Unlicensed Devices General Technical Requirements - Detailed Material

October 2005
TCB Workshop

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Office of Engineering Technology
Laboratory Division

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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://gullfoss2.fcc.gov/oetwl/index.html
https://svartifoss2.fcc.gov/oetwl/index.html

Contract Test Firms on File
https://gullfoss2.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/labhelp

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

Radar detectors

- RO&O ET Docket 01-278
  http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-02-211A1.pdf
- Equipment Class “CRD”
- Conducted Section 15.107
- Radiated Section 15.109(h)
- Frequent compliance issues.
  - Block diagram must have all applicable frequencies such as for the sweep generator frequency, IF frequency and local oscillator frequencies.
- The device must comply with the general radiated emissions limits of Section 15.109 of the Rules in the 11.7 to 12.2 GHz VSAT band. No radiated emissions tests need to be performed in other bands other than the specified 11.7 to 12.2 GHz.
- Test procedure at
  - http://www.fcc.gov/oet/ea/eameasurements.html

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.

Class B computer and peripherals

- Computers, laptops, printers, monitors….
  Use ANSI C63.4 Test procedure.

- Line conducted Section 15.107
- Radiated Section 15.109
- Equipment Class: JBC for computers, JBP for peripherals
  Provide radiated and conducted test data.
  - Check that the proper frequency range was investigated.
  - Frequent Compliance issues
    Test all ports on EUT
    Minimum Test configuration
    Check frequency range of radiated measurements per 15.33

TV interface devices

- VCR's, RF modulator, video game
- ANSI C63.4 procedure

  Equipment Class: HID
- Section 15.115
  - Output signal limits on audio and video signal as well as spurious emissions.
  - Transfer switch isolation test (if required)
  - Radiated and AC line conducted test
    - Line conducted Section 15.107
    - Radiated Section 15.109
- Frequent issues

  Check for 75 Ohm output HID because some spectrum analyzers are 50 Ohm systems. Take into account any losses due to 75/50 ohm converter.

  Internal photo's- Remove shielding on RF modulators.

EAS(Part 11)

- Emergency Alert Systems
- Subject to EAS protocol
- Test report. Compliance with Class A radiated and conducted limits.
- Equipment Class. “EAD”
- Very few filings.

Part 11 Encoder / Decoders

- Low power FM and TV stations must comply with Emergency broadcast system requirement.
- Need decoder unit.
- Depopulate previously approved encoder/decoder unit. Cannot sell under same identifier. Not electrically identical. When going for second identifier and decoder is the same, we'll accept copies of decoder test but need new spurious radiated emissions data.
- Turn off encoder through software. Can sell under the same identifier. Class II not required to update. Must notify FCC Lab to be listed by Enforcement Bureau.
- EAS system requires frequencies to be listed.
  - List AM/FM/TV frequencies as appropriate.
  - May change in the near future, if not already.

Part 18 Consumer ISM devices

- Consumer ISM devices are subject to DOC or Certification.*
  - RF lighting devices, Jewelry cleaners, Microwave oven's…
  - * Exception (Consumer Ultrasonic equipment <500 Watts, <90 kHz VERIFIED)
- Technical report requirements in 18.207
- Limits in Part 18 Subpart C, Technical standards are based on frequency of operation, type of device.
  - Unlimited radiated energy in ISM bands listed in 18.301.
- Compliance Information in Section 18.212
- Information to users in 18.213
  - Interference potential
  - Maintenance of system
  - Measures to correct interference
  - Advisory statement for RF lighting devices.
- AC line conducted limits in 18.307
  - Use "CE" or "O5" note code except for RF lighting devices.
- Encouraged to use MP-5.
- Frequent compliance issues
  - Missing compliance information and/or information to users.

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 Section15.209(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.

PC Motherboard with Integrated TX Module Policy 1 of 2

1. Approval must not allow undefined mixing of motherboards and radios. Authorization is only for the specific transmitter board/components layout and specific CPU motherboard layout within a filing.

2. Approve as composite system subject to certification for transmitter portion, and additional certification or DoC for motherboard portion as subassembly under 15.102.

3. Emissions testing is to be done both with enclosure open for motherboard portion, and enclosure closed for transmitter portion, therefore allowing alternate enclosures.

PC Motherboard with Integrated TX Module Policy 2 of 2

4. Radiated limits apply to specific device – i.e. motherboard has relaxed limits with enclosure open.

5. Filing should clearly account for at least 2.925(d) label visibility, 15.32 CPU requirements, 15.203 antenna connector, 15.204 sold-as-system.

6. To ensure RF exposure compliance, this approval procedure is limited for operations in mobile or fixed RF exposure conditions, i.e., desktop computer - not portable laptop, tablet, etc.

7. Motherboard/transmitter approvals shall be for use with connectored/cabled antennas only, with antennas external to enclosure, not printed-circuit antennas installed or embedded on the motherboard. Due to use of metal enclosures for PC's.

8. TCBs may approve specific motherboard/transmitter devices, per conditions described above.

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

RFID
15.231

- Operation of passive tags RF ID systems allowed in 15.231 as long as all requirements are met. Especially…
  - Deactivated within 5 seconds per event activation.
  - Data transmission under 15.231(e)
    - Ensure silent period and transmission duration is met under all circumstances.
  - Individual/Separate Transmissions can be categorized under 15.231(a)-(d) or 15.231(e)
    - No mixing of rules for transmission!

RFID
15.245

Question: We have a request to certify a 2.45GHz device under 15.245. The device communicates with tag transmitters which come into range. We think this is not a field disturbance sensor and is therefore excluded from this section by 15.245(a). Please confirm that RF communications capacity with another device is not allowed by field disturbance sensors unless specifically called out (for example in 15.253(a)).

Response: Data transfer is possible only with FDS systems using passive tags and only if the data transfer function is ancillary to the primary purpose of a FDS system which is the detection of the presence of people or objects.

RFID
15.247

Part 15.247 Frequency Hopping RFID Systems

- Compliance with the transmit and receive nominal bandwidth matching requirement in Section 15.247(a)1, is achieved by the tag reader, not the passive tag. The receive bandwidth in the reader must nominally match or can be less than either the modulated signal from the tag reader signal or the passive tag signal.
- The maximum 20dB bandwidth of the modulated signal from the tag reader is used to determine the Channel separation requirements for the tag reader. This considered when there is a minimum number of hop frequencies required.
- Under Section 15.247, a tag reader system can send CW signals as part of a half duplexed signal on each hop frequency. The half-duplexed signal consists of the modulated reader signal followed by the CW signal. The modulated signal sends data to and is received by the tag. The CW signal is used only to power the passive tag.
- A tag reading system that uses only an un-modulated CW signal cannot operate under Section 15.247 but may operate under another rule such as Section 15.249 because Section 15.249 does not have a modulation requirement.
- SEE ALSO RFID Q&A in Section 15.247

RFID
15.247

Determining Antenna Gain for RF ID Systems Operating Under 15.247

Question: How does the Commission determine the antenna gain for RF ID systems operating under Section 15.247 that employ both vertical and horizontal radiating elements?

Reply: Some RF ID systems transmit simultaneously on both a vertical and a horizontal antenna to improve the read rates for tags that have unpredictable orientations

.

For such systems the Commission will **use the highest linear vertical or horizontal gain to determine compliance with Section 15.247**. Thus, for example, an RF ID tag reader that employs a 6 dBi gain vertical antenna and a 6 dBi gain horizontal antenna will be treated as having a 6 dBi gain. An RF ID tag reader that employs a 9 dBi gain vertical antenna and a 6 dBi gain horizontal antenna will be treated as having 9 dBi gain.

Section 15.247 limits the conducted output power to 1 Watt. Therefore, for systems that employ a single transmitter to feed both the vertical and horizontal antenna, the total power may not exceed 1 Watt. Similarly, if separate transmitters are used to feed each antenna element, the aggregate conducted output power may not exceed 1 Watt. Note that Section 15.247 requires a reduction in conducted output power for antenna gains in excess of 6 dB for certain frequency bands.

We recognize that, from a technical standpoint, simultaneous transmissions on both vertical and horizontal radiating elements effectively yields a circularly or elliptically polarized antenna that will have higher gain than that of the individual vertical and horizontal antenna elements. However, it does not appear necessary or appropriate to treat such antennas as circularly or elliptically polarized for purposes of determining the compliance with Section 15.247. We note, for example, that the frequency bands covered by Section 15.247 typically do not employ circularly or elliptically polarized antennas and therefore would not "see" any increase in signal levels.

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 polices.
- 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

Pulsed transmitters

- Check PRF and pulse width of pulsed transmitters.

  Watch out for devices with very fast pulses < 1 mS. Use HP note 150- 2 for guidelines on pulse desensitivity.
  - Device May be categorized as UWB.
- For pulse modulated devices with a PRF less than 20 Hz(greater than 50 mS) when QP limits are specified, Peak detection is employed. We then compare the peak level to the QP limit. See section 15.35.
- For burst transmissions where the burst repetition rate is less than 20 Hz(greater than 50 mS) and the burst width is too short for the QP detector to fully respond, peak detection is employed and the peak level is compared to the QP limit.

  * May modify signal for continuous operation to make QP measurement. However, also supply PEAK measurement.
- Typical devices include those for…

  - meter readers where transmission of a singe transmission packet is sent in bursts(e.g. once every 5 seconds or once a day)

Pulsed transmitters

- **DUTY CYCLE CORRECTION FACTORS**
- Purpose - average detector measurements are dependent on the pulse width or pulse train characteristics and the measuring instrument specifications, so repeatability is almost impossible from test instrument to test instrument.
  - Basic formula (15.35(c))
  - Duty cycle = on time/100 milliseconds or period, whichever is less
  - On time = N1L1+N2L2+...+NN-1LN-1+NNLN
  - Where N1 is number of type 1 pulses, L1 is length of type 1 pulses, etc.
  - Restating the basic formula
  - Duty cycle = (N1L1+N2L2+...+NN-1LN-1+NNLN)/100 or T, whichever is less
  - Where T is the period of the pulse train

Pulsed transmitters

- EXAMPLE 1
- A transmitter sends a pulse once every 120 milliseconds. The pulse length is 4 milliseconds. What is the duty cycle?
- Answer 1
- Duty cycle = 4/100
- Duty cycle = .04 or 4 %.
- To correct the peak reading to the average value of an emission, you either multiply the percent duty cycle factor expressed in decimal form (.04) times the field strength value
- expressed in terms of microvolt/meter @ 3 meters.
- Suppose the peak reading is 1000 uV/m @ 3 meters. If you multiply 1000 times .04, you get 40 uV/m @ 3 meters as the average field strength.
- OR
- You take 20 times the log of (.04) to convert to the duty cycle correction factor to dB and add this value from the field strength when expressed in terms of dB above a microvolt/meter (dBuV/meter) @ 3 meters.
- The 1000 uV/m @ 3 meters level is equivalent to 60 dBuV/m @ 3 meters. 20 log (.04) equals -27.958 dB (approximately -28 dB). 60-28=32 dBuV/m @ 3 meters or 39.76 uV/m @ 3 m (approximately 40 uV/m @ 3 m).

