Wireless Regulations for Radio Devices
FCC and ISED

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FCC and IC Regulations

Overview of FCC and ISED Equipment Authorization Requirements

- Rules / Regulations / KDB Publications
- General Rules / Measurement Standards
- Application Process
- Permissive Changes
- Modular Approvals
- Q&A

Regulatory Requirements

North America Regulations

Electronic devices are subject to different types of regulations

- EMC: FCC & Industry Canada Requirements
    - Intentional and Unintentional
    - Licensed and Unlicensed

- Safety: NEC & OSHA

- Medical: FDA 510(k) Premarket Notification
    - Center for Device and Radiological Health (CDRH) – thousands of compiled case histories

US Regulations

- Code of Federal Regulations Title 47:
  - Part 2: General Requirements
    - » §2.1091, §2.1093 *
  - Part 15: Unintentional & Unlicensed Intentional
  - Part 18: ISM
  - Part 22, 24, etc.: Licensed
    - » Cellular devices
  - Part 80, 90, etc.: Licensed
    - » Marine, Land-Mobile

  *SAR: ANSI C95.1-1991: Non-ionizing Radiation Hazards

Canada

Industry Canada Requirements

- ICES-CS03: Unintentional Emitters
  - Digital Apparatus
- RSS-GEN: Overall
- RSS-1xx: