§ 68.308 Signal power limitations.

(Reworded and Changed)

§ 68.308(b)(1)

(i) The power of all signal energy, in the 200 - 3995 Hz voiceband, delivered by registered terminal equipment or registered protective circuitry to the appropriate loop simulator – other than non-permissive data equipment or data protective circuitry shall not exceed -9 dBm when averaged over any 3 second interval.

(ii) For 2-wire and 4-wire lossless tie trunk type interfaces, the maximum power of other than live voice signals delivered to a 600-Ohm termination shall not exceed -15 dBm when averaged over any three second interval.

Rationale for Harmonized Requirement

Requirements are the same as the current Part 68 requirements. With the proposed deletion of the CTS the table has been dropped and the requirement has been included in text. Notes (a) and (b) have been removed since they were judged not to be useful by the committee.

§ 68.308 Signal power limitations.

(Reworded and Changed)

§ 68.308(b)(1)

(iii) For OPS lines, the maximum power of other than live voice delivered to an OPS line simulator circuit shall not exceed -9 dB with respect to one milliwatt, when averaged over any 3-second interval.

Rationale for Harmonized Requirement

Comparison of OPS signal levels in the through-gain table indicates that a level of -9 dBm is allowed for OPS line interfaces.

§ 68.308 Signal power limitations.

(Reworded, Delete and Changed)

§ 68.308(b)(1)

(iv) For AIOD channels....

Deleted

(iv) For registered test equipment or registered test circuitry the maximum signal power delivered to a loop simulator circuit shall not exceed 0 dBm when averaged over any 3-second interval.

(v) For registered test...

Deleted

(v) For voiceband private lines using ringdown or inband signaling the maximum power of other than live voice signals delivered to a 600 Ohm termination shall not exceed -13 dBm when averaged over any 3-second interval.

(vi) For voiceband private lines using inband signaling in the band 2600 ± 150 Hz, the maximum power delivered to a 600 Ohm termination shall not exceed -8 dBm during the signaling mode. The maximum power delivered to a 600 Ohm termination in the on-hook steady state supervisory condition shall not exceed -20 dBm. The maximum power of other than live voice signals delivered to a 600-Ohm termination during the non-signaling mode and for other inband systems shall not exceed -13 dBm when averaged over any 3-second interval. ~~The maximum signal power may be exceeded by as much as 1.0 dB by any single unit of equipment or circuitry, provided that the power averaged over all units of production complies with the specified limitation.~~

Rationale for Harmonized Requirement:

The 1 dB tolerance has been deleted since it is a manufacturing tolerance and not a type approval criteria.

§ 68.308 Signal power limitations.

(Reworded and Changed)

§ 68.308(b)(2)

(i) For all operating conditions of registered terminal equipment and registered protective circuitry, the maximum power in the frequency band below 3995 Hz delivered to a loop simulator circuit shall not exceed the following when averaged over any 3-second interval:

(A) 0 dBm when used for network control (DTMF).

(B) 0 dBm when DTMF is used for manual entry end-to-end signaling. When the device is used for this purpose it shall not generate more than 40 DTMF digits per manual key stroke.

(C) -9 dBm in all other cases.

Rationale for Harmonized Requirement

The network control signal requirements have been made more precise by defining the bandwidth and using '0 dBm' instead of 'one milliwatt'. This is consistent with other requirements in the harmonized document. The use of DTMF keypad signaling for transaction services has been accommodated, while maintaining the existing signal power limits for permissive level modems. The limit of 40 DTMF pulses per keystroke has been selected to accommodate existing dialers, and at the same time, prevent the transmission of extensive data sequences at high levels under the guise of transaction services.

§68.308 Signal power limitations.

(Reworded)

§ 68.308(b)(2)

(ii) For tie trunk applications, the maximum power delivered to a 600 Ohm termination for registered terminal equipment and registered protective circuitry under all operating conditions shall not exceed -4 dBm over any 3 second interval.

Rationale for Harmonized Requirement

These requirements are the same as the existing Part 68 requirements. With the proposed removal of the CTS requirements the table has been eliminated and the requirement inserted in the text.

§ 68.308 Signal power limitations.

