1600- OR 2000-CYCLE SINGLE FREQUENCY SIGNALING CIRCUIT SD-56202-01

ANALYSIS AND CLEARANCE OF TROUBLE

1. GENERAL

1.01 This section describes methods and procedures that may be followed in the analysis and clearance of troubles encountered in 1600- or 2000-cycle single frequency signaling circuits.

1.02 This section is reissued to add to the voltage readings, amplify varistor test information and to change the rating of the section from AT&TCo Provisional to AT&TCo Standard. Since this reissue covers a general revision, arrows ordinarily used to indicate changes have been omitted.

1.03 This procedure is based on the failure of the signaling circuit to meet the test requirements described in Section 179-217-501 and where so indicated, could not be adjusted in accordance with Section 179-217-701. The headings are as follows:

A. Sensitivity of Receiver

B. Pulsing Performance of Receiver

C. Guard Sensitivity

D. Transmitter Performance

E. Relay Timing

F. Voice Amplifier

G. Blocking Amplifier

H. Blocking Network

I. Varistor Data

In the trouble-locating procedures unless otherwise specified, the same switch and attenuator settings on the signaling testing circuit SD-56137-01, used for tests in Section 179-217-501 or adjustments in Section 179-217-701, are required.

2. APPARATUS

2.01 In addition to the apparatus mentioned in Sections 179-217-501 and 179-217-701, the apparatus listed below may be required.

2.02 Electron tube test set, KS-15559-L1, or KS-15560-L1.

2.03 Volt-ohm-milliammeter, M9B or KS-14510.

2.04 Varistor test set, KS-12054.

2.05 Cold cathode tube test set.

3. TROUBLE CONDITIONS

A. Sensitivity Receiver

3.01 If unable to adjust P2 and P3 potentiometers as specified in Section 179-217-701, test for:

(a) Faulty V2 and V3 electron tubes.

Note: It is essential that both the V2 and V3 electron tubes be checked in this case, for although replacing either one might permit the requirement to be barely met, the one new tube might (due to extremely high cathode activity) temporarily hide the fact that the other remaining tube is extremely weak and will fail in a short period.

(b) Trouble ground or open circuit in the operating path of the R relay.

(c) Component failure in the electron portion of the receiver.

3.02 Check that the tubes have proper plate, screen, cathode, and grid voltages in accordance with Table 1A or 1B with no signal input.

TABLE 1A

Typical DC Voltage Readings Using M9B Meter

No Signal Input

METER SCALE USED	VOLTMETER CONNECTIONS +V TERM. TO	—V TERM. TO	VOLTMETER READING
3V DC	2 (See Note 1)	(See Note 2)	2.0 — 2.4
150V DC	7 (See Note 1)	Grd	88 — 95
150V DC	5 (See Note 1)	Grd	120 — 127
15V DC	Grd	11 (See Note 3)	7.6 — 8.8

TABLE 1B

Typical DC Voltage Readings Using KS-14510 Meter

No Signal Input

METER SCALE USED	VOLTMETER CONNECTIONS +V TERM. TO	—V TERM. TO	VOLTMETER READING
3V DC	2 (See Note 1)	(See Note 2)	2.1 — 2.5
300V DC	7 (See Note 1)	Grd	96 — 102
300V DC	5 (See Note 1)	Grd	126 — 129
12V DC	Grd	11 (See Note 3)	7.8 — 8.8

Notes

1. Terminal card associated with V2 tube.
2. 25A terminal punching mounted at T4 transformer position.
3. Socket terminal of signal-guard detector unit.

3.03 If the typical voltages of Table 1A or 1B are approximately obtained, proceed in accordance with Tables 2A or 2B and 3A or 3B which give typical receiver ac and dc voltage measurements with a signal tone input to the receiver. Tables 2A and 2B are of value in locating trouble encountered during sensitivity adjustments while 3A and 3B are useful in locating trouble encountered in low sensitivity tests. Although limits are given, any slight deviation from those stated will not necessarily be indicative of complete component failure, but large deviations will serve to aid in localizing any trouble encountered. Three levels of applied signal tone are used.

