RSS-247 — Digital Transmission Systems, Frequency Hopping Systems and Licence-Exempt Local Area Network Devices in 902-928 MHz, 2400-2483.5 MHz, 5150-5350 MHz, and 5470-5895 MHz bands

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Issue 4
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Preface

Radio Standards Specification RSS-247, issue 4, *Digital Transmission Systems, Frequency Hopping Systems and Licence-Exempt Local Area Network Devices in 902-928 MHz, 2400-2483.5 MHz, 5150-5350 MHz, and 5470-5895 MHz bands,* replaces RSS-247, issue 3, *Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices*, dated August 2023.

The main technical changes are:

1. removed the restriction on operation of devices in the 5600 MHz to 5650 MHz frequency range.
2. modified section 6.4 related to hybrid devices to introduce requirements distinguishing hybrid devices from a mere combination of FHS and DTS devices.
3. removed the directional antenna/antenna array calculation since the directional gain calculation is covered in the normative reference ANSI C63.10 and the measurement procedure in the accepted KDBs.
4. added clarification for LE-LANs operating within vehicles in the bands 5150-5250 MHz and 5250-5350 MHz.
5. modified point b) in section 7.3.1.3 related to the unwanted emissions of transmitters operating in the 5150-5250 MHz to clarify the requirement.

6. added a reporting requirement to section 7.1 for devices implementing transmitter power control.
7. modified the transmit power control requirement in sections 7.3.1.2 and 7.3.2.2.
8. modified section 7.3.2.1 to introduce the indoor labeling requirement for the unwanted emissions.
9. modified section 7.3.2.3 to clearly identify the different unwanted emission limits of transmitters operating in the band 5250-5350 MHz
10. moved the definitions from section 7.3.5 to the definitions section.

The main editorial changes are:

11. added the frequency ranges in the title of the document.
12. updated section 3 definitions to include additional terms, clarify others, and moved definitions from other parts of the document.
13. modified section 6 to group together the requirements for frequency hopping systems by band.
14. modified section 6 to group together the requirements for the digital transmission systems.
15. modified section 7.3.6.3 related to dynamic frequency selection to identify the requirements to be applied to a client without radar detection.
16. made additional editorial changes, restructured numerous sections and provided clarifications, as appropriate, to improve the overall document readability.

Inquiries may be submitted by one of the following methods:

1. Online using the General Inquiry form (in the form, select the Directorate of Regulatory Standards radio button and specify "RSS-247" in the General Inquiry field)
2. By mail to the following address:

   Innovation, Science and Economic Development Canada
   Engineering, Planning and Standards Branch
   Attention: Regulatory Standards Directorate
   235 Queen Street
   Ottawa ON K1A 0H5
   Canada
3. By email to consultationradiostandards-consultationnormesradio@ised-isde.gc.ca

Additional information and guidance are available on the Innovation, Science and Economic Development Canada (ISED) webpages Common Questions and Answers and General Notices.

Comments and suggestions for improving this standard may be submitted online using the Standard Change Request form, or by mail or email to the above addresses.

All ISED publications related to spectrum management and telecommunications are available on the Spectrum Management and Telecommunications website.

Issued under the authority of the Minister of Industry

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Wen Kwan
Director General
Engineering, Planning and Standards Branch

1. Scope

This Radio Standards Specification (RSS) outlines the certification requirements for frequency hopping systems (FHS), digital transmission systems (DTS) and combination (hybrid) systems operating in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz frequency bands.

This RSS also includes licence-exempt local area network (LE-LAN) and DTS devices operating in the 5150-5250 MHz, 5250-5350 MHz, 5470-5725 MHz, 5725-5850 MHz, and 5850-5895 MHz bands, as specified in SP-5150 MHz, *Spectrum Utilization Policy for Licence-exempt Wireless Local Area Networks in the 5 GHz Range (Issue 2)*, and in SMSE-012-22, *Decision on the Technical and Policy Framework for Radio Local Area Network Devices in the 5850-5895 MHz Band and for the Intelligent Transportation Systems in the 5895-5925 MHz Band*.

2. General requirements and references

This section sets out the general requirements and references related to this RSS.

2.1 Coming into force and transition period

This document will be in force as of the date of its publication on Innovation, Science and Economic Development Canada's (ISED) website.

However, a transition period of six months from the publication date will be provided. During this period, applications for certification under RSS-247 issue 3 or issue 4 will be accepted. After this period, only applications for the certification of equipment under RSS-247, issue 4, will be accepted, and equipment manufactured, imported, distributed, leased, offered for sale, or sold in Canada shall comply with this present issue.

A copy of RSS-247, issue 3, is available upon request by to consultationradiostandards-consultationnormesradio@ised-isde.gc.ca.

2.2 Certification requirements

Equipment covered by this standard is classified as Category I equipment. Either a technical acceptance certificate (TAC) issued by ISED's Certification and Engineering Bureau (CEB) or a certificate issued by a recognized certification body (CB) is required.

2.3 Licensing requirements

Equipment covered by this standard is exempt from licensing requirements pursuant to section 15 of the *Radiocommunication Regulations*.

2.4 RSS-Gen compliance

Equipment being certified under this standard shall also comply with the general requirements set out in Radio Standards Specification RSS-Gen, *General Requirements for Compliance of Radio Apparatus*. Where contradictions exist between this standard and RSS-Gen, this standard shall take precedence.

2.5 Normative publications

The following documents shall be consulted in conjunction with this RSS:

- ANSI/USEMCSC C63.10, *American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices*
- ETSI EN 301 893, *Broadband Radio Access Networks (BRAN); 5 GHz high performance RLAN; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive*

Note that ETSI EN 301 893 is only applicable for equipment utilizing dynamic frequency selection (DFS).

The applicable version of the ETSI/ANSI standards and any accepted KDBs is on the Normative Test Standards and Acceptable Alternate Procedures webpage.

