Reference Specification

for

Coaxial Cable Home Networking

IDA RS XX
Issue 1, Date

Info-Communications Development Authority of Singapore
Resource Management and Standards
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Contents

PART A INTRODUCTION

1. SCOPE

1.1 This specification describes the use of in-premises coaxial wiring for high speed data networking within the home. The Specification defines the minimum technical requirements for the connection of Home Networking Transceivers (HNT) over the in-premises coaxial wiring.

1.2 The use of the coaxial home networking MUST NOT interfere with the TV or broadband access services carried in the same medium.

1.3 Compliance with this Specification on the whole is voluntary. However, HNT users and providers can only claim that their devices are in conformity with this Specification when mandatory provisions indicated by the words "shall" and "must" are fulfilled.

2. GENERAL REQUIREMENTS

2.1 Power Supply

The HNT may be a.c. or d.c. powered. For an a.c. powered equipment, the Specification shall be complied with when operating from an a.c. mains supply of voltage, 230V ± 10% and frequency, 50 Hz ± 2%. Where external power supply is used, e.g. AC adaptor, it shall not affect the capability of the equipment to meet the Specification.

2.2 Identification of Equipment

The HNT equipment shall be marked with the supplier or manufacturer's name or identification mark, and the supplier or manufacturer's model or type reference. The markings required shall be legible, indelible and readily visible.

2.3 Safety Requirements

The HNT equipment shall be tested for compliance with the International Electrotechnical Commission IEC 60950 safety standard [1]. The requirements in IEC 60950 that are applicable to the equipment (e.g. class of equipment, type of TNV circuit and types of components) shall be identified and complied with.

2.4 Electromagnetic Compatibility (EMC) Requirements

The HNT equipment shall comply with the "EMC requirements for Telecommunication Equipment" (IDA TS EMC).

3. REFERENCES

ITU-T Rec G.9954 (01/2007)	Home Networking Transceivers – Enhanced Physical, Media Access, and Link Layer Specifications
IDA TS EMC	EMC requirements for Telecommunication Equipment
IEC 60950:2005	International Electrotechnical Commission – Safety of Information Technology Equipment

[1] The safety standard includes, among others, protection of telecommunications network service personnel and users of other equipment connected to the network from hazards in the HNT.

4. ABBREVIATIONS

DOCSIS	Data over Cable Services Interface Specifications
HNT	Home Networking Transceivers
IF	Isolation Function
IFG	Inter-Frame Gap
LLC	Link Layer Control
MAC	Media Access Control
MII	Media Independent Interface
PSD	Power Spectral Density
RG	Residential Gateway
WAN	Wide Area Network

PART B HOME NETWORKING TRANSCEIVERS

(Based on ITU-T Rec. G.9954 01/2007)

1. SYSTEM REFERENCE MODEL FOR COAXIAL HOME NETWORKING TRANSCEIVERS

1.1 Figure 1-1 shows the basic reference model for in-premises coaxial home networking transceivers (HNT). The interface of concern in this Specification is the wire-side electrical and logical interface (W1) between a HNT station and the coaxial cable.

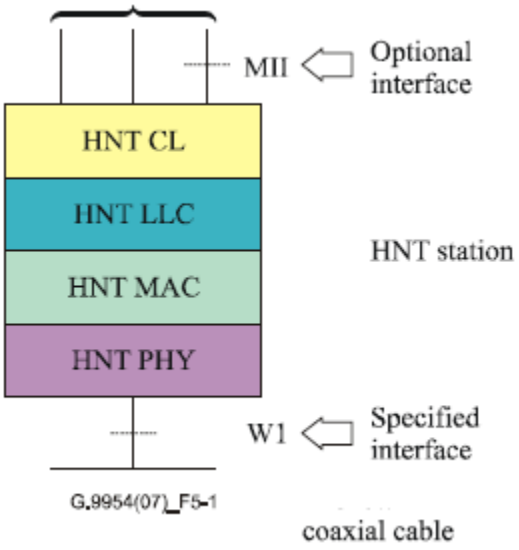

Figure 1-1 (Figure 5-1/G.9954): **Basic Reference Model**

1.2 The HNT system implements a *shared medium* single-segment network, as shown in Figure 1-2 (Figure 5-3/G.9954) below. All stations on a segment are logically connected to the same shared channel on the coaxial cable.

