



Unlicensed Devices General Technical Requirements - Overview

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**Joe Dichoso
Equipment Authorization Branch**

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Outline

- General Information
 - Web links
 - TCB exclusion list
 - General TCB review advice
- Specific Review Guidelines
 - Part 15 unintentional radiators.
 - Radar detectors
 - Scanning receivers
 - TV interface devices
 - Class B computer and peripherals
 - EAS, Emergency Alert Systems (Part 11)
 - Part 18 Consumer ISM devices.
 - Part 15 Intentional radiators



Web links

Telecommunications Certification Bodies (TCBs)

Electronic Filing Site

<https://gulfoss2.fcc.gov/oetwl/index.html>

<https://svartifoss2.fcc.gov/oetwl/index.html>

Contract Test Firms on File

<https://gulfoss2.fcc.gov/prod/oet/cf/eas/reports/TestFirmSearch.cfm>

<https://svartifoss2.fcc.gov/prod/oet/cf/eas/reports/TestFirmSearch.cfm>

Knowledge Database Site

www.fcc.gov/abhelp

Measurement Techniques

<http://www.fcc.gov/oet/ea/eameasurements.html>

OET site (Headlines and Releases) <http://www.fcc.gov/oet/>

Part 15 rules

<http://www.fcc.gov/oet/info/rules/>



TCB exclusion list

- **TCB's cannot approve the following devices**
 - Devices listed on the RF safety TCB exclusion list.
 - UWB devices
 - Access BPL (Part 15 Subpart G)
 - Learned mode transmitters (Part 15)
 - Software Defined Radios (all)
 - Certain types of Smart Antenna Systems (SAS). See SAS guidance.
 - UNII devices with DFS capability
 - Implanted transmitters
 - New Technologies
 - License devices
 - 3650 equipment in Part 90



General TCB review advice

- TCB's must ensure that the device is fully compliant and the filing is complete and consistent.
 - The filing must show that the device is compliant with all applicable rules.
 - *Use applicable test procedures (e.g. ANSI C63.4), guidelines, checklists, Public Notices and applicable rules.
 - *Look for frequent compliance issues.
 - The filing must be consistent throughout the filing.
 - *All information such as Output power, frequencies, operational description, specifications, device usage etc... in the filing must agree.
 - *No discrepancies in the filing between the Manual, EMC report, RF safety report, operational description, Grant condition, photo's, grant condition etc..



Specific review guidelines.

- Part 15 unintentional radiators.
 - Radar detectors
 - Scanning receivers
 - TV interface devices
 - Class B computer and peripherals
- EAS, Emergency Alert Systems (Part 11)
- Part 18 Consumer ISM devices.
- Part 15 transmitters



Scanning receivers

- Section 15.121
- Requirements (*Check current rules for details and any changes*)
- Tuning Range 30-824, 849-869, 894-960 MHz
- Equipment Class- **CSR**
- Incapable of operating in cellular frequencies
- Line conducted Section 15.107
- Radiated Section 15.109
- R&O: ET Docket 98-76 Released 3/31/99
- Image rejection : 38 dB minimum
- Label: warning against modifications to allow cellular reception
 1. Statement assessing the vulnerability of the scanning receiver to possible modifications and describing the design features that prevent modification of the scanning receiver to receive cellular transmissions
 2. Statement describing the design steps taken to make tuning, control and filtering circuitry inaccessible
 3. Test data and description of the procedure used to demonstrate 38 dB rejection ratio compliance
 4. Label with the required warning against modifications to allow cellular reception. (15.121(f))



Scanning receivers

- Frequent compliance issues
 - Must indicate the how tuning, control and filtering circuitry is inaccessible and if modification will render inoperable.
 - In lieu of testing per 15.31(m), We require testing at three frequencies for each local oscillator in lieu of testing per 15.31(m).
 - Also, test scanning receiver in scan mode.
 - Pursuant to Part 0.457(d)(1)(ii), portions of scanner application will not be made available for public inspection (held confidential)
Schematic diagram, block diagram, operational description, internal photos
*** Mark these exhibits confidential.



Part 15 Intentional Radiators

- General information on transmitters. General information on transmitters.
 - General Checklist
 - Modular approvals
 - EMC co-location policy
 - RFID policies
 - WLAN – WISP interpretations
- Miscellaneous transmitters.
 - Pulsed transmitters
 - Water Meter transmitters.
 - Implant transmitters
- Miscellaneous measurement info
 - Alternative peak measurements
 - Test procedure for radiated measurements at a band edge.
- Specific rule parts e.g.
 - Permissive Changes
 - 15.203, Antenna requirements
 - 15.204, external amplifiers and antenna modifications
 - 15.207, AC line conducted requirements
 - Subpart C transmitters DTS and FHSS filing guidelines
 - UPCS
 - UNII UNII filing guidelines
 - UWB
 - Access BPL



General Checklist for Low Power Transmitters subject to Certification. Page 1 of 5

- FCC Identifier:** _____
- Specific Rule Section applied for** _____ (e.g. Section 15.235)
- EUT description** _____
- Output power** _____
- Is output power consistent throughout filing?** _____
- Operating Frequencies:** _____
Center frequency of the lowest channel to the highest channel on grant.
- Confidential request per Section 0.459 ?** _____
- Composite device ?** _____
- Modular Approval ?** _____
- Class II permissive change statement ?** _____ Do the changes require a new application?



