

§ 68.310

47 CFR Ch. I (10-1-00 Edition)

all ones signal sequence is being produced as measured across a 100 ohm terminating resistance shall not exceed +19 dBm. The power in a 3 kHz band about 1.544 MHz shall be at least 25 dB below that in a 3 kHz band about 772 kHz.

(v) *Encoded Analog Content.* If registered terminal equipment connected to 1.544 Mbps digital service contains an analog-to-digital converter, or generates signals directly in digital form that are intended for eventual conversion into voiceband analog signals, the encoded analog content of the subrate channels within the 1.544 Mbps signal must be limited. The maximum equivalent power of encoded analog signals for other than live voice that are not intended for network control signaling as derived by a zero level decoder test configuration shall not exceed -12 dBm when averaged over any 3-second time interval. The maximum equivalent power of encoded analog signals as derived by a zero level decoder test configuration for signals intended for network control signaling shall not exceed -3 dBm when averaged over any 3-second interval.

[62 FR 61671, Nov. 19, 1997; 63 FR 25173, 25174, May 7, 1998]

§ 68.310 Transverse balance limitations.

(a) *Technical description and application.* The Transverse Balance<sub>m-1</sub>, coefficient is expressed as

$$\text{BALANCE}_{m-1} = 20 \log_{10} \frac{e_M}{e_L}$$

TABLE 68.310(a)

	Analog voiceband	Subrate digital	1.544 Mbps digital
Longitudinal Termination—Z <sub>1</sub> .....	500 ohms .....	See Table 310(b) .....	90 ohms.
Metallic Source Impedance—Z <sub>0</sub> .....	600 ohms .....	135 ohms .....	100 ohms.
Lower Frequency—f <sub>1</sub> .....	200 Hz .....	200 Hz .....	10 kHz.
Upper Frequency—f <sub>2</sub> .....	4 kHz .....	( <sup>1</sup> ) .....	1.544 MHz.
Metallic Voltage for Test—E .....	0.775 V .....	0.367 V .....	0.316 V.

<sup>1</sup> The upper frequency equals the digital line rate for the subrate service under test (See Table 68.310(b)).

(b) *Analog voiceband equipment.* All registered analog voiceband equipment shall be tested in the off-hook state. The minimum transverse balance requirement in the off-hook state shall

(1) Where e<sub>L</sub> is the longitudinal voltage produced across a longitudinal termination Z<sub>1</sub> and e<sub>M</sub> is the metallic voltage across the tip-ring or tip 1 and ring 1 interface of the input port when a voltage (at any frequency between f<sub>1</sub> and f<sub>2</sub>, see Table 68.310(a) is applied from a balanced source with a metallic impedance Z<sub>0</sub> (see Table 68.310(a)). The source voltage should be set such that e<sub>M</sub> = E volts (see Table 68.310(a) when a termination of Z<sub>0</sub> is substituted for the terminal equipment.

(2) The minimum transverse balance coefficient specified in this section (as appropriate) shall be equalled or exceeded for all 2-wire network ports, OPS line ports and the transmit pair (tip and ring) and receive pair (tip 1 and ring 1) of all 4-wire network ports at all values of dc loop current that the port under test is capable of drawing when attached to the appropriate loop simulator circuit (See § 68.3). An illustrative test circuit that satisfies the above conditions is shown in Figure 68.310-1(a) for analog and 68.310-1(b) for digital and subrate; other means may be used to determine the transverse balance coefficient specified herein, provided that adequate documentation of the appropriateness, precision, and accuracy of the alternative means is provided by the applicant.

(3) The minimum transverse balance requirements specified below shall be equalled or exceeded under all reasonable conditions of the application of earth ground to the equipment or protective circuitry under test.

be 40 dB, throughout the range of frequencies specified in Table 68.310(a). For some categories of equipment, additional requirements also apply to the

on-hook state. When both off-hook and on-hook requirements apply, they are:

State	Frequency (f)	Balance
Off-hook .....	200 Hz ≤ f ≤ 4000 Hz .....	≥40 dB.
On-hook .....	200 Hz ≤ f ≤ 1000 Hz .....	≥60 dB.
On-hook .....	1000 Hz ≤ f ≤ 4000 Hz .....	≥40 dB.