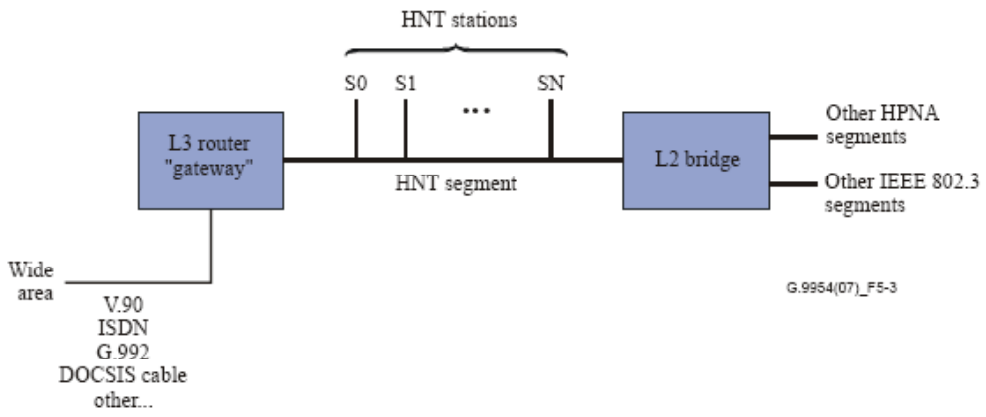

Figure 1-2 (Figure 5-3/G.9954): **HNT shared medium network segment on the coaxial cable**

1.3 Figure 1-3 below shows an example of the home network using Coaxial Home Networking, where a variety of types of network devices (e.g. IP Set-top Boxes) are connected via the coaxial cables in the home, to a Internet Gateway Device (RG) and possible bridges to other home network segments, possibly based on other home networking technologies (e.g. wireless, power-line).

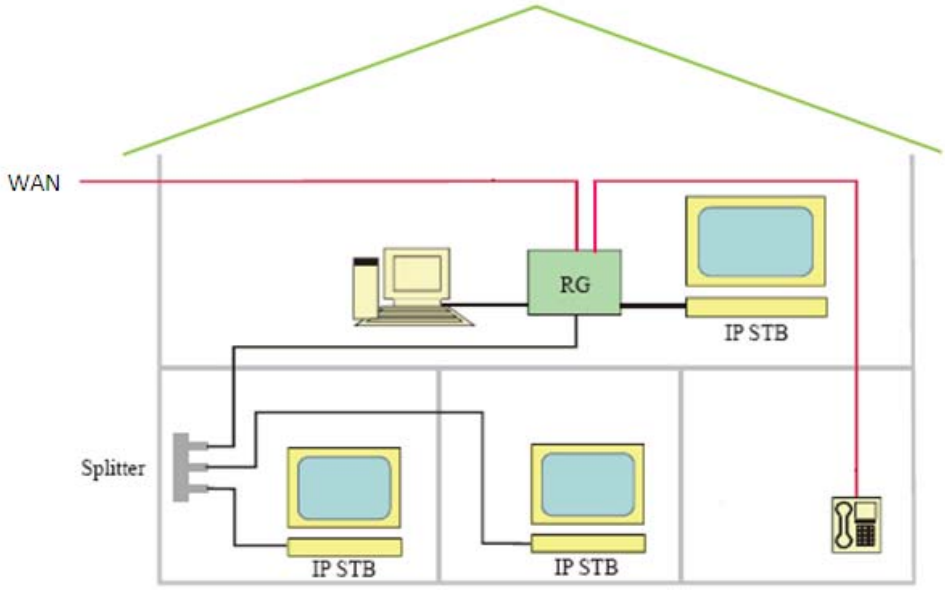

Figure 1-3 (modified from Figure 5-4/G.9954): **Home network using the coaxial cable**

1.4 An Isolation Function (IF) shall be implemented, where the in-premise coaxial network is not physically disconnected from the coaxial access network, to prevent interference between HNT devices operating on in-premises wiring and access network technologies that use an overlapping frequency spectrum, e.g. DOCSIS.

The IF shall be installed at the distribution point, i.e. before the coaxial splitter point where the main cable is split into the different room points.

The IF serves two functions: to ensure network separation between neighbours and to isolate the coaxial home networking from the coaxial broadband access network.

The IF shall allow provide a minimum of 60dB isolation and shall allow broadcast TV signals (i.e. 85~864 MHz) to pass through to the home network.