General Checklist for Low Power Transmitters subject to Certification. (Continued) Page 2 of 5

General Rule Requirements:

- Section 15.19: label requirements
- Section 15.27: special accessories (modifications approved by applicant?)
- Section 15.33: Frequency range of radiated measurements.
- Section 15.35: Measurement detector function and bandwidths.
- Section 15.202: Operating frequencies in US bands.
- Section 15.203: antenna connector requirement.
- Section 15.204: complete transmitter approved? Amplifier approval req.
- Section 15.205: restricted band requirements.
- Section 15.207: line conducted test.
- Section 15.209: general spurious emissions.
- Section 15.214: Cordless phone requirements only.
- Section 15.215: additional provisions, spurious less than fundamental? **20 dB within operating frequency band in the rule section applied for?**
- Check specific rule requirements in the Section of the rules applied for.**
 - a) fundamental limit
 - b) spurious limits
 - c) bandedge compliance
 - d) Operational restrictions or provisions
 - e) Other specific requirements(s)



General Checklist for Low Power Transmitters subject to Certification. (Continued) Page 3 of 5

Section 2.1033

- _____ A copy of the installation and operating instructions to be furnished the user. *User information?*
- _____ A brief description of the circuit functions of the device along with a statement describing how the device operates.
- _____ A block diagram showing the frequency of all oscillators in the device.
- _____ A schematic diagram.
- _____ Internal and external Photo's



General Checklist for Low Power Transmitters subject to Certification. (Continued) Page 4 of 5

General Test requirements noted.

- Section 15.31: measurement standards.
- Section 15.35: Peak measurements when Average limits are specified.
- Are all available ports filled?
- Bandwidth test, if appropriate, to ensure band edge compliance.
- Tested in three orthogonal planes when applicable.
- EUT antenna position adjusted to maximize emissions.
- User controls adjusted to maximize emissions.
- Input signals adjusted to maximize emissions.
- Test procedure accepted by the FCC? Identify _____
- Was the proper antenna used for testing? Note: For measurements below 30 MHz, a loop antenna must be used and rotated about its Horizontal and Vertical positions to maximize emissions?



General Checklist for Low Power Transmitters subject to Certification. (Continued) Page 5 of 5

General Interpretations:

- _____ Spurious emissions cannot be higher than the fundamental regardless if all emissions comply.
- _____ Regardless of output power or field strength, intentional radiators require Certification. Exceptions per 15.201
- _____ Does it connect to a computer or have any other functions? A composite device may require an additional authorization depending on the applicable requirements.
- _____ Portions of the fundamental may **not** be in the restricted band even if it complies with Section 15.209 (except for UWB devices). However, the center frequency may not be in the restricted band. The frequency stability must not bring the center frequency into the restricted band. The receiver input bandwidth frequencies must not include the restricted band.
- _____ Is the frequency greater than 9 kHz? We do not authorize transmitters below 9 kHz.
- _____ Is the return frequency of RF tags or similar devices in the restricted band?
- _____ **Check the additional specific interpretations for the type of device applied for.**



Modular approvals

- Modular intent is to allow manufacturers to build new devices with same transmitter in multiple hosts without the need for Re-Certification of the transmitter.
- Modular Approval Public Notice
- http://www.fcc.gov/Bureaus/Engineering_Technology/Public_Notices/2000/da001407.doc
 - Check that modular approval filings address all requirements.
- Modular approval must be requested to obtain modular approval.
 - Provide a cover letter requesting modular approval and addressing the following 9 requirements for modular approvals.
 - If module meets all 9 requirements, grant must state
“Modular approval”
- Limited modular approval. If any of the requirements cannot be met, limited modular approval can be approved to LIMIT approval in a specific way to meet the requirement(s).
 - e.g. If module does not have shielding, the limited modular approval, could be approved for a specific host/s to meet shielding requirement.
 - e.g. If the module is limited to laptops with specific antenna installation to meet RF safety requirement.
 - For Limited modular approvals, grant must state
“Limited modular approval”
 - Grant conditions and installation instructions should agree with LMA requirements.
 - e.g. Module must be installed in xyz laptops.



Modular policies

- A change from non-modular approval to modular approval requires a new FCC identifier.
- A change from modular approval to limited modular approval requires a new FCC identifier.

Modular review issues

- Remove all modular references on grant if approval is for a non-modular device.
- Watch out for undeclared and optional co-located transmitter. i.e. Bluetooth
- Do not lay antennas for cabled modules on wooden table.
- Licensed modular transmitters requirements are similar.



EMC Co-location Testing Policy

- Policy for EMC evaluation of co-located independent transmitters in a single enclosure (e.g. laptop, handheld). This does not apply to multi-radio systems with coordinated transmitters (e.g. beam forming systems, multi-sector radio systems).

- Simultaneous transmission data (radiated and antenna conducted) is required to be submitted only when the devices can transmit simultaneously and share a common antenna.

- The grantee is still responsible for compliance, even though we no longer require simultaneous transmission data to be submitted, (except for above exception).

- When a co-located, independent and non-coordinated transmitter is added, the evaluation of RF exposure conditions may still be required along with a filing of a Class II Permissive change request. However, **no additional EMC test data need to be submitted.**
 - The RF Exposure requirements are currently under review.



RFID General

- RFID Passive Tag Policy
 - A passive tag does not contain batteries and is not certified individually.
 - Only the tag reader needs to be tested. At this time, the current technology for passive tags is such that the emission levels from the passive tags are much lower than the allowed levels for the tag reader.
 - The fundamental passive tag emissions may not operate within a restricted band, just as the tag reader is prohibited from operating in a restricted band.
- Circularly polarized or Elliptically polarized antennas
 - When determining Antenna Gain for RF ID Systems Operating Under 15.247, use the highest linear vertical or horizontal gain to determine compliance with Section 15.247.
- Specific RF ID policies in 15.231, 15,245 and 15.247



WLAN – WISP interpretations

- Fixed Remote station can operate as a point to point system even if the base station operates as a point to multipoint system.
- Equivalent Antenna changes allowed without additional filings. See Section 15.204 antenna change policies.
- Adding additional amplifiers only allowed for 15.247 and 15.407 devices. Amplifier must be Certified with the transmitter per Section 15.204(d)1.
- All Sectorized systems are point to multipoint subject to 4 Watt EIRP limit except those systems that qualify as a Smart Antenna System(SAS). See SAS guidelines.
- For SAS system only, Prohibited Broadcasting does not include occasional broadcast management signals or non-permanent multi-casting See SAS guidelines.