Acronyms

- ANSI: American National Standards Institute
- ETSI: European Telecommunications Standards Institute

- KDB: Knowledge Database

2.6 Related documents

All ISED publications related to spectrum management and telecommunications are available on the Spectrum management and telecommunications website. In addition to related documents specified in RSS-Gen, refer to the following documents as needed:

- SP-5150 MHz, *Spectrum Utilization Policy for Licence-exempt Wireless Local Area Networks in the 5 GHz Range (Issue 2)*
- SMSE-012-22, *Decision on the Technical and Policy Framework for Radio Local Area Network Devices in the 5850-5895 MHz Band and for Intelligent Transportation Systems in the 5895-5925 MHz Band*

3. Definitions

Access point (AP) is a transceiver that is intended to operate as at least one of the following:

a. a bridge in a peer-to-peer connection

b. a connector between the wired and wireless segments of the network

c. a relay between wireless network segments

Channel closing transmission time is the aggregate duration of transmissions by LE-LAN devices during the channel move time, which starts upon detection of an interfering signal above the interference detection threshold. This aggregate includes the normal transmission time, and the intermittent signals required to facilitate changes.

Channel move time is the time needed by an LE-LAN device to cease all transmissions on the current channel upon detection of a radar signal.

Client mode is an operating mode in which the transmissions of the LE-LAN device are under the control of a controller.

Controller mode is an LE-LAN that has an operating mode in which the device has the capability to transmit without receiving an enabling signal. In this mode, the device is able to select a channel and initiate a network by sending

enabling signals to other LE-LAN devices.

Digital transmission system (DTS) is a device that utilizes digital modulation techniques.

Dynamic frequency selection (DFS) is a mechanism that dynamically detects signals from other systems and avoids co-channel operation with those systems, notably radar systems.

DFS detection threshold is the required detection level defined by detecting a received signal strength that is greater than a threshold specified within the device channel bandwidth.

Fixed outdoor AP is a transceiver that is attached to a permanent outdoor structure or used at a fixed outdoor temporary location and is not used while in motion.

Fixed outdoor client device is intended as a customer premise equipment under the control of a fixed outdoor AP, which is attached to a permanent outdoor structure or used at a temporary outdoor location and is not used while in motion

Frequency hopping systems (FHS) employ a spread spectrum technology in which the carrier is modulated with coded information in a conventional manner, causing a conventional spreading of the radio frequency (RF) energy around the carrier frequency. The carrier frequency is not fixed, but changes at fixed intervals under the direction of a coded sequence.

Indoor AP is intended to operate in locations completely enclosed by walls and a ceiling.

Indoor operation is a mode of operation wherein a device is surrounded by walls and a ceiling during operation.

Indoor subordinate device is a transceiver having its transmissions under the control of an indoor AP.

In-service monitoring is a mechanism to check a channel in use by the LE-LAN device for the presence of a radar signal.

Licence-exempt local area network (LE-LAN) device is an apparatus that may operate as an access point device or a client device.

Maximum conducted output power is the total transmitted power delivered to all antennas and antenna elements averaged across all symbols in the signalling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or transmitting at a reduced power level. If multiple modes of operation are implemented, the maximum conducted output power is the highest total transmit power occurring in any mode.

Transmitter power control (TPC) is a feature that enables an LE-LAN device to dynamically switch between several transmission power levels in the transmission process. The intent of this feature is to use the lowest power level necessary to establish and maintain connectivity between LE-LAN devices.

Vehicle is defined as an enclosed mobile machine that transports people or cargo on a road (definition for the purpose of this RSS).

4. External radio-frequency (RF) power amplifiers

External RF Power Amplifiers (ERFPA) may be marketed separately for use with devices certified under this standard under the following conditions:

a. the ERFPA shall be certified with the device with which it is intended to be used, such that the amplifier-device combination does not exceed any of the limits specified for the device alone; and

b. the ERFPA shall be marketed only for use with the device with which it has been certified, the following statement shall be included on the packaging and in the user manual:

Under Innovation, Science, and Economic Development Canada regulations, this external radio frequency power amplifier (insert ISED certification number of radio frequency power amplifier) may only be used with the

transmitter with which the amplifier has been certified by Innovation, Science and Economic Development Canada. The certification number for the transmitter with which this amplifier is permitted to operate is IC:XX…X-YY…Y.

5. Measurement method

In addition to the requirements in RSS-Gen and the requirements of this standard, measurement methods are provided in ANSI C63.10.

6. Requirements for frequency hopping systems, digital transmission systems and hybrid systems operating in the bands 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz

This section sets out the requirements for frequency hopping systems (FHS), digital transmission systems (DTS) and hybrid systems.

6.1 General

This section applies to FHS operating in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands, as well as to DTS in the 902-928 MHz and 2400-2483.5 MHz bands. Systems in these bands can be frequency hopping, digital transmission and/or a combination (hybrid) of both types. The transmissions of DTS in the 5725-5850 MHz band shall comply with the requirement in section 7 of this standard.

FHS that synchronize with another or several other systems to avoid frequency collisions among them via off-air sensing or via connecting cables are not hopping randomly and therefore are not permitted for certification under this standard.

6.2 Frequency hopping systems (FHS)

FHS are not required to employ all available hopping frequencies during each transmission. However, the system comprising both the transmitter and the receiver, must be designed to comply with all of the requirements in this section in case the transmitter is presented with a continuous data or

information stream. In addition, a system employing short transmission bursts must comply with the definition of frequency hopping equipment and must distribute its transmissions over the minimum number of hopping channels specified in this section.

Incorporation of intelligence into an FHS that enables it to recognize other users of the band and to avoid occupied frequencies is permitted, provided that the FHS chooses or adapts its hopset without having to synchronize with another or several other systems. The coordination of FHS in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

6.2.1 General requirements for bandwidth and hopping channels applicable to all bands

The following bandwidth and hopping channel requirements shall apply to FHS operating in the bands 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz:

a. the bandwidth of a frequency hopping channel is the 20 dB emission bandwidth, measured with the hopping stopped. The system's RF bandwidth is equal to the channel bandwidth multiplied by the number of channels in the hopset. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

b. the hopping channel carrier frequencies shall be separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

6.2.2 Frequency Hopping Systems operating in the band 902-928 MHz

This section sets out the bandwidth, hopping channels and power for FHS operating in the band 902-928 MHz.