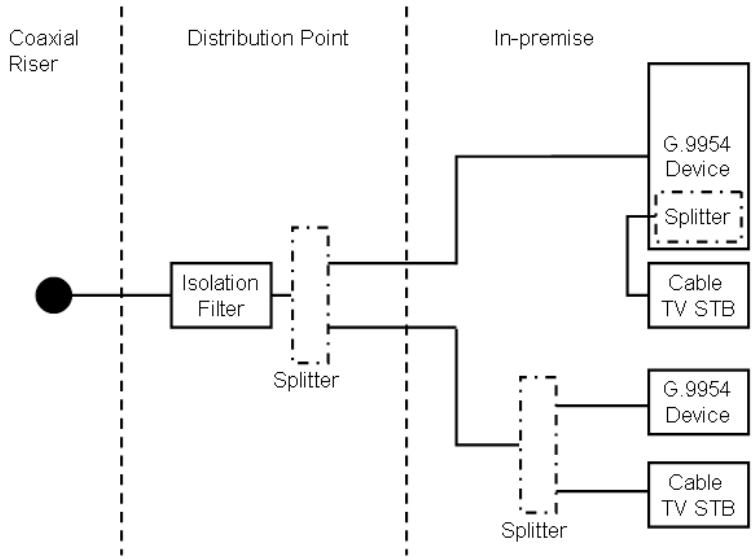

Figure 1-4a: **Isolation Function**

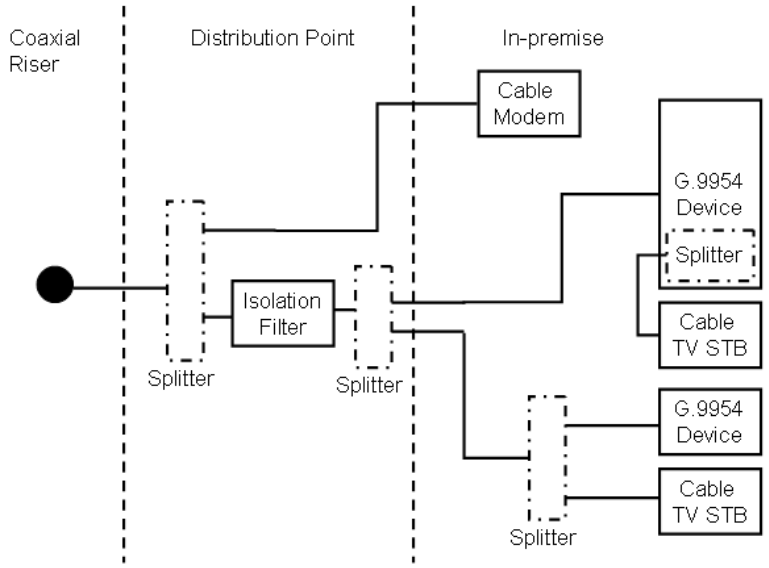

Figure 1-4b: **Isolation Function (with Co-existence of DOCSIS)**

2. FREQUENCY AND POWER SPECTRAL DENSITY

2.1 Frequency Spectrum

The HNT shall operate in one of the spectral modes below:-

Spectral mode A:	4 to 20 MHz
Spectral mode B:	12 to 28 MHz
Spectral mode C:	36 to 52 MHz
Spectral mode D:	4 to 36 MHz
Spectral mode E:	12 to 44 MHz
Spectral mode F:	36 to 68 MHz
	(or 52 to 68MHz for Docsis co-existence)

2.2 Isolation Filter Requirements

The IF shall be installed, if required to (1) pass through broadcast FM and TV signals; (2) provide isolation from Docsis network; and/or (3) isolate HNT from neighbours.

The IF shall minimally fulfill the specifications as provided in Table 2-1 and Figure 2-1 below.

S.No	Specification (w.r.t. 75 Ohm Impedance), f (MHz)	HNT Mode	
		A to F	Sub-F
1	Attenuation		
	f <= 42MHz	>= 61dB	<= 1dB[2]
	42MHz < f < 52MHz	>= 61dB	>= (1 + (f-42)*40/10)dB
	52MHz <= f <= 68MHz	>= 61dB	>= 41dB
	68MHz < f < 85MHz	<= (61 - (f-68)*60/17)dB	<= (41 - (f-68)*40/17)dB
	f >= 85MHz	<= 1dB	<= 1dB
2	Return Loss		
	f <= 42MHz	<= 1dB	>= 12dB
	42MHz < f < 52MHz	<= 1dB	<= (12 - (f-42)*11/10)dB
	52MHz <= f <= 68MHz	<= 1dB	<= 1dB
	68MHz < f < 85MHz	>= (1 + (f-68)*11/17)dB	>= (1 + (f-68)*11/17)dB
	f >= 85MHz	>= 12dB	>= 12dB
3	Ripple	<= 2dB	<= 2dB