Miscellaneous transmitters



Part 15 In ground Water Meter transceivers

- Allows testing in ground as opposed to an open area test site (OATS).
- Professional installation is required.
- Section 15. 249 requires Quasi-Peak Measurements in the 902-928 MHz band.
- Instructions must provide appropriate details for the installation of the transmitter in the pits and must specify the types of pits.
- Condition grant accordingly.
 - Professional installation and specific types of pits.
- Tests
 - Use mast. Do not use a tripod with fixed height.
 - Section 8.1 in ANSI C63.4 should be consulted. Frequency scans of the EUT field strength with both polarities of the measuring antenna shall be made at a minimum of 16 azimuth angles (nominally 22.5 degrees) around the EUT.



Implant transmitters

- TCB's cannot approve implant transmitters
- For EAB filings
 - use "IT" note code.
 - Account for RF safety requirements.
 - Test on OATS test table or in appropriate Part-95-like in-liquid phantom.



Miscellaneous measurement info



RADIATED MEASUREMENTS AT A BANDEDGE

● See Marker Delta Method in appendix at [http://www.fcc.gov/Bureaus/Engineering_Technology/Public Notices/2000/da000705.txt](http://www.fcc.gov/Bureaus/Engineering_Technology/Public_Notices/2000/da000705.txt)



Specific Rule Sections



2.1043

Permissive Change polices

- Adding additional frequencies to an approved device. Submit new test report on new frequencies!
 - OEM Changes
 - Additional frequencies allowed by Class II if...
 - No Hardware changes
 - No increase in output power rating on new frequencies
 - Equipment Code remains the same.
 - » *Changes that require new Equipment code requires new ID except for SDR approvals.*
 - RF safety changes do not require new ID
 - End user Changes
 - Software only changes to add frequencies requires SDR approval
- Non-modular to modular change requires new ID. Modular change to LMA requires new ID.
- Output Power rating change requires new ID.
- TX Chip changes allowed with Class II
 - pin for pin compatible. Same basic function from external perspective. No change in radio parameters.
- Only small changes to enclosure allowed. Otherwise, new ID is required.
- A change that results in a Non-electrically equivalent device, requires new ID.
 - E.g. Adding or subtracting an on board amplifier component requires new ID.

***RF safety changes and changes per Section 2.1043 also need to be considered.



15.202

- Client devices in ad hoc mode must be limited to USA frequencies. Therefore, passive listening of client devices in ad hoc mode on non-USA frequencies is not allowed.
- Active listening (beacon transmissions) on non-USA frequencies is not permissible
- **Question 1:** Is it permissible to control country-of-origin setting of master/client devices with the use of a key "switch" that is shipped with the product to the specific country? The frequency of operation is limited by encrypted key "switch" software.
 - **Reply 1: No,** The key "switch" encryption method is not strong enough to acceptably prevent transmission on non authorized US frequency bands.
- Reduction in channels; PC I or PC II, Tests required to verify PC type. No change in output power and software change only.
- Increase in frequency range. For Non SDR device, PC II allowed to extend range only by software. Hardware change requires new FCC identifier. Submit tests for new frequency range.



15.203

- Motion to stay RF connector Public Notice on Antenna connector extended indefinitely http://www.fcc.gov/Bureaus/Engineering_Technology/Public_Notices/2000/da002225.txt
Petition for reconsideration pending. See Ray Laforge at RLaforge@fcc.gov

“...MMCX, MCX, and reverse polarity SMA, reverse polarity BNC and reverse polarity TNC type antenna connectors...”

- Until petition is worked on, **these connectors are acceptable.**

- We have in the past, allowed the following to show compliance with Section 15.203.
 - 1) Use of permanent, industrial epoxy, loctite or solder to make the connection permanent prior to shipping.
 - 2) Allowed the use of standard connectors if the transmitter has a sensing circuitry that disables the transmitter if an unauthorized antenna is used. An application should detail how this is accomplished.
 - 3) The use of a standard connector is also allowed if the connector is within the transmitter enclosure and can only be accessed by disassembly of the transmitter that is not normally required. Check the manual to ensure that the user has no access to the connector.
 - 4) BIOS lock. Radio card and laptop exchange code to ensure only authorized system works in laptop.
- **Professional installation.** Must be justified and grant condition must state **“This device must be professionally installed.”**



Professional installation justification

The applicant should confirm the following when justifying Professional installation:

Professional installation

To qualify for professional installation, you must explain why the hardware cannot simply be purchased and installed by the average (technically inclined) person

1) Marketing

* The device cannot be sold retail, to the general public or by mail order. It must be sold to dealers.

2) Requires professional installation;

- installation must be controlled.
- installed by licensed professionals (EUT sold to dealer who hire installers)
- installation requires special training. (special programming, access to keypad, field strength measurements made) What is unique, sophisticated, complex, or specialized about your equipment which REQUIRES it to be installed by a professional installer?

3) Application

-The intended use is generally not for the general public. It is generally for industry/commercial use.



15.204

- Do Not authorize a Part 15 standalone amplifier
- Do Not authorize a Part 15 amplifier and antenna device (aka active antenna).
- Authorize only complete transmitter systems.
- Device must be marketed as a system to end user.

Exceptions.

-Standalone amplifier is certified with system per Section 15.204(d)

-Device may be OEM installed but device must be complete system to end user.

Grant condition: **OEM installation only.**

User manual must not have user installation instructions.

- BIOS lock. Radio and antenna sold separately. Radio card and laptop exchange code to ensure only authorized system works in laptop.

Grant condition: "**This device must utilize a BIOS lock mechanism which ensures use only with hosts as specified in the Certification filing.**"

*** Do not grant user installable plug-in mini PCI radio cards that operate with antennas built in laptop and can be used in any laptop computer with mini PCI plug in slot.



