

**Federal Communications Commission
Office of Engineering and Technology
Laboratory Division**

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RADAR DEVICES CERTIFYING UNDER THE PROVISIONS OF §15.255.

1. INTRODUCTION

On March 18, 2023, the Commission released a Report and Order (FCC 23-35, ET Docket No. 21-264) that amended the §15.255 rules to allow for non-fixed, short-range, millimeter-wave radar operations. Radar devices intended for operation in the 57-71 GHz (60 GHz) frequency band now have several options for FCC equipment authorization, each with corresponding technical requirements and limitations codified in §15.255.

One of the most significant changes brought about by the amended rules is the removal of the limitation on operation to fixed locations. This opens a world of possibilities for vehicular and other mobile applications, including limited usage in unmanned aircraft.

This publication is designed to provide manufacturers and users of radar devices with comprehensive, initial guidance on the information that should be included in Pre-Approval Guidance (PAG) inquiries to the FCC laboratory. It also outlines the recommended measurement procedures for obtaining the data necessary to demonstrate compliance with the applicable technical requirements for certification.

2. FREQUENCY RANGES OF OPERATION

The §15.255 rules permit unlicensed operation over the 57-71 GHz (60 GHz) frequency band, but the new radar certification opportunities created by the rules amendment primarily limit operation to the lower half of the frequency band (57-64 GHz) by further segmenting this lower half of the frequency band into 2.4 gigahertz, 4.56 gigahertz, and 7.0 gigahertz wide partitions, each with specific emission limits and technical requirements detailed below.

3. RADAR CERTIFICATION OPTIONS

With the new rule amendment, several options exist for certifying field disturbance sensors, including radars, for operating in the 60 GHz frequency band. Listed below are the various options. A tabular representation of certification options is provided in Annex A of this document.

- a. Any terrestrial radar transmitting in the 57-71 GHz frequency band can be certified under §15.255(c)(2) with a peak conducted output power limit of -10 dBm and a peak EIRP limit of 10 dBm.
- b. Any terrestrial radar transmitting within the 61.0-61.5 GHz ISM band segment, with a maximum EIRP output of 40 dBm (average) and 43 dBm (peak), can be certified under the §15.255(c)(2)(v) rules.
- c. Radars intended for operation onboard unmanned aircraft in the 60.0-64.0 GHz band segment can

364244 D01 Meas 15.255 Radars v01

be certified under §15.255(b)(3) with a peak EIRP limit of 20 dBm and a required off-time of at least 16.5 milliseconds within any contiguous 33.0 millisecond interval.

- d. Terrestrial, including vehicular (in-cabin) radar devices in the 57.0-59.4 GHz band segment, can be certified under §15.255(c)(2)(i), with peak EIRP limits of 20 dBm for indoor operation and 30 dBm for outdoor operation.
- e. All terrestrial radar within the 57.0-61.56 GHz band segment can be certified under §15.255(c)(2)(ii), with a peak EIRP limit of 3 dBm with no off-time requirement, or 20 dBm with a corresponding off-time requirement of 16.5 milliseconds within any 33.0-millisecond interval.
- f. Any terrestrial radar operating within the 57.0-64.0 GHz band segment can be certified under §15.255(c)(2)(iii)(A), with a peak EIRP limit of 14 dBm and a corresponding off-time requirement of 25.5 milliseconds within any 33.0-millisecond interval.
- g. Permanent or temporary fixed radar intended solely for outdoor or other than in-cabin vehicular applications can be certified under §15.255(c)(2)(iii)(B) with a peak EIRP limit of 20 dBm and a corresponding off-time requirement of 16.5 milliseconds within any contiguous 33.0 millisecond interval.
- h. Pulsed radar applications with a maximum pulse duration of 6 nanoseconds and transmitting within the 57-64 GHz band segment can be certified under §15.255(c)(3), with an average EIRP limit of 13 dBm, a peak EIRP limit of 33 dBm, and a transmit duty cycle limit of 10%; in addition, the average integrated EIRP within the 61.5-64.0 GHz band must not exceed 5 dBm in any 0.3-microsecond interval.

Note: Any discrete off-time periods of less than 2 milliseconds are not considered when determining the total off-time over any 33-millisecond interval.