Pulsed transmitters

- EXAMPLE 2
- A transmitter has the following pulse train plots. What is its duty cycle correction factor?
- Answer 2
- The first plot shows the period to be 34.557 milliseconds..
- The second plot shows the long pulses last 688.889 microseconds or.689 milliseconds.
- The third plot shows that the short pulses last .356 milliseconds.
- There are 10 long pulses and 6 short pulses on the third plot.
- According to the general formula given above
- Duty cycle = (N1L1+N2L2+...+NN-1LN-1+NNLN)/100 or T
- this reduces to
- Duty cycle = ((10)(.689)+(6)(.356))/34.6
- ((6.89)+(2.14))/34.6 = 9.03/34.6 = .260982659 = .26 or -11.7 dB

Pulsed transmitters

- EXAMPLE 3
- A transmitter uses a code that changes each time a pulse train transmission is initiated (The Commission calls these "rolling codes"). The duty factor ranges from 45 to 64 %. What duty cycle correction factor should they use?
- Answer 3
- Use the duty cycle correction factor that gives the lowest correction. A duty cycle of 45 % yields a correction factor of -6.9 dB (20 log .45 = -6.9 dB). A duty cycle of 64 % yields a correction factor of -3.8 dB 20 log .64 = -3.8 dB). Therefore, use the 64 % duty cycle correction factor. The test report should verify that the duty cycle factor does change with each transmission by showing several (not all) sample pulse trains.

Pulsed transmitters

- **RADIATED MEASURMENTS OF FUNDAMENTAL wide band carrier based pulsed systems that are <u>not</u> filed under the UWB rules.**
- Only spurious emissions are permitted in restricted band
- Main lobe must not be in restricted band.
- 20 dB of Main lobe must be within frequency band of authorization.
- How do you estimate the Main lobe width of a carrier pulsed on for 1 nanosecond?
  - Mainlobe is approximately = 2/pulse width Mainlobe= 2GHz for pulse width of 1 nanosecond.
  - Mainlobe must be measured due to effects of antenna and/or cable effecting signal.
- **UNMODULATED (CW) CARRIER**
- 1. With the pulsing stopped, the peak level of the fundamental emission is measured with a 1 MHz RBW and a VBW equal to, or greater than, the RBW. No pulse desensitization factor is added to this level.
- The average level of the fundamental emission is determined by subtracting the calculated duty cycle factor from the peak level measured above. No pulse desensitization factor is added to this level.
- **OTHERWISE,**
- 1. Hewlett Packard Application Note 150-2 (pulsed RF). Republished by Agilent.
- This training is not intended to replace a thorough understanding of the above application note. It is intended to give you a basic understanding of its applications regarding EMC measurements.
- Also, see PN http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-04-3946A1.doc

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
    - "IT" Implanted Transmitter
  - Account for RF safety requirements.
  - Test on OATS test table or in appropriate Part-95-like in-liquid phantom.

Miscellaneous measurement info

Alternative peak output power procedures.

Alternative peak output power procedures.

Channel bandwidth

Bandwidth power function for output power measurements(#1-8)

For Peak output power measurements when the analyzer RBW is not large enough as required, the analyzer band power function can be used.

(For UNII output power measurements where VBW averaging is allowed. See the UNII test procedure.)*

1) Set the RBW and VBW to the maximum available.

2) Set the band limits as appropriate for the power measurement. (e.g. 6dB, 20 dB or 26 dB bandwidth). Expand the band limits by about 0.5*RBW on each end.

3) Turn average off.

4) Set sweep to automatic.

5) Set the span just large enough to capture the emission.

6) Use a peak detector on max hold.

7) The analyzer should be in linear (rather than log) display mode.

8) Let the emission stabilize before making a final reading.

BW correction factor-

10 log (6dB BW of emission/ analyzer RBW) * Use largest available analyzer RBW.

RADIATED MEASUREMENTS AT A BANDEDGE

- **See Marker Delta Method in appendix at**
  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.

15.19 Labeling

- Check FCCID label for correct number.
- If the device is larger than the palm of your hand (e.g. mouse or remote control transmitter), the 2-part warning statement can go on the label with the FCCID. Provide justification.
- The label must be visible on the exterior of the product.
  - Do not attach the label inside a battery compartment.
    - OK for licensed cell phones.
  - Do not place label on battery door.
- If manual is only provided in other forms such as a disk or internet, the 2-Part warning statement may also go on disk or internet.

15.103

- Vehicular Battery Chargers (VBC) for Cellular Phones Exempted per Section 15.103(a).
  - Exempted per Section 15.103(a).
    - The VBC is not promoted for applications other than use within a vehicle. Section 15.103(a) exempts digital devices used exclusively in transportation vehicles
    - Classified as a digital device under Part 15 of our rules.
    - Subject only to our non-interference provisions (Sections 15.5 and 15.29).

15.103

- Comparison Noise Emitter (CNE) exempted under Section 15.103(c)
  - Comparison Noise Emitter (CNE) used to evaluate anechoic chambers and Open Area Test Sites (OATS is exempt from an Equipment Authorization under Section 15.103(c).
    - The CNE in question
      - broadband noise source
      - low power
      - permanently attached antenna
      - operates over the frequency range of 9 kHz to 2 GHz.
      - Used by a skilled technician
  - Other types of reference noise sources used in a shielded enclosures for immunity and similar types of testing, or a license must be obtained under Part 5 of the Rules.

15.202 Rule

Section 15.202 Certified operating frequency range

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Client devices that operate in a master/client network may be certified if they have the capability of operating outside permissible Part 15 frequency bands, provided they operate on only permissible Part15 frequencies under the control of the master device with which they communicate.

Master devices marketed within the United States must be limited to operation on permissible Part 15 frequencies.

Client devices that can also act as master devices must meet the requirements of a master device.

For the purposes of this section, a master device is defined as a device operating in a mode in which it has the capability to transmit without receiving an enabling signal. In this mode it is able to select a channel and initiate a network by sending enabling signals to other devices. A network always has at least one device operating in master mode. A client device is defined as a device operating in a mode in which the transmissions of the device are under control of the master. A device in client mode is not able to initiate a network.

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 theuse 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

- **ANTENNA REQUIREMENTS** (Section 15.203)
- Purpose - to prevent attaching any other antenna(s) (from the one(s) approved with the transmitter) to a Part 15 transmitter. All antennas must be listed in the filing.
- There are three ways to demonstrate compliance
- 1) Antenna permanently attached
  - Antenna soldered to a printed circuit board
  - Antenna permanently glued with epoxy to a standard connector
    1. Specify the type of adhesive to be use
    2. Confirm that the adhesive will be applied at the factory (prior to shipment)
- 2) Unique (non-standard) antenna connector
- Standard antenna connector - Any antenna connector found in an electronic parts catalogue is not unique and, therefore, prohibited by Section 15.203
- Examples of standard connectors that are prohibited
- BNC, TNC, N, SMA, SMX, and F type connectors.
- Unique antenna connectors
  - Standard connectors with a left-handed thread
  - Reverse polarity connectors (standard connectors in which the male pin has been inserted in what is normally the female end of the connector and vise-versa)
  - Standard connectors with non-standard thread gauge or physical dimensions
  - Screw-type connectors typically used by cordless phones
- 3) Professional installation.
- Justifying Professional installation does not justify that ANY antenna can be used with the tx.

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.

Professional installation

- Grant condition - In those situations where we agree that professional installation is "*required*", we condition the Grant accordingly (i.e., "**This device must be professionally installed**.").
- Professional installation examples
- Transmitters used for data and control signal transmissions located in oil fields
- Transmitters mounted on trains and train stations
- Pole-mounted transmitters used by utility companies
- Transmitters mounted on traffic signals for use by police and/or emergency vehicles.
- *** Section 15.203 Antenna requirement applies to all devices except
  - 15.211 – Tunnel radio systems
  - 15.213 – Cable locating equipment
  - 15.217 – 160 - 190 kHz transmitters
  - 15.219 – 510 – 1705 kHz transmitters
  - 15.221 – 525 – 1705 kHz transmitters
  - Perimeter protection systems and some field disturbance sensors requiring professional installation

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.

AC line conducted data for Part 15 Modules.

- Section 15.207(a) requires test data unless the device is battery powered.
- Battery powered examples.
  - The transmitter is powered by an on-board battery.
    - Transmitter has a battery connector/compartment.
  - The transmitter is only intended for battery powered applications and installed by OEM.
    - Device is conditioned only for battery powered applications and a limited module approval is issued.
    - Any new non-battery application requires a new authorization.
  - The transmitter is installed only in the manufacturers equipment that will be battery powered.
    - Device is conditioned accordingly and a limited module approval is issued.

CISPR AC Line Conducted Limits for All Transmitters

- The CISPR AC line conducted limits only apply to Part 15 and 18 devices.
  - Devices that operate under any other rule parts (e.g., 22, 24, 90, etc.) are not affected by this rule change.

- To update a Part 15 grant, a Class II permissive change filing is submitted showing compliance with the CISPR AC line conducted limits.
  - Applies to devices will continue to be marketed after July 11, 2005.
  - The conducted output power of the device does not change beyond the tolerance for this measurement (+/- 0.5 dB).

- The policies for filing Class II permissive changes are different for some Part 18 devices because Part 18 devices had no AC line conducted emissions limits before we adopted the CISPR limits.
  - Microwave ovens
    - http://gullfoss2.fcc.gov/prod/oet/cf/kdb/forms/FTSSearchResultPage.cfm?id=20040&switch=I
  - Contact the lab for other devices

Note codes “CE” or “O5”

- AC line conducted limits 15.207

  -The "CE" note was used all on devices that are tested and comply with the new requirements and are granted before July 11, 2004. After July 10 all new approvals must meet the new rules.

  - The "05" note was used on all devices that met the current line conducted regulations and not the new limits up until the time that all devices must meet the new rules.

  -An issue that comes up based on the way the rulemaking is worded is that the rulemaking uses the words "...must be authorized by ..." in the transition date sections. For TC applications this is correct but for EA applications it means that a device received on July 11, 2004 under the old rules would have to be granted by July 12, 2004. The proposed solution for this is to process EA applications based on the receipt date but TC applications must be granted by the transition date.

  -“CE" - This device has shown compliance with the conducted emissions limits in 15.107, 15.207, or 18.307 adopted under FCC 02-157 (ET Docket 98-80) and may be marketed after July 11, 2005 and is not affected by the 15.37(j) and 18.123 transition provisions.

  -"05" - The manufacture and importation of this device must cease on July 10, 2005.

AC line-conducted emissions measurements of Part 15 transmitters that operate < 30 MHz

- Section 13.1.3.1 of ANSI C63.4-2003 allows testing of Part 15 transmitters for AC line conducted emissions with a dummy load instead of the transmitter's antenna if the antenna is detachable. This section is for exploratory AC power line conducted emission measurements. A dummy load may also be used in Annex H, paragraph H1(b) of C63.4 (the step-by-step procedures) for AC power line conducted emissions from a Part 15 transmitter if the antenna is detachable.
- Although C63.4 is designed for Part 15 transmitters that operate above 30 MHz with a detachable antenna, we are willing to accept measurements on a 13.56 MHz transmitter done with a dummy load under the following conditions:

1) First, perform the AC line conducted tests with the antenna attached to make sure the device complies with the 15.207 limits outside the transmitter's fundamental emission band.
2) Second, retest with a dummy load to make sure the device complies with the 15.207 limits inside the transmitter's fundamental emission band. Only the fundamental TX emission band needs to be retested.

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.

15.213 Cable locating equipment

- Verified
- Do Not Certify devices in this Section.