Table 2-1: **Isolation Function (IF) Specifications**

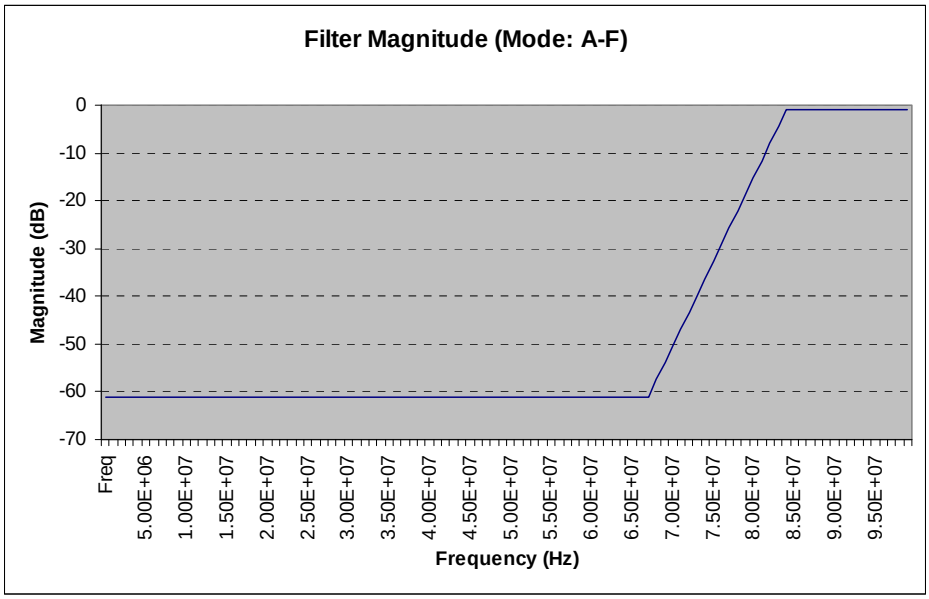

Figure 2-1a: **Isolation Function for Modes A to F**

[2] The filter may exclude 0~5MHz for the purpose of lightning/surge protection, if desired.

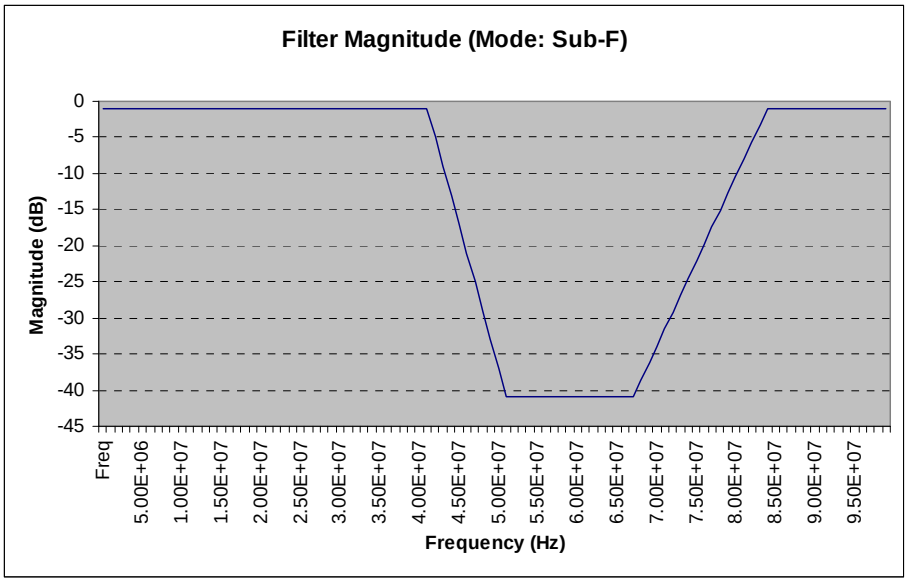

Figure 2-1b: **Isolation Function for Sub-Mode F**

2.3 Spectral Masks

When transmitting in spectral mode A, the HNT metallic power spectral density (PSD) shall be constrained by the upper bound depicted in Figure 2-2 (Figure 7-17/G.9954) and Table 2-2 (Table 7-8/G.9954) with the measurement made across a 75-ohm load between centre and ground at the transmitter W1 interface. The upper bound shall apply to all symbol rates and constellations.