4. PRE-APPROVAL GUIDANCE (PAG) REQUIREMENTS

Section §2.964 of the FCC rules specifies that Pre-Approval Guidance (PAG) procedures be applied when compliance review procedures have not fully matured. Since these equipment authorization procedures are still developing, and given the complexities associated with multiple certification options, applications for radar devices certifying under the 15.255 rules will be subject to a PAG¹ review.

The objective of the PAG review will be to validate that appropriate requirements are considered based on factors such as operational frequency range, peak output power levels, and signal periodicity. As such, PAG reviews can be processed quickly if all the relevant information is provided. The required information to be submitted for each of the certification options above is detailed in Annex B.

5. GENERAL MEASUREMENT CONSIDERATIONS

Several potential test-related matters must be considered when performing compliance measurements.

¹ See KDB Publication 388624 and attachment [388624 D02 Pre-Approval Guidance List](#) and PAG code RDR255

5.1. Test Configuration Considerations

Compliance measurements will likely require emissions to be measured radiated due to integrated antennas in the equipment under test (EUT). As such, the separation distance between both the transmit and receive (test) antennas shall be greater than or equal to the far-field distance.²

The ANSI C63.10-2020 standard, incorporated by reference in §15.38(e)(4) of the FCC rules, provides additional guidance concerning test setup considerations.

5.2. Test Instrumentation Considerations

Low-noise pre-amplifiers may be necessary to improve the measurement instrument's effective dynamic range to perform accurate radiated measurements.

Relative to the emission limit, adequate measurement instrumentation headroom shall exist to perform average power measurements, including caution to not overload or compress the pre-amplifier from potential emissions peak excursions.

When the measured fundamental frequency exceeds the measurement instrument's maximum frequency range, an RF upconverter or external harmonic mixer in the test measurement path will become necessary. In these unique test measurement scenarios, the upconverter bandwidth must be greater than the fundamental emission bandwidth. Observe caution when utilizing harmonic mixers, as harmonic mixers introduce undesired image frequencies. See FCC technical report TR 14-1001 for additional information regarding these test-associated considerations.

When using a spectrum analyzer to perform peak power measurements of pulsed radar emissions, a phenomenon known as pulse desensitization can occur, leading to inaccurate measurement results. A pulse desensitization factor must be included to adjust the measured signal amplitude. More information regarding pulse desensitization can be found in Clause 4.1.5.2.7 and Annex C of the C63.10-2020 standard and industry literature.

Similarly, when using a spectrum analyzer to perform peak power measurements of frequency-modulated continuous wave (FMCW) radar emissions, decreased sensitivity and resolution may require an FMCW correction factor to be applied to the measured value. Additional information regarding FMCW desensitization can be found in Clause 4.1.5.2.8 and Annex L of the C63.10-2020 standard.

Unless stated otherwise, the measurement device shall have its resolution bandwidth (RBW) set to 1 to 5% of the signal bandwidth. If it is impracticable due to high signal bandwidths, a minimum RBW of 1 MHz shall be used.

5.3. EUT Considerations

The operation of the EUT during compliance testing shall represent regular use of the equipment.

Compliance testing shall include the EUT's mode of operation that results in the highest transmitter activity (on time), consistent with the requirement to measure and report the highest transmitted power in any mode of operation.

² See ANSI C63.10-2020 section 9.1.4

For transmitters that utilize multiple modulation schemes, it may be necessary to independently test each modulation scheme to correctly demonstrate compliance with the rules.

For radar transmitters employing FMCW or other frequency-agile techniques, the requisite RF parameters shall be measured with the active frequency sweep, hop, or step function (i.e., §15.31(c) does not apply).

6. FUNDAMENTAL EMISSION BANDWIDTH MEASUREMENT

For pulsed transmitters, the fundamental emission bandwidth is defined at the -10 dB points specified in §15.255(C)(3).

For other than pulsed radar transmitters, the fundamental emission bandwidth is presumed to be “...*the width of a frequency band such that, below the lower and above the upper-frequency limits, the mean powers emitted are each equal to a specified percentage $\beta/2$ of the total mean power of a given emission. Unless otherwise specified in an ITU-R Recommendation for the appropriate class of emission, the value of $\beta/2$ should be taken as 0.5%,*” as defined in §2.1(c) of the FCC rules. This is also known as the 99% occupied bandwidth (OBW).