15.214 Cordless Telephones

- Applies to all Cordless Telephones
- Must meet Cordless telephone definition in Section 15.3(j)

15.217

- **Section 15.217** General section (Does not prohibit certain devices or modulation types)
- **Operating frequencies**: 160-190 kHz
- **Requirements:** ::(*Check current rules for details and any changes)*
- Fundamental: Input power to the final RF stage limited to 1 watt
- Length of the transmission line, antenna and ground lead(if used) limited to 15 meters.
- Spurious emissions: 20 dB below the unmodulated carrier

- **Check list:** Use the General Checklist with the following frequent compliance issues.

  -Confirm the level of the unmodulated carrier and check the spurious limits.

  - Check to see if a Loop antenna was used for testing? Rod antennas are not permitted.

  -Confirm that the Loop antenna was rotated about the horizontal and vertical axis?

  -The proper Equipment Class is “DCD”

15.219

- **Section 15.219** General section
- **Operating frequencies**: 510 - 1705 kHz.
- **Requirements** ::(*Check current rules for details and any changes)*
- Fundamental: Input power to the final RF stage is limited to 100 mW.
- Length of the transmission line, antenna and ground lead(if used) limited to 3 meters.
- Spurious emissions: 20 dB below the unmodulated carrier.
- **Check list:** Use the General Checklist with the following frequent compliance issues.
  - Check to see if a Loop antenna was used for testing?
  - Rod antennas are not permitted.
  - Confirm that the Loop antenna was rotated about the horizontal and vertical axis?
  - Check for compliance of spurious emissions in the restricted bands.
  - The proper Equipment Class is “DCD”

15.221

- Operation in the band 525 kHz-1705 kHz
- Carrier current systems and transmitters employing leaky coaxial cables as the antenna.
- VERIFIED
- Do Not Certify devices in this Section.

15.223

- **Section 15.223** General section
- **Operating frequencies** 1.705 - 10 MHz.
- **Requirements**:(*Check current rules for details and any changes)*
- Fundamental: 100 uV/m at a distance of 30 meters. (average)
- When BW<10% Fc, Higher of 15 uV/m or BW(kHz)/ Fc(MHz)
- Spurious emissions: Section 15.209.
- **Check list:** Use the General Checklist with the following frequent compliance issues.
-

-Restricted band requirements

Fundamental can not be in a restricted band.

-Exception: Swept frequency field disturbance devices in the band 1.705-10 MHz that will be covered later.

- Check for compliance with the spurious emissions in restricted bands.
- Check for Peak measurement data
- Check to see if a Loop antenna was used for testing? Rod antennas are not permitted.
- Confirm that the Loop antenna was rotated about the horizontal and vertical axis?

Swept Frequency Anti-pilferage Device
Section 15.223

- **Section 15.223**
- **Operating frequencies** 1.705 - 10 MHz.
- **Requirements**::(*Check current rules for details and any changes)*
- (Fundamental: 100 uV/m at a distance of 30 meters. (average)
- Higher of 15 uV/m or BW(kHz)/ Fc(MHz) when BW<10% Fc
- *The total width of the swept signal is considered to determine the 6 dB bandwidth for calculating the field strength limit.*

  Spurious emissions: Section 15.209.
- ***There are two common systems. The carrier swept system and the carrier hopped system.***
- ***1) Carrier swept systems are allowed to sweep through restricted bands per Section 15.205(d)1.***
- *When applying 15.205(d)(1), swept frequency field disturbance sensors which sweep thru restricted bands, the 1% of the sweep time allowed to be spent in a restricted band should be applied to each restricted band separately. That is, do not add up the frequency range of every restricted band thru which the device sweeps for comparison to the device's sweep range.*
- ***2) Carrier hopped systems are NOT allowed to operate in restricted bands**. This system must avoid hopping on discrete frequencies in the restricted band.*

Section 15.223
Frequent compliance issues

- **Check list:** Use the General Checklist with the following frequent compliance issues.
  - Frequency sweep stopped for radiated measurements?
  - Restricted band requirements. What kind of system is it?
  - The proper Equipment Class "FAP"
  - Check to see if a Loop antenna was used for testing? Rod antennas are not permitted.
  - Confirm that the Loop antenna was rotated about the horizontal and vertical axis?
  - Quasi-peak measurements are made with the frequency stopped.
  - Check for peak measurement data.
- For average measurements, a duty cycle correction factor is NOT applied to carrier swept systems. However, a duty cycle correction factor IS applied for Carrier hopped systems as follows…

  **For carrier hopped systems that hop on discrete frequencies, you can apply the averaging described in 15.35. The averaging factor should be determined by measuring (with a 9 kHz measurement instrument RBW) how long the hopping signal actually spends on a frequency during any 100 ms time interval. If the device goes through its hop set and returns to the same frequency during the 100 ms measuring interval, then the total occupancy time on that frequency during the 100 ms interval should be used in calculating the duty cycle correction.*

  **Note that if the hopping frequencies are so close that more than one frequency falls within the 9 kHz measurement instrument bandwidth, then the above duty cycle measurement applies to the total time occupied by all frequencies falling within the 9 kHz bandwidth during the 100 ms time interval.*

15.225

- **Section 15.225:** General section
- **Operating frequencies**: 13.110 - 14.010 MHz
- **Requirements**:(*Check current rules for details and any changes)* Fundamental; Various levels depending on frequency.
- Spurious: Section 15.209.
- Frequency tolerance: ±0.01%
- **Check list:** Use the General Checklist with the following frequent compliance issues.

  - Bandedge compliance

  - Does a plot of the bandwidth show bandedge compliance?

  - Quasi peak measurement of the fundamental

  - Check to see if a Loop antenna was used for testing? Rod antennas are not permitted.

  -Confirm that the Loop antenna was rotated about the horizontal and vertical axis?

15.227

- **Section 15.227** General Section
  Operating frequencies: 26.96 - 27.28 MHz.
- **Requirements:**:(*Check current rules for details and any changes)*
- - Fundamental: 10,000 uV/m at 3 meters. (Average)
  -Spurious emissions: Section 15.209.
- **Check list:** Use the General Checklist with the following frequent compliance issues.
  - Bandedge compliance
  - Does a plot of the bandwidth show bandedge compliance?
  - Check for Peak measurement data.
  -Check to make sure Rod antennas were not used.

15.229

Section 15.229 General Section

- **Operating frequencies:** 40.66 - 40.70 MHz.
- **Requirements**:(*Check current rules for details and any changes)*
- Fundamental: 1000 uV/m at 3 meters. QP
  Perimeter protection alternative: 500 uV/m at 3 meters. Average
- Spurious: Section 15.209
- Frequency tolerance: ±0.01% of the operating frequency
- **Check list:** Use the General Checklist with the following frequent compliance issues.
-

- Bandedge compliance. Check the bandwidth plot to help determine compliance.
- Check for the proper measurement detector.
- Peak measurement data

15.231

- **Section 15.231** Periodic transmitters.
- **Operating frequencies:** 40.66 - 40.70 MHz and above 70 MHz.
- **Requirements:**:(*Check current rules for details and any changes)*
- Periodic operation except as specified in Section 15.231(e).
- Transmission of a control signal only.
- Toys are not permitted.
- Continuous transmission such as voice and, video not permitted.
- Data transmissions not permitted.
- Recognition codes for sensor identification allowed.
- 5 second transmission limitation.
- Manual transmission must deactivate 5 seconds after release.
- Automatic transmissions must cease 5 seconds after activation.
- Transmissions at regular predetermined intervals are not permitted. However,
- Polling or supervision transmissions to determine system integrity of transmitters used in security or safety applications are allowed if the periodic rate of transmission does not exceed one transmission of not more than one second duration per hour for each transmitter.
- *** Transmissions with a non-predetermined(random) delay time every few seconds are not allowed.
- Transmissions during emergencies involving fire, security, and safety of life, when activated to signal an alarm, may operate during the pendency of the alarm condition.
- Fundamental and spurious limits are listed in the table of Section 15.231(b). Average limit or alternatively Quasi peak
- Spurious limit is 20 dB below the fundamental limit.
- Bandwidth requirement
- Frequency tolerance requirement for devices in 40.66-40.70 MHz.

15.231 manual vs automatic activation clarification.

- Manual activation means that you, yourself, personally physically move an actual switch, lever, or whatever, the movement of which causes the transmitter to transmit.
- Automatic operation means that a sensor detects a change in something and causes the transmitter to activate as a result of that change without any intervention by some person.

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.**

Section 15.231(e)

- **Section 15.231(e)**
- Lower field strength and no operation limitation except for automatic transmission requirement.
- **Requirements**:(*Check current rules for details and any changes)*
- Automatic transmission limitation requirement: (The duration of each
- transmission shall not be greater than one second and the silent period between transmissions shall be at least 30 times the duration of the transmission but in no case less than 10 seconds)
- Fundamental limits are listed in the table.
- Spurious limit is 20 dB below the fundamental limit.
- **Check list:** Use the General Checklist with the following frequent compliance issues.

  - Automatic transmission limitation description missing or does not sufficiently indicate compliance. Check the duration of transmission.
  - Check for Peak measurement data.
  - Check for the correct spurious limits. Limit is based on the fundamental frequency not the emission frequency.
  - 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.

Cordless Phones
Section 15.233

- **Section 15.233**
- **Operating frequencies**: 43.71 - 44.49 MHz, 46.60 - 46.98 MHz, 48.75 - 49.51 MHz and 49.66 - 50.0 MHz.
- **Requirements**::(*Check current rules for details and any changes)*
- **Section 15.214** (provides additional requirements for cordless phones)
- Single application for both base and portable handset allowed.
- A separate application for registration under Part 68 of this Chapter is required.
- Privacy label
- Security code requirement. Provide a statement indicating how the device complies. Minimum # 256 Codes
- **Section 15.233**
- Restricted to Cordless phones
- Frequencies paired as listed in the Table except for Channels 1-15.
- *Exception*. The original 10 channels must pair with the frequencies shown in the rules.
- For phones on Channels 1-15, an automatic channel selection mechanism is required to prevent the establishment of a link on any occupied frequency. Provide a statement of compliance with this requirement.
- Information regarding interference to TV's and VCR's.
- **Fundamental**: 10,000 microvolts/meter at 3 meters. (average)
- Within 20 kHz of listed frequency.
- **Spurious**: Higher of Section 15.209 or 26 dB below the unmodulated carrier.
- Report all emissions exceeding 20 microvolts/meter at 3 meters
- Test with all external accessories.
- Frequency $\pm$0.01% of the operating frequency.

15.233 Cordless phones Frequent issues

- **Check list:** Use the General Checklist with the following frequent compliance issues.

  - Automatic channel selection mechanism. A description must clearly indicate how the phone will not establish a link on any of the new frequencies without first examining each frequency of intended use.

  - A flow diagram is helpful to explain link operation.

  - Both frequencies must be checked for interference before establishment of a link**.**

  - We require a test to show compliance with the automatic channel selection mechanism.

  - Repeaters are not allowed. They do not meet the definition of a cordless phone.

  -The proper Equipment Class is “ETS”

  “ETB” for an application of the Base unit only

  “ETR” for an application of the Remote unit only

15.235

- **Section 15.235** General Section except that Cordless phones are prohibited.

- **Operating frequencies**: 49.82 - 49.90 MHz.
- **Requirements**::(*Check current rules for details and any changes)*
- - Fundamental: 10,000 microvolts/meter at 3 meters. (Average)
  - Spurious: Section 15.209
  - Bandedge requirement within 10 kHz of band: Higher of Section 15.209 or 26dB below the level of the unmodulated carrier.
  - Cordless telephones are prohibited
- **Check list:** Use the General Checklist with the following frequent compliance issues.
  - Band edge Compliance. Check the Bandwidth plot to determine compliance.
  - Check for Peak measurement data.

