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analog content of the digital signal must be limited. The maximum equivalent power of the encoded analog signals, other than live voice as derived from a zero-level-decoder test configuration, shall not exceed -12 dBm when averaged over a three second interval. The maximum equivalent power of encoded analog signals, as derived by a zero-level decoder test configuration, for network control signaling, shall not exceed -3 dBm when averaged over any three-second interval.

[45 FR 20853, Mar. 31, 1980, as amended at 46 FR 40192, Aug. 7, 1981; 47 FR 10219, Mar. 10, 1982; 47 FR 39687, Sept. 9, 1982; 49 FR 48721, Dec. 14, 1984; 50 FR 48210, Nov. 22, 1985; 51 FR 945, Jan. 9, 1986; 51 FR 16689, May 6, 1986; 61 FR 42392, Aug. 15, 1996; 62 FR 9989, Mar. 5, 1997]

§ 68.310 Longitudinal balance limitations.

(a) *Technical description and application.* The metallic-to-longitudinal balance coefficient, $BALANCE_{m-1}$, is expressed as:

$$BALANCE_{m-1} = 20 \log_{10} \frac{\theta_M}{\theta_L}$$

where e_L is the longitudinal voltage produced across a 500-ohm longitudinal termination and e_M 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 $200 < f < 4000$ Hertz) is applied from a balanced 600-ohm metallic source. The source voltage should be set such that $e_M = 0.775$ volts rms (0dBm) when a 600 ohm termination is substituted for the terminal equipment. The minimum 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(a); other means may be used to determine the balance coefficient specified herein, provided that adequate documentation of the appropriateness, precision, and accuracy of the alternative means is provided by the applicant. The minimum 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:

Paragraph	Equipment state	Minimum balance	Frequency range
(b)	On-hook	60	200–1000
	On-hook	40	1000–4000
	Off-hook	40	200–4000
(c)	On-hook	60	200–1000
	On-hook	40	1000–4000
	Off-hook	40	200–4000
(d)	Off-hook	40	200–4000
	On-hook	60	200–1000
(e)	On-hook	40	1000–4000
	Off-hook	40	200–4000
(e)	On-hook	60	200–1000
	On-hook	40	1000–4000
(e)	Off-hook	40	200–4000
	Off-hook	40	200–4000
(f)	On-hook	60	200–1000
	On-hook	40	1000–4000
(g)	Off-hook	40	200–4000
	Off-hook	40	200–1000
(h)	On-hook	60	200–1000
	On-hook	40	1000–4000
(i)	Off-hook	40	200–4000
	Off-hook	40	200–1000
(j)	On-hook	60	200–1000
	On-hook	40	1000–4000

(b) *Registered one-port terminal equipment for 2-wire non-data applications with loop start, ringdown, inband signaling or voiceband metallic channels.* The one-port shall be driven from a 600-ohm metallic source having a 500-ohm longitudinal impedance.

(c) *Registered one-port terminal equipment for 2-wire data applications with loop start, ringdown, inband signaling or voiceband metallic channels.* The one-port shall be driven from a 600-ohm metallic source having a 500-ohm longitudinal impedance.

(d) *Registered one-port equipment for ground-start and reverse-battery applications.* The one-port shall be driven from a 600-ohm metallic source having a 500-ohm longitudinal impedance.

(e) *Registered protective circuitry for 2-wire applications with loop start, ringdown, inband signaling or voiceband metallic channels.* These 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 which 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(e) shows the interface of the protective circuitry being tested and the required arrangement at the interface to other equipment.

(f) *Registered protective circuitry for ground-start and reverse-battery applications.* These 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 which will be reflected to the telephone connection as 600-ohms in the off-hook state of the protective circuit. Figure 68.310(e) shows the interface of the protective circuitry under test and the required arrangement at the interface to the other equipment.

(g) *Registered multi-port equipment for loop-start applications.* These criteria shall be satisfied for all ports when the ports 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 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 port under test shall be driven from a 600-ohm metallic source having a 500-ohm longitudinal impedance. The termination for all ports other than the particular one whose balance coefficient is being measured shall have a metallic impedance of 600 ohms and a longitudinal impedance of 500 ohms. Figure 68.310(g) shows this termination.

(h) *Registered multi-port equipment for ground start and reverse battery applications.* These 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 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 port under test shall be driven from a 600-ohm metallic source having a 500-ohm longitudinal impedance. The terminations for all ports other than the particular one

whose balance coefficient is being measured shall have a metallic impedance of 600 ohms and a longitudinal impedance of 500 ohms. Figure 68.310(g) shows this termination.