(Reworded)

§ 68.308(b)

(4) Registered data circuit terminal equipment shall be capable of operation in at least one of the states discussed in (i), (ii) or (iii) below. The output power level of the data circuit terminal equipment shall not be alterable, by the customer, to levels which exceed the signal power limits specified herein.

(i) Data circuit terminal equipment intended to operate with a programming resistor for signal level control shall not exceed the programmed levels given in Table 68.308(a).

(ii) Data circuit terminal equipment intended to operate in the fixed loss loop (FLL) state shall not transmit signal power that exceeds -4 dBm, in the 200 - 3995 Hz voiceband, when averaged over any and all 3 second intervals.

(iii) Data circuit terminal equipment shall not transmit signals from 200 to 3995 Hz that exceed -9 dBm, when averaged over any and all 3 second intervals.

Table 68.308(a)

Programming Resistor (R_p)*	Programmed Data Equipment Signal Power Output
short	0 dBm
150 Ohms	-1 dBm
336 Ohms	-2 dBm
569 Ohms	-3 dBm
866 Ohms	-4 dBm
1240 Ohms	-5 dBm
1780 Ohms	-6 dBm
2520 Ohms	-7 dBm
3610 Ohms	-8 dBm
5490 Ohms	-9 dBm

*Tolerance of R_p is ± 1%

Rationale for Harmonized Requirement

The proposed requirements are similar, the text has been simplified and shortened. The Table 68.308(a) has been duplicated in this section for ease of reference, it also remains in § 68.502. This table indicates the required value of the programming resistors to limit the signal power levels for programmable and universal data configurations. The output signal power tolerance has been removed.

Table 68.308(b) ALLOWABLE NET AMPLIFICATION BETWEEN PORTS (A)(C)(D)(E)

TO / FROM (E)	Tie Trunk Type Ports			Integrated Services Trunk	OPS Ports (2-Wire) (B)	Public Switched Network Ports (2-Wire)	HCC Digital PBX-CO 4-Wire
	2/4-Wire	Subrate 1.544 Mbps Satellite 4W	Subrate 1.544 Mbps Tandem 4W				
2/4-Wire Tie	0 dB	3 dB	3 dB	3 dB	6 dB	-	-
Subrate 1.544 Mbps Satellite 4W Tie	0 dB	-	3 dB	3 dB	6 dB	-	-
Subrate 1.544 Mbps Tandem 4W Tie	-3 dB	0 dB	0 dB	0 dB	3 dB	-	-
Integrated Services Trunk	-3 dB	0 dB	0 dB	0 dB	3 dB	-	-
RTE Digital	0 dB	0 dB	0 dB	0 dB	3 dB	3 dB	0 dB
RTE (B) PSTN/OPS	-3 dB	-3 dB	-3 dB	- 3 dB	0 dB	0 dB	-3 dB
OPS (B) (2-Wire)	-2 dB	1 dB	1 dB	1 dB	4 dB	4 dB	1 dB
Public Switched Network (2-Wire)	-	-	-	-	3 dB	3 dB	-
HCC Digital PBX-CO (4-Wire)	-	-	-	-	3 dB	-	-

§ 68.308 Signal power limitations.

(Reworded and Changed)

§68.308(b)(5) & Table 68.308(b)

(A) The source impedance for all measurements shall be 600 Ohms. All ports shall be terminated in appropriate loop or private line channel simulator circuits or 600-Ohm terminations.

Rationale for Harmonized Requirement

The Through Gain Table has been updated to reflect new equipment and to be consistent with the PBX loss level plan. References to 4-Wire CTS (Conventional Term. Set) trunks have been removed to be consistent with the proposal to remove CTS from the rules since such interfaces are no longer in current use. Note C has been deleted to remove the reference to CTS and the other notes have been renumbered. All references to "average' and "maximum have been deleted as they refer to manufacturing tolerance and not to the Part 68 type approval process.

§ 68.308 Signal power limitations.