Section 15.237 Auditory Assistance Devices

- Operating frequencies
  72.0-73.0, 74.6-74.8, 75.2-76.0 MHz
- Requirements:(*Check current rules for details and any changes)*
- 80 mV/m at 3m within 200 kHz band
  1.5 mV/m at 3m outside 200kHz band
  Limited to auditory assistance device per 15.3(a)
  Average detector
  Couple the general checklist with the following frequent compliance issues
  - Band-edge measurements
  - Peak measurement
  - Adjacent to restricted bands:73.0-74.6, 74.8-75.2 MHz
  - Use must fit definition in 15.3(a). Check manual for use and marketing discrepancies. Use grant condition to help restrict use.

15.239

- **Section 15.239** General section
- **Operating frequencies**: 88 - 108 MHz.
- **Requirements**::(*Check current rules for details and any changes)*
  Fundamental: 200 kHz wide and must be within 88-108 MHz.
- 250 microvolts/meter at 3 meters. (Average)
- Spurious: Section 15.209.
- **Check list:** Use the General Checklist with the following frequent compliance issues.

  - Check for a Bandwidth test with input at maximum.
    User controls or audio input adjusted to maximize emission for test.
  - Check the tuning range of FM transmitter
  - Does the device tune outside of the 88-108 MHz band?
    *Operate tuning mechanism. Some tuning mechanism's do not limit frequencies within band.

15.240

- **Section 15.240** RFID to identify contents of commercial shipping containers

  Operating frequencies: Operation in the band 433.5-434.5 MHz.
- **Requirements:** (Restriction on use, type of operation and location. *Check current rules for details and any changes)*

  Fundamental:11,000 uV/meter at 3 m (Average)

  55,000 uV/meter at 3 m (Peak)

  Spurious: Section 15.209.

  Operation limitation 60 second duration, 10 second

  silent period
- **Check list:** Use the General Checklist with the following frequent compliance issues.

  -Check manual and installation instructions for agreement with appropriate operational requirements (a)- (e).

  -Check limits on spurious emissions

15.241 and 15.242

DO NOT GRANT Part 15 devices in these sections.

Per 15.37(i)

- Effective October 16, 2002, an equipment approval may no longer be obtained for medical

  telemetry equipment operating under the provisions of § 15.241 or § 15.242. The requirements for

  obtaining an approval for medical telemetry equipment after this date are found in Subpart H of Part 95

  of this chapter.

15.243

- **Section 15.243** Restricted to devices measuring characteristics of material.
  - **Operating frequencies**: 890 - 940 MHz.
  - **Requirements**::(*Check current rules for details and any changes)*
  - Fundamental: 500 microvolts/meter at 30 meters. (average)

    Spurious: Section 15.209.

    Voice communications or the transmission of any other type of message prohibited.

    Self-contained with no external or readily accessible controls which may be adjusted to permit operation in a manner inconsistent with the provisions in this Section.

    Any antenna that may be used with the device shall be permanently attached thereto and shall not be readily modifiable by the user.

    Check list: Use the General Checklist with the following frequent compliance issues.

    - Use of this section for purposes other than measuring characteristics of material.

    - Check for peak measurement data.

15.245

- **Section 15.245 Field disturbance sensor (FDS)**
- **Operating frequencies**
- **902-928,2435-2465, 5785-5815, 10500-10550 and 24075-24175 MHz**
- **Requirements**:(*Check current rules for details and any changes)*
- **The limit on both the fundamental and the harmonics are stated in 15.245(b) and are based on the fundamental frequency**
- **Out of band emissions except harmonics must be 50 dB below fundamental or meet limits in 15.209 whichever is lesser attenuation**
- **Average detector**
- **Further requirements/limits depend on frequency and use of the device. See Rules**
- **Couple the general checklist with the following frequent compliance issues**

  - Harmonics in restricted bands

  - Band-edge measurement

  - Peak readings

  - Employing pulses may require a correction factor per 15.35

  - If tested in metal tanks, grand condition must state that device must only be used in metal tanks.

FDS tag reader policy

- Question: We have a request to certify a 2.45GHz device under 15.245. The device communicates with tag transmitters which come into range. We think this is not a field disturbance sensor and is therefore excluded from this section by 15.245(a). Please confirm that RF communications capacity with another device is not allowed by field disturbance sensors unless specifically called out (for example in 15.253(a)).

- Response: Data transfer is possible only with FDS systems using passive tags and only if the data transfer function is ancillary to the primary purpose of a FDS system which is the detection of the presence of people or objects.

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.

Passive tags used with Frequency Hopping Tag Reading systems operating in Section 15.247. Frequently Asked Questions

Q: Is a passive tag subject to Certification?

A: No, a passive tag does not contain batteries and by itself is not authorized.

Q: Are passive tags tested for Certification?

A: No, 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. However, even with the low emission levels, the fundamental passive tag emission(s) may not operate within a restricted band just as the tag reader is prohibited from operating in a restricted band. The tag reader receiver should never include restricted band frequencies.

Q: How can compliance with the transmit and receive nominal bandwidth matching requirement in Section 15.247(a)1 be achieved?

A: This requirement is achieved by the tag reader not the passive tag. The receive bandwidth in the reader must nominally match or can be less than either the modulated signal from the tag reader signal or the passive tag signal. The receive bandwidth can be achieved with the use of baseband/DSP filters and does not have to be centered with either the passive tag signal or the tag reader signal.

Q: Is there a limit on the bandwidth of the fundamental emission from the tag reader or the passive tag signal?

A: The maximum 20dB bandwidth of the modulated signal from the tag reader is used to determine the Channel separation requirements for the tag reader. This must be considered when determining the designed bandwidth whenever there is a minimum number of hop frequencies required. Since the emissions from the passive tag are much lower than the allowed levels for the tag reader, we are not worried about the bandwidth of the passive tag signal.

Q: Can the Tag Reader utilize a CW signal?

A: A tag reading system that uses only an un-modulated CW signal cannot operate under Section 15.247 but may operate under another rule such as Section 15.249 because Section 15.249 does not have a modulation requirement. Under Section 15.247, a tag reader system can send CW signals as part of a half duplexed signal on each hop frequency. The half-duplexed signal consists of the modulated reader signal followed by the CW signal. The modulated signal sends data to and is received by the tag. The CW signal is used only to power the passive tag. For example, the tag reader sends a modulated data signal for 7 msec, followed by a CW signal on the same frequency for 7 msec to power the passive tag before the reader hops to the next frequency. A short CW burst prior to the half duplexed signal can be used to wake up the tag.

In band spurious emissions for Section 15.247 devices

- **In band spurious emission limit is general the same as fundamental limit. However, in no case can the level of any spurious emission exceed the level of the fundamental.**
- **For a product operating under Section 15.247, the only limit on the emission level appearing within the assigned band is based on the fundamental limit, e.g., one watt output from the transmitter into a 6 dBi antenna is the limit anywhere within the 902-928 MHz band.**

RFID
15.247

Determining Antenna Gain for RF ID Systems Operating Under 15.247

Question: How does the Commission determine the antenna gain for RF ID systems operating under Section 15.247 that employ both vertical and horizontal radiating elements?

Reply: Some RF ID systems transmit simultaneously on both a vertical and a horizontal antenna to improve the read rates for tags that have unpredictable orientations

.

For such systems the Commission will **use the highest linear vertical or horizontal gain to determine compliance with Section 15.247**. Thus, for example, an RF ID tag reader that employs a 6 dBi gain vertical antenna and a 6 dBi gain horizontal antenna will be treated as having a 6 dBi gain. An RF ID tag reader that employs a 9 dBi gain vertical antenna and a 6 dBi gain horizontal antenna will be treated as having 9 dBi gain.

Section 15.247 limits the conducted output power to 1 Watt. Therefore, for systems that employ a single transmitter to feed both the vertical and horizontal antenna, the total power may not exceed 1 Watt. Similarly, if separate transmitters are used to feed each antenna element, the aggregate conducted output power may not exceed 1 Watt. Note that Section 15.247 requires a reduction in conducted output power for antenna gains in excess of 6 dB for certain frequency bands.

We recognize that, from a technical standpoint, simultaneous transmissions on both vertical and horizontal radiating elements effectively yields a circularly or elliptically polarized antenna that will have higher gain than that of the individual vertical and horizontal antenna elements. However, it does not appear necessary or appropriate to treat such antennas as circularly or elliptically polarized for purposes of determining the compliance with Section 15.247. We note, for example, that the frequency bands covered by Section 15.247 typically do not employ circularly or elliptically polarized antennas and therefore would not "see" any increase in signal levels.

Please note the following regarding the requirements for Hybrids and clarification of spread spectrum systems with regard to the recent changes to the spread spectrum rules.
1 of 4

- Prior to the recent changes to the spread spectrum rules, there were two major types of spread spectrum systems. They were direct sequence and frequency hopping spread spectrum ("FHSS") systems. These two distinct systems were required to comply with separate rule requirements. The new rules, however, allow manufacturers more flexibility and are not as limiting. The new rules provide more flexibility for manufacturers by eliminating the requirement to employ direct sequence modulation techniques along with its associated requirement to comply with a minimum processing gain. Instead, manufacturers now may employ wideband digital modulation under the new rules for Digital Transmissions Systems ("DTS").

- It is possible for a device to be designed to operate as a DTS, as a FHSS system, or using a combination of these two modulation types. Because of this, we have received several requests for interpretations by manufacturers that wish to produce transmission systems that employ both frequency hopping (or channel changing) techniques using digitally modulated channels. We believe that such systems fall under three possible combinations of standards, depending on the exact methods of modulation.

Please note the following regarding the requirements for Hybrids and clarification of spread spectrum systems with regard to the recent changes to the spread spectrum rules.
2 of 4

- First example: We will allow a manufacturer of a combination DTS and FHSS system to demonstrate compliance with the rules required for DTS operation or for FHSS operation. There is no need to demonstrate compliance with both the FHSS standards and the DTS standards.

- Second example: Systems may employ two mutually exclusive operational modes. One mode would be as a FHSS system and the other would be as a DTS. For example, a device may be operated as a FHSS system while transmitting data and as a DTS while in the acquisition mode. When operating in this manner, the device must fully comply with the rules for a FHSS system when operating in that mode and as a DTS when operating in that mode. The two types of operation must be distinct so that each mode of operation can be distinguished and separately demonstrated to comply with the pertinent standards.

Please note the following regarding the requirements for Hybrids and clarification of spread spectrum systems with regard to the recent changes to the spread spectrum rules.
3 of 4

- Third example: The third method of authorizing a combination system is as a hybrid system under the provisions described in Section 15.247(f) of the rules. Prior to the new rules on DTS operation, a hybrid system consisted of a transmission system that employed a combination of both direct sequence and frequency hopping techniques. Such systems were required to show compliance with a 17 dB processing gain. This is no longer required since the processing gain requirement has been replaced by the DTS regulations.