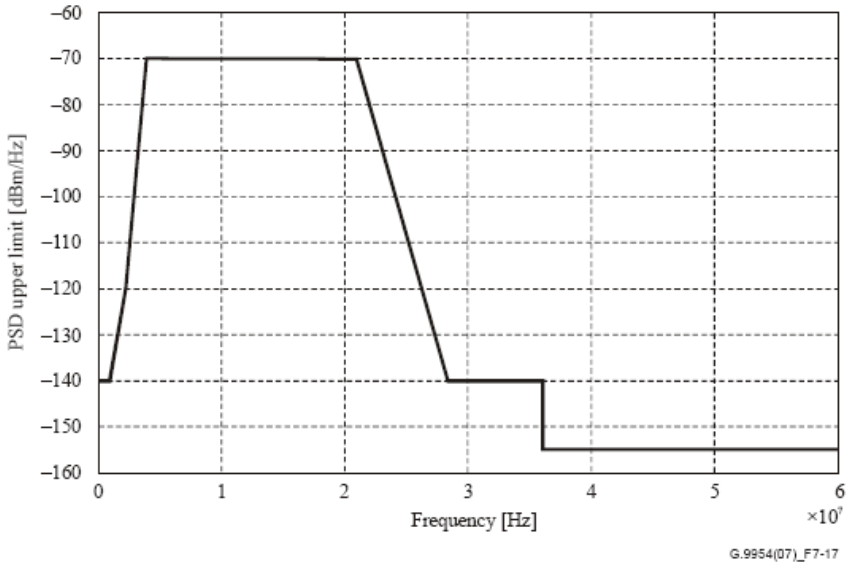

Figure 2-2 (Figure 7-17/G.9954): **Transmit PSD upper bound for Spectral Mode A**

Frequency [MHz]	PSD limit [dBm/Hz]
$0.015 < f \leq 1$	–140
$1 < f \leq 2.3$	$-140 + (f - 1) \times 20/1.3$
$2.3 < f \leq 4$	$-120 + (f - 2.3) \times 50/1.7$
$4 < f \leq 21$	–70
$21 < f \leq 28.4$	$-70 - (f - 21) \times 70/7.4$
$28.4 < f \leq 36$	–140
$36 \leq f$	–155

Table 2-2 (Table 7-8/G.9954): **Transmit PSD upper bound for Spectral Mode A**

When transmitting in spectral mode B, the HNT metallic power spectral density (PSD) shall be constrained by the upper bound depicted in Figure 2-3 (Figure 7-18/G.9954) and Table 2-3 (Table 7-9/G.9954) with the measurement made across a 75-ohm load between centre and ground at the transmitter W1 interface. The upper bound shall apply to all symbol rates and constellations.

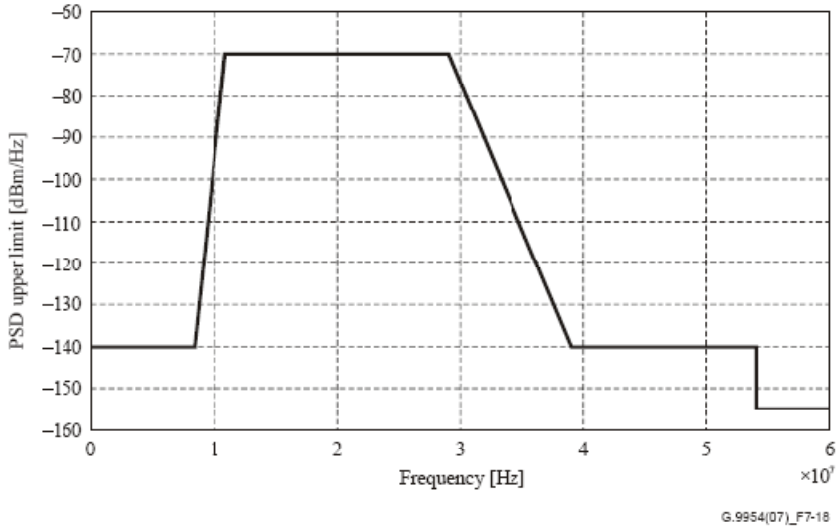

Figure 2-3 (Figure 7-18/G.9954): **Transmit PSD upper bound for Spectral Mode B**

Frequency [MHz]	PSD limit [dBm/Hz]
$0.015 < f \leq 8.5$	-140
$8.5 < f \leq 11$	$-140 + (f - 8.5) \times 70/2.5$
$11 < f \leq 29$	-70
$29 < f \leq 39$	$-70 - (f - 29) \times 70/10$
$39 < f \leq 54$	-140
$54 \leq f$	-155

Table 2-3 (Table 7-9/G.9954): **Transmit PSD upper bound for Spectral Mode B**

When transmitting in spectral mode C, the HNT metallic power spectral density (PSD) shall be constrained by the upper bound depicted in Figure 2-4 (Figure 7-19/G.9954) and Table 2-4 (Table 7-10/G.9954) with the measurement made across a 75-ohm load between centre and ground at the transmitter W1 interface. The upper bound shall apply to all symbol rates and constellations.