(1) For analog one-port 2-wire terminal equipment with loop-start, ringdown, or inband signaling or for voiceband metallic channel applications, both off-hook and on-hook requirements apply.

(2) For analog one port equipment with ground-start and reverse-battery signaling only off-hook requirements apply.

(3) For analog registered protective circuitry for 2-wire applications with loop-start, ringdown, or inband signaling; or for voiceband metallic channel applications, both off-hook and on-hook requirements apply. Criteria shall be met with either terminal of the interface to other equipment connected to earth ground. The interface to other equipment shall be terminated in an impedance that will be reflected to the telephone connection as 600 Ohms in the off-hook state of the registered protective circuit, and the interface should not be terminated in the on-hook state. Figure 68.310(f) shows the interface of the protective circuitry being tested and the required arrangement at the interface to other equipment.

(4) For analog registered protective circuitry with ground-start and reverse-battery signaling only off-hook requirements apply. Criteria shall be met with either terminal of the interface to other equipment connected to earth ground. The interface to other equipment shall be terminated in an impedance that will be reflected to the telephone connection as 600 ohms in the off-hook state of the registered protective circuit. Figure 68.310(f) shows the interface of the protective circuitry under test and the required arrangement at the interface to the other equipment.

(5) For analog multi-port equipment with loop-start signaling both off-hook and on-hook requirements apply. Criteria shall be satisfied for all ports when all the ports not under test are terminated in their appropriate net-

works, as will be identified below, and when interface connections other than the ports are terminated in circuits appropriate to that interface. The minimum transverse balance coefficients shall also be satisfied for all values of dc loop current that the registered equipment is capable of drawing through each of its ports when these ports are attached to the loop simulator circuit specified in these rules. The termination for all ports other than the particular one whose transverse balance coefficient is being measured shall have a metallic impedance of 600 ohms and a longitudinal impedance of 500 ohms. Figure 68.310(c) shows this termination.

(6) For analog multi-port equipment with ground-start and reverse-battery signaling, only off-hook requirements apply. Criteria shall be satisfied for all ports when all ports not under test are terminated in their appropriate networks as will be identified below, and when interface connections other than the ports are terminated in circuits appropriate to that interface. The minimum transverse balance coefficients shall be satisfied for all values of dc loop current that the registered equipment is capable of drawing through each of its ports when these ports are attached to the loop simulator circuit specified in these rules. The terminations for all ports other than the particular one whose transverse balance coefficient is being measured shall have a metallic impedance of 600 ohms and a longitudinal impedance of 500 ohms. Figure 68.310(c) shows this termination.

(7) For analog registered terminal equipment and protective circuitry for 4-wire network ports, both the off-hook and on-hook requirements apply. The pair not under test shall be terminated in a metallic impedance of 600 ohms. Other conditions are as follows:

(i) For analog registered protective circuitry with loop-start, ground-start, reverse battery, ringdown, or inband signaling; or for voiceband metallic channel applications. Criteria shall be met with either terminal of the interface to other equipment connected to earth ground. The interface to other

equipment shall be terminated in an impedance that will result in 600 ohms at each of the transmit and receive pairs of the 4-wire telephone connection in the off-hook state of the registered protective circuit, and the interface should not be terminated in the on-hook state. Figure 68.310(d) shows the interface of the protective circuitry being tested and the required arrangement at the interface to other equipment.

(ii) For analog multiport equipment with loop start, ground start, and reverse battery, ringdown, or inband signaling; or for voiceband metallic channel applications. Criteria shall be satisfied for all network ports when all the ports not under test are terminated as defined below, and when interface connections other than the network ports are terminated in circuits appropriate to the interface. The criteria shall also be satisfied for all values of dc loop current that when the port is connected to the appropriate 4-wire loop simulator circuit. The terminations for both pairs of all network ports not under test shall have a metallic impedance of 600 ohms and a longitudinal impedance of 500 ohms. Figure 68.310(c) shows this termination.