(Reworded and Changed)

§ 68.308(b)(6)

NOTE: The following definitions apply to return loss requirements:

RL the return loss of 2-wire terminal equipment at the interface with respect to 600 Ohms + 2.16 μF (i.e., Z_{ref} = 600 Ohms + 2.16 μF).

$$RL \triangleq 20 \log_{10} \left| \frac{Z_{PBX} + Z_{ref}}{Z_{PBX} - Z_{ref}} \right|$$

RL_i the terminal equipment input (receive) port return loss with respect to 600 Ohms (i.e., Z_{ref} = 600 Ohms).

$$RL_i \triangleq 20 \log_{10} \left| \frac{Z_{PBX\ (input)} + Z_{ref}}{Z_{PBX\ (input)} - Z_{ref}} \right|$$

RL_o the terminal equipment output (transmit) port return loss with respect to 600 Ohms (i.e., Z_{ref} = 600 Ohms).

$$RL_o \triangleq 20 \log_{10} \left| \frac{Z_{PBX\ (output)} + Z_{ref}}{Z_{PBX\ (output)} - Z_{ref}} \right|$$

tl the transducer loss between the receive and transmit ports of the 4-wire PBX.

tl_f is the transducer loss in the <u>forward</u> direction from the <u>receive</u> port to the <u>transmit</u> port of the PBX.

$$tl_f \triangleq 20 \log_{10} \left| \frac{I_i}{I_r} \right|$$

where I_i is the current sent into the <u>receive</u> port and I_r is the current received at the <u>transmit</u> port terminated at 600 Ohms.

tl_r is the transducer loss in the reverse direction, from the transmit port to the receive port of the PBX.

$$tl_r \triangleq 20 \log_{10} \left| \frac{I_t}{I_r} \right|$$

where I_t is the current sent into the transmit port and I_r is the current received at the receive port terminated at 600 Ohms.

NOTE: The source impedance of I_t is 600 Ohms

Rationale for Harmonized Requirement

Section (6)(iii) requirements for the four-wire conventional terminating set interface has been removed. This is consistent with the committee's proposal to remove four-wire conventional terminating sets from the rules. There are minor editorial changes to the text.

§ 68.308 Signal power limitations.

(Reworded and Changed)

§ 68.308(b)(7)(ii)

(A) The maximum open circuit voltage across the tip (T(OPS)) and ring (R(OPS)) leads for all classes shall not exceed 56.5 volts, and

(B) Except for class A OPS interfaces, the maximum dc current into a short circuit across tip (T(OPS)) and ring (R(OPS)) leads shall not exceed 140 mA.

(C) Deleted

Rationale for Harmonized Requirement

Paragraph (C) is deleted because this requirement for a minimum dc current of 20 MA to the simulator circuit was specified to ensure proper operation of the registered terminal equipment the end of the OPS loop. It is not relevant to prevention of network harm.

§ 68.308 Signal power limitations.

(Delete)

(8) For Message Registration....

Deleted

§ 68.308(c)

(3) For Message Registration....

Deleted

Rationale for Harmonized Requirement:

These deletions are consistent with the proposal to remove message registration from the rules.

§68.308 Signal power limitations.

(Reworded and Changed)

(d) *Longitudinal voltage at frequencies below 4 kHz.* The weighted root-mean squared voltage* averaged over 100 milliseconds that is resultant of all of the component longitudinal voltages in the 100 Hz to 4 kHz band after weighting according to the transfer function of f/4000 where f is the frequency in Hertz, shall not exceed the maximum indicated under the conditions stated in § 68.308(g).

Rationale for Harmonized Requirement:

This section has been reworded to eliminate the Figure 68.308(a) and incorporate the transfer function in the text.

§ 68.308 Signal power limitations.

(Reworded)

§ 68.308(f)

(1) *Metallic voltages - frequencies below 4 kHz.*

(i) *Weighted rms voltage in the 10 Hz to 4 kHz frequency band.* The weighted rms metallic voltage in the frequency band from 10 Hz to 4 kHz, averaged over 100 milliseconds that is the resultant of all the component metallic voltages in the band after weighting according to the transfer function of f/4000 where f is the frequency in Hertz, shall not exceed the maximum indicated below under the conditions stated in § 68.308(g).

(3) *Longitudinal Voltage.*

(i) *Frequencies below 4 kHz.* The weighted rms voltage in the frequency band from 10 Hz to 4 kHz, averaged over 100 milliseconds is the resultant of all the component longitudinal voltages in the band after weighing according to the transfer function of f/4000, where f is the frequency in Hz, shall not exceed the maximum indicated below under the conditions stated in § 68.308(g).