FOR TABLE 2A OR 2B

	+4 UNIT	+7 UNIT
Low level	−24 db	−21 db
Medium level	−16 db	−13 db
High level	−4 db	−1 db

FOR TABLE 3A OR 3B

	+4 UNIT	+7 UNIT
Low level	−16 db	−13 db
Medium level	−4 db	−1 db
High level	+4 db	+7 db

TABLE 2A

**Typical AC and DC Voltages Using M9B Meter
With Signal Input, S Relay Normal,
and Dummy Plug in R Jack**

METER SCALE USED	VOLTMETER CONNECTIONS +V TERM. TO	—V TERM. TO	VOLTMETER READINGS WITH VARIOUS INPUTS LOW	MEDIUM	HIGH
3V AC	2(T3)	1(T3)	—	—	0.8 — 0.82
3V AC	7(T3)	Pchg (V)	—	—	1.0 — 1.1
150V AC	4(T4)	3(T4)	40 — 48	80 — 86	103 — 115
3V AC	2(See Note 3)	(See Note 4)	2 — 2.6	2 — 2.6	2.1 — 2.8
150V AC	2(T4)	1(T4)	11 — 15	20 — 24	27 — 31
150V AC	1(See Note 1)	3(See Note 1)	20 — 24	33 — 38	41 — 45
150V AC	1(See Note 1)	11(See Note 1)	20 — 24	33 — 37	40 — 43
3V AC	3(See Note 1)	11(See Note 1)	0.4 — 0.7	0.8 — 1.2	1.0 — 1.5
150V DC	B(See Note 2)	A(See Note 2)	23 — 28	37 — 42	44 — 48
3V DC	A(See Note 2)	C(See Note 2)	0.04 — 0.13	0.2 — 0.36	0.44 — 0.75
150V DC	6(See Notes 1 and 5)	Grd	0 — 0.15	3.5 — 4	4 — 5

TABLE 2B

Same as Table 2A, Except Using KS-14510 Meter

METER SCALE USED	VOLTMETER CONNECTIONS +V TERM. TO	—V TERM. TO	VOLTMETER READINGS WITH VARIOUS INPUTS LOW	MEDIUM	HIGH
3V AC	2(T3)	1(T3)	—	—	0.9 — 0.92
3V AC	7(T3)	Pchg (V)	—	—	1.5 — 1.52
300V AC	4(T4)	3(T4)	40 — 48	78 — 88	103 — 115
3V AC	2(See Note 3)	(See Note 4)	2 — 2.5	2.1 — 2.6	2.2 — 2.8
60V AC	2(T4)	1(T4)	12 — 16	23 — 28	30 — 32
60V AC	1(See Note 1)	3(See Note 1)	22 — 26	35 — 39	42 — 45
60V AC	1(See Note 1)	11(See Note 1)	22 — 26	35 — 38	41 — 44
3V AC	3(See Note 1)	11(See Note 1)	0.5 — 0.8	0.9 — 1.3	1.1 — 1.4
60V DC	B(See Note 2)	A(See Note 2)	28 — 33	45 — 48	52 — 56
3V DC	A(See Note 2)	C(See Note 2)	0.15 — 0.5	0.45 — 0.9	0.9 — 1.6
300V DC	6(See Notes 1 and 5)	Grd	2 — 3	6 — 7	7 — 9

TABLE 3A

Typical AC and DC Voltages Using M9B Meter With Signal Input, S Relay Operated, and Dummy Plug in R Jack