(8) For analog PBX equipment (or similar systems) with class B or class C off-premises interfaces, only off-hook requirements apply. Criteria shall be satisfied for all off-premises station interface ports when these ports are terminated in their appropriate networks for their off-hook state, and when all other interface connections

are terminated in circuits appropriate to that interface. The minimum transverse balance coefficients shall also be satisfied for all values of dc loop current that the registered PBX is capable of providing through off-premises station ports when these ports are attached to the off-premises line simulator circuit specified in these rules.

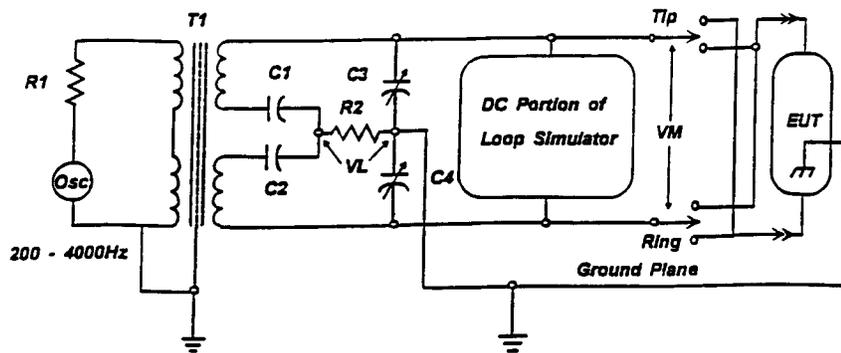
(9) For Type Z equipment with loop-start signaling, both off-hook and on-hook requirements apply. Equipment that has on-hook impedance characteristics which that do not conform to the requirements of § 68.312 (e.g., Type Z), shall comply with minimum transverse balance requirements of 40 dB in the voiceband. See § 68.312(h) for conditions upon registration of "Type Z" equipment.

(c) *Digital equipment.* The minimum transverse balance requirements for registered terminal equipment connected to digital services shall be equalled or exceeded for the range of frequencies applicable for the equipment under test and under all reasonable conditions of the application of earth ground to the equipment. All such terminal equipment shall have a transverse balance in the acceptable region of Figure 68.310(e) for the range of frequencies shown in Table 68.310(b) for the specified digital service in question. The metallic impedance used for the transverse balance measurements for all subrate services shall be 135 ohms and for 1.544 Mbps shall be 100 ohms. The longitudinal termination for 1.544 Mbps and subrate services shall be as defined in Table 68.310(b).

TABLE 68.310(b)—FREQUENCY RANGES OF TRANSVERSE BALANCE REQUIREMENTS FOR DIGITAL SERVICES

Digital service	Frequency range	Longitudinal termination (ohms)	Metallic termination (ohms)
2.4	200 to 2.4 kHz	500	135
3.2	200 to 3.2 kHz	500	135
4.8	200 to 4.8 kHz	500	135
6.4	200 to 6.4 kHz	500	135
9.6	200 to 9.6 kHz	500	135
12.8 <sup>1</sup>	200 to 12.8 kHz	500/90	135
19.2 <sup>1</sup>	200 to 19.2 kHz	500/90	135
25.6 <sup>1</sup>	200 to 25.6 kHz	500/90	135
38.4 <sup>1</sup>	200 to 38.4 kHz	500/90	135
56 <sup>1</sup>	200 to 56 kHz	500/90	135
72 <sup>1</sup>	200 to 72 kHz	500/90	135
1.544	10 kHz to 1.544 MHz	90	100

<sup>1</sup> For 200 to 12 kHz the longitudinal termination shall be 500 ohms and above 12 kHz the longitudinal termination shall be 90 ohms.