15.204 Antenna Changes

- Filing includes antenna list and photos.
 - Antenna type(s), gain, model no.& manufacturer
- Additional Equivalent antennas can be substituted then marketed and used by anyone without a filing.*
 - *Exceptions Must comply with 2.1043
 - UWB devices. Emissions from UWB devices highly dependent on specific antenna.
 - UNII with DFS. Testing IS required with lowest gain antenna.
 - Millimeter wave devices with Radiated Power Spectral Density requirements.
 - Certain Portable devices due to RF safety concerns. See RF safety policy.
- Any new antenna type or higher gain antenna must be filed by the grantee with a Class II permissive change.
- Additional Equivalent antennas must be of the same type (e.g. yagi, dish) and are of equal or less gain than an antenna in the filing.
- Equivalent antennas have similar in band and out of band characteristics.
 - Consult specification sheet for cutoff frequencies.
- 15.203 must be met. End user /operator can substitute standard connector but can no longer market device.



15.205

- Regardless of the levels, a device may not operate in a restricted band.
- For 2.4 GHz 802.11b/g WLAN devices, operating in the 2400 - 2483.5 MHz frequency band the following channel plan is generally used.
 - Channel 1 : 2412 MHz
 - Channel 2 : 2417 MHz
 - Channel 3 : 2422 MHz
 - Channel 4 : 2427 MHz
 - Channel 5 : 2432 MHz
 - Channel 6 : 2437 MHz
 - Channel 7 : 2442 MHz
 - Channel 8 : 2447 MHz
 - Channel 9 : 2452 MHz
 - Channel 10 : 2457 MHz
 - Channel 11 : 2462 MHz
 - Channel 12 : 2467 MHz
 - Channel 13 : 2472 MHz
 - Channel 14 : 2484 MHz
- Operation on channel 14 is not allowed.
- Operation on the channels near the restricted band but within the allowed frequencies is possible only if it meets all of the requirements.
 - Restricted band field strength limits have to be met. The antenna must be taken into account. For devices with low output power, these channels may be compliant with a low gain antenna but non-compliant with a higher gain antenna.
 - Section 15.215(c) which requires that the 20 dB bandwidth of the emission to be within the 2400-2483.5 MHz band for this device.
 - Check all modulations and data rates.



15.207

- AC line conducted test requirement for transmitters.
- Not applicable for Battery operated devices.
- For transmitters that use AC to DC power adapters that are not supplied by the grantee, compliance must be shown with an unmodified “off the shelf” AC to DC power adapter.



15.209

- **Section 15.209** General section (Does not prohibit certain devices or modulation types)
-
- **Operating frequencies:** Transmitters in 15.209 can operate on any frequency except restricted bands in 15.205 and in frequencies listed in 15.209(a). 54-72 MHz, 76-88MHz, 174-216 MHz or 470-806 MHz.
- **Requirements:** ::(Check current rules for details and any changes)
- **Fundamental:** Must be below radiated limits 15.209(a).
- **Spurious emissions:** Must be below level of fundamental.

- **Check list:** Use the General Checklist with the following frequent compliance issues.
 - Confirm the level of the fundamental and compare to spurious levels.
 - Check to see if a Loop antenna was used for testing? Rod antennas are not permitted.
 - levels in table listed in 15.209(a) is Quasi-peak except for emissions in the bands 9-90kHz, 110-490kHz and above 1000 MHz. Limits in these three bands are Average.
 - 15.209(g) perimeter protection may only operate under 15.209 in the bands 54-72 MHz and 76-88 Mhz. Limited to industrial, business and commercial applications.



15.211 Tunnel Radio Systems

- Verified
- Do Not Certify devices in this Section.



15.215 Additional provisions

- Unwanted emissions may not be higher than fundamental emission.
- 20 dB bandwidth must be within operating frequency bands listed in Sections 15.217-15.257 and Subpart E.
 - Check for compliance with this requirements especially in narrow operating bands or when operating frequency is close to bandedge.



15.231 Frequent issues

- **Check list:** Use the General Checklist with the following frequent compliance issues.
 - A device must operate under the rules in 15.231(a-d) and/or 15.231(e). Do not mix requirements in one with the other.
 - Check for Peak measurement data when applicable.
 - Check for the correct spurious limits. Limit is based on the fundamental frequency not the emission frequency.
 - Continuous transmissions during non safety of life conditions are not permitted.
 - e.g. Asset protection is not considered a Safety of life Condition
 - Toggle switches that lock the button in the “on” position and causes transmission greater than 5 seconds is prohibited. Common in Crane controllers.
 - Data transmission prohibited. Transmission of temperature, pressure and elapsed time are considered data and are not allowed.
 - Toys are prohibited.



Public Notice on Trainable Garage door openers.

Public Notice on Trainable Garage door openers.

http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-02-2850A1.pdf

Requires Certain information to be submitted.

- Effective December 3, 2002, all applications for certification of "Learned Mode" or "Trainable" transmitters must be submitted to the FCC Laboratory for processing. These devices are defined in the October 28, 2002, Public Notice DA 02-2850, found at www.fcc.gov/oet/info. If a TCB is presently processing an application for such a device, the TCB should contact Ray LaForge at rlaforge@fcc.gov, at the FCC Laboratory for guidance. **TCBs will be notified when they may process these applications.**



15.247

Spread spectrum devices

- Test for DTS and FHSS at <http://www.fcc.gov/oet/ea/eameasurements.html>
- DTS (Digital Transmission Systems) rules replace DSS (Direct Sequence Spread spectrum)
 - Processing gain requirement eliminated.
 - Equipment Class "DTS" do not use "DSS"
 - See rules and use additional separate document for DTS guideline
 - Use Smart Antenna System (SAS) guidelines as appropriate
 - Spread spectrum system defined in 2.1 is also allowed as a DTS
- Frequency Hopping Spread Spectrum devices.
 - New rules in 2.4 GHz band offer minimum of 15 channels at 125 mW.
 - Equipment Class is "DSS"
 - Use rules and Public Notice on frequency hoppers as guideline
- Frequent issues
 - Output power.
 - Use procedure in Public notice or use alternative output power
 - Discrepancies between EMC and RF safety reports.
 - List the center frequency of the lowest channel to the center frequency of the highest channel for each band.
 - Restricted band 2483.5-2500 MHz compliance
 - Do not approve Tag readers that use only CW signal or have wide receiver input bandwidth and does not hop in synchronization with tx.
 - Show compliance with Frequency hopping operational requirements in 15.247(a)1 and 15.247(g) and 15.247(h).
 - Test all modulation capabilities
 - E.g. 802.11b and 802.1g modes must be tested.



