	Remove test probe.	10	†	ORIG or ANS	30 VDC	M-1 907A	TP-2 RE-STRAINER unit	ORIG or ANS	Both ANS and ORIG modes should fall within this range.	REST lamp will light and reading on TTS-28 will be between 0.9 and 1.3 vdc.	7	Check lamp and wiring if lamp does not light. ***Note:*** Remove TIMER unit and adjust resistor R-5 on RESTRAINER to meet this requirement. If this requirement cannot be met replace RESTRAINER first, then DISCRIMINATOR unit.	1
7		11	†	ANS				ANS		REST lamp shall remain lit.	End of Test	(A) Replace RESTRAINER unit (B) Replace DISCRIMINATOR unit	1

* Before connecting 907A to EXTENDER card, set ADJ at 500 or higher to prevent damage to pot.

† Per Table A.

TABLE G

LIMITER UNIT TEST USING 907A DATA TEST SET

Step	Preparation*	907A Data Test Set			TTS-28			Atnd Set	Normal Indication and Procedure	Next Step	Abnormal Indication and Procedure	Next Step
		Sw-A	Sw-B	ANS-ORIG	Function Switch	Probe (+)	Probe (−)					
1	Connect EXTENDER card to 907A with connecting cord assembly ED-71287-20G1. Remove HYBRID and MODULATOR units. Slide EXTENDER card into HYBRID unit slot and carefully insert MODULATOR unit into EXTENDER card.	7	†	ORIG	0 DBM BRDG	GRD	TP-1 of LIMITER unit	ORIG	TTY will connect. Reading should be more positive than −1.0 dbm. This indicates LIMITER is clipping and receive level at station is −50 dbm or better.	3	TTY does not connect.	2
2		6	†	ORIG	0 DBM BRDG	GRD	TP-1 of LIMITER unit	ORIG	Set will connect. Reading should be more positive than −1.0 dbm	3	Set does not connect. Refer to SENSITIVITY test Table I.	1
3	Remove test probes.	7	†	ORIG	1.5 VDC	TP-4 SEND BREAK TIMER	GRD	ORIG	Reading should be greater than 0 vdc. This indicates that space-hold circuit is inactive when receiving a proper signal.	4	Replace SEND BREAK TIMER unit.	3
4	Remove test probes. To check LIMITER for a weak signal operation make the following measurements. Remove TIMER.	4	†	ORIG	0 DBM BRDG	GRD	TP-1 LIMITER unit	ORIG	Reading should be more negative than −1.0 dbm. This indicates LIMITER is not receiving an acceptable tone.	5	Replace LIMITER unit.	1
5	Remove test probes.	4	†	ORIG	1.5 VDC	GRD	TP-4 SEND BREAK TIMER unit	ORIG	Reading should be greater than 0.25 vdc. This indicates that space hold (carrier fail) circuit is operating properly.	End of Test	Replace SEND BREAK TIMER unit.	3

* Before connecting 907A to EXTENDER card, set ADJ at 500 or higher to prevent damage to pot.

† Per Table A.

TABLE H

DISCRIMINATOR UNIT TESTS USING 907A DATA TEST SET

Step	Preparation*	907A Data Test Set			TTS-28			Atnd. Set	Action	Normal Indication and Procedure	Next Step	Abnormal Indication and Procedure	Next Step
		Sw-A	Sw-B	ANS-ORIG	Function Switch	Probe (+)	Probe (−)						
1	Connect EXTENDER card to 907A with connecting cord assembly ED-71287-20G1. Remove HYBRID and MODULATOR units. Slide EXTENDER card into HYBRID unit slot and carefully insert MODULATOR unit into EXTENDER card.	6	†	ANS				ANS	When CON relay operates, remove TIMER unit.	CON relay operates and TTY runs closed.	2	If CON relay does not operate make SENSITIVITY test per Table I. If machine runs open make voltage tests beginning with Step 3.	
2		3	†	ANS						TTY runs open	3	TTY runs closed	3‡
3	Reinsert TIMER unit.	6	†	ANS	30 VDC	TP-1 DISCRIMINATOR unit	GRD	ANS	When CON relay operates, remove TIMER unit.	Reading should be more positive than −0.5 vdc.	4§	Replace DISCRIMINATOR unit.	1
4	Remove test probes.	3	†	ANS	30 VDC	GRD	TP-1 DISCRIMINATOR unit	ANS		Reading should be greater than 2.6 vdc. TTY runs open.	5	Replace DISCRIMINATOR unit.	1
5	Remove test probes.	6	†	ANS	30 VDC	GRD	TP-2 DISCRIMINATOR unit	ANS		Reading should be less than 0.2 vdc. TTY runs closed.	6	Replace DISCRIMINATOR unit.	1
6	Remove test probes.	3	†	ANS	30 VDC	TP-2 DISCRIMINATOR unit	(−) Test point on rectifier	ANS		Reading should be less than 2.6 vdc. TTY runs open.	End of Test	Replace DISCRIMINATOR unit.	1

* Before connecting 907A to EXTENDER card, set ADJ at 500 or higher to prevent damage to pot.