METER SCALE USED	VOLTMETER CONNECTIONS +V TERM. TO	−V TERM. TO	VOLTMETER READINGS WITH VARIOUS INPUTS LOW	MEDIUM	HIGH
3V AC	2(T3)	1(T3)	—	0.8 — 0.82	1.7 — 1.72
3V AC	7(T3)	Pchg (V)	—	1.0 — 1.1	1.87 — 1.89
150V AC	4(T4)	3(T4)	27 — 32	86 — 95	100 — 108
3V AC	2(See Note 3)	(See Note 4)	2 — 2.6	2 — 2.6	2.1 — 2.8
150V AC	2(T4)	1(T4)	7.5 — 10	22 — 27	26 — 30
150V AC	1(See Note 1)	3(See Note 1)	13 — 17	37 — 42	40 — 45
150V AC	1(See Note 1)	11(See Note 1)	13 — 17	36 — 41	39 — 44
3V AC	3(See Note 1)	11(See Note 1)	0.25 — 0.45	0.9 — 1.4	1.1 — 1.6
150V DC	B(See Note 2)	A(See Note 2)	17 — 21	41 — 44	44 — 48
3V DC	A(See Note 2)	C(See Note 2)	0 — 0.05	0.3 — 0.5	0.4 — 0.8
150V DC	6(See Notes 1 and 5)	Grd	–1 — 0	3.5 — 4.5	4 — 5

TABLE 3B

Same as Table 3A, Except Using KS-14510 Meter

METER SCALE USED	VOLTMETER CONNECTIONS +V TERM. TO	−V TERM. TO	VOLTMETER READINGS WITH VARIOUS INPUTS LOW	MEDIUM	HIGH
3V AC	2(T3)	1(T3)	—	0.9 — 0.94	1.85 — 1.87
3V AC	7(T3)	Pchg (V)	—	1.45 — 1.5	2.66 — 2.68
300V AC	4(T4)	3(T4)	24 — 32	85 — 95	100 — 107
3V AC	2(See Note 3)	(See Note 4)	2 — 2.5	2.1 — 2.6	2.2 — 2.7
60V AC	2(T4)	1(T4)	8 — 10	25 — 28	28 — 31
60V AC	1(See Note 1)	3(See Note 1)	15 — 19	38 — 41	41 — 44
60V AC	1(See Note 1)	11(See Note 1)	15 — 19	37 — 40	40 — 43
3V AC	3(See Note 1)	11(See Note 1)	0.35 — 0.5	1 — 1.5	1.2 — 1.8
60V DC	B(See Note 2)	A(See Note 2)	20 — 24	47 — 52	52 — 55
3V DC	A(See Note 2)	C(See Note 2)	0 — 0.35	0.7 — 1.2	1 — 2.1
300V DC	6(See Notes 1 and 5)	Grd	(See Note 6)	7 — 8	7 — 9

Notes for Tables 2A, 2B, 3A, and 3B

1. Terminals on socket of signal-guard detector unit.
2. Testing terminals on the front of signal-guard detector unit.
3. Terminal on card associated with V2 tube.
4. Punching mounted at T3 transformer position.
5. Terminal 6 of the socket of signal-guard detector unit is not wired in all offices.
6. The reading ranges from just perceptible minus voltage to just perceptible plus voltage.

Note: The voltages given in the tables are, in general, different from the normal operating voltages, such as could be measured with a high-impedance vacuum tube voltmeter.

3.04 If the voltage measurements do not approximate the typical readings given in Tables 2A or 2B and 3A or 3B, check tone circuit continuity through testing circuit and T3 transformer. If this appears to be satisfactory, check circuit connections to components and the component parts.

3.05 If varistors VR20, VR21, VR24, and VR25 are suspected due to low voltage readings, check in accordance with heading I Varistor Data.

B. Pulsing Performance of Receiver

3.06 Inability to meet per cent limits at R jack as outlined in Adjustment G of Section 179-217-701 may be due to:

(a) Faulty VR3 varistor. Test in accordance with heading I Varistor Data.

(b) Lack of guard voltage indicated by failure to meet the higher limits.

(1) Test varistors VR20 and VR21 in accordance with heading I Varistor Data.

(2) If satisfactory, test varistors VR22 and VR23 using the same data.

(c) Excessive guard voltage or low signal channel voltage indicated by failure to meet the lower limits.

(1) Check voltages using Table 2A or 2B.

(2) Test varistors VR24 and VR25 in accordance with heading I Varistor Data.

3.07 If the R jack requirements are met and the E lead per cent break cannot be adjusted, proceed as follows:

(a) Check VR12 varistor in accordance with heading I Varistor Data.