DTS filing guidance 1 of 5

- Direct Transmission Systems Systems- 15.247
- **15.247(a):**
- ___ Does the EUT meet the definition of a Digital Transmission System, based on the technical description of the EUT?
Digital modulation is required see Section 15.403(b) *
* Spread spectrum system defined in 2.1 is also still allowed.
- **15.247(a)(2):**
- ___ Were acceptable test procedures and instrument settings used to measure the 6 dB bandwidth?
- ___ Does the measured 6 dB bandwidth comply with the minimum 500 kHz requirement?
- **15.247(b):**
- ___ Were acceptable test procedures and instrument settings used to measure the peak output power?
A peak power meter is the preferred measuring instrument. If an analyzer is used, be sure the RBW is greater than the 6 dB bandwidth.
*Alternative to peak measurement allowed. See DTS test procedure.
- **15.247(b)(3):**
- ___ Does the measured peak output power comply with the appropriate limit?
Look for consistency throughout the test report, user's manual, and technical descriptions, wrt the various measured and/or stated output power levels.



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- **15.247(b)(4):**
- _____ Does the measured peak output power, in conjunction with the stated antenna gain, comply with the *de facto* +36 dBm EIRP limit for all proposed antennas?
- **Note that the output power limit is reduced in order to comply with the *de facto* EIRP limit. If the measured output power is already below the limit, a reduction may not be necessary.**
- **If compliance with the EIRP limit is achieved for various antennas by adjusting the output power at the time of installation, then professional installation of this transmitter is required. The installation manual must contain adequate instructions such that the correct output power can be chosen for any antenna being used.**
- **15.247(c):**
- _____ Is the appropriate *de facto* EIRP limit met for fixed, point-to-point operation in the 2.4 GHz band for all proposed antennas? [RF conducted peak output power limit = 30 dBm - ((Gain - 6dBi)/3), dropping all fractions.]
- **Note that the output power limit is reduced in order to comply with the *de facto* EIRP limit. If the measured output power is already below the limit, a reduction may not be necessary.**
- **Again, if compliance with the EIRP limit is achieved for various antennas by adjusting the output power at the time of installation, then professional installation of this transmitter is required. The installation manual must contain adequate instructions such that the correct output power can be chosen for any antenna being used.**
- *****No reduction in output power for point to point operation at 5.8 GHz band**
- *****900 MHz band limited to 4 Watt(36 dBm) EIRP.**
- _____ **For Smart Antenna System, Use SAS guidelines.**



DTS filing guidance 3 of 5

- **15.247(c):**
- ___ Does the proposed point-to-point system meet the appropriate requirements, and do the installation instructions contain the correct language?
- **Understand the intent behind allowing the EIRP relaxation for point-to-point applications only.**
- **When multiple antennas are listed in the installation manual, those that may only be used in point-to-point applications should be clearly indicated.**
- ___ Are the appropriate installation/user's manual language for point to point systems included?
- ___ Does the device comply with the RF safety requirements? Is the device on the TCB exclusion list?
- ___ Single Sector systems are Point to multipoint systems!
- **15.247(d):**
- ___ Were acceptable test procedures and instrument settings used for both spurious radiated and RF conducted measurements?
- ___ Do the measured spurious RF conducted emission levels comply with the 20 dBc limit, both at the bandedges, and for all other spurious emissions through the 10th harmonic, or 40 GHz (whichever is lower)?
- **RBW may be reduced at the bandedges.**
- **Devices that utilize a permanently attached antenna must demonstrate compliance with the 20 dBc requirement based wholly on radiated measurement results. For radiated emissions not located in a restricted band, a peak detector and a RBW of 100 kHz may be used, and compared to the radiated level of the fundamental, as measured with a peak detector and a RBW of 100 kHz.**



DTS filing guidance 4 of 5

- Do the measured spurious radiated emission average levels comply with the Section 15.209 limit, for all radiated emissions in restricted bands, as defined in Section 15.205, through the 10th harmonic, or 40 GHz (whichever is lower)?
- A duty cycle correction factor, as defined in Section 15.35(c), may be applied to a measurement made with an average detector, or its equivalent, to further reduce the value.
- Measurements may be performed on the highest gain antenna of each “type”. In other words, if multiple yagi, patch, and dish antennas are proposed, only the highest gain yagi, patch, and dish must be tested.
- Measurements should also be made on the lowest gain antenna, so that the EUT is operating at its highest available output power, in order to test for case radiation.
- Do the measured spurious radiated emission peak levels comply with the Section 15.35(b) limit, for all radiated emissions in restricted bands, as defined in Section 15.205, through the 10th harmonic, or 40 GHz (whichever is lower)?
- Unless the measured peak field strength levels comply with the average limit, then both peak and average data must be submitted.
- Look for consistency in reported peak and average measurements.
- Measurements may be performed on the highest gain antenna of each “type”. In other words, if multiple yagi, patch, and dish antennas are proposed, only the highest gain yagi, patch, and dish must be tested. Measurements should also be made with the EUT operating at its highest available output power, in order to test for case radiation.
- It is likely that compliance with the Section 15.209 field strength limit in the 2483.5-2500 MHz restricted band will determine the maximum output power allowable at the upper bandedge channel for each antenna. The installation manual must make this clear.