(i) *Registered terminal equipment and registered protective circuitry for 4-wire network ports.* The pair under test shall be driven from a 600-ohm metallic source having a 500-ohm longitudinal impedance. The pair not under test shall be terminated in a metallic impedance of 600-ohms.

(1) *Registered protective circuitry for loop start, ground start, reverse, battery, ringdown, inband signaling or voiceband metallic channel applications.* These 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(j) shows the interface of the protective circuitry being tested and the required arrangement at the interface to other equipment.

(2) *Registered multipoint equipment for loop start, ground start, and reverse battery, ringdown, inband signaling, or voiceband metallic channel applications.* These criteria shall be satisfied for all network ports when the ports are terminated as defined below, and when interface connections other than network ports are terminated in circuits appropriate to the interface. The criteria shall also be satisfied for all values of dc loop current that the registered equipment is capable of drawing through each port when the port is connected to the appropriate 4-wire loop simulator circuit, Figure 68.3(c) or 68.3(d). 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. Figures 68.310(g) shows this termination.

(j) *Registered PBX equipment (or similar systems) with Class B or Class C off-premises interfaces.* These criteria shall be satisfied for all off-premises station interface ports when these ports are

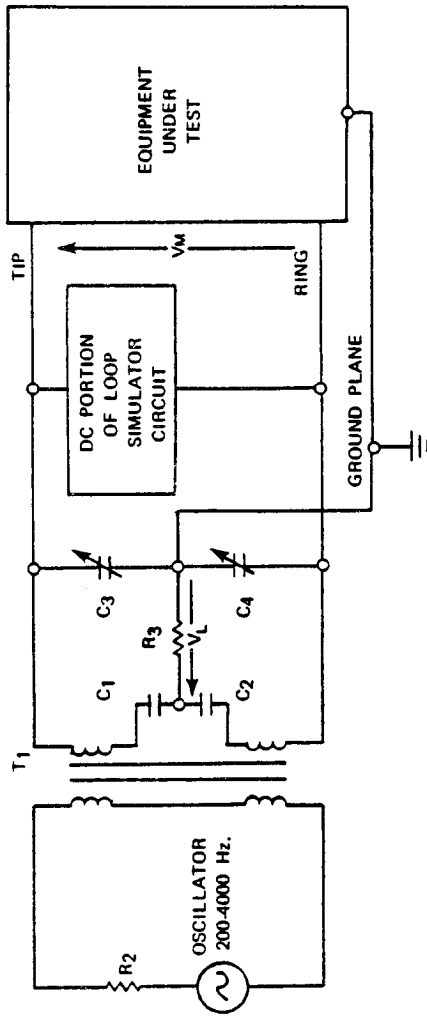
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terminated in their appropriate networks for their off-hook state, and when all other interface connections are terminated in circuits appropriate to that interface. The minimum balance coefficients shall also be satisfied for all values of dc loop 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. The port under test shall be driven from a 600-ohm metallic source having a 500-ohm longitudinal impedance.

(k) *Ring type Z equipment for loop-start applications.* Equipment which has on-hook impedance characteristics which do not conform to the requirements of §68.312 (e.g., "Type Z"), need comply with a minimum balance requirement of 40 dB in the frequency range 200 to 400 Hertz, under the applicable subparagraph above. See §68.312(f) for conditions upon registration of "Type Z" equipment.

(l) The maximum balance requirement for registered terminal equipment connected to digital services specified in Figure 68.310(k) shall be equaled 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 longitudinal balance in the acceptable region of Figure 68.310(k). The metallic termination used for the longitudinal balance measurements for 2.4, 4.8, 9.6, and 56 Kbps shall be 135 Ohms plus or minus one percent. The metallic termination used for the longitudinal balance measurements (M-L balance) for subrate, ISDN (BRA) and PSDS shall be 135 ohms \pm 1% and for 1.544 Mbps and ISDA (PRA) shall be 100 ohms \pm 1%. The longitudinal termination for these measurements (L-M balance) shall be 90 ohms in all cases.