6.2.2.1 Bandwidth and hopping channels

The following bandwidth and hopping channel requirements shall apply:

a. the maximum 20 dB bandwidth of the hopping channel shall be 500 kHz.

b. if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 s within a 20 s period.

c. if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 s within a 10 s period.

6.2.2.2 Transmitter output power and equivalent isotropically radiated power (e.i.r.p.) requirements

The following transmitter output power and e.i.r.p. requirements shall apply:

a. if the hopset uses 50 or more hopping channels, the maximum peak conducted output power shall not exceed 1.0 W, and the e.i.r.p. shall not exceed 4 W.

b. if the hopset uses less than 50 hopping channels, the maximum peak conducted output power shall not exceed 0.25 W and the e.i.r.p. shall not exceed 1 W.

6.2.3 Frequency Hopping Systems operating in the band 2400-2483.5 MHz

This section sets out the bandwidth, hopping channels and power for FHS operating in the band 2400-2483.5 MHz.

6.2.3.1 Bandwidth and hopping channels

The following bandwidth and hopping channel requirements shall apply:

a. FHS operating in the band 2400-2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided

that the systems operate with an output power no greater than 0.125 W.

b. FHS operating in the band 2400-2483.5 MHz shall use at least 15 hopping channels. The average time of occupancy on any channel shall not be greater than 0.4 s within a period of 0.4 s, multiplied by the number of hopping channels employed. Transmissions on particular hopping frequencies may be avoided or suppressed provided that at least 15 hopping channels are used.

6.2.3.2 Transmitter output power and equivalent isotropically radiated power (e.i.r.p.) requirements

The following transmitter output power and e.i.r.p. requirements shall apply:

a. if the hopset uses 75 or more hopping channels, the maximum peak conducted output power shall not exceed 1.0 W.

b. if the hopset uses less than 75 hopping channels the maximum peak conducted output power shall not exceed 0.125 W.

c. the e.i.r.p. shall not exceed 4 W, except as provided in sections 6.5 a) and b).

6.2.4 Frequency Hopping Systems operating in the band 5725-5850 MHz

This section sets out the bandwidth, hopping channels and power for FHS operating in the band 5725-5850 MHz.

6.2.4.1 Bandwidth and hopping channels

The following bandwidth and hopping channel requirements shall apply:

a. FHS operating in the band 5725-5850 MHz shall use at least 75 hopping channels. The maximum 20 dB bandwidth of the hopping channel shall be 1 MHz. and

b. the average time of occupancy on any frequency shall not be greater than 0.4 s within a 30 s period.

6.2.4.2 Transmitter output power and equivalent isotropically radiated power (e.i.r.p.) requirements

The following transmitter output power and e.i.r.p. requirements shall apply:

a. for FHS operating in the band 5725-5850 MHz the maximum peak conducted output power shall not exceed 1 W, and

b. the e.i.r.p. shall not exceed 4 W, except as provided in section 6.5 a) and b).

6.3 Digital transmission systems (DTS)

DTS include systems that employ digital modulation techniques resulting in spectral characteristics similar to direct sequence systems.

DTS operating in the band 5725-5850 MHz shall meet the requirements of section 7 of this document.

6.3.1 Bandwidth and conducted power spectral density

The following applies to the bands 902-928 MHz and 2400-2483.5 MHz:

a. the minimum 6 dB bandwidth shall be 500 kHz.

b. the transmitter power spectral density conducted from the transmitter to the antenna(s) shall not be greater than 8 dBm/3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of section 6.3.2 The power spectral density shall be determined using the same method as is used to determine the maximum conducted output power.

6.3.2 Transmitter output power and e.i.r.p. requirements

For DTS operating in the band 902-928 MHz, the maximum peak conducted output power shall not exceed 1W, and the e.i.r.p. shall not exceed 4 W.

For DTS operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1W, and the e.i.r.p. shall not exceed 4 W, except as provided in section 6.5 a) and b).

As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power.

6.4 Hybrid Systems

Hybrid systems employ a combination of both frequency hopping and digital transmission techniques at the same time on the same carrier, and shall comply with the following.

a. the power spectral density requirements for digital modulation operation, when the frequency hopping operation is stopped, shall not exceed 8 dBm/3 kHz.

b. the frequency hopping operation shall have an average time of occupancy on any frequency not exceeding 0.4 s within a duration in seconds equal to the number of hopping frequencies multiplied by 0.4, when the frequency hopping function is enabled.

c. there is no minimum number of hopping channels.

d. hybrid systems shall have a true frequency hopping system, as set out in sections 6.2.1 a) and 6.2.1 b). The hybrid systems shall comply with:

    i. the minimum channel separation,

    ii. the pseudo-random hop sequence, and

    iii. the receiver matching bandwidth and synchronization.

6.5 Transmitter output power and e.i.r.p. requirements for fixed point-to-point (FPTP) and point-to-multipoint (PTMP) systems

The equipment must comply with the following requirements, where applicable:

a. FPTP systems in the bands 2400-2483.5 MHz and 5725-5850 MHz are permitted to have an e.i.r.p. higher than 4 W provided that the higher e.i.r.p. is achieved by employing higher gain directional antennas and not higher transmitter output powers.

b. PTMP, omnidirectional applications and multiple co-located transmitters, in the bands 2400-2483.5 MHz and 5725-5850 MHz, transmitting the same information are prohibited from exceeding an e.i.r.p. of 4 W. However, remote stations of PTMP systems shall be permitted to operate at an e.i.r.p. greater than 4 W under the same conditions as for FPTP systems under 6.5 a).

c. transmitters operating in the band 2400-2483.5 MHz may employ antenna systems that emit multiple directional beams simultaneously or sequentially, for the purpose of directing signals to individual receivers or to groups of receivers, provided that the emissions comply with the following:

    i. different information must be transmitted to each receiver.