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- **15.247(e):**
- ___ Were acceptable test procedures and instrument settings used to measure peak power spectral density?
- **Make sure sweep is not too fast.**
- **EUT must be continuously transmitting.**
- ___ Does the measured peak power spectral density comply with the +8 dBm/3 kHz limit?
- 15.33, 15.35, 15.203, 15.204, 15.205, 15.207, and 15.214:
- ___ Does the direct sequence system comply with these Sections?
- **15.101(a):**
- ___ If the EUT also meets the definition of a personal computer peripheral, then that portion of the EUT must also be authorized, through Verification (if Class A), Certification, or DoC. If Class A use is proposed, then a justification for this rating must be provided. Was this done?



Smart Antenna Systems (SAS) guidelines 1 of 18

- Use as a guideline for multiple antenna/beam systems.
- Use Note Code SA: Smart antenna system that uses beam steering or beam forming capabilities to form multiple beams.
 - This Note Code was developed to track smart antenna systems operating under the new spread spectrum rules in Section 15.247 and complying with Sections 15.249(c)(2)(i) to (iv). However, the Note Code can also be used for any device that operates in any other rule part as long as the device uses beam forming/steering or can form multiple beams.
- Smart antenna test guidelines in development.
 - Do not use combiner for output power measurements.
 - Make measurements at each antenna port and add up power from all ports
- SAS policies
 - Prohibited Broadcasting does not include occasional broadcast management signals or non-permanent multi-casting.

Loot at technology/operation of the device rather than marketing
Ensure consistency between approval and user manual.



Smart Antenna System (SAS) Guidelines 2 of 18

- TCB's can only approve these specific systems.
 - FCC approves all others.
 - 1) Phased array systems
 - 2) Sectorized systems
 - 3) Spatial Multiplexing "MIMO*" systems with or without cyclic delay diversity.
- Check the operational description to ensure that the device is one of the above systems. Do not rely on marketing literature alone.
 - Only Spatial Multiplexing "MIMO" systems or Phased array "MIMO" can be approved.
 - TCB's cannot approve systems using a combination of the above. For example, TCB's cannot approve a Phased array Spatial Multiplexing "MIMO" system.
- *It is noted that the term MIMO, an acronym for Multiple Input Multiple Output, has been used to describe some devices that employ phased array technology rather than spatial multiplexing technology. Such devices would fit into the phased array category used in this document.

Multiple antenna output antenna systems.



Smart Antenna System (SAS) Guidelines -Type of operation 3 of 18

- Because the type of operation determines the applicable requirements (e.g. output power), devices in Section 15.247 or 15.407 must be categorized as one of the following as described in the following pages.
 - Point to point system(P2P),
 - Point to multipoint(P2MP) system
 - Smart antenna system (SAS) under Section 15.247(c)2.

- Therefore, review the filing to ensure that the type of operation is correct.



Smart Antenna System (SAS) Guidelines -SAS System 4 of 18

- Section 15.247(c)2 Smart Antenna System (SAS) operation.
 - Operation at 2.4 GHz under 15.247(c)2.
 - More than two beams are formed.
 - Communication to multiple or mobile receivers allowed.
 - Different information is sent to different receivers.
 - Does not include occasional management/control signals or occasional multicasting.
 - Sectorized systems are allowed.
- If not SAS, then system is either P2P or P2MP
- Hoppers at 2.4 GHz can qualify as SAS system.



Smart Antenna System (SAS) Guidelines -P2P System 5 of 18

- Point to point (P2P) system. Communication from one fixed point to another fixed point.
 - Includes phased array systems communicating to one fixed receiver at a time.
 - Broadcasting is not allowed.
 - The point to point link should be achieved only by the intended recipient receiving the signal by way of the directional angle of the antenna modified for individual transmissions.
 - Does not include sectorized systems communicating to one receiver at a time except those that qualify as a SAS system.

Includes phased array systems communicating to one fixed receiver at a time. Broadcasting is not allowed and you transmit to each individual one at a time and the receivers are at known, fixed locations, then the system can be considered point to point and can be authorized. The point to point link should not be obtained through the use of an encoded address similar to tone encoding, but instead should be achieved only by the intended recipient receiving the signal by way of the directional angle of the antenna modified for individual transmissions. Per 15.204 the antenna system must be authorized with the transmitter

Does not include sectorized systems communicating to one receiver at a time except those that qualify as a SAS system.



Smart Antenna System (SAS) Guidelines -P2MP System 6 of 18

- Point to multipoint (P2MP) system.
Communication to multiple or mobile receivers.
 - Includes all Sectorized systems except those that qualify as a SAS systems.



Smart Antenna System (SAS) Guidelines -Determine Output power 7 of 18

- Output power limit is determined by....
 - Rule part applied
 - 15.247 or 15.407
 - Frequency band
 - Type operation
 - Point to point (P2P) system
 - Point to multipoint (P2MP) system
 - Smart Antenna (SAS) system
 - Operates under 15.247(c)2i-iv.
 - Directional gain



Smart Antenna System (SAS) Guidelines -Directional Gain Computation 8 of 18

- Phased array systems
 - Directional gain = gain of antenna element + $10 \log(\# \text{ of TX antenna elements})$
- Sectorized systems
 - Directional gain = gain of each antenna
- Spatial Multiplexing “MIMO” system
 - For any spatial multiplexing “MIMO” mode in which the elements are always driven incoherently at each frequency...
 - Directional gain = gain of each antenna
 - For all other modes that drive multiple antenna elements, including legacy modes for communicating with non-MIMO devices...
 - Directional gain = gain of antenna element + $10 \log(\# \text{ of TX antenna elements})$



Smart Antenna System (SAS) Guidelines -Output power 9 of 18

- Except for devices complying with Section 15.247(c)2i-iv, conducted output power refers to the total power within a given band.
 - The Spread Spectrum bands 902-928, 2400-2483.5 and 5725-5850 MHz and the UNII bands of 5150-5250 MHz, 5250-5350 MHz, 5470-5725 MHz, and 5725-5825 MHz are all considered separate bands—each subject to its own in-band power limit.
 - If a device can transmit simultaneously on the same or different channels within one of those bands, the power must be summed across channels within the band.
- Signal combiners should be avoided because it can produce anomalous results if the summed signals exhibit any correlation

For example, for a UNII multi-sectored access point transmitting simultaneously on more than one channel, the sum of all output powers must meet the output power limit (e.g. 1 watt).