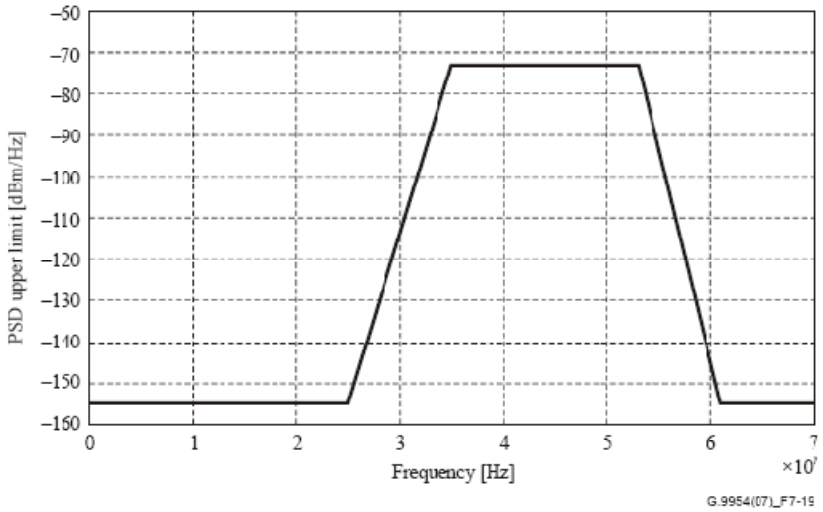

Figure 2-4 (Figure 7-19/G.9954): **Transmit PSD upper bound for Spectral Mode C**

Frequency [MHz]	PSD limit [dBm/Hz]
$0.015 < f \leq 25$	–155
$25 < f \leq 35$	$-155 + (f - 25) \times 82/10$
$35 < f \leq 53$	–73
$53 < f \leq 61$	$-73 - (f - 53) \times 82/8$
$61 \leq f$	–155

Table 2-4 (Table 7-10/G.9954): **Transmit PSD upper bound for Spectral Mode C**

When transmitting in spectral mode D, the HNT metallic power spectral density (PSD) shall be constrained by the upper bound depicted in Figure 2-5 (Figure 7-20/G.9954) and Table 2-5 (Table 7-11/G.9954) with the measurement made across a 75-ohm load between centre and ground at the transmitter W1 interface. The upper bound shall apply to all symbol rates and constellations.

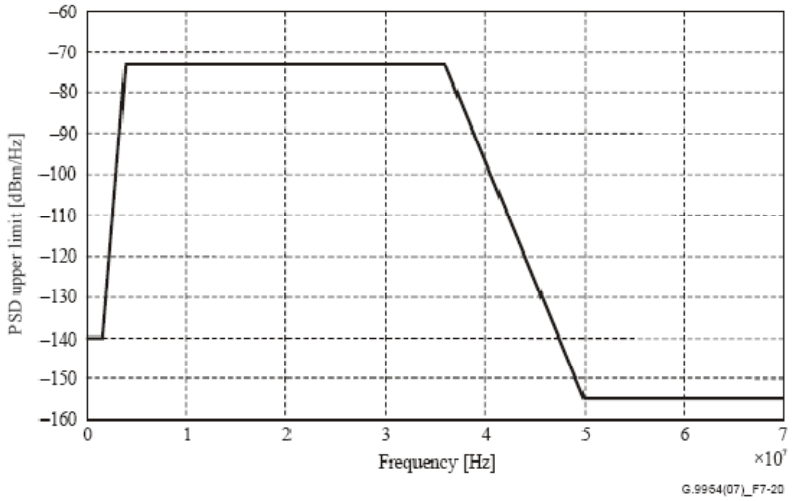

Figure 2-5 (Figure 7-20/G.9954): **Transmit PSD upper bound for Spectral Mode D**

Frequency [MHz]	PSD limit [dBm/Hz]
$0.015 < f \leq 1.7$	–140
$1.7 < f \leq 4$	$-140 + (f - 1.7) \times 67/2.3$
$4 < f \leq 36$	–73
$36 < f \leq 50$	$-73 - (f - 36) \times 82/14$
$50 \leq f$	–155

Table 2-5 (Table 7-11/G.9954): **Transmit PSD upper bound for Spectral Mode D**

When transmitting in the spectral mode E, the HNT metallic power spectral density (PSD) shall be constrained by the upper bound depicted in Figure 2-6 with the measurement made across a 75-ohm load between centre and ground at the transmitter W1 interface. The upper bound shall apply to all symbol rates and constellations.