ANSI C63.10-2020 Clauses 9.3 and 9.4 provide standardized procedures recognized by the FCC for measuring the relative (-10 dB) bandwidth and the 99% OBW.

7. FUNDAMENTAL EMISSION MEASUREMENT

The majority of §15.255 output power limits are specified in terms of peak EIRP. Several factors must be considered when using a spectrum or signal analyzer to perform radiated power measurements to determine the peak EIRP.

Spectrum and signal analyzers typically do not have an available resolution bandwidth capable of fully capturing fundamental emissions with bandwidths on the order of several GHz; therefore, a 1-MHz RBW shall be used in conjunction with the peak hold function while sweeping in free run mode until the maximum amplitude has been captured.

There are at least two possible approaches for determining the peak EIRP using a spectrum or signal analyzer: 1) To directly measure the peak amplitude of the radiated power for use in determining the peak EIRP. 2) To measure the average (RMS) radiated power and include the transmission duty cycle to calculate the peak power. Each of these approaches has its unique considerations.

ANSI C63.10-2020 Clause 9 generally applies to testing of §15.255 devices, excluding Clause 9.9, where footnote 73 no longer applies to radar devices operating under the amended §15.255 rules (i.e., using an RF detector is no longer required).

8. UNWANTED EMISSIONS

Unwanted emission amplitudes shall be measured according to the procedures provided in Clauses 9.10 and 9.11 of ANSI C63.10-2020.

9. FREQUENCY STABILITY

§15.255(f) of the FCC rules specifies that the bandwidth of the fundamental emission must be contained within the authorized frequency band over a temperature range of -20 to +50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage.

According to §2.1055, frequency stability shall be measured at the highest and lowest operating frequencies and with the modulation that produces the widest emission bandwidth. The same methods shall be used for determining emission bandwidth as defined in section 6 of this document (i.e., -10 dB relative bandwidth or 99% OBW).

The frequency stability measurement procedures described in Clause 9.5 of C63.10-2020 shall be used to demonstrate compliance with the §§15.255(f) and 2.1(c) requirements.

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01/XX/2024: 364244 D01 Meas 15.255 Radars v01 is an Initial Publication

Annex A - 15.255 Applicable Technical Parameters

Table A-1. Industry Consensus Agreement

Mode	Frequency Range (GHz)	Use Cases	Power Limit (Peak EIRP)	Off-Time Requirement: off times (≥ 2 ms) must sum to at least X ms per 33 ms interval
Field disturbance sensors excluding outdoor drones /UA (<i>i.e.</i> , unmanned aircraft – see below)	57.0 - 59.4	All	20 dBm for indoor 30 for outdoor, including all vehicular applications	None
	57.0 - 61.56	All	3 dBm	None
	57.0 - 61.56	All	20 dBm	16.5 ms off time per 33 ms
	57.0 - 64.0	All	14 dBm	25.5 ms off time per 33 ms
	57.0 - 64.0	Fixed outdoor or vehicular uses (except in-cabin) ³	20 dBm	16.5 ms off time per 33 ms
Outdoor drones/UA	60 - 64	Drones/UA	20 dBm	16.5 ms off time per 33 ms

NOTES:

- Switching between frequency range requirements is allowed in successive 33 ms frames (for example, operation in the 57-61.56 GHz band under applicable parameters in the first 33 ms frame followed by operation in the 57-64 GHz band under applicable parameters in the second 33 ms frame, *etc.*).
- No separate duty cycle requirements are imposed on active 60 GHz transmitters beyond what is stated in the right-most column.
- Fixed operation includes temporarily or permanently fixed operations. Vehicular uses include operations where the device is installed within or on the exterior of a vehicle intended for outdoor use (such that any indoor use is incidental – for example, an automobile in a parking garage) but excludes all in-cabin applications or operations.