Please note the following regarding the requirements for Hybrids and clarification of spread spectrum systems with regard to the recent changes to the spread spectrum rules.
4 of 4

- **A hybrid system** uses both digital modulation and frequency hopping techniques at the same time on the same carrier. This is similar to the combination DTS/FHSS system described above in the first example but the system is subject to slightly different standards. As indicated in Section 15.247(f), a hybrid system must comply with the power density standard of 8 dBm in any 3 kHz band when the frequency hopping function is turned off. The transmission also must comply with a 0.4 second/channel maximum dwell time when the hopping function is turned on. There is no requirement for this type of hybrid system to comply with the 500 kHz minimum bandwidth normally associated with a DTS transmission; and, there is no minimum number of hopping channels associated with this type of hybrid system. However, the hopping function must be a true hopping system, as described in Section 15.247(a)(1). The specific requirements in Section 15.247(a)(1) are: 1) A minimum channel separation. 2) Pseudorandom hop sequence. 3) Equal use of each frequency. 4) Receiver matching bandwidth and Synchronization. The additional requirements in Section 15.247 for a hybrid transmitter include the requirements the 1 watt output limit and RF safety requirements in Section 15.247(b) and the spurious emission limits of Section 15.247(c).

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.

DTS filing guidance 2 of 5

- **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 - ((Gant-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

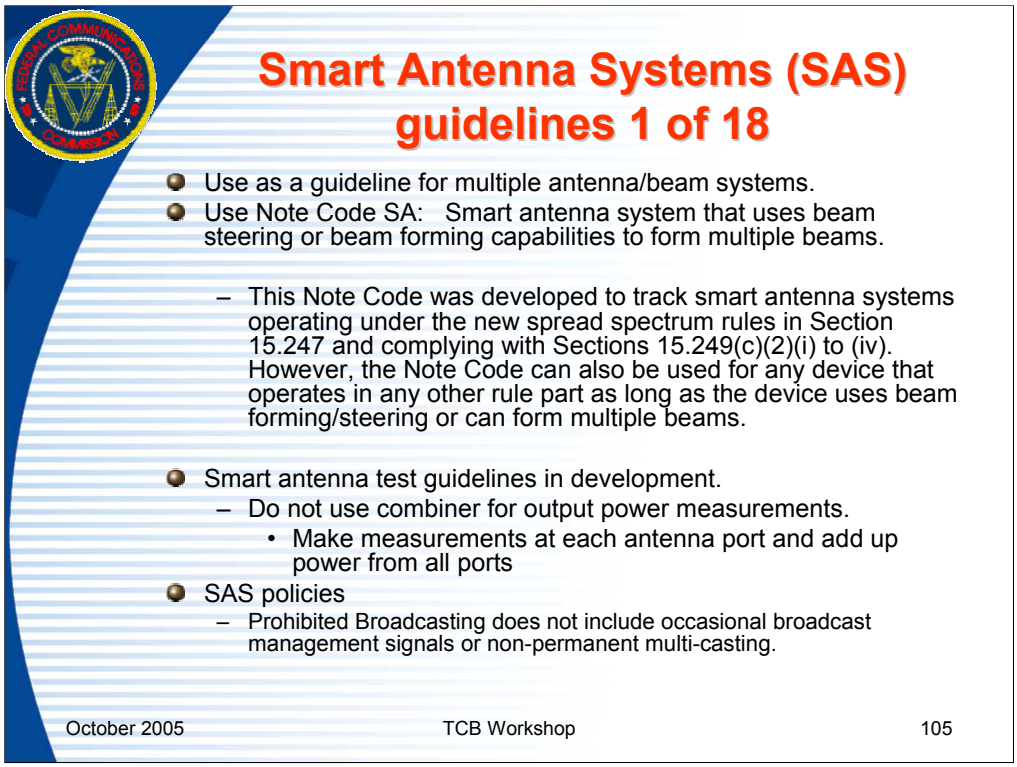
- **15.247(c:**
- ___ Does the proposed point-to-point system meet the appropriate requirements, and do the installation instructions contain the correct language?
- **Understand the intent behind allowing the EIRP relaxation for point-to-point applications only.**
- **When multiple antennas are listed 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.**

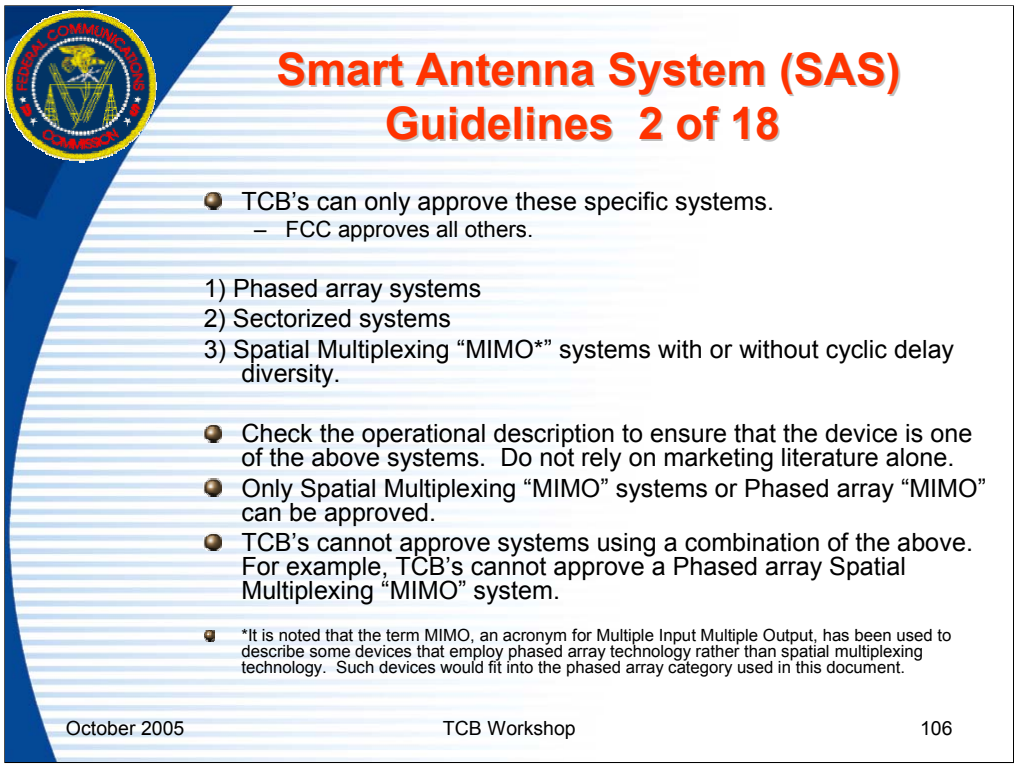
DTS filing guidance 5 of 5

- **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?



Loot at technology/operation of the device rather than marektinng

Ensure consistency between approval and user manual.



Multiple antenna output antenna systems.

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

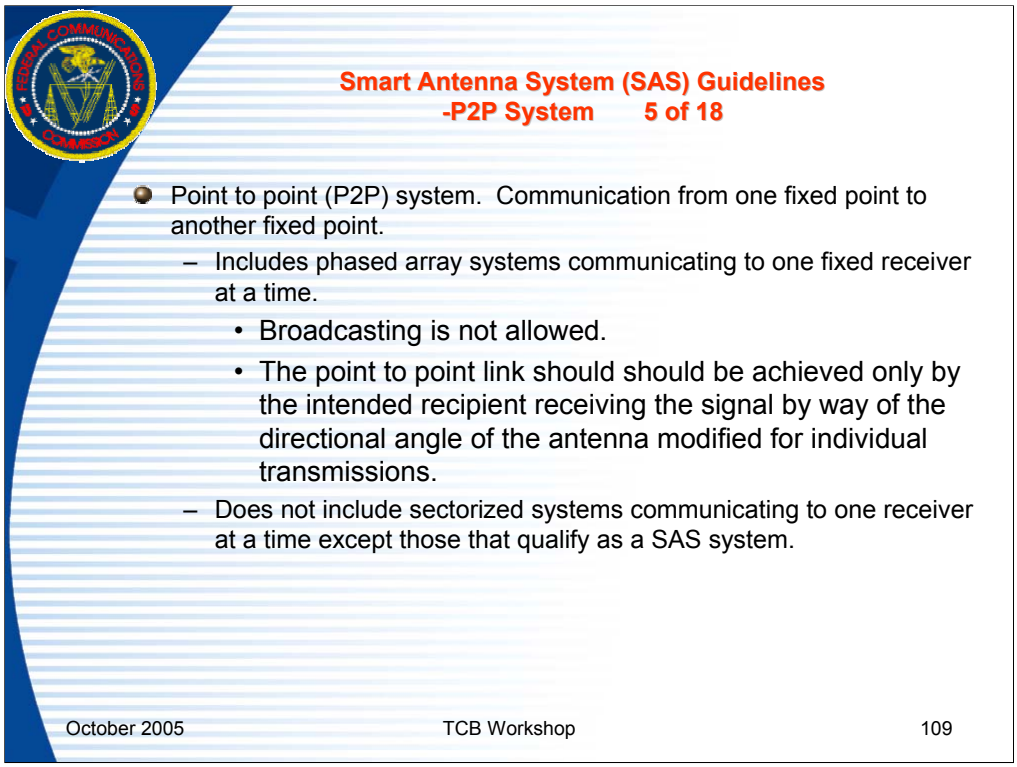
- Because the type of operation determines the applicable requirements (e.g. output power),

  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.



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

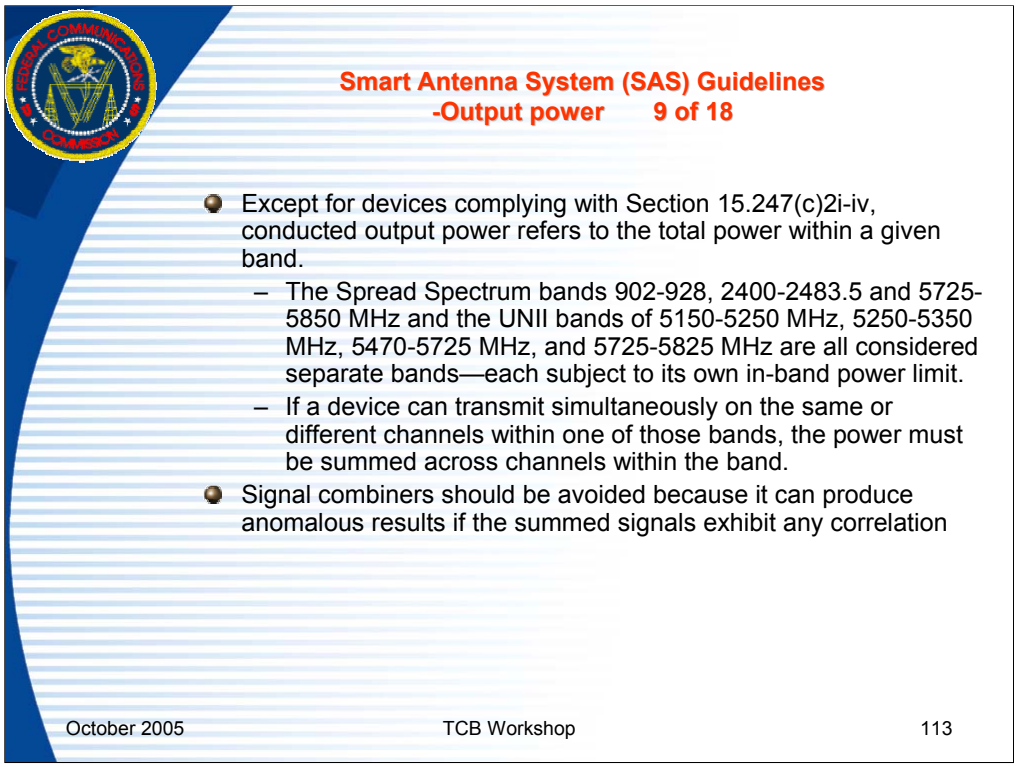
- Point to multipoint (P2MP) system. Communication to multiple or mobile receivers.
  - Includes all Sectorized systems except those that qualify as a SAS systems.