    ii. if the transmitter employs an antenna system that emits multiple directional beams, but does not emit multiple directional beams simultaneously, the total output power conducted to the array or arrays that comprise the device (i.e. the sum of the power supplied to all antennas, antenna elements, staves, etc., and summed across all carriers or frequency channels) shall not exceed the applicable conducted output power limit as specified in sections 6.2.3.2 and 6.3.2. However, the total conducted output power shall be reduced by 1 dB below the specified limits for each 3 dB that the directional gain of the antenna/antenna array exceeds 6 dBi.

    iii. if a transmitter employs an antenna that operates simultaneously on multiple directional beams using the same or different frequency channels, the power supplied to each emission beam is subject to the applicable power limit specified in sections 6.2.3.2 and 6.3.2. If transmitted beams overlap, the power shall be reduced to ensure that their aggregate power does not exceed the applicable limit specified in sections 6.2.3.2 and 6.3.2. In addition, the aggregate power transmitted simultaneously on all beams shall not exceed the applicable limit specified in sections 6.2.3.2 and 6.3.2 by more than 8 dB.

iv. transmitters that transmit a single directional beam shall operate under the provisions of sections 6.2.3.2, 6.3.2, 6.5 a), and 6.5 b).

6.6 Unwanted Emissions

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum device, digitally modulated device, or hybrid system is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power – based on either an RF conducted or a radiated measurement – provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 6.3.2, the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

7. Requirements for LE-LAN devices and DTS operating in the 5 GHz band

This section outlines the requirements for LE-LAN devices and DTS operating in the 5 GHz band. It specifically applies to LE-LAN devices operating in the 5150-5250 MHz, 5250-5350 MHz, 5470-5725 MHz, 5725-5850 MHz, and 5850-5895 MHz bands, as well as to DTS using digital modulation in the 5725-5850 MHz bands that are not intended LE-LAN operation.

7.1 General

The fundamental emissions of the equipment shall be measured in terms of average value.

Devices with occupied bandwidths which overlap different bands shall comply with all applicable requirements for the portion of the occupied bandwidth within each respective band. This applies to e.i.r.p., power spectral density, and maximum conducted output power limits.

For devices requiring transmitter power control (TPC) being certified under this standard, a measurement with TPC enabled shall be reported. Measurement method and setup shall be described in detail and measurements with and without TPC enabled shall be provided in the test report. Measurement data shall demonstrate that the device transmits at a reduced transmit power when TPC functionality is enabled.

For the purposes of this section, whenever reference is made to occupied bandwidth, the letter B shall be used and shall be expressed in MHz.

7.2 Types of modulation

Equipment shall employ digital modulation.

7.3 Power and unwanted emissions limits

Equipment is required to comply with the provisions outlined in RSS-Gen regarding emissions that fall within restricted frequency bands, as specified in that document. If the transmission is in bursts, the provisions of RSS-Gen for pulsed operation shall apply.

Unwanted emissions shall be measured using the outermost carrier frequencies or channels, and the center frequencies of these carriers or channels must be clearly identified in the test report.

7.3.1 Frequency band 5150-5250 MHz

This section sets out the requirements for equipment operating in band 5150-5250 MHz.

7.3.1.1 General

LE-LAN devices are restricted to indoor operation, including the use inside of trains, only in the band 5150-5250 MHz. However, original equipment manufacturer (OEM) devices, which are installed in vehicles by vehicle manufacturers, are permitted.

The devices certified under this section are not permitted to be used on airplanes.

7.3.1.2 Power limits

For OEM devices installed in vehicles, the maximum e.i.r.p. shall not exceed the lesser of:

a. 30 mW; or

b. 1.76 + 10 $\log_{10}$B, dBm.

OEM devices installed in vehicles with a maximum e.i.r.p. greater than 15 mW shall implement TPC in order to have the capability to operate at least 3 dB below the maximum permitted e.i.r.p. of 30 mW.

For all other devices the maximum e.i.r.p. spectral density shall not exceed 10 dBm/MHz. The maximum e.i.r.p. shall not exceed the lesser of:

a. 200 mW; or

b. 10 + 10 $\log_{10}$B, dBm.

7.3.1.3 Unwanted emission limits

For transmitters with operating frequencies in the band 5150-5250 MHz:

a. all emissions outside the 5150-5350 MHz band shall not exceed -27 dBm/MHz peak e.i.r.p. spectral density;

b. any unwanted emissions that falls between the upper edge of the 26 dB bandwidth and 5350 MHz shall be attenuated below the channel power by at least 26 dB, when measured using a resolution bandwidth between 1 and 5% of the occupied bandwidth.

c. if the occupied bandwidth also falls within the 5250-5350 MHz band, the transmission is considered as intentional and the devices shall comply with all requirements in the band 5250-5350 MHz including implementing DFS (see section 7.3.6) and TPC, on the portion of the emission that resides in the 5250-5350 MHz band.

7.3.2 Frequency band 5250-5350 MHz

This section sets out the requirements for equipment operating in band 5250-5350 MHz.

7.3.2.1 General

Devices operating in the 5250-5350 MHz band shall comply with the DFS requirements in section 7.3.6.

For devices installed in vehicles, only in-vehicle OEM devices installed by vehicle manufacturers are permitted.

Devices demonstrating compliance with section 7.3.2.3 b)ii, except for OEM devices installed in vehicles by vehicle manufacturers, shall be labelled or include in the user manual the following text: "for indoor use only".

The devices certified under this section are not permitted to be used on airplanes.

7.3.2.2 Power limits

For OEM devices installed in vehicles, the maximum e.i.r.p. shall not exceed the lesser of:

a. 30 mW; or

b. 1.76 + 10 $\log_{10}$B, dBm.

OEM devices installed in vehicles with a maximum e.i.r.p. greater than 15 mW shall implement TPC in order to have the capability to operate at least 3 dB below the maximum permitted e.i.r.p. of 30 mW.