(b) Check components R19, P6, C3, C4, and C5 for operation and wiring.

(c) Test VR17 and VR18 varistors in accordance with heading I Varistor Data.

C. Guard Sensitivity

3.08 ***Talk Condition Failure***

(a) If the limits under this high guard condition cannot be met, check the guard and signal channel voltages using Table 3A or 3B.

(b) If there is a lack of guard voltage (test attenuator control reads too low), check that the guard channel is not short-circuited and the R15 resistor is not connected across terminals 3 and 4 of the N1 network through the contacts of the S and GR relays.

(c) Test VR20 and VR21 varistors in accordance with heading I Varistor Data.

(d) If there is excessive guard voltage (test attenuator control reads too high), check that the S relay has operated and reduced the receiver to low sensitivity.

(e) If unable to adjust S relay with P4 potentiometer, test VR13 and VR14 varistors in accordance with heading I Varistor Data.

3.09 ***Awaiting Subscriber Answer Failure — Receiver at Originating End***

Check that the R26 resistor is connected between terminals 2 and 3 of the N1 network and terminals 3 and 4 are short-circuited through the contacts of the S and GR relays.

3.10 ***Awaiting Subscriber Answer Failure — Receiver at Terminating End***

Check voltages using Table 2A or 2B.

D. Transmitter Performance

3.11 Low level signal tone failure may be due to:

(a) Faulty VR1 or VR2 varistor. Test in accordance with heading I Varistor Data.

(b) False ground on the T or R leads.

(c) CO relay has not properly cut and terminated the voice pair in 600 ohms.

(d) Defective capacitors or resistors in the transmit tone path.

3.12 Low level signal tone too high.

Check that HL relay is released, putting R16 resistor in the circuit.

3.13 If the limits of suppressed tone are not met, the trouble is probably due to faulty VR1 and VR2 varistors. Test in accordance with heading I Varistor Data.

3.14 Momentary high-level signal tone failure may be due to:

(a) HL relay releasing too fast.

(1) Send pulses of 72% break at 9 PPS on M lead and HL relay should remain operated while M relay pulses. If HL relay releases, check its mechanical and electrical requirements.

(b) Defective VR4 and VR5 varistors. Test in accordance with heading I Varistor Data.

E. Relay Timing

3.15 ***Timing of CO Relay***

(a) Failure of the CO relay to meet its hold requirement is due, in most cases, to a faulty VR6 or VR7 varistor. Test in accordance with heading I Varistor Data.

(b) If VR6 and VR7 are satisfactory, check adjustment of CO relay.

3.16 ***Timing of T Relay***

(a) If the T relay follows 60 IPM, its locking path is not functioning.

(1) To check, remove T electron tube and the relay should hold.

(2) If the relay holds, check the tube.

(3) If the tube is satisfactory, check for +130 volts at terminal 2 of the T tube socket with the T relay held operated.

(4) If the voltage is satisfactory, check R27, R28, and R29 resistors, C9 and C10 capacitors.

3.17 ***Timing of RR Relay***

(a) If unable to adjust P5 potentiometer to meet the RR relay requirements, check for:

(1) Defective VR15 and VR16 varistors. Test in accordance with heading I Varistor Data.

(2) RR relay out of adjustment.

(3) S relay out of adjustment.

F. Voice Amplifier

3.18 Inability to meet the receiver voice amplifier gain requirements by adjustment of the P1 potentiometer may be due to:

(a) A faulty V1 electron tube.

(b) Incorrect voltages. Check using Table 4A or 4B.

(c) Defective P1 potentiometer.

3.19 If the 1000-cycle gain requirements have been met and the filter-out condition cannot be met, check the following:

(a) The S relay is operated and RF relay is released.

(b) There is a short across terminals 9 and 10 of the N1 network.

(c) Possible trouble condition on the lead connected to terminal 11 of the N1 network.

3.20 If the filter-in requirement cannot be met, check the following:

(a) The RF relay is operated.

(b) Short is removed from terminals 9 and 10 of the N1 network.