Smart Antenna System (SAS) Guidelines -Output power measurement 10 of 18

- P2MP systems
 - For each band, Sum power measurements across all transmitter outputs for all simultaneous transmissions on all channels.

- P2P systems
 - Sum power across all transmitter outputs.
 - Only one transmitted beam allowed at a time.



Smart Antenna System (SAS) Guidelines -Output power measurement 11 of 18

- SAS systems operating under Section 15.247(c)2i-iv
 - Phased array system
 - Single beam power: Measure power to each antenna element during transmission in a single beam, then sum the power measurements across elements.
 - Aggregate power : As above, but measure during transmission in simultaneously transmitted beams.
 - Sectorized system
 - Single beam power: Measure power to antenna for each beam
 - Aggregate power: Sum power measurements across transmitter outputs for simultaneously transmitted beams.
 - Spatial multiplexing MIMO system
 - TCB's cannot approve this system as a SAS system.

Spatial multiplexing MIMO system

TCB's cannot approve this system as a SAS system.

SAS systems must form multiple beams.

A Spatial multiplexing MIMO system forming multiple beams would require a combination with a phased array or sectorized system.

These combo systems cannot be approved by a TCB.



Smart Antenna System (SAS) Guidelines -Output power 12 of 18

- Review the filing to ensure that the output power was properly measured and the output power limit was calculated properly based on the type of operation, rule part and directional gain of the antenna.



Smart Antenna System (SAS Guidelines -Power Spectral Density 13 of 18

- Aggregate PSD across transmitters in linear power units across each transmitter output.
- For transmitters operating simultaneously, the combined output must meet the requirement.
 - Check compliances on simultaneous transmitter outputs on the same frequency channels.

For conducted PSD tests, PSD should be aggregated across transmitters by summing spectra in linear power units.

For sectorized antenna devices, phased array devices, and Spatial Multiplexing MIMO devices, the requirement must be met individually on each transmitter output. In addition, all transmitter outputs that can operate simultaneously must be aggregated through a combiner, and the combined output must also meet the requirement. (The combiner test should be performed on all devices that have multiple simultaneous outputs, but is especially important for devices having simultaneous transmitter outputs on the same frequency channels.)



Smart Antenna System (SAS) Guidelines

-Conducted out of band emissions 14 of 18

- Each transmitter output must comply.
- For simultaneous transmitter outputs, the combined output must also meet the requirement.
 - Check compliance when on simultaneous outputs on different frequency channels

The requirement must be met individually on each transmitter output.

In addition, all transmitter outputs that can operate simultaneously must be aggregated through a combiner, and the combined output must also meet the requirement. (The combiner test should be performed on all devices that have multiple simultaneous outputs, but is especially important for devices having simultaneous transmitter outputs on different frequency channels.)



Smart Antenna System (SAS) Guidelines -Radiated emissions 15 of 18

- Single and multiple beam configurations (when applicable) must be considered.
- Multiple simultaneous Channels
 - Check compliance on same and different channels when applicable.
 - Bandedge edge and Restricted bands
- Antenna installation
 - Antenna spacing
 - Beam angle and azimuth (when applicable)
 - Measurements should be performed in a representative sampling of beam positions. For example, for a device with a single steerable beam, it is recommended that tests be performed with a three beam positions—one at each extreme steering angle and one near the middle of the steering range. In any case, ensure that the angle forming the maximum beam is tested.



Beam Overlap for SAS systems under Section 15.247(c)2i-iv 16 of 18

- A description of compliance with the maximum beam overlap requirement may be sufficient to show compliance.
- Description must specify...
 - 1) Beamwidth. Do 3 dB beamwidths overlap? If 3 dB beamwidths overlap, a measurement is required if the sum of the output power is greater than or equal to the single beam output power limit for the device.
 - 2) Antenna installation.
Describe direction and spacing.
 - 3) Beam angle and elevation when applicable.



Beam Overlap for SAS systems under Section 15.247(c)2i-iv 17 of 18

- **Radiated Beam Overlap measurement.** Applicable when 3 dB beams can overlap and non-compliance is possible (e.g. device operates within 3 dB of allowed max power on overlapped beams).
- **Beam Overlap defined.** At any point, at a distance "r" from the EUT, the sum of the power received from overlapping beams on the same or different channels must be less than or equal to the Maximum EIRP allowed for a single beam.
- **Measure the field strength E V/m for each beam at the point of overlap at distance "r".** For "n" number of beams.

$$\frac{((\text{Sum } 1 \text{ to } n; E_1 + E_2 + \dots + E_n) \times r)^2}{30} \leq \text{EIRP max Watts}$$

*Assumes Gaussian beam. For non-Gaussian beams, please contact the FCC.

- If EIRP max is exceeded, the power in each beam must be reduced to satisfy the equation. Else, device fails.



Smart Antenna System (SAS) Filing Guidelines -TCB Approval Notes 18 of 18

- Use Smart antenna Note code SA when applicable.
 - Note Code SA: Smart antenna system that uses beam steering or beam forming capabilities to form multiple beams.
- List the maximum single beam aggregate output power on the grant in the technical specification for each frequency band.
- Indicate whether the system is Phased array, Sectorized or Spatial Multiplexing “MIMO”.