All other devices shall comply with the following:

a. the maximum power spectral density shall not exceed 11 dBm/MHz and the maximum conducted output power shall not exceed the lesser of:
    i. 250 mW; or
    ii. 11 + 10 $\log_{10}$B, dBm.
b. the maximum e.i.r.p. shall not exceed the lesser of:
    i. 1.0 W; or
    ii. 17 + 10 $\log_{10}$B, dBm.
c. Devices with a maximum e.i.r.p. greater than 500 mW shall implement TPC in order to have the capability to operate at least 6 dB below the maximum permitted e.i.r.p. of 1 W.

7.3.2.3 Unwanted emission limits

Devices shall comply with the following:

a. all emissions outside the band 5150-5350 MHz shall not exceed -27 dBm/MHz peak e.i.r.p spectral density.

b. all emissions inside the band 5150-5250 MHz shall either:

   i. not exceed -27 dBm/MHz peak e.i.r.p spectral density, or

   ii. comply with the power spectral density for operation in section 7.3.1.2.

7.3.2.4 Additional requirements

In addition to the above requirements, devices shall comply with the following, where applicable:

a. outdoor fixed devices with a maximum e.i.r.p. greater than 200 mW shall comply with the following e.i.r.p. at different elevation angles, where θ is the angle above the local horizontal plane (of the Earth) as shown below:

Table 1: Outdoor AP elevation angle mask with e.i.r.p. greater than 200 mW

e.i.r.p	**θ**
-13 dBW/MHz	$0^o \leq \theta < 8^o$
-13 − 0.716 (θ-8) dBW/MHz	$8^o \leq \theta < 40^o$
-35.9 − 1.22 (θ-40) dBW/MHz	$40^o \leq \theta \leq 45^o$
-42 dBW/MHz	$\theta > 45^o$

The measurement procedure defined in Appendix A of this document shall be used to verify the compliance to the e.i.r.p. at different elevation angles.

b. devices, other than outdoor fixed devices, having a maximum e.i.r.p. greater than 200 mW shall comply with either i. or ii. below:

i. devices shall comply with the e.i.r.p. elevation angle mask in section 7.3.2.4 a); or

ii. devices shall implement a method to permanently reduce their e.i.r.p. via a firmware feature in the event that ISED requires the e.i.r.p. reduction. The test report must demonstrate how the device's power table can be updated to meet this firmware requirement. The manufacturer shall provide this firmware to update all systems automatically in compliance with the directions received from ISED.

7.3.3 Frequency band 5470-5725 MHz

This section sets out the requirements for equipment operating in 5470-5725 MHz band.

7.3.3.1 General

Devices operating in the 5470-5725 MHz band shall comply with the DFS requirements in section 7.3.6.

7.3.3.2 Power limits

Equipment operating in the band 5470-5725 MHz band shall comply with the following power limits:

a. the maximum conducted output power shall not exceed the lesser of:

i. 250 mW; or
ii. 11 + 10 $\log_{10}$B, dBm.

b. the maximum power spectral density shall not exceed 11 dBm/MHz.

c. the maximum e.i.r.p. shall not exceed the lesser of:

i. 1.0 W; or
ii. 17 + 10 $\log_{10}$B, dBm.

d. equipment with a maximum e.i.r.p. greater than 500 mW shall implement TPC in order to have the capability to operate at least 6 dB below the maximum permitted e.i.r.p. of 1 W.

7.3.3.3 Unwanted emission limits

Equipment operating in the bands 5470-5725 MHz shall comply with the following unwanted emission limits:

a. for devices with fundamental emissions fully contained within the 5470-5725 MHz band, all unwanted emissions outside the band 5470-5725 MHz shall not exceed -27 dBm/MHz peak e.i.r.p. spectral density.

b. for devices with bandwidth overlapping the band edge of 5725 MHz, all unwanted emissions shall not exceed -27 dBm/MHz peak e.i.r.p. spectral density at 5850 MHz instead of 5725 MHz.

7.3.4 Frequency band 5725-5850 MHz

This section sets out the requirements for equipment operating in the 5725-5850 MHz band.

7.3.4.1 General

For equipment that has channels that span across 5850 MHz (e.g. 5725-5895 MHz) shall comply with the requirements described in section 7.3.5.

7.3.4.2 Bandwidth

For equipment operating in the band 5725-5850 MHz, the 6 dB bandwidth shall be at least 500 kHz.

7.3.4.3 Power limits

Equipment operating in the band 5725-5850 shall comply with the following power limits:

a. the maximum conducted output power shall not exceed 1 W; and

b. the maximum output power spectral density shall not exceed 30 dBm/500 kHz.

When using transmitting antennas with a directional gain exceeding 6 dBi, the maximum conducted output power and the output power spectral density shall be reduced by the amount in dB that the directional gain of the antenna

exceeds 6 dBi.

However, FPTP devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter maximum conducted output power and the power spectral density. FPTP operations exclude the use of PTMP systems, omnidirectional applications and multiple collocated transmitters transmitting the same information. However, remote stations of PTMP systems shall be permitted to operate at e.i.r.p. greater than 4 W under the same conditions as for FPTP systems.

7.3.4.4 Unwanted emission limits

Equipment operating in the band 5725-5850 MHz shall comply with the following peak e.i.r.p. spectral density limits:

a. 27 dBm/MHz at frequencies from the band edges decreasing linearly to 15.6 dBm/MHz at 5 MHz above or below the band edges;

b. 15.6 dBm/MHz at 5 MHz above or below the band edges decreasing linearly to 10 dBm/MHz at 25 MHz above or below the band edges;

c. 10 dBm/MHz at 25 MHz above or below the band edges decreasing linearly to -27 dBm/MHz at 75 MHz above or below the band edges; and

d. -27 dBm/MHz at frequencies more than 75 MHz above or below the band edges.

7.3.5 Frequency band 5850-5895 MHz

This section sets out the requirements for equipment operating in band 5850-5895 MHz.

7.3.5.1 General

Outdoor operations in the 5850-5895 MHz band, including channels that span across 5850 MHz (e.g. 5725-5895 MHz), shall be limited to fixed APs and fixed client devices.

Indoor operation in the 5850-5895 MHz band, including channels that span across 5850 MHz, shall be limited to APs, clients and subordinate devices. AP and subordinate devices shall be labelled or include in the user manual the following text "for indoor use only".