G. Blocking Amplifier

3.21 Inability to meet the blocking amplifier gain requirements by adjustment of the P potentiometer may be due to:

(a) A faulty V electron tube.

(b) Incorrect voltages. Check using Table 4A or 4B.

(c) Defective P potentiometer.

3.22 If the 1000-cycle gain requirements have been met and the filter-out condition cannot be met, check the following:

(a) The F relay is operated.

(1) Make of 1 and 2 top contacts puts a short across terminals 9 and 10 (1 and 2) of the N network.

(2) Break of 2 and 3 top contacts opens the lead to terminal 11 (3) of the N network.

Note: Terminals in parentheses are used by odd-numbered amplifiers.

TABLE 4A

Typical DC Voltage Readings Using M9B Meter
No Signal Input

METER SCALE USED	VOLTMETER CONNECTIONS +V TERM. TO	−V TERM. TO	VOLTMETER READINGS
150V DC	5(V1) card or 5(V)	Grd	117 — 121
150V DC	6(V1) card or 6(V)	Grd	119 — 125
3V DC	7(V1) card or 7(V)	Grd	1.9 — 2.3

TABLE 4B

Same as Table 4A, Except Using KS-14510 Meter

METER SCALE USED	VOLTMETER CONNECTIONS +V TERM. TO	−V TERM. TO	VOLTMETER READINGS
300V DC	5(V1) card or 5(V)	Grd	122 — 126
300V DC	6(V1) card or 6(V)	Grd	124 — 130
3V DC	7(V1) card or 7(V)	Grd	2 — 2.4

H. Blocking Network

3.23 The insertion loss will usually be satisfactory if the 1000-cycle loss requirement has been met. If not, proceed as follows:

Check F relay for electrical and mechanical requirements.

I. Varistor Data

3.24 When operation difficulties are believed to be due to defective varistors, their forward and reverse resistance may be tested in the circuit by means of the M9B or KS-14510 meter in accordance with Table 5A or 5B. Certain paired varistors may also be tested in the circuit by means of the KS-12054 varistor test set in accordance with the procedure of 3.25. A rigorous out-of-circuit test may also be made with the KS-12054 varistor test set.

3.25 To make an in-circuit test of paired varistors VR20 and VR21, VR22 and VR23, VR24 and VR25, remove the detector unit from the signaling unit, and remove the cover plates. Connect the KS-12054 varistor test set to the varistor in accordance with Section 100-160-101 and test to determine if they meet the following requirements.

Forward indication for each varistor

SCALE	READING
F2V	1.5 volts or less

Reverse indication for each varistor

SCALE	READING
2MA	0.73 milliampere or less
2MA	*0.67 milliampere or less

* For VR22 and VR23 with ZD wiring

Note: The reverse current for either varistor of a pair may be as high as 1.1 milliamperes provided the pair measured in series has a reading of 0.37 milliampere or less. For VR22 and VR23 with ZD wiring the reading for either varistor may be as high as 1 milliampere provided the pair measured in series has a reading of 0.36 milliampere or less.

3.26 The values shown in Tables 5A and 5B are intended as a guide for locating defective varistors. These values cannot be used as rigorous tests for varistors due to the wide variations in circuit shunts and the low dc voltage applied to the varistor during the test, especially with the M9B meter. Make these tests without power on the receiver and with same conditions as the Test Notes of Tables 5A and 5B.

Note: Once a 400-type varistor is removed from the circuit, it is not advisable to re-use the varistor, as excessive heat will damage it. (See Sections 032-173-301 and 069-140-811.)

3.27 In order to measure ***reverse*** resistance (that is, resistance during negative voltage application to terminal 1), connect the + jack of the KS-14510 meter or the RX pin jack of the M9B meter to terminal 1 (positive end) of the varistor. Connect the − jack of the KS-14510 meter or the X pin jack of the M9B meter to the other terminal of the varistor.

3.28 In order to measure ***forward*** resistance (that is, resistance during positive voltage application to terminal 1), connect the − jack of the KS-14510 meter or the X pin jack of the M9B meter to terminal 1 (positive end) of the varistor. Connect the + jack of the KS-14510 meter or the RX pin jack of the M9B meter to the other terminal of the varistor.