FHSS

- Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Transmitters

<http://www.fcc.gov/oet/ea/eameasurements.html>



FHSS filing guidance 1 of 7

- **Frequency Hopping Spread Spectrum Systems- 15.247**
- **15.247(a):**
- ___ Does the EUT meet the definition of a frequency hopping spread spectrum system, based on the technical description of the EUT? (See Section 2.1)
- **15.247(a)(1):**
- ___ Is the frequency hopping channel separation at least 25 kHz, or the 20 dB bandwidth (see below) of the emission, based on either the technical description or on measured data?*
- **This applies to all channels used in a specific transmission event, not necessarily to all available channels.**
 - *Alternatively, 2.4 GHz FHSS systems have separation of 25 kHz or 2/3 of the 20 dB bandwidth. 125 mW power applies
- ___ Is the hopping sequence pseudorandom, based on the technical description? (See the definition of a Frequency Hopping System in Section 2.1)
- **Fixed channel increments are not allowed.**
- ___ Is each channel used equally on average, based on the technical description?
- **Beacon channels are permitted for isochronous systems only, not for asynchronous systems or dual-mode systems.**
- ___ Does the associated system receiver have a compliant input bandwidth, based on the measured 20 dB emission bandwidth? (See below)
- **The required equivalent input bandwidth may be realized in either hardware or software.**
- ___ Does the associated system receiver have the ability to hop in synchronization with the transmitter, based on the technical description?
- **Fast scanning between hops is permitted.**



Millimeter wave test procedure

- **MILLIMETER WAVE TEST PROCEDURES**
 - <http://www.fcc.gov/oet/ea/eameasurements.html>



UPCS Part 15, Subpart D

- Unlicensed Personal Communications Service Devices.
- Operating frequencies 1920-1930 MHz.
- Equipment Class
 - PUB Part 15 Unlicensed PCS Base Station
 - PUE Part 15 Unlicensed PCS portable Tx held to ear
 - PUF Part 24 Licensed Portable transmitter held to face
 - PUT Part 24 Licensed Portable Transmitter worn on body
- Scope:A3
- TCB approval possible. Use TCB exclusion list
- Use the latest test measurement procedure of ANSI C63.17. Obtain a copy of from IEEE. Stephen.Berger@IEEE.org



UPCS

- Section 15.307 UTAM affidavit.
 - Applicant certifies UTAM membership
 - WWW.UTAM.org
 - Phone no. 1-800-429-8826
 - Submit copy of Affidavit. Example on Next page
 - Changes to UTAM requirements on April 5, 2005
 - Nomadic devices allowed
 - Description of Automatic disabling mechanism for relocation not needed
 - UTAM labeling not required.
 - Effectively eliminated Sec. 15.311 & 15.307(c)-(g).



UPCS affidavit example

UTAM, Inc.

● SECTION 15.307(b) AFFIDAVIT

I, Michael Stima, Managing Director of UTAM, Inc., hereby swear and affirm that:

_____ is a participating member of UTAM, Inc. in good standing for purposes of Section 15.307(b) of the FCC rules.

Subscribed to and sworn this
___ day of _____, 200_

Michael Stima, Managing Director
UTAM, Inc.
1170 U.S. Hwy 22
P.O. Box 8126
Bridgewater, New Jersey 08807
Tel: (508) 526-3636



UNII devices Subpart E

- Use New UNII test procedure
 - http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-02-2138A1.pdf
- Equipment Class: NII
- Frequencies: 5.15-5.35, 5.47-5.725 and 5.725-8.825 GHz.
 - Dynamic Frequency Selection (DFS) for devices in the 5.25-5.35 GHz band and 5.47-5.725 GHz band.
 - Interim DFS Test procedure is in the Appendix of the Rules.
 - Transmit power control(TPC) 5.47-5.725 GHz band.
 - Only a statement that the device has TPC is required to be submitted in the filing. No test required.
- Frequent issues
 - 15.407 (c)-(g)
 - (c) automatic shutoff
 - (d) integral antenna.
 - NO LONGER REQUIRED!
 - (e) indoor use for 5.15-5.25 GHz
 - Use grant condition and manual statements.
 - (f) RF safety
 - (g) frequency stability



UNII devices

- Transition dates for UNII devices operating in the 5.25-5.35 GHz band have been extended by 1 year.
 - http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-05-43A1.doc
 - January 20, 2006; Initial Certifications must comply with DFS and TPC requirements
 - Permissive change filings on grandfathered equipment (devices filed prior to January 20, 2006) can be filed until January 20, 2007.
 - January 20, 2007; All devices imported and marketed must comply.
- DFS test procedure still pending.



R&O UNII devices (continued)

- Test procedure will be updated in the near future
 - Do not deviate from accepted procedure
 - Contact NTIA to participate in test procedure discussions.
 - CGlass@NTIA.doc.gov
 - NTIA provides software scripts and schematics needed to operate and build specific test equipment.
 - Complex test requires specialized equipment and software.
- Class II permissive change for existing equipment to add DFS capability.
 - Allowed only for software change implemented by OEM.
 - End user software change requires SDR approval.
 - Any hardware change requires NEW AUTHORIZATION



UWB Subpart F

- TCB cannot approve UWB devices at this time
- For test labs measuring an UWB for an EAS filing, an interpretation letter can be obtained at....
- <http://gulfoss2.fcc.gov/prod/oet/cf/kdb/forms/FTSSearchResultPage.cfm?id=20253&switch=P>



Subpart G Access Over Broadband Power lines (Access BPL)

- TCB cannot Certify at this time.
- Measurement guidelines can be found at
 - <http://www.fcc.gov/oeet/ea/eameasurements.html>
- Summary of rules
 - BPL devices are “carrier current systems” **[15.3(f)]**
 - Part 15 interference requirements
 - Must not cause harmful interference
 - Must accept interference from other devices
 - Emission limits
 - AC-Line Conducted limits **[15.107]**
 - Devices operating < 30 MHz: 1000 uV in 535 – 1705 MHz
 - Devices operating > 30 MHz: Same as digital device limits
 - » 150 kHz – 30 MHz
 - Radiated limits
 - < 30 MHz Intentional radiator limits **[15.209]**
 - » 1.705-30 MHz: 30 uV/m at 30 m)
 - > 30 MHz Unintentional radiator limits **[15.109]**
 - » 30-88 MHz: 90 uV/m at 10 m (Class A); 100 uV/m at 3 m (Class B); etc.
 - Field strength measurements are “in situ”
 - Minimum of 3 installations that are “representative of typical installation sites”



The end