† Per Table A.

‡ If readings are correct but machine did not run open in Step 2, check wiring and selector magnet driver.

§ Voltage readings in Steps 3 and 4 are the output of the DISCRIMINATOR network. Voltage readings in Steps 5 and 6 are the output of the DISCRIMINATOR unit.

TABLE I

SENSITIVITY TEST USING 907A DATA TEST SET

Step	Preparation*	907A Data Test Set			TTS 28			Atnd. Set	Normal Indication and Procedure	Next Step	Abnormal Indication and Procedure	Next Step
		Sw-A	Sw-B	ANS-ORIG	Function Switch	Probe (+)	Probe (−)					
1	Connect EXTENDER card to 907A with connecting cord assembly ED-71287-20G1. Remove HYBRID and MODULATOR units. Slide EXTENDER card into HYBRID unit slot and carefully insert MODULATOR unit into EXTENDER card.	7	†	ORIG or ANS				ORIG or ANS	AN, M and then CON relays operate.‡ TTY connects	3	CON relay does not operate. Set does not connect.	2
2		6	†	ORIG or ANS				ORIG or ANS	AN, M and then CON relays operate † TTY connects. LIMITER unit potentiometer should be adjusted clockwise just enough to permit proper relay operation under condition specified in Step 1.	1	Set does not connect. Check LIMITER unit per Table G and DISCRIMINATOR unit per Table H.	1
3		4	†	ORIG or ANS				ORIG or ANS	TTY will print some meaningless copy and data set will go to "on-hook" condition indicating LIMITER unit is not overly sensitive.	End of Test	Check LIMITER unit. Check DISCRIMINATOR unit.	1

* Before connecting 907A to EXTENDER card, set ADJ at 500 or higher to prevent damage to pot.

† Per Table A.

‡ In ORIG mode, relay OR operates.

TABLE J

DISTORTION TEST USING 907A DATA TEST SET

Step	Preparation*	907-A			164C4 TMS					Action	Normal Indication and Procedure	Step	Abnormal Indication and Procedure	Step
		Sw-A	Sw-B	ORIG-ANS	Loop	Speed	Display	Code	Loop Input					
1	Connect 907A to EXTENDER card using connecting cord assembly ED-71287-20 G1. Remove SEND BREAK TIMER unit and insert EXTENDER card into SEND BREAK TIMER slot. Plug 359A cord into SIG jack of 907-A and INPUT jack of 164C4.	18	OFF	ORIG	20	100/8	PIP	8/100	NORMAL	Depress LCL key and type repeated Y character.	Read DISTORTION on 164C4. This reading is SEND DISTORTION. If within limits, go to next step.	2	If out of limits make adjustments as required.	1
2	Remove EXTENDER card and reinsert SEND BREAK TIMER unit.											3		
3	Remove RESTRAINER unit and insert the EXTENDER card into RESTRAINER unit slot.	19	OFF*	ORIG	20	100/8	PIP	8/100	NORMAL	Ground D-66. Dial a source of telegraph signals over the telephone network.	Read DISTORTION on 164C4. This reading is RECEIVE DISTORTION. TTY will run but is blinded, local copy will not be received, and local copy cannot be typed.	End of Test	If out of limits make adjustments as required.	3

* Before connecting 907A to EXTENDER card, set ADJ at 500 or higher to prevent damage to pot.

TABLE K

BIAS TEST USING 907A DATA TEST SET

Step	Preparation*	907A Data Test Set			TTS-28			Atnd. Set	Action	Normal Indication and Procedure	Next Step	Abnormal Indication and Procedure	Next Step
		Sw-A	Sw-B	ANS-ORIG	Function Switch	Probe (+)	Probe (−)						
1	Connect EXTENDER card to 907A with connecting cord assembly ED-71287-20G1. Remove HYBRID and MODULATOR units. Slide EXTENDER card into HYBRID unit slot and carefully insert MODULATOR unit into EXTENDER card.	5	Per Table A	ANS or ORIG	30 VDC	M-1 907A	TP-2 DISCRIMINATOR unit	ANS or ORIG	Block RB relay released. Set ADJ of 907A to 500. Remove strap from D-73 and D-74.	TTY will connect.	2	Check LIMITER unit per Table G.	
2	Depress TST key.	3	Per Table A	ANS or ORIG	30 VDC†	M-1 907A	TP-2 DISCRIMINATOR unit	ANS or ORIG	Set ADJ of 907A for meter reading of 0 vdc. This adjustment should be upward from 500. *Do Not Adjust below 200.*	TTY runs open. Reading should be 0 vdc.	3	If TTY runs open but reading of 0 vdc cannot be reached by adjusting ADJ, trouble could be in voltage divider circuit on TIMER unit, or trouble in RESTRAINER unit.‡ Check EOT in Part 8, Item C.	1
3		8	Per Table A	ANS or ORIG	30 VDC	M-1 907A	TP-2 DISCRIMINATOR unit	ANS or ORIG		Reading should be less than 1 vdc. ***Note:*** 1 volt equal 5 per cent bias. TTY types meaningless copy.	End of Test	Higher voltage readings indicate machine may be out of limits.	