TABLE 5A

Varistor Ohmmeter Test Readings Using KS-14510 Volt-Ohm-Milliammeter

VARISTOR DESIGNATION	TYPE	APPROXIMATE FORWARD RESISTANCE SCALE	APPROXIMATE FORWARD RESISTANCE MAX OHMS	APPROXIMATE REVERSE RESISTANCE SCALE	APPROXIMATE REVERSE RESISTANCE MIN OHMS	TEST NOTES
VR1-2	400C or G	Rx10	320	Rx1000	122,000	Disconnect one side of varistor.
VR3	400A	Rx10	130	Rx10	350	With "X" wiring.
VR4-5	400E	Rx10	125	Rx100	450	HL relay & varistors in parallel. CO & HL relays normal.
VR6-7	400E	Rx10	125	Rx100	450	SR, HL, CO & M relays released. Insulate 4-5 top of HL relay. Varistors in parallel.
VR8-9	400B	Rx10	150	Rx1000	25,000	SR, HL, CO & M relays released. Insulate 4-5 top of HL relay. Varistors in parallel.
VR10-11	400E	Rx10	150	Rx1000	50,000	SR relay released. Varistors in parallel.
VR12	400B	Rx10	300	Rx1000	80,000	Remove RG relay.
VR13-14	400E	Rx10	160	Rx1000	50,000	Varistors in parallel. GR relay operated. M relay released. Insulate 1-2 top of GR relay.
VR15-16	400E	Rx10	125	Rx100	450	Varistors & RR relay in parallel. S relay released. P5 turned fully clockwise.
VR17	400E	Rx10	300	Rx1000	50,000	S relay operated. Insulate 1-2 top of S relay. Remove RG relay.
VR18	400A	Rx10	180	Rx1000	60,000	S relay operated. Insulate 1-2 top of S relay. Remove RG relay.
VR19	310A	Rx10	590	Rx10	590	GR relay operated.
VR20-21-22 23-24-25	400C	Rx10	310	Rx1000	100,000	

TABLE 5B

Varistor Ohmmeter Test Readings Using M9B Volt-Ohm-Milliammeter

VARISTOR DESIGNATION	TYPE	APPROXIMATE FORWARD RESISTANCE SCALE	MAX OHMS	APPROXIMATE REVERSE RESISTANCE SCALE	MIN OHMS	TEST NOTES
VR1-2	400C or G	Rx10	320	Rx1000	122,000	Disconnect one side of varistor.
VR3	400A	Rx10	130	Rx10	350	With "X" wiring.
VR4-5	400E	Rx10	125	Rx100	450	HL relay & varistors in parallel. CO & HL relays normal.
VR6-7	400E	Rx10	125	Rx100	450	SR, HL, CO & M relays released. Insulate 4-5 top of HL relay. Varistors in parallel.
VR8-9	400B	Rx10	150	Rx1000	25,000	SR, HL, CO & M relays released. Insulate 4-5 top of HL relay. Varistors in parallel.
VR10-11	400E	Rx10	150	Rx1000	50,000	SR relay released. Varistors in parallel.
VR12	400B	Rx10	300	Rx1000	80,000	Remove RG relay.
VR13-14	400E	Rx10	160	Rx1000	50,000	Varistors in parallel. GR relay operated. M relay released. Insulate 1-2 top of GR relay.
VR15-16	400E	Rx10	125	Rx100	450	Varistors & RR relay in parallel. S relay released. P5 turned fully clockwise.
VR17	400E	Rx10	300	Rx1000	50,000	S relay operated. Insulate 1-2 top of S relay. Remove RG relay.
VR18	400A	Rx10	180	Rx1000	60,000	S relay operated. Insulate 1-2 top of S relay. Remove RG relay.
VR19	310A	Rx10	590	Rx10	590	GR relay operated.
VR20-21-22 23-24-25	400C	Rx10	310	Rx1000	100,000	