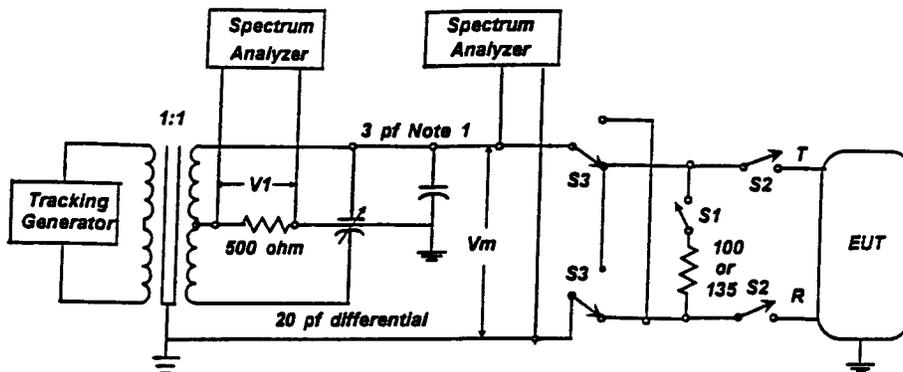


**Figure 68.310-1(a)**  
**Illustrative Test Circuit for Transverse Balance (Analog)**

- $T_1$  600 ohms:600 ohms split audio transformer  
 $C_1, C_2$  8 mF, 400 V dc, matched to within 0.1 %  
 $C_3, C_4$  100 to 500 pF adjustable trimmer capacitors  
 Osc. Audio oscillator with source resistance  $R_1$  less than or equal to 600 ohms  
 $R_1$  Selected such that  $Z_{osc} + R_1 = 600$  ohms  
 $R_2$  500 ohms

**NOTES:**

- $V_M$  should not be measured at the same time as  $V_L$
- Use trimmer capacitors  $C_3$  and  $C_4$  to balance the test circuit to 20 dB greater balance than the equipment standard for all frequencies specified, with a 600 ohm resistor substituted for the equipment under test.
- Exposed conductive surfaces on the exterior of the equipment under test should be connected to the ground plane for this test.
- When the Terminal Equipment makes provision for an external connection to ground (G), the Terminal Equipment shall be connected to ground. When the Terminal Equipment makes no provision for an external ground, the Terminal Equipment shall be placed on a ground plane which is connected to ground and has overall dimensions at least 50 % greater than the corresponding dimensions of the Terminal Equipment. The Terminal Equipment shall be centrally located on the ground plane without any additional connection to ground.

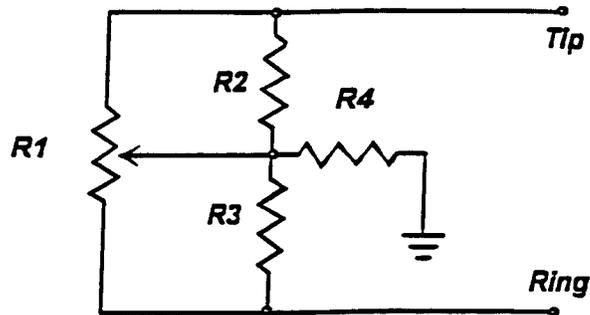


**Notes:**

1. The 3 pF capacitor may be placed on either line of the test set, as required, to obtain proper balancing of the bridge.
2. Use an  $R_{CAL}$  value of 100 ohms for 1.544 Mbps devices and 135 ohms for substrate devices.
3. The effective output impedance of the tracking generator should match the appropriate test impedance. See Note 2. The spectrum analyzer's input must be differentially balanced to measure  $V_m$ .
4.  $R_2$  should be chosen according to Table 68.310(b).