Rationale for Harmonized Requirement

These sections have been reworded for clarification and to include the transfer function in the text..

§ 68.308 Signal power limitations.

(Reworded)

§ 68.308(g)

(1) All registered terminal equipment, except equipment to be used on LADC, and all registered protective circuitry must comply with the limitations when connected to a termination equivalent to the circuit depicted in Figure 68.308(b) and when placed in all operating states of the equipment except during network control signaling. ~~For message registration in the ground return mode, a termination equivalent to Figure 68.308 (c) is required, and metallic voltage limitations do not apply.~~ LADC registered terminal equipment must comply with the metallic voltage limitations when connected to circuits of § 68.3(k) and must comply with the longitudinal limitations when connected to circuits of Figure 68.308(a), as indicated.

Rationale for Harmonized Requirement

This section has been reworded to delete the reference to message registration. Figure 68.308(c) has been deleted and Figure b has been renumbered and the title changed to reflect its revised status.

§ 68.308 Signal power limitations.

(Reworded)

§ 68.308(g)

(3) Registered terminal equipment and registered protective circuitry with provision for through-transmission from other equipments shall comply with the limitations with a 1000 Hz tone applied from a 600-Ohm source (or, if appropriate a source which reflects a 600-Ohm impedance across tip and ring) at the maximum level that would be applied during normal operation. Registered protective circuitry for data shall also comply with the tone level 10 dB higher than the overload point.

(4) For registered terminal equipment or registered protective circuitry with non-registered signal source input, such as music on hold, the out of band signal power requirements shall be met using an input signal with a frequency range of 200 Hz to 20 kHz and the level set at the overload point.

Rationale for Harmonized Requirement:

These sections have been reworded to include reference to the "overload point" in order to clarify the compliance requirements with the out of band signal power rules for non-registered signal sources.

§ 68.308 Signal power limitations.

(Reworded and Changed)

§ 68.308(h)

(1) *Limitations on Terminal Equipment Connection to Subrate Digital Services.*

(i) *Pulse repetition rate.* The pulse repetition rate shall be synchronous with 2.4, 3.2, 4.8, 6.4, 9.6, 12.8, 19.2, 25.6, 56.0, 64 or 72 kbps per second.

(ii) *Template for maximum output pulse.* When applied to a 135 Ohm resistor, the instantaneous amplitude of the largest isolated output pulse obtainable from the registered terminal equipment shall not exceed by more than 10% the instantaneous voltage defined by a template obtained as follows: The limiting pulse template shall be determined by passing an ideal 50% duty cycle rectangular pulse with the amplitude/pulse rate characteristics defined in Table 68.308(b) through a single real pole low pass filter having a cutoff frequency in Hertz equal to 1.3 times the bit rate. For bit rates of 2.4, 3.2, 4.8, 6.4, 9.6 and 12.8 kbps, the filtered pulses shall also be passed through a filter providing the additional attenuation in Table 68.308(c).

Table 68.308(b) - Driving Pulse Amplitude

Line Rate (kbps)	User Data Rate (R) (kbps)	Amplitude (A) (volts)
2.4	2.4	1.66
3.2	2.4 with SC*	1.66
4.8	4.8	1.66
6.4	4.8 with SC*	1.66
9.6	9.6	0.83
12.8	9.6 with SC*	0.83
19.2	19.2	1.66
25.6	19.2 with SC*	1.66
56	56	1.66
72	56 with SC*	1.66
72	64	1.66

* SC: Secondary Channel

Table 68.308(c) - Minimum Additional Attenuation

Line Rate (R) (kbps)	Attenuation in Frequency Band 24-32 kHz (dB)	Attenuation in Frequency Band 72-80 kHz (dB)
2.4	5	1
3.2	5	1
4.8	13	9
6.4	13	9
9.6	17	8
12.8	17	8

The attenuation indicated may be reduced at any frequency within the band by the weighting curve of Table 68.308(d). Minimum rejection is never less than 0 dB; i.e., the weight does not justify gain over the system without added attenuation.