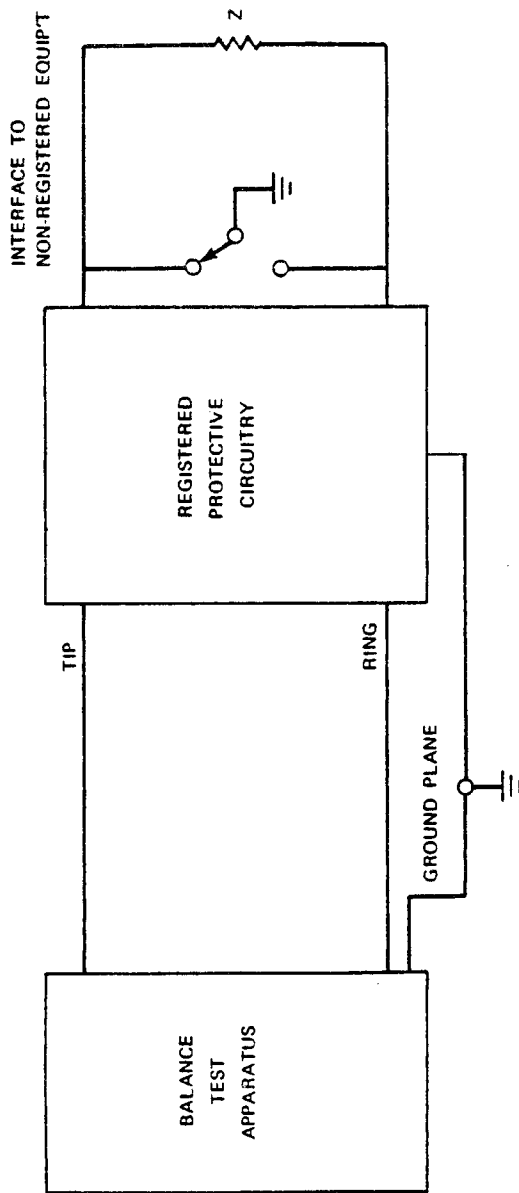
- T₁ - W.E.Co. #111C or 119E, or A.D.C. #118F, or equivalent.
- C₁, C₂ - 8 microfarad, 400 WVDC, matched to within 0.1%.
- C₃, C₄ - 100 to 500 picofarad adjustable trimmer capacitors.
- Osc. - Audio oscillator with source resistance, R₁ 5600 ohms.
- R₂ - Selected such that R₁ + R₂ = ohms.
- R₃ - 500 ohms.

NOTES:

1. V_M should not be measured at the same time as V_L.
2. Use trimmer capacitors C₃ and C₄ 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.
3. Exposed conductive surfaces on the exterior of the equipment under test should be connected to the ground plane for this test.

Figure 68.310(a) - Illustrative test circuit complying with Section 68.310(a)

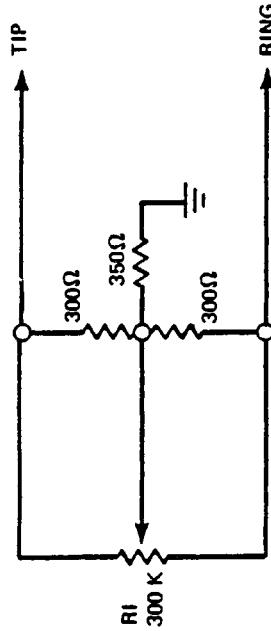
Required termination for connections to non-registered equipment:



Z - selected so that the reflected impedance at tip and ring is 600 ohms.

Figure 68.310(e)

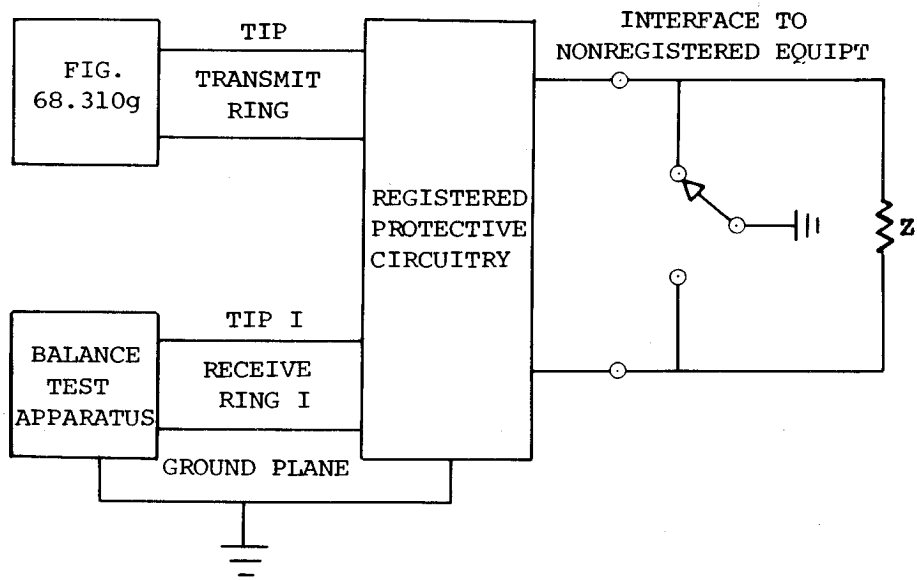
Off-Hook Termination of Multi-port Equipment for Ports not under tests:



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

Figure 68.310(g)

REQUIRED TERMINATION FOR CONNECTIONS TO NONREGISTERED EQUIPMENT:



NOTE:

- Z- SELECTED SO THAT THE REFLECTED IMPEDANCE AT TIP I AND RING I IS 600 ohms.
- CONFIGURATION SHOWN IS FOR MEASUREMENT OF RECEIVE PAIR.

Fig. 68.310 (j)
4 Wire

LONGITUDINAL BALANCE REQUIREMENT FOR DIGITAL SERVICES

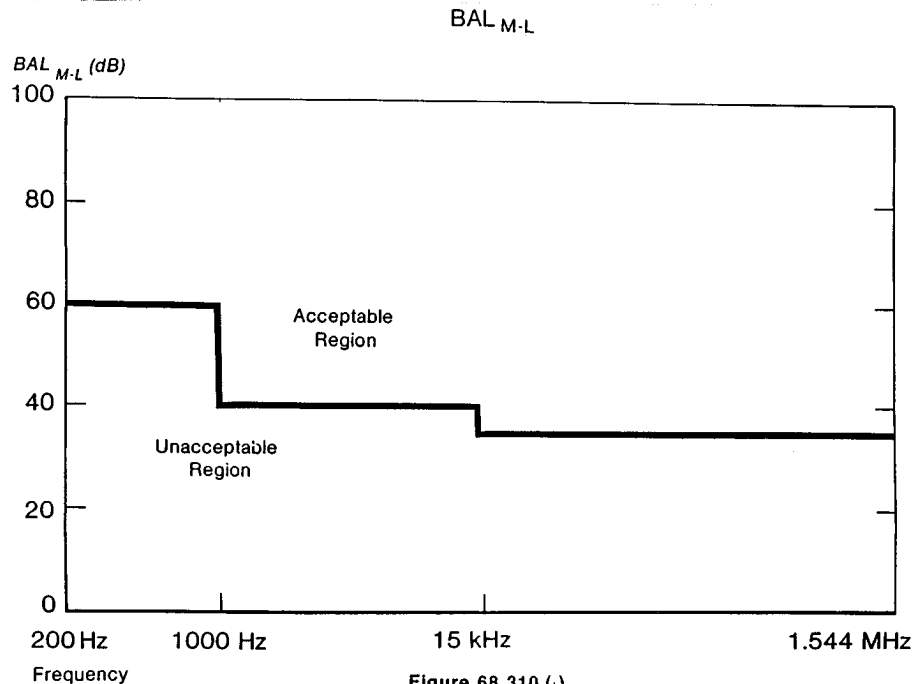


Figure 68.310 (j)

[45 FR 20853, Mar. 31, 1980, as amended at 45 FR 54343, Aug. 15, 1980; 45 FR 61632, Sept. 17, 1980; 47 FR 39687, Sept. 9, 1982; 49 FR 48724, Dec. 14, 1984; 51 FR 950, Jan. 9, 1986; 51 FR 16690, May 6, 1986; 61 FR 42393, Aug. 15, 1996]

§ 68.312 On-hook impedance limitations.

(a) *General.* The limitations in this section that involve 2-wire network ports apply to tip and ring of the public switched network. For 4-wire network ports (tip, ring, tip 1, and ring 1) with loop-start or ground-start signaling, the limitations apply when tip and ring conductors are connected together and treated as one of the conductors of a tip and ring pair and the tip 1 and ring 1 conductors are connected together and treated as the other conductor of a tip and ring pair.

(b) Limitations on individual equipment intended for operation on loop-start telephone facilities, including PSDS Type II in the analog mode:

(1) Registered terminal equipment and registered protective circuitry

shall conform to the following limitations, for each Ringing Type which is listed as part of its Ringer Equivalence:

(i) The dc resistance between tip and ring conductors, and between each of the tip and ring conductors and earth ground, shall be greater than 5 megohms for all dc voltages up to and including 100 volts.

(ii) The dc resistance between tip and ring conductors, and between each of the tip and ring conductors and earth ground shall be greater than 30 kilohms for all dc voltages between 100 and 200 volts.

(iii) During the application of simulated ringing, as listed in table I below, the total dc current, shall not exceed 3.0 milliamperes.