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

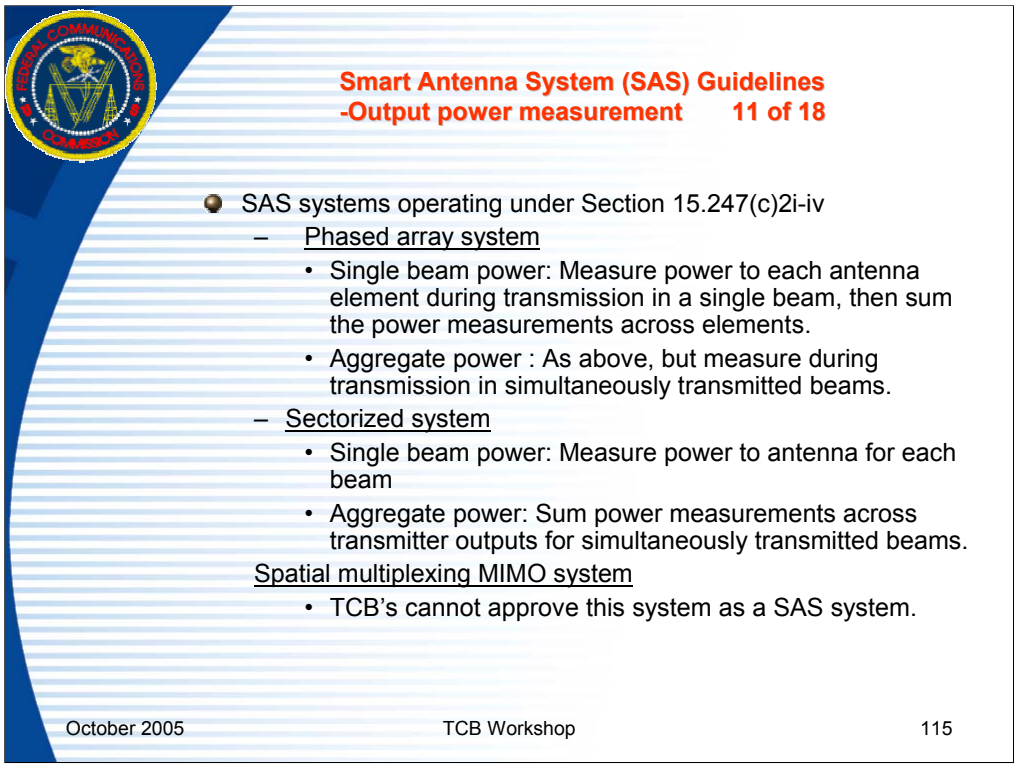
- Phased array systems
  - Directional gain = gain of antenna element + 10 log(# of TX antenna elements)
- Sectorized systems
  - Directional gain = gain of each antenna
- Spatial Multiplexing “MIMO” system
  - For any spatial multiplexing “MIMO” mode in which the elements are always driven incoherently 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(# of TX antenna elements)



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.



Spatial multiplexing MIMO system

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

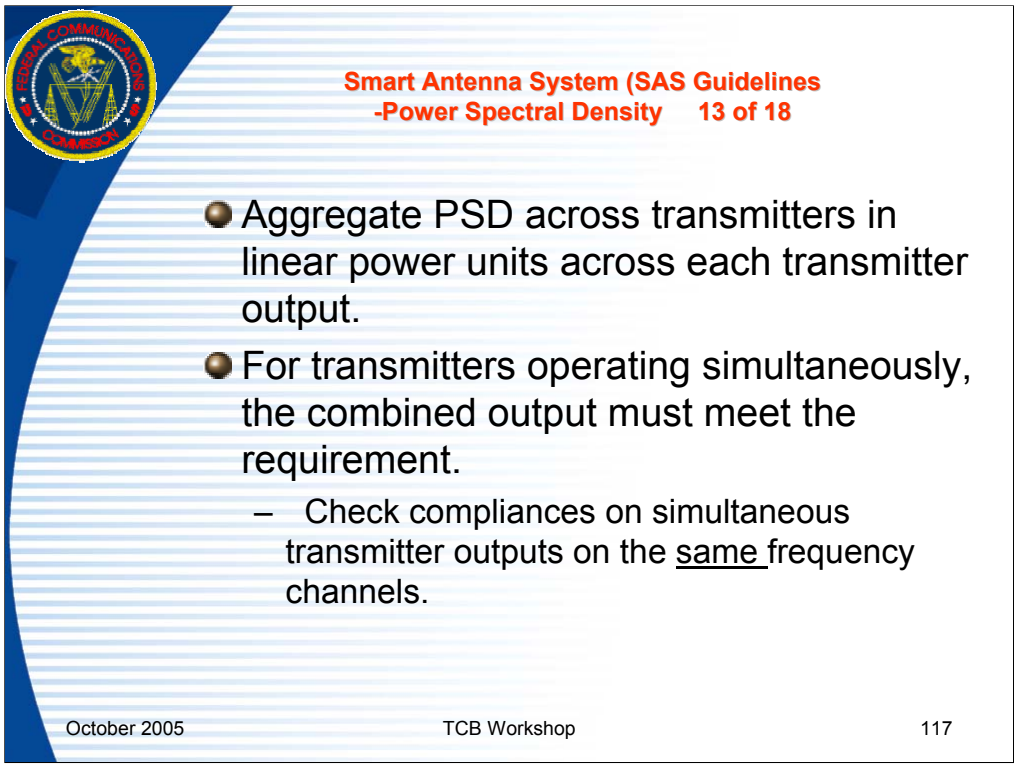
SAS systems must form multiple beams.

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.

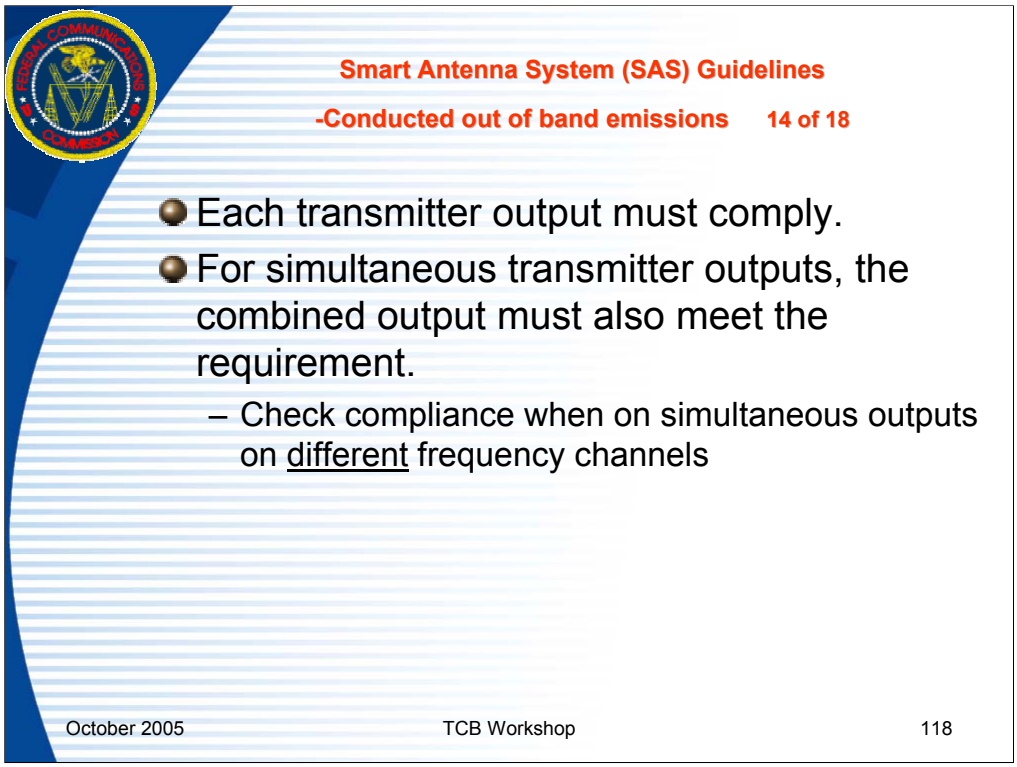
Smart Antenna System (SAS) Guidelines -Output power 12 of 18

- 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.



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.)



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

- 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

- 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.

$$\frac{((\text{Sum 1 to n; } E1+E2+\ldots En) \times r)^2}{30} \leq \text{EIRP max Watts}$$

*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.**

FHSS filing guidance 2 of 7

- **15.247(a)(1)(i),(ii) and (iii):**
- ___ Were acceptable test procedures and instrument settings used to measure the 20 dB bandwidth and the dwell time?
- **A RBW of at least 1% of the emission bandwidth may be used.**
- ___ Does the measured 20 dB bandwidth comply with the appropriate limit?
- ___ Does the dwell time (average time of occupancy) per channel comply with the 0.4 second limit?
- **This refers to total transmit time within the period of investigation.**
- ___ Is the proper number of hopping channels employed, in all modes of operation? (This is determined by the measured 20 dB bandwidth and the frequency range)
- **This includes various paging and/or acquisition modes.**
- **___ 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 occupied bandwidth. The hopping function must be disabled.**
- ___ Does the measured peak output power comply with the appropriate limit? (The output power depends on the frequency range and the number of hopping channels)
- **Look for <u>consistency</u> throughout the test report, user's manual, and technical descriptions wrt the various measured and/or stated output power levels.**

FHSS filing guidance 3 of 7

- **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 <u>limit</u> 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.**
- **<u>15.247(c):</u>**
- ___ 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 - ((Gant-6dBi)/3), dropping all fractions.]
- **Note that the output power <u>limit</u> 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, 1 dB reduction below power limit for every 1 dB over 6 dBi antenna gain.**
- ***For Smart Antenna Systems (SAS) see also smart antenna system guidelines**

FHSS filing guidance 4 of 7

- **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?
- **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, however, potential high frequency spurs created by the hopping function must be compliant. The hopping function must be disabled for all other tests.**
- **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.**

FHSS filing guidance 5 of 7

- ___ 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 correction factor, based on the total channel dwell time in a 100 ms period, may be mathematically 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 on the lowest gain antenna, so that the EUT is operating at its highest available output power, in order to test for case radiation.**

FHSS filing guidance 6 of 7

- **15.247(g):**
- ___ Does the design of the frequency hopping system allow it to comply with all pertinent requirements when presented with a lengthy data stream? (i.e., is it designed to be more than a frequency agile system designed to always transmit all information in a single hop?)
- **Systems that employ short transmission bursts must still use all channels equally, on average. This typically means that each new transmission event must start on the next channel in the hop sequence, and may not reset to the first channel for the next transmission event.**
- **15.247(h):**
- ___ Does the frequency hopping system comply with the non-coordination requirement?
- **Coordination, from a single central intelligence, may not occur if the intent is to avoid collisions. Coordination for other purposes is permitted (e.g., the time of transmission, for TDD or TDMA purposes).**
- **15.247(i):**
- _____ Does the device comply with the RF safety requirements? Is the device on the TCB exclusion list?

FHSS filing guidance 7 of 7

- 15.33, 15.35, 15.203, 15.204, 15.205, 15.207, and 15.214:
- ___ Does the frequency hopping 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?