³ See §15.255(c)(2)(iii)(B)

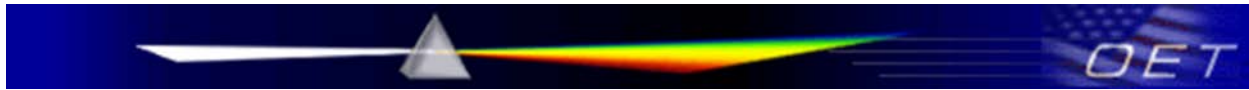


Table A-2. Pulse Radar Joint Agreement

Technical Parameter	Permissible Pulse Radar Operations
Operating frequency (high)	64 GHz
Operating frequency (low)	57 GHz
Duty cycle	10%, evaluated in any 0.3 μ s time window
Average EIRP	13 dBm, evaluated in any 0.3 μ s time window, and the average integrated EIRP within 61.5 to 64.0 GHz shall not exceed 5 dBm in any 0.3 μ s time window
Pulse duration	< 6 ns
Peak EIRP	Peak RF emissions must not exceed 20 dB greater than the maximum permitted average emission limit applicable to the equipment under test.

Annex B - PAG Checklist

The following list specifies the information the applicant must provide in a PAG inquiry to expedite the FCC review.

- a. Applicants for certification under §15.255(c)(2), in addition to a show of compliance to the specified limits, shall explain how conducted output power was determined and demonstrate compliance to the limits.
- b. Applicants for certification to operate in the 60.0-61.5 GHz ISM band under §15.255(c)(2)(v), in addition to showing compliance to the stated technical requirements, shall also demonstrate that the fundamental emission bandwidth is entirely contained within the band.
- c. For radar devices intended for operation in the 60-64 GHz band segment and for use onboard unmanned aircraft per §15.255(b)(3), in addition to a show of compliance to the output power limit, data showing that the fundamental emission bandwidth is contained within the designated band segment and time domain data demonstrating compliance to the off-time requirement shall be provided. Additionally, an explanation must be provided as to how the altitude restriction will be realized. Note that there is also a similar altitude restriction in the FAA rules at §107.51 within Title 14 of the Code of Federal Regulations (CFR).
- d. Applications for radar operation in the 57.0-59.4 GHz band segment under the §15.255(c)(2)(i) rule provision, in addition to showing compliance to the stated limits, shall also provide data demonstrating that the fundamental emission bandwidth is entirely contained within the designated band segment, and a statement as to whether usage will be limited to indoor or outdoor operations and how such limitations will be ensured.
- e. For radar devices intended to operate in the 57.0-61.56 GHz band segment under the provisions of §15.255(c)(2)(ii), in addition to a show of compliance to the applicable limits, provide data showing that the fundamental emission bandwidth is fully contained within the authorized band segment. Where appropriate ($3 \text{ dBm} < \text{EIRP} \leq 20 \text{ dBm}$), time domain data showing compliance to the off-time requirement shall be provided.
- f. Radar devices intended for operation over the 57.0-64.0 GHz band segment under the requirements of §15.255(c)(2)(iii), in addition to showing compliance with the applicable limits, shall also provide data demonstrating that the fundamental emission bandwidth is fully contained within the designated band segment and time domain data demonstrating that the stated off-time requirement is satisfied under all operational conditions.
- g. If the radar is to be certified for operation over the 57.0-64.0 GHz band segment under the auspices of §15.255(c)(2)(iii)(A), provide data showing that the fundamental emission bandwidth is wholly contained within the authorized band segment and time domain data demonstrating compliance to the associated off-time requirement, in addition of a show of compliance to the relevant limits.
- h. If the radar is to be certified for operation over the 57.0-64.0 GHz band segment under the §15.255(c)(2)(iii)(B) requirements, in addition to showing compliance to the stated limits, provide data showing that the fundamental emission bandwidth is wholly contained within the authorized band segment and time domain data demonstrating compliance to the associated off-time requirement. Where applicable, explain comprehensively how the “fixed” requirement will be satisfied and maintained or how the device will be limited to exterior vehicular applications.

- i. If certifying a pulsed radar for operation over the 57.0-64.0 GHz band under the §15.255(C)(3) rules requirements, in addition to showing compliance with the specified limits, show that the fundamental emission bandwidth is constrained to the designated band segment and provide time domain data showing the maximum pulse duration and the maximum duty cycle within any three- μ s time window.

If the radar device is to be certified under multiple rule parts, data shall be provided demonstrating compliance with the corresponding rule requirements. In addition, information shall be provided on how switching between modes is limited to 33-ms time increments.

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