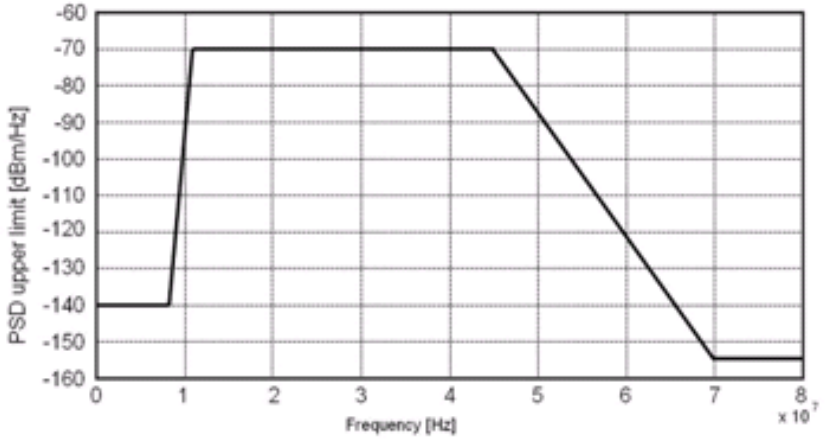

Figure 2-6: **Transmit PSD upper bound for Spectral Mode E**

When transmitting in the spectral mode F, the HNT metallic power spectral density (PSD) shall be constrained by the upper bound depicted in Figure 2-7 with the measurement made across a 75-ohm load between centre and ground at the transmitter W1 interface. The upper bound shall apply to all symbol rates and constellations.

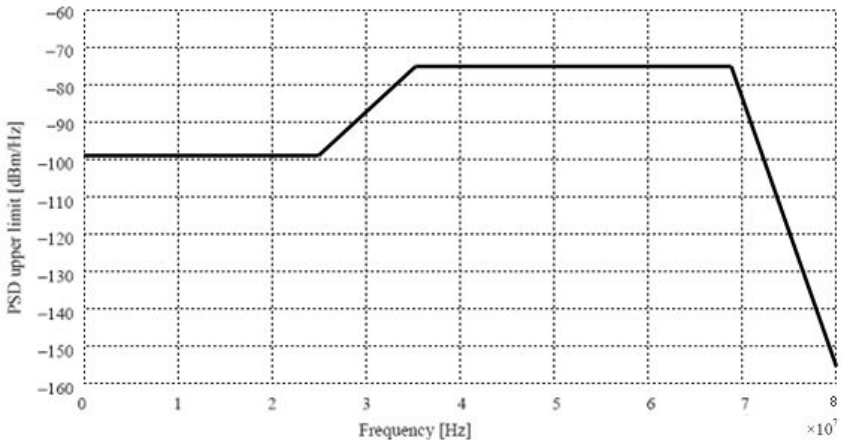

Figure 2-7: **Transmit PSD upper bound for Spectral Mode F**

When transmitting in the alternative sub-spectral mode F, the HNT metallic power spectral density (PSD) shall be constrained by the upper bound depicted in Figure 2-8 with the measurement made across a 75-ohm load between centre and ground at the transmitter W1 interface. The upper bound shall apply to all symbol rates and constellations.

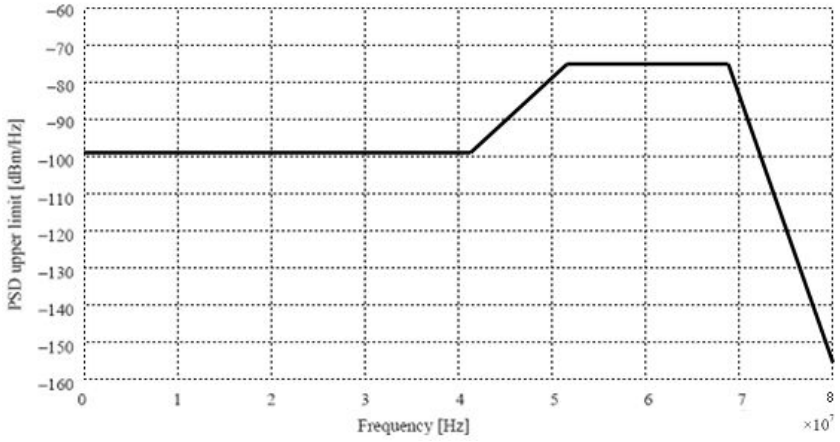

Figure 2-8: **Transmit PSD upper bound for sub-Spectral Mode F**

When transmitting in spectral mode A, the resolution bandwidth used to make this measurement shall be 10 kHz for frequencies between 2.5 and 60.0 MHz, and 3 kHz for frequencies between 0.015 and 2.5 MHz. An averaging window of 213 seconds shall be used, and 1500-octet MTUs separated by an IFG duration of silence shall be assumed. A total of 50 kHz of possibly non-contiguous bands may exceed the limit line under 2.5 MHz, with no sub-band greater than 20 dB above the limit line. A total of 50 kHz of possibly non-contiguous bands may exceed the limit line between 28.5 and 60.0 MHz, with no sub-band greater than 20 dB above the limit line.