15.249

- **General use**
- **Operating frequencies**
  902-928, 2400-2483.5, 5725-5875 MHz
  24.0-24.25 GHz
- **Requirements**:(*Check current rules for details and any changes)*
- **The limit on both the fundamental and harmonics are stated in 15.249(a) and (b).**
- **Point to point systems in 24 GHz allowed more field strength.**
- **Out of band emissions except harmonics must be 50 dB below harmonics or to limits in 15.209 whichever is the lesser attenuation**
- **Quasi-peak detector below 1 GHz and average above**
- **Couple the general checklist with the following frequent compliance issues**

- Use quasi-peak limits within the 902-928 MHz band

- Cordless phones

Compliance with 15.214

Privacy label per 15.214(c)

Minimum of 256 security codes

In band spurious limits for 15.249

- **The limit for spurious emissions under Sec. 15.249 is 50 mV/m, as measured at 3 meters with a quasi-peak detector, anywhere within the 902-928 MHz band. The limits for emissions outside of the 902-928 MHz band are the 15.209 limits. The spurious emissions may not exceed the level of the fundamental emission.**

15.250

- Operation of wideband systems within the band 5925-7250 MHz.
- BW requirement
- Operation aboard aircraft or Satellite prohibited
- No toys
- Fixed infrastructure not allowed
- Check for all operational restrictions or prohibitions.

15.251

- General use
- Operating frequencies
- 2.9-3.26, 3.267-3.332 , 3.339-3.3458 and 3.358-3.6 GHz
- Equipment Class "EAV"

  Requirements:(*Check current rules for details and any changes)*
- Operation limited to Automatic Vehicle Identification Systems (AVIS) which use swept frequency techniques for the purpose of automatically identifying transportation vehicles.
- Fundamental 3000 uV/m per MHz. at 3 meters in any direction
  - When in operating position 400 uV/m per MHz at 3 meters in any direction within ± 10 degrees of the horizontal plane.
  - Spurious 100 uV/m per MHz at 3 meters from 30 MHz to 20 GHz.
  - Limits are average. Peak limit in 15.35 applies.
  - Minimum sweep of 4000 sweeps/second. Maximum sweep of 50,000 sweeps/second.
  - Directional antenna
  - AVIS signal can only occur when vehicle is in radiated field.
  - Additional labeling requirement
  - Additional measurement requirements in 15.251(g) 1-4.
- Couple the general checklist with the following frequent compliance issues
  - Ensure operations is limited to AVIS systems.
  - Check for additional measurement requirements in 15.251(g) 1-4.

15.252

- Operation of wideband vehicular radar systems within the bands 16.2-17.7 GHz and 23.12-29.0 GHz.
- Check for proper operation.

Section 15.253 and 15.255

- High frequency /millimeter wave rule sections.
- Frequencies 15.253, 46.7-46.9 GHz and 76-77 GHz
- Frequencies 15.255, 57-64 GHz
- Ensure compliance with all applicable rules.
  - Limits may be based on type of operation (in motion or not in motion, forward looking versus rear looking vehicle mounted tx), frequency of operation or bandwidth
- Operation is limited and Certain uses prohibited.
  - 15.253 limited to vehicle mounted field disturbance sensors used as vehicle radar systems.
  - 15.255 Operation not permitted for equipment on aircraft or satellites. Also not permitted for Field disturbance sensors unless for fixed operation.
- High frequency testing
  - Use millimeter wave test procedure as guideline.
  - Check for far field measurements.
  - Check for required frequency range of radiated measurements.
  - Check to make sure equipment and test setup will have enough sensitivity to measure required limits.
  - For millimeter wave devices, since each antenna must also comply with peak power density requirements and also the shape and size of the antenna will affect the measurement distance (far field), **data for all antennas submitted for millimeter wave devices should be submitted in the equipment authorization filing.**

15.257

- Operation within the band 92-95 GHz.
- Devices limited to indoor use.
- High frequency testing
  - Use millimeter wave test procedure as guideline.
  - Check for far field measurements.
  - Check for required frequency range of radiated measurements.
  - Check to make sure equipment and test setup will have enough sensitivity to measure required limits.
  - For millimeter wave devices, since each antenna must also comply with peak power density requirements and also the shape and size of the antenna will affect the measurement distance (far field), **data for all antennas submitted for millimeter wave devices should be submitted in the equipment authorization filing.**

Millimeter wave test procedure

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

Millimeter wave filing guidelines 1 of 6

- **Vehicle Radar Systems (47 C.F.R. Section 15.253)**
- 15.253(a):
- ___ Does the EUT meet the definition of a vehicle-mounted field disturbance sensor, as its primary mode of operation, based on the technical description?
- 15.253(b):
- ___ Were acceptable test procedures and instrument settings used to measure the radiated power density of the fundamental emission?
- ___ Does the measured power density comply with the appropriate limit, as determined by the frequency band of operation, the position of the EUT with respect to the vehicle, and whether or not the vehicle is in motion?
- 15.253(c):
- ___ Do all out-of-band emissions meet the definition of spurious emissions?
- 15.253(c)(1):
- ___ Were acceptable test procedures and instrument settings used to measure unwanted radiated emission levels below 1 GHz?
- ___ Do the measured unwanted radiated emission levels comply with the Section 15.209 field strength limit?

Millimeter wave filing guidelines 2 of 6

- 15.253(c)(2):
- ___ Were acceptable test procedures and instrument settings used to measure the radiated power density of spurious emissions?
- ___ Was the correct frequency range investigated?
- ___ Do the measured spurious power densities comply with the appropriate limit, as determined by the frequency band of operation, the frequency of the spurious emission, and the position of the EUT with respect to the vehicle?
- 15.253(c)(3)
  - ____ If applicable, does the FDS operating in 76-77 GHz comply with 1000pW/cm^2 limit at 3 meters for spurious emissions above 200 GHz?
- 15.253(c) (4)
  - ____ If applicable, was the FDS operating in 76-77 GHz inevestigated up to 231 GHz.
- 15.253(d):
- ___ Were acceptable test procedures and instrument settings used to determine the peak levels of the measured radiated power densities of all emissions?
- ____ Do the peak levels of the measured power densities comply with the limit of Section 15.35(b)?

Millimeter wave filing guidelines 3 of 6

- 15.253(e):
- ___ Was an acceptable test procedure was used to measure frequency stability?
- ___ Does the measured frequency stability data indicate that the fundamental emission will be maintained within the band of operation under all conditions of normal operation, as specified in the user's manual?
- 15.203 and 15.204:
- ___ Does the EUT comply with these Sections?
- *Test procedures for mm wave devices are, as of yet, undocumented. When a "recommended" test procedure is released by the OET Lab, or by some industry group, guidance will be provided as to what is considered "acceptable test procedures".
- *Convert power density limits to EIRP levels, then to equivalent field strengths at the measurement distance. Measured field strengths may then be compared to these values.
- *Determine whether measurements are made in the far field or not, so that a proper distance correction factor may be applied.
- *In re 15.253(d)- a test or a calculation may be used to determine the peak level of the emission, as determined by the emission characteristics.
- *In re 15.253(e)- a plot of the emission at the bandedge, with the EUT tuned to a bandedge channel, may be required for devices that do not utilize a standard carrier which may be measured.

Millimeter wave filing guidelines 4 of 6

- **mm-Wave Systems - Section 15.255**
- 15.255(a):
- ___ Does the EUT operate in a manner which is not excluded by this Section, based on the technical description, user's manual, or any advertising literature which has been submitted?
- 15.255(b)(1) and (2):
- ___ Were acceptable test procedures and instrument settings used to measure the peak radiated power density and the occupied bandwidth of the fundamental emission?
- ___ Were acceptable methods used to calculate the average radiated power density of the fundamental emission?
- ___ Does the measured peak power density comply with the appropriate limit, as determined by the type of operation, the occupied bandwidth, and the frequency of the emission?
- ___ Does the calculated average power density comply with the appropriate limit, as determined by the type of operation, the occupied bandwidth, and the frequency of the emission?
- 15.255(b)(3):
- ___ Were acceptable test procedures and instrument settings used to measure the peak output power and the peak radiated power density of the fundamental emission?
- ___ Do the measured peak output power and peak radiated power density comply with the appropriate limit?
- 15.255(c)(1):
- ___ Do all out-of-band emissions meet the definition of spurious emissions?
- 15.255(c)(2):
- ___ Were acceptable test procedures and instrument settings used to measure unwanted radiated emission levels below 1 GHz?
- ___ Do the measured unwanted radiated emission levels comply with the Section 15.209 field strength limit?

Millimeter wave filing guidelines 5 of 6

- 15.255(c)(3):
- ___ Were acceptable test procedures and instrument settings used to measure the radiated power density of spurious emissions?
- ___ Was the correct frequency range investigated?
- ___ Do the measured spurious power densities comply with the 90 pW/cm2 limit?
- 15.255(c)(4):
- ___ Does the EUT comply with Section 15.215(b)?
- 15.253(d):
- ___ Are all emissions in the 59.0-59.05 GHz band either spurious, or related to a publicly accessible coordination channel?
- 15.253(e):
- ___ Were acceptable test procedures and instrument settings used to measure the peak output power and emission bandwidth?
- ___ Does the measured peak output power comply with the appropriate limit, as determined by the emission bandwidth?
- 15.255(f):
- ___ Was an acceptable test procedure was used to measure frequency stability?
- ___ Does the measured frequency stability data indicate that the fundamental emission will be maintained within the band of operation under all conditions of normal operation, as specified in the user's manual?
- 15.255(g) RF safety compliance?
- 15.255(h):
- ___ Does the applicant state that the EUT will not be equipped with external phase-locking inputs that permit beam-forming arrays to be realized?
- 15.255(i):
- ___ If applicable, does the applicant state that the EUT transmits the required identification feature?
- ___ Does the required identification feature contain all of the necessary information?
- ___ Is a method specified whereby interested parties can obtain sufficient information, at no cost, to enable them to fully detect and decode this transmitter identification information?

Millimeter wave filing guidelines 6 of 6

- 15.203, 15.204, and 15.207:
- ___ Does the EUT comply with these Sections?

*Convert power density limits to EIRP levels, then to equivalent field strengths at the measurement distance. Measured field strengths may then be compared to these values.

- *Determine whether measurements are made in the far field or not, so that a proper distance correction factor may be applied.
- * In re 15.255(f)- a plot of the emission at the bandedge, with the EUT tuned to a bandedge channel, may be required for devices that do not utilize a standard carrier which may be measured.

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

In band spurious emissions for UNII devices

- In band spurious emission limit is general the same as fundamental limit. However, in no case can the level of any spurious emission exceed the level of the fundamental.

- For UNII devices under Section 15.407…
  - a transmitter operating at 5.2 GHz can emit at the level specified in 15.407(a)(1) anywhere in the 5.15-5.35 GHz range.
  - a transmitter operating at 5.3 GHz can emit at the level specified in 15.407(a)(2) anywhere in the 5.25-5.35 GHz range.
  - a transmitter operating at 5.3 GHz can emit at the level specified in 15.407(a)(1) anywhere in the 5.15-5.25 GHz range if it's indoor-only with an integral antenna or at -27 dBm/MHz in the 5.15-5.25 GHz range if it operates outdoors or does not have an integral antenna.
  - a transmitter operating at 5.8 GHz can emit at the level specified in 15.407(a)(3) anywhere in the 5.725-5.825 GHz range.