Indoor client devices shall have their transmissions under the control of an indoor AP or an indoor subordinate device and shall not be capable of initiating a network.

Indoor APs shall have the following characteristics:

a. shall be powered by a wired connection;

b. shall not be battery powered;

c. shall have a permanent antenna;

d. shall not have a weatherized enclosure;

e. shall have a direct connection to the Internet.

Indoor subordinate devices shall have their transmissions under the control of an indoor AP and shall have all the following characteristics:

a. shall be powered by a wired connection

b. shall not be battery powered

c. shall have a permanent antenna

d. shall not have a direct connection to the Internet

e. shall not have a weatherized enclosure

f. shall only connect to indoor access points, other indoor subordinate devices or client devices, all within a single building or structure

A fixed outdoor AP shall provide connectivity to fixed outdoor client devices and fixed outdoor AP.

A fixed outdoor client device shall not be capable of initiating a network, and shall be under the control of a fixed outdoor AP.

7.3.5.2 Bandwidth

All equipment shall have a 6 dB bandwidth of at least 500 kHz.

7.3.5.3 Power limits

Equipment operating in the band 5850-5895 MHz shall comply with the following limits:

a. for fixed outdoor APs, the maximum e.i.r.p. shall not exceed 4 W (36 dBm). The maximum e.i.r.p. spectral density shall not exceed 23 dBm/MHz. The maximum e.i.r.p. measured at any elevation angle greater than 30 degrees above the horizon, shall not exceed 125 mW (21 dBm) over the 5850-5895 MHz frequency band.

b. for fixed outdoor client devices, the maximum e.i.r.p. shall not exceed 1 W (30 dBm). The maximum e.i.r.p. spectral density shall not exceed 17 dBm/MHz.

c. for indoor APs, the maximum e.i.r.p. shall not exceed 4 W (36 dBm). The maximum e.i.r.p. spectral density shall not exceed 20 dBm/MHz.

d. for indoor subordinate devices, the maximum e.i.r.p. shall not exceed 4 W (36 dBm). The maximum e.i.r.p. spectral density shall not exceed 20 dBm/MHz.

e. for indoor client devices, the maximum e.i.r.p. shall not exceed 1 W (30 dBm). The maximum e.i.r.p. spectral density shall not exceed 14 dBm/MHz.

7.3.5.4 Unwanted emission limits

For the band edge 5725 MHz and below, all devices shall be measured using **peak detection** and shall comply with the following e.i.r.p. spectral density limits:

a. 27 dBm/MHz at frequencies from the 5725 MHz band edge decreasing linearly to 15.6 dBm/MHz at 5 MHz below the 5725 MHz band edge

b. 15.6 dBm/MHz at 5 MHz below the 5725 MHz band edge decreasing linearly to 10 dBm/MHz at 25 MHz below the 5725 MHz band edge

c. 10 dBm/MHz at 25 MHz below the 5725 MHz band edge decreasing linearly to -27 dBm/MHz at 75 MHz below the 5725 MHz band edge

d. -27 dBm/MHz at frequencies more than 75 MHz below the 5725 MHz band edge

For the 5895 MHz band edge and above, all devices shall be measured using **average detection** and shall comply with the following e.i.r.p. spectral density limits:

a. fixed outdoor APs and fixed outdoor client devices shall not exceed -27 dBm/MHz at or above the 5895 MHz band edge.

b. indoor APs or indoor subordinate devices shall not exceed 15 dBm/MHz at the 5895 MHz band edge and shall decrease linearly to not exceed -7 dBm/MHz at or above 5925 MHz.

c. client devices shall not exceed -5 dBm/MHz at the 5895 MHz band edge and shall decrease linearly to not exceed -27 dBm/MHz at or above 5925 MHz.

7.3.6 DFS for equipment operating in the bands 5250-5350 MHz, 5470-5725 MHz

This section sets out the requirements for equipment utilizing DFS and operating in the 5250-5350 MHz and 5470-5725 MHz bands.

7.3.6.1 General

To demonstrate compliance with the DFS radar requirements outlined in this section, ISED accepts either the FCC KDB Procedure 905462 or the DFS test procedure specified in ETSI EN 301 893.

For devices operating in the 5600-5650 MHz band, only the ETSI EN 301 893 test procedure shall be used to demonstrate compliance. Devices using the FCC KDB Procedure 905462 must operate exclusively within the 5250-5350 MHz, 5470-5600 MHz, 5650-5725 MHz bands, or any combination of these bands.

If any part of an operating device's emission bandwidth falls in the bands 5250-5350 MHz or 5470-5725 MHz, the device shall comply with requirements in the following sections.

7.3.6.2 DFS radar signal detection threshold

Devices shall employ a DFS radar detection mechanism to detect the presence of radar systems and to avoid co-channel operation with radar systems. The device must detect radar signals within its entire emission bandwidth. The minimum DFS radar signal detection threshold is described below in Table 2.

Table 2: DFS Detection threshold for controller devices and client devices with radar detection

Devices	**DFS Threshold**
Devices with a maximum e.i.r.p. < 200 mW AND a maximum Power Spectral Density < 10 dBm/MHz	-62 dBm
Devices with 200 mW ≤ maximum e.i.r.p. ≤ 1 W	-64 dBm
Note: The detection threshold power is the received power, averaged over a 1 µs reference to a 0 dBi antenna.	

7.3.6.3 Operational requirements

Devices shall comply with the following requirements, however, client devices without radar detection are only required to comply with the channel move time in c) and channel closing transmission time in d):

a. **In-service monitoring:** an LE-LAN device shall be able to monitor the operating channel to check that a co-channel radar has not moved or started operation within range of the LE-LAN device. During in-service monitoring, the LE-LAN radar detection function continuously searches for radar signals between normal LE-LAN transmissions.

b. **Channel availability check time:** the device shall check whether there is a radar system already operating on the channel before it initiates a transmission on a channel and when it moves to a channel. The device may start using the channel if no radar signal with a power level greater than the interference threshold value specified in section 7.3.6.2 above is detected within 60 s. This requirement only applies in the controller operational mode.

c. **Channel move time:** after a radar signal is detected, the device shall cease all transmissions on the operating channel within 10 s.

d. **Channel closing transmission time:** is comprised of 200 ms starting at the beginning of the channel move time plus any additional intermittent control signals required to facilitate a channel move (an aggregate of 60 ms) over the remaining 10 s period of the channel move time.