- $T_1$ : 100 ohms:100 ohms C.T. wide band transformer  
 12.4 to 24.5 pF differential trimmer  
 $R_2 = Z_1$  from Table 68.310(a)  
 $R_{CAL} = Z_0$  from Table 68.310(a)  
 $R_1$ - Selected so that  $R_1 + 50 \text{ ohms} = Z_0$  from Table 68.310(a)

**Figure 68.310-1(b)**  
**Illustrative Test Circuit for Transverse Balance (Digital)**



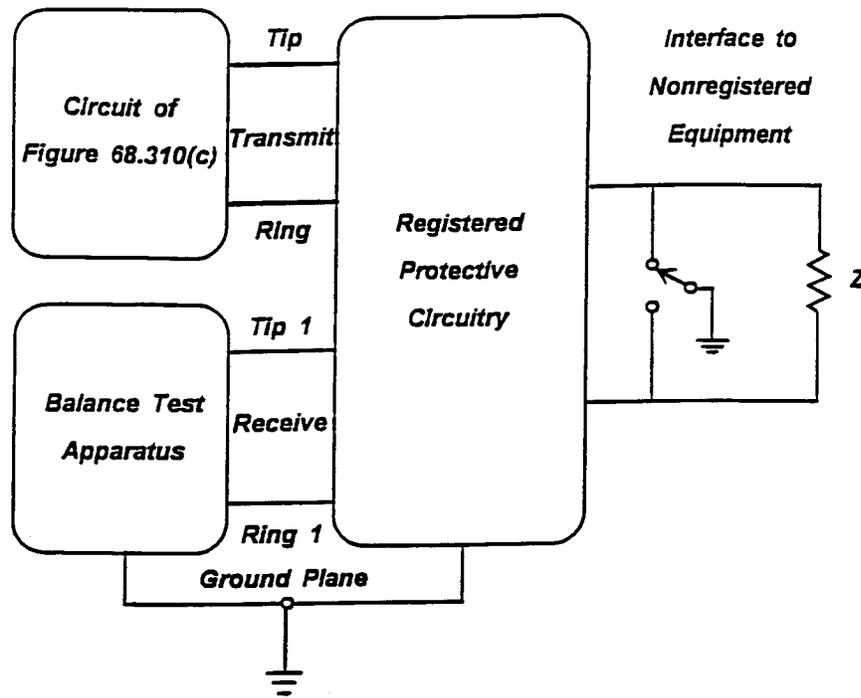
Where:  $R_2 = R_3 = 300$  ohms,  $R_4 = 350$  ohms,  $R_1 = 300$  k ohms, for analog voiceband

$R_2 = R_3 = 67.5$  ohms,  $R_4 = 56.3$  ohms,  $R_1 = 100$  kohms, for subrate digital

$R_2 = R_3 = 50$  ohms,  $R_4 = 65$  ohms,  $R_1 = 100$  k ohms, for 1.544 Mbps

$R_1$  is used to adjust termination balance. Balance of this termination shall be adjusted to at least 60 dB between 200 and 1000 Hz, and at least 40 dB between 1000 and 4000 Hz, and to at least 35 dB at 1.544 MHz.

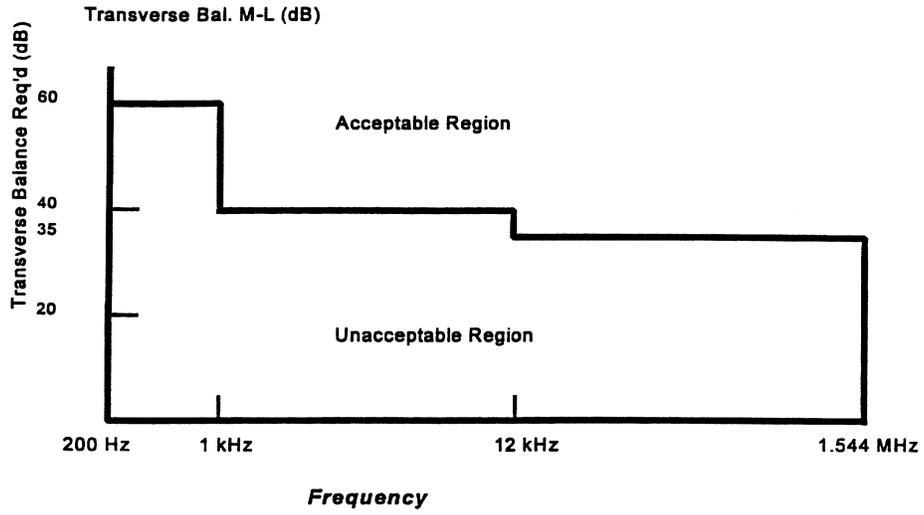
**Figure 68.310(C)**  
**Off-Hook Termination of Multiport Equipment for Ports Not under Test**