Table 68.308(d)
Attenuation Curve

24-32 kHz Band	72-80 kHz Band	Attenuation Factor dB
24	72	-18
25	73	- 3
26	74	- 1
27	75	0
29	76	0
29	77	0
30	78	- 1
31	79	- 3
32	80	-18

(iii) *Average power.* The average output power when a random signal sequence, (0) or (1) equiprobable in each pulse interval, is being produced as measured across a 135 Ohm resistance shall not exceed 0 dBm for 9.6 and 12.8 kbps or +6 dBm for all other rates shown in Table 68.308(b).

Rationale for Harmonized Requirement:

The harmonized requirements are the same as the current Part 68 requirements, except secondary channel rates have been added to the requirements to cover for all the rates currently provided by the terminal equipment. The graphic portion of Figure 68.308(d) was removed and the table was incorporated in the text as Table 308(d) with no change in the information.

§ 68.308 Signal power limitations.

(Reworded and Changed)

§ 68.308(h)

(2) Limitations on Terminal Equipment Connecting to 1.544 Mbps Digital Services.

(i) *Pulse repetition rate.* The free running line rate of the transmit signal shall be 1.544 Mbps with a tolerance of ± 32 ppm., i.e. , ± 50 bps.

Rationale for Harmonized Requirement:

These proposed limits are tighter than the present Part 68 requirements but they were adopted with the understanding that these are current industry practices, therefore there is no additional burden on product manufacturers. The wording has been changed to "free running line rate" as this is the worst case.

§ 68.308 Signal power limitations.

(Reworded and Changed)

§ 68.308(h)(2)

(ii) *Output pulse templates.* The registered terminal equipment shall be capable of optionally delivering three sizes of output pulses. The output pulse option shall be selectable at the time of installation.

(a) *Option A output pulse.* When applied to a 100 Ohm resistor, the instantaneous amplitude of the largest output pulse obtainable from the registered terminal equipment shall fall within the pulse template illustrated in Figure 68.308(e). The mask may be positioned horizontally as needed to encompass the pulse, and the amplitude of the normalized mask may be uniformity scaled to encompass the pulse. The baseline of the mask shall coincide with the pulse baseline.

(b) *Option B output pulse.* When applied to a 100 Ohm resistor, the instantaneous amplitude of the output from the registered terminal equipment obtained when Option B is implemented shall fall within the pulse template obtained by passing the bounding pulses permitted by Figure 68.308(e) through the following transfer function.

$$\frac{V_{out}}{V_{in}} = \frac{n_2 S^2 + n_1 S + n_0}{d_3 S^3 + d_2 S^2 + d_1 S + d_0}$$