* Before connecting 907A to EXTENDER card, set ADJ at 500 or higher to prevent damage to pot.

† In Step 2 TTS-28 can be switched to 1.5-vdc scale after initial reading.

‡ Later model RESTRAINER units have transistors Q8 and Q9.

TABLE L

TIMING TESTS USING 907A TEST SET

*Preparation**

1. Connect EXTENDER card to 907A with connecting cord assembly ED-71287-20G1.
2. Remove HYBRID and MODULATOR units.
3. Slide EXTENDER card into HYBRID unit slot and carefully insert MODULATOR unit into EXTENDER card.

Test Description	907A Test Set				Test Lead Connections	Action	Normal Indication and Procedure	Abnormal Indication and Procedure
	Sw-A	Sw-B	ORIG-ANS	ADJ				
Monitor Mark ORIG Mode	14	9	ORIG	383	T1 to TP2 of TIMER unit. T2 to TP3 of TIMER unit.	Depress and *hold* RESET button on 907A. Depress ORIG key on attendant set. Release RESET button.	GOOD lamps on 907A will light.	If either HIGH or LOW lamps do not light, replace TIMER and/or RESTRAINER units.
SF Guard Interval	14	7	ORIG	390 720	T1 to TP2 of TIMER unit. T2 to TP3 of TIMER unit.	Depress and *hold* RESET button on 907A. Depress ANS key on attendant set. Release RESET button.	Either the HIGH or GOOD lamps will light. Either the LOW or GOOD lamps will light.	If either indication is wrong replace the TIMER unit.
Monitor Mark ANS Mode	14	9	ORIG	185	T1 to TP2 of the TIMER unit. T2 to TP3 of the TIMER unit.	Depres ANS key on attendant set, wait approximately 1 second for SF Guard interval, then depress and *hold* RESET button. Operate ANS-ORIG key on 907A to ANS, and release RESET button. Data set will time out in about 6 seconds.	GOOD lamps on 907A will light.	If either HIGH or LOW lamps do not light, replace TIMER and/or RESTRAINER units.
Send Break	12	9	ANS	160	T1 to TP1 of the TIMER unit. T2 to TP2 of DISCRIMINATOR.	Depress ANS key on attendant set. *Momentarily* depress RESET button of 907A. Depress and *hold* BREAK key of TTY.	GOOD and BRK-RLS lamps will light.	If either HNGH or LOW lamp does not light, replace SEND BREAK TIMER unit.
Monitor Space	14	9	ANS	255	T1 to TP2 of the TIMER unit. T2 to TP3 of TIMER unit.	Depress ANS key, after CON relay operates, block S relay released, and RB relay operated. Depress and *hold* RESET button. Operate the ANS-ORIG key of 907A to ORIG, wait one second then release RESET button.	GOOD lamps will light. BRK-RLS lamp lights. TTY runs open.	If either HIGH or LOW lamps do not light, replace TIMER and/or RESTRAINER units.
Monitor Break	14	9	ANS	085	T1 to TP2 of the TIMER unit. T2 to TP3 of the TIMER unit.	Depress ANS key, when CON relay operates, block RB relay released. Depress and *hold* RESET button. Operate ANS-ORIG key of 907A to ORIG, wait one second then release RESET button.	GOOD lamps will light. TTY runs open.	If either HIGH or LOW lamps do not light, replace TIMER and/or RESTRAINER units.
Send Mark	14	9	ANS	085	T1 to TP2 of the TIMER unit. T2 to TP3 of TIMER unit.	Block AN operated, block RB released, block S relay operated, *momentarily* depress RESET button.	GOOD lamps will light.	If either HIGH or LOW lamps do not light, replace TIMER and/or RESTRAINER units.
Send Space	14	9	ANS	510	T1 to TP2 of the TIMER unit. T2 to TP3 of TIMER unit.	Block AN or OR, the S and RB relays operated. After CON relay operates, *momentarily* depress RESET button.	GOOD lamps will light.	If either HIGH or LOW lamp does not light, replace TIMER unit.

* Before connecting 907A to EXTENDER card, set ADJ at 500 or higher to prevent damage to pot.

TABLE M

PERMISSABLE VARIATIONS FROM EML

Type of Loop	Variation
	db
Without carrier or repeater	±1
With E7 repeater only	±1
With all other repeaters and/or carrier	±2