   The aggregate duration of all transmissions shall not count quiet periods between transmissions.

e. **Non-occupancy period:** a channel that has been flagged as containing a radar signal, either by a channel availability check or in-service monitoring, is subject to a 30-minute non-occupancy period where the channel cannot be used by the LE-LAN device. The non-occupancy period starts from the time that the radar signal is detected.

7.3.7 Additional Requirements

The following requirements shall apply:

a. the device shall automatically discontinue transmission in cases of absence of information to transmit, or operational failure. A description on how this is done shall accompany the application for equipment certification. Note that this is not intended to prohibit transmission of control or signalling information or the use of repetitive codes where required by the technology.

b. all LE-LAN devices must contain security features to protect against modification of software by unauthorized parties.

Manufacturers must implement security features in any digitally modulated devices capable of operating in any of the frequency ranges within the 5 GHz band, so that third parties are not able to reprogram the device to operate outside the parameters for which the device was certified. The software must prevent the user from operating the transmitter with operating frequencies, output power, modulation types or other radio frequency parameters outside those that were approved for the device. Manufacturers may use various means, including the use of a private network that allows only authenticated users to download software, electronic signatures in software or coding in hardware that is decoded by software to verify that new software can be legally loaded into a device to meet these requirements and must describe the methods in their application for equipment certification.

Manufacturers must take steps to ensure that DFS functionality cannot be disabled by the operator of the LE-LAN device.

c. the user manual for LE-LAN devices shall contain instructions related to the restrictions mentioned in the above sections, namely that:

    i. any devices capable of operating in the band 5150–5250 MHz shall only be used indoors to reduce the potential for harmful interference to co-channel mobile satellite systems (this requirement does not apply to OEM devices installed in vehicles by vehicle manufacturers);

    ii. for devices with detachable antenna(s), the maximum antenna gain permitted for devices in the bands 5250-5350 MHz and 5470-5725 MHz shall be such that the equipment still complies with the e.i.r.p. limit;

    iii. for devices with detachable antenna(s), the maximum antenna gain permitted for devices in the band 5725-5850 MHz shall be such that the equipment still complies with the e.i.r.p. limits as appropriate; and

    iv. where applicable, antenna type(s), antenna models(s), and worst-case tilt angle(s) necessary to remain compliant with the e.i.r.p. elevation mask requirement set forth in section 7.3.2.4 or 7.3.5.3

shall be clearly indicated.

Annex A: Measurement procedures for e.i.r.p. at various elevations for the band 5250-5350 MHz

This appendix sets out the measurement procedures for e.i.r.p. at various elevations.

A1. General

This appendix details two methodologies for assessing compliance of a product regarding the e.i.r.p. at different elevations against the applicable requirement set forth in section 7.3.2.4 of this document.

A2. Measurement method 1

Measurements shall be taken, using the following steps, at a test site that has been validated using the procedures of ANSI C63.4 or CISPR 16-1-4 (refer to RSS-Gen for applicable versions) for measurements above 1 GHz, so as to simulate a near free-space environment.

1. line the ground plane with absorbers between the transmitter and the receive antenna to minimize reflections. The absorbers used should have a minimum-rated attenuation of 20 dB through the measurement frequency range of interest. The absorbers shall be positioned to replicate the layout used when compliance with the applicable acceptability criterion was achieved, as set forth in the aforementioned site validation standards.
2. set the height of the receive antenna to 1.5 m. The receive antenna must be one that was designed and fabricated to operate over the entire frequency range of interest, for example, an appropriate standard gain horn.
3. the distance between the receive antenna and the radiating source shall be sufficient in order to ensure far-field conditions.
4. mount the transmitter at a height of 1.5 m.

5. configure the equipment under test (EUT) to produce the maximum power spectral density as measured while assessing compliance with section 7.3.2 (i.e. channel frequency, modulation type and data rate). If the EUT is equipped with a detachable antenna and the antenna is intended for remote installation (i.e. tower-mounted), the EUT may be substituted with a suitable signal generator. The level and frequency settings on the generator shall be set to reproduce the maximum power spectral density, measured within a 1 MHz bandwidth, obtained while assessing compliance to section 7.3.2.
6. position the transmitter or the radiating antenna so that elevation pattern measurements can be taken.
7. find the 0° reference point in the horizontal plane.
8. care should be taken when positioning the receive antenna to avoid cross-polarization. Antennas of known mounting polarization should be assessed with the receive antenna oriented in the same polarity. If the polarization of the transmit antenna is unknown or the transmit antenna can be mounted in either polarization, e.i.r.p. measurements should be performed to find which mounting polarity provides the highest e.i.r.p. value. Testing shall be carried out with the receive antenna and the EUT mounted in each polarity.
9. the emission shall be centred on the display of the spectrum analyzer with the following settings:
    a. if the power spectral density of the EUT was assessed with a peak detector and the antenna cannot be detached from the EUT, the spectrum analyzer shall be set to a peak detector with a resolution and video bandwidths of 1 MHz.
    b. if the power spectral density of the EUT was assessed using a sample detector with power averaging and the antenna cannot be detached from the EUT, the spectrum analyzer shall be set to a sample detector, configured to produce 100 power averages and set with a resolution bandwidth, as well as a video bandwidth of 1 MHz.

c. if the antenna can be detached from the EUT, a continuous wave (CW) signal equal to that of the power spectral density measurement may be used, the spectrum analyzer shall be set to peak detector with a resolution bandwidth and video bandwidth of 1 MHz.

10. rotate the turntable 360° recording the field strength at each step. Throughout the main beam of the antenna, the step size shall be kept to a maximum of 1°.