GUIDANCE FOR REVIEWING OF COMPLIANCE SUBMISSIONS FOR UNII DEVICES:

- **SEE UNII test procedures at**
  - http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-02-2138A1.pdf
- 15.401:
- **1)** Does the EUT meet the definition of a UNII device, based on the technical description of the EUT? (See Section 15.403(i))
- Modulation must be digital. While "high data rate" is not specifically defined, policy requires a minimum data rate of **1 Mbps.**
- 15.407(a):
- **2)** Were acceptable test procedures and instrument settings used to measure the peak transmit power, emission bandwidth, peak power spectral density, and peak excursion of the modulation envelope? (See Sections 15.403(e), (c), and (d))
- 15.407(a)(1):
- **3)** Does the measured peak transmit power comply with the appropriate limit, based on the measured emission bandwidth?
- **Look for consistency throughout the test report, user's manual, and technical descriptions, wrt the various measured and/or stated transmit power levels.**
- **4)** Does the measured peak power spectral density (psd) comply with the +4 dBm/MHz limit?
- **5)** Does the measured peak transmit power, in conjunction with the stated antenna gain, comply with the *de facto* EIRP limit (calculated peak transmit power limit + 6 dBi) for all proposed antennas?
- Note that the transmit power **limit is reduced in order to comply with the *de facto* EIRP limit. If the measured transmit power is already below the limit a reduction may not be necessary.**

GUIDANCE FOR REVIEWING OF COMPLIANCE SUBMISSIONS FOR UNII DEVICES:

- If compliance with the EIRP limit is achieved for various antennas by adjusting the transmit 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 transmit power can be chosen for any antenna being used.
- **6)** Does the measured peak power spectral density, in conjunction with the stated antenna gain, comply with the *de facto* +10 dBm EIRPower spectral density (EIRPsd) limit for all proposed antennas?
- Note that the psd limit is reduced in order to comply with the *de facto* EIRPsd limit. If the measured psd is already below the limit a reduction may not be necessary.
- 15.407(a)(2):
- **7)** Does the measured peak transmit power comply with the appropriate limit, based on the measured emission bandwidth?
- Look for consistency throughout the test report, user's manual, and technical descriptions, wrt the various measured and/or stated transmit power levels.
- **8)** Does the measured peak power spectral density comply with the +11 dBm/MHz limit?
- **9)** Does the measured peak transmit power, in conjunction with the stated antenna gain, comply with the *de facto* EIRP limit (calculated peak transmit power limit + 6 dBi) for all proposed antennas?
- Note that the transmit power limit is reduced in order to comply with the *de facto* EIRP limit. If the measured transmit 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 transmit 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 transmit power can be chosen for any antenna being used.
- **10)** Does the measured peak power spectral density, in conjunction with the stated antenna gain, comply with the *de facto* +17 dBm EIRPsd limit for all proposed antennas?
- Note that the psd limit is reduced in order to comply with the *de facto* EIRPsd limit. If the measured psd is already below the limit a reduction may not be necessary.

GUIDANCE FOR REVIEWING OF COMPLIANCE SUBMISSIONS FOR UNII DEVICES:

- 15.407(a)(3):
- **11)** Does the measured peak transmit power comply with the appropriate limit, based on the measured emission bandwidth?
- Look for consistency throughout the test report, user's manual, and technical descriptions, wrt the various measured and/or stated transmit power levels.
- **12)** Does the measured peak power spectral density comply with the +17 dBm/MHz limit?
- **13)** Does the measured peak transmit power, in conjunction with the stated antenna gain, comply with the *de facto* EIRP limit (calculated peak transmit power limit + 6 dBi) for all proposed antennas?
- Note that the transmit power limit is reduced in order to comply with the *de facto* EIRP limit. If the measured transmit 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 transmit 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 transmit power can be chosen for any antenna being used.
- **14)** Does the measured peak power spectral density, in conjunction with the stated antenna gain, comply with the *de facto* +23 dBm EIRPsd limit for all proposed antennas?
- Note that the psd limit is reduced in order to comply with the *de facto* EIRPsd limit. If the measured psd is already below the limit a reduction may not be necessary.
- **15**) Does the measured peak transmit power, in conjunction with the stated antenna gain, comply with the *de facto* EIRP limit (calculated peak transmit power limit + 23 dBi) for all proposed antennas to be used solely in point-to-point applications?
- Note that the transmit power limit is reduced in order to comply with the *de facto* EIRP limit. If the measured transmit 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 transmit 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 transmit power can be chosen for any antenna being used.

GUIDANCE FOR REVIEWING OF COMPLIANCE SUBMISSIONS FOR UNII DEVICES:

- **16)** Does the measured peak power spectral density, in conjunction with the stated antenna gain, comply with the *de facto* +40 dBm EIRPsd limit for all proposed antennas to be used solely in point-to-point applications?
- Note that the psd limit is reduced in order to comply with the *de facto* EIRPsd limit. If the measured psd is already below the limit a reduction may not be necessary.
- **17)** 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.
- 15.407(a)(6):
- **18)** Does the ratio of peak modulation envelope excursion to peak transmit power meet the 13 dB/MHz limit?
- The comparison between the two measured levels is made within the same 1 MHz segment.
- 15.407(b)(1)-(3):
- **19)** Were acceptable test procedures and instrument settings used to measure the EIRP of emissions outside of the frequency bands of operation, both within and outside of the passband of all proposed antennas?
- **20**) Do the measured unwanted emission EIRP levels comply with the appropriate limits, as determined by the frequency band of operation and the frequency of the spurious emission, up to 40 GHz, for all proposed antennas?
- These limits are on the Effective Isotropic Radiated Transmit Power. The same measurement settings used to measure the transmit power of the fundamental emission may be used here.
- Within the passband of the antenna an RF conducted measurement may be made. This level, added to the stated antenna gain for each proposed antenna, must comply with the limit.

GUIDANCE FOR REVIEWING OF COMPLIANCE SUBMISSIONS FOR UNII DEVICES:

- Outside of the passband of the antenna a radiated measurement must be made, as the gain of the antenna outside of its passband is uncertain, or, the emission may radiate from the case of the EUT. This measured field strength must then be converted to an equivalent EIRP for comparison to the limit.
- It is likely that compliance with the unwanted emission EIRP limit, particularly at the bandedges, will determine the maximum transmit power allowable at bandedge channels for each antenna. The installation manual must make this clear.
- 15.407(b)(5):
- **21)** Were acceptable test procedures and instrument settings used to measure unwanted radiated emission levels below 1 GHz, and AC line conducted emissions?
- Use ANSI C63.4 as a guide.
- **22)** Do the measured unwanted radiated emission levels comply with the Section 15.209 field strength limit?
- *In order to demonstrate compliance with this particular requirement, 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.
- **23)** Do the measured AC line conducted emission levels comply with the Section 15.207 limit?
- 15.407(b)(6):
- **24)** Were acceptable test procedures and instrument settings used to measure the field strength of all unwanted radiated emissions in restricted bands, as defined in Section 15.205?
- **25)** Do the measured unwanted radiated emission average levels comply with the Section 15.209 field strength limit, up to 40 GHz?
- *In order to demonstrate compliance with this particular requirement, 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.*

GUIDANCE FOR REVIEWING OF COMPLIANCE SUBMISSIONS FOR UNII DEVICES:

- 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 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.
- **26)** Do the measured unwanted radiated emission peak levels comply with the Section 15.35(b) field strength limit, up to 40 GHz?
- In order to demonstrate compliance with this particular requirement, a true peak measurement must be made- instrument settings used to measure the peak transmit power may not be used. (i.e. VBW ≥ RBW)
- *In order to demonstrate compliance with this particular requirement, 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.*
- 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.
- Section 15.407(b)(7):
- **27**) Was the device also adjusted to the channels closest to the upper and lower bandedges when measuring for compliance with the emission limits?
- If the peak power measurement was performed with VBW > 1MHz and no other averaging, the peak excursion test is not required.
- 15.407(c):

GUIDANCE FOR REVIEWING OF COMPLIANCE SUBMISSIONS FOR UNII DEVICES:

- **28)** Does the EUT discontinue transmission under the proper conditions, based on the technical description?
- 15.407(d):
- **29)** Does the EUT use an integral transmitting antenna if it operates in the 5.15-5.25 GHz band, based on the technical description and photographs?
- An antenna that attaches with a connector inside of the case is acceptable, provided that there is no need for the user to ever open the case. Check the user's manual.
- 15.407(e):
- **30)** Will the EUT will be restricted to indoor operation if it operates in the 5.15-5.25 GHz band, based on the technical description, user's manual, and any advertising literature provided?
- 15.407(f):
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- **31)** UNII devices are subject to the radio frequency exposure requirements specified in 1.1307(b), 2.1091, and 2.1093. How does the device comply?
- . **For TCB applications, follow the TCB RF exposure procedure.**
- 15.407(g):
- **32)** Was an acceptable test procedure used to measure frequency stability?
- **33)** Does the measured frequency stability data indicate that the fundamental emission will be maintained within the band of operation under all conditions of normal operation, as specified in the user's manual?
- A plot of the emission at the bandedge, with the EUT tuned to a bandedge channel, may be required for devices that do not utilize a standard carrier that may be measured.
- 15.33, 15.35, 15.203, and 15.204:
- **34)** Does the UNII system comply with these Sections?
- 15.101(a):
- **35)** 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?

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://gullfoss2.fcc.gov/prod/oet/cf/kdb/forms/FTSSearchResultPage.cfm?id=20253&switch=P

UWB

- UWB RO&O, Allowed operation of devices in Restricted bands.
- The Commission established technical standards and operating restrictions for three types of UWB devices based on their potential to cause interference. These three types of devices are:
- 1) imaging systems including GPRs, wall imaging systems, through-wall imaging systems, surveillance systems and medical imaging devices;
- 2) vehicular radar systems;
- 3) communications and measurement systems consisting of indoor-only devices and hand held devices that may be operated anywhere.
- Limits and requirements are based on type of device and operating frequency range.

UWB

- Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems
  - FCC 04-285 ET Docket No. 98-153
  - Adopted 12-15-2004, Published 2/9/05, effective 3/11/05
  - http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-04-285A1.doc
  - Improve automotive safety and tracking systems that could be employed for personnel location, such as hospital patients and emergency rescue crew, as well as for such functions as inventory control.
  - Certain Non-UWB devices permitted use of peak emission levels, similar to the levels applied to UWB devices, for wideband emissions in the 5925-7250 MHz, 16.2-17.7 GHz and 23.12-29.0 GHz bands.
  - Allows certain measurements for vehicular radar systems employing gating to be measured with gating active. Normally continuous transmission required.

RMS measurements for UWB devices

Website:
http://gullfoss2.fcc.gov/prod/oet/cf/kdb/forms/FTSSearchResultPage.cfm?id=20288&switch=P

- The first option is to use an analyzer that incorporates an RMS detector. Check analyzer specifications.
- Set integration time properly.
  - In order to obtain the maximum 1 millisecond (mS) integration time, the ((sweep time) / number of bins), should be less than or equal to 1 mS. The default number of bins(also referred to as points) on some analyzers is 601 points (pts).
  - Do not use trace averaging or average detector.
- Alternatively
  - When an analyzer does not incorporate a true RMS detector, there is also a method described in Appendix F, paragraph (3) in the First Report and Order (FCC 02-48)
    - Detailed in the interpretation letter at the above website.
    - When obtaining RMS values in either manner, describe and/or provide the formula used to post-process the data with the Certification filing.

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/oet/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