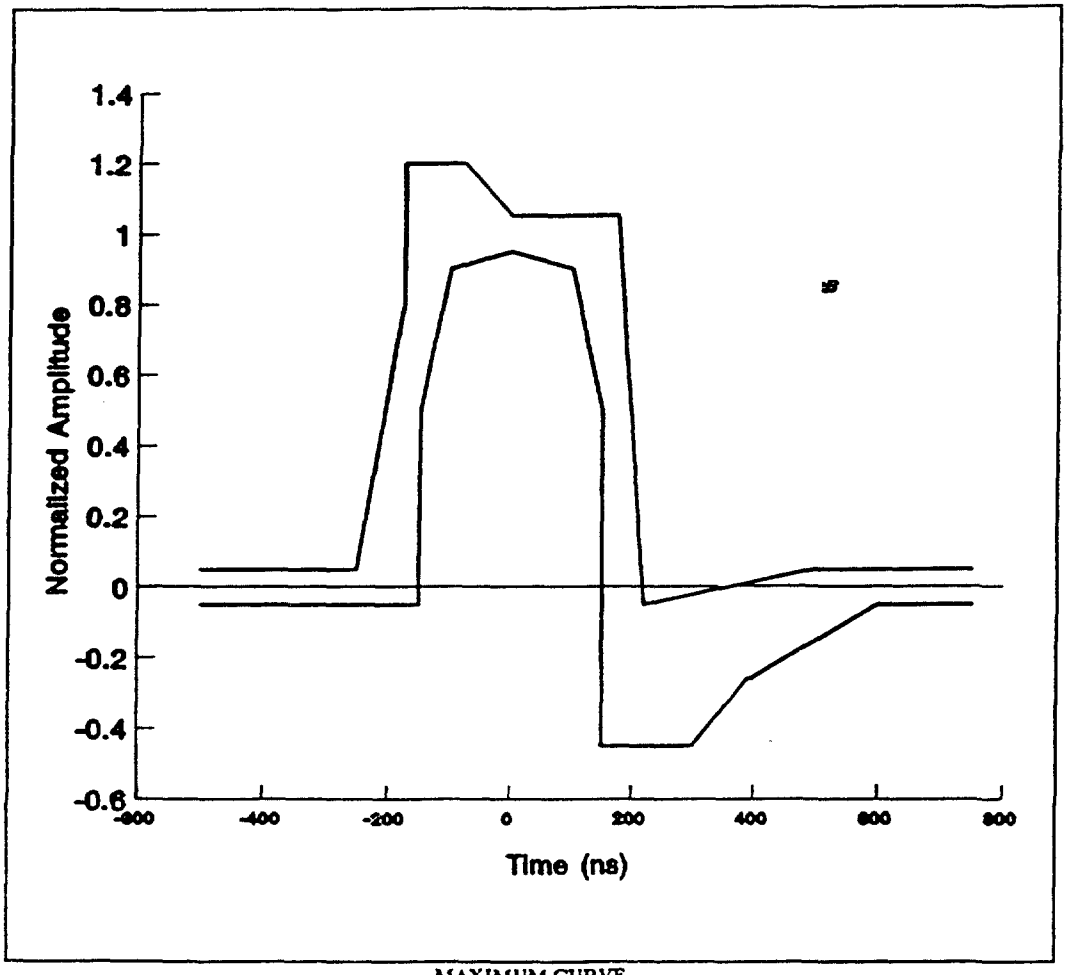
where:

$n_0 = 1.6049 \times 10^6$
$n_1 = 7.9861 \times 10^{-1}$
$n_2 = 9.2404 \times 10^{-8}$
$d_0 = 2.1612 \times 10^6$
$d_1 = 1.7223$
$d_2 = 4.575 \times 10^{-7}$
$d_3 = 3.8307 \times 10^{-14}$
$S = j 2 \prod f$
f = frequency (Hertz)

(c) *Option C output pulse.* When applied to a 100 Ohm resistor, the instantaneous amplitude of the output from the registered terminal equipment obtained when Option C is implemented shall fall within the pulse template obtained by passing the pulses obtained in Option B through the transfer function in Option B a second time.

Rationale for Harmonized Requirement:

The harmonized pulse mask for Option A (no LBO) was changed to the mask for DS1 equipment as found in EIA/TIA 547-1989 Standard. This mask is intended for equipment output and is less restrictive in terms of pulse amplitude (3.6 V allowed instead of the current Part 68 of 3.3 V for this option).



MAXIMUM CURVE

NANO-SECONDS	-500	-250	-175	-175	-75	0	175	220	500	750		
NORMALIZED AMPLITUDE	.05	.05	.8	1.2	1.2	1.05	1.05	-.05	.05	.05		

MINIMUM CURVE

NANO-SECONDS	-500	-150	-150	-100	0	100	150	150	300	396	600	750
NORMALIZED AMPLITUDE	-.05	-.05	.5	.9	.95	.9	.5	-.45	-.45	-.26	-.05	-.05

Figure 68.308 (e) Ref. EIA/TIA 547-1989)
Isolated Pulse Template and Corner Points for 1.544 Mbps equipment
Note: The pulse amplitude is 2.4 to 3.6 V. (Use constant scaling factor to fit normalized template.)

§ 68.308 Signal power limitations.

(Reworded and Changed)

§ 68.308(h)(2)

(iv) *Output power.* The output power in a 3 kHz band about 772 kHz when an 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.

Rationale for Harmonized Requirement:

This requirement has been restated in words for option A and the table has been deleted. The minimum requirements were deleted as they do not relate to network harm. Only the maximum power for the equipment state without Line Build Out (LBO) is necessary, as the output power characteristics with the different LBO states are evaluated by the output pulse template section.