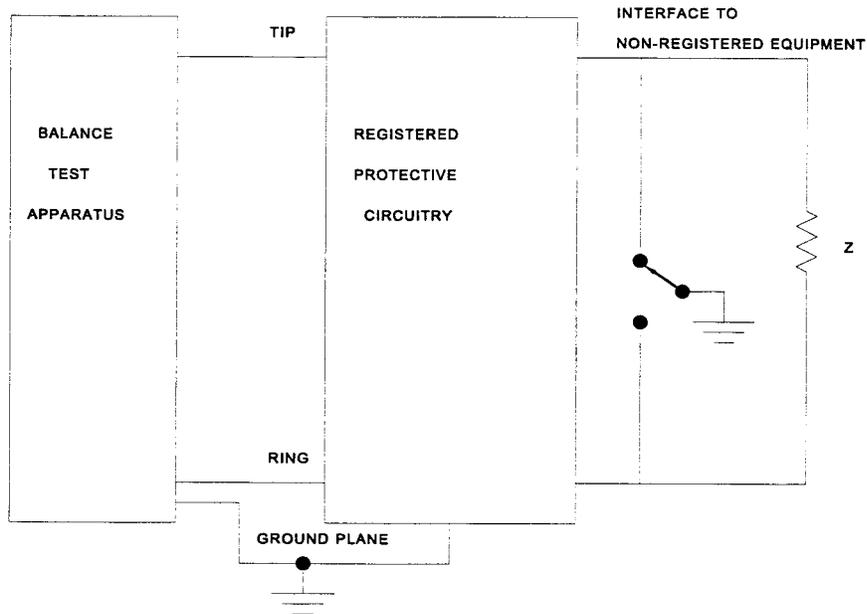
*Z* Selected so that the reflected impedance at tip 1 and ring 1 is 600  $\Omega$ , 135  $\Omega$ , or 100  $\Omega$  depending on service type of EUT.

Configuration shown is for measurement of receive pair.

**Figure 68.310(d)**  
**Required Termination for Connections to Non-Registered Equipment**



**Figure 68.310(e)**  
**Transverse Balance Requirements for Digital Services**



Z - Selected so that the reflected impedance at tip and ring is 600 Ω, 135 Ω, or 100 Ω depending on the service type of EUT

**FIGURE 68.310 (f)  
REQUIRED TERMINATION FOR CONNECTIONS TO NON-REGISTERED EQUIPMENT**

[62 FR 61682, Nov. 19, 1997; 63 FR 25174, 25175 May 7, 1998]

**§ 68.312 On-hook impedance limitations.**

(a) *General.* Requirements in this section apply to the tip and ring conductors of 2-wire interfaces. These requirements also apply to 4-wire loop-start or ground-start interfaces, in the following configuration:

(1) The tip and ring conductors are connected together and treated as one of the conductors of a tip and ring pair.

(2) The tip 1 and ring 1 conductors are connected together and treated as the other conductor of a tip and ring pair.

NOTE TO § 68.312: Throughout this section, references will be made to simulated ringing. Ringing voltages to be used and impedance limitations associated with simulated ringing are shown in Table 68.312(a).

TABLE 68.312(a)

Ring type	Range of compatible ringing frequencies (Hz)	Simulated ringing voltage superimposed on 56.5 volts dc	Impedance limitations (ohms)
A	20±3	40 to 130 volts rms	1400
	30±3	40 to 130 volts rms	1000
B	15.3 to 34	40 to 130 volts rms	1600
	>34 to 49	62 to 130 volts rms	1600