When transmitting in spectral mode B, the resolution bandwidth used to make this measurement shall be 10 kHz for frequencies between 2.5 and 60.0 MHz, and 3 kHz for frequencies between 0.015 and 2.5 MHz. An averaging window of 213 seconds shall be used, and 1500-octet MTUs separated by an IFG duration of silence shall be assumed. A total of 50 kHz of possibly non-contiguous bands may exceed the limit line under 8.5 MHz, with no sub-band greater than 20 dB above the limit line. A total of 50 kHz of

possibly non-contiguous bands may exceed the limit line between 39.0 and 60.0 MHz, with no sub-band greater than 20 dB above the limit line.

When transmitting in spectral mode C, the resolution bandwidth used to make this measurement shall be 10 kHz for frequencies between 2.5 and 80.0 MHz, and 3 kHz for frequencies between 0.015 and 2.5 MHz. An averaging window of 213 seconds shall be used, and 1500-octet MTUs separated by an IFG duration of silence shall be assumed. A total of 50 kHz of possibly non-contiguous bands may exceed the limit line under 25.0 MHz, with no sub-band greater than 20 dB above the limit line. A total of 50 kHz of possibly non-contiguous bands may exceed the limit line between 61.0 and 80.0 MHz, with no sub-band greater than 20 dB above the limit line.

When transmitting in spectral mode D, the resolution bandwidth used to make this measurement shall be 10 kHz for frequencies between 2.5 and 70.0 MHz, and 3 kHz for frequencies between 0.015 and 2.5 MHz. An averaging window of 213 seconds shall be used, and 1500-octet MTUs separated by an IFG duration of silence shall be assumed. A total of 50 kHz of possibly non-contiguous bands may exceed the limit line under 2.5 MHz, with no sub-band greater than 20 dB above the limit line. A total of 50 kHz of possibly non-contiguous bands may exceed the limit line between 50.0 and 70.0 MHz, with no sub-band greater than 20 dB above the limit line.

When transmitting in spectral mode E, the resolution bandwidth used to make this measurement shall be 10 kHz for frequencies between 2.5 and 70.0 MHz, and 3 kHz for frequencies between 0.015 and 2.5 MHz. An averaging window of 213 seconds shall be used, and 1500-octet MTUs separated by an IFG duration of silence shall be assumed. A total of 50 kHz of possibly non-contiguous bands may exceed the limit line under 2.5 MHz, with no sub-band greater than 20 dB above the limit line. A total of 50 kHz of possibly non-contiguous bands may exceed the limit line between 50.0 and 70.0 MHz, with no sub-band greater than 20 dB above the limit line.

When transmitting in spectral mode F or sub-mode F, the resolution bandwidth used to make this measurement shall be 10 kHz for frequencies between 2.5 and 80.0 MHz, and 3 kHz for frequencies between 0.015 and 2.5 MHz. An averaging window of 213

seconds shall be used, and 1500-octet MTUs separated by an IFG duration of silence shall be assumed. A total of 50 kHz of possibly non-contiguous bands may exceed the limit line under 2.5 MHz, with no sub-band greater than 20 dB above the limit line. A total of 50 kHz of possibly non-contiguous bands may exceed the limit line between 80.0 and 100.0 MHz, with no sub-band greater than 20 dB above the limit line.

3. ELECTRICAL CHARACTERISTICS

3.1 Transmit Power

Stations shall transmit according to the transmit power limitations described in Table 3-1 (Table 7-7/G.9960), corresponding to the spectral mode they transmit. Transmit power shall be measured during the header, across a 75-ohm load between centre and ground, integrated from 0 to 100 MHz.

Spectral mode	Transmit power limit [dBm]
A	[-2 +1]
B	[-2 +1]
C	[-5 -2]
D	[-2 +1]
E	[-2 +1]
F	[-2 +1]

Table 3-1 (Table 7-7/G.9954): **Transmit Power Requirements**

3.2 Transmit Voltage

Stations that are not transmitting shall emit less than -85 dBVrms measured across a 75-ohm load between centre and ground.