    Once outside the main beam of the antenna, the maximum step size shall be as follows, when compared to the requirements of section 7.3.2:

    a. between 0° and 8°, maximum step size of 2°;

    b. between 8° and 40°, maximum step size of 4°;

    c. between 40° and 45°, maximum step size of 1°;

    d. between 45° and 90°, maximum step size of 5°.

    Once the mask reaches 90°, the mask will be inverted and the step size will follow in the same manner as above.

    For the purpose of this procedure, the main beam of the antenna is defined as the 3 dB beamwidth.

11. convert the measured field strength values in terms of e.i.r.p. density (dBW/1 MHz) using the following equation:

$$\text{e.i.r.p. density (dBW/1 MHz)} = 10 \log\left(\frac{(E \cdot r)^2}{30} \right)$$

    E = field strength in V/m

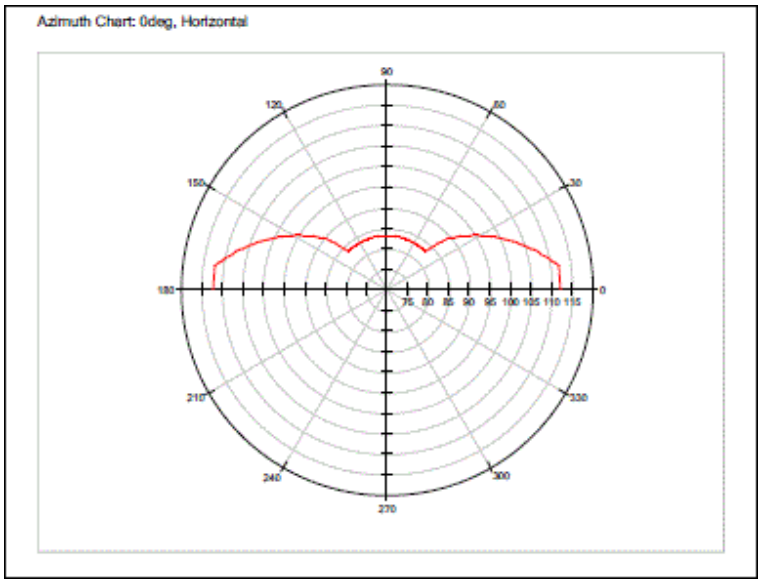
    r = measurement distance in metres

12. plot the results against the emission mask with reference to the horizontal plane.

13. Using the plot, the 0° can be rotated to determine the worst-case installation tilt angle.

14. Testing shall be performed using the highest gain antenna for every antenna type, if applicable.

The following figure is an example of a polar elevation mask measured using the Method 1 reference to dBµV/m at 3 m.



A3. Measurement method 2

This method can only be used if an accurate antenna pattern for elevation is provided by the manufacturer. The elevation plot must show sufficient attenuation to assess compliance with the elevation mask. The manufacturer's installation instructions must be consulted for any installation tilt recommendations.

1. use the value of the maximum conducted power spectral density measured under section 7.3.2 to change the values on the amplitude axis of the antenna pattern such that it reads in e.i.r.p. density:

   e.i.r.p. density = PSD_{MAX} + G

   where:

- e.i.r.p. density is the equivalent isotropically radiated power density in dBW/MHz
- PSD_{MAX} is the maximum conducted output power spectral density (expressed in dBW and based on a 1MHz measurement bandwidth);
- G is the antenna gain in dBi

If the antenna pattern provided by the manufacturer is normalized, also add the maximum gain value in dBi:

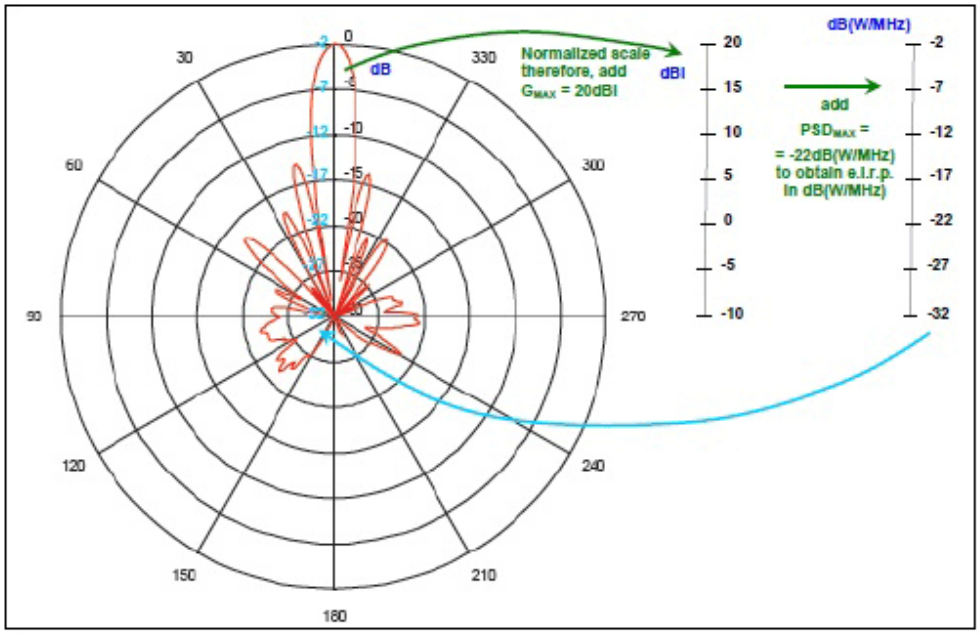
e.i.r.p. density = $PSD_{MAX} + G_{Norm} + G_{MAX}$

where:

- G_{Norm} is the normalized gain value, in dB (original amplitude axis of the antenna pattern)
- G_{MAX} is the maximum antenna gain value, in dBi

2. on the same polar plot, updated as per the above, draw the horizon mask according to the specification detailed in 7.3.2.4.
3. the 0° point can be rotated if required to make the EUT comply with the horizon mask. The tilt angle required to comply with the mask will represent the minimum installation tilt. This value should be inserted into the user manual to clearly identify the installation requirements to remain compliant with section 7.3.2.4 under post-installation conditions.

The following figure is an example of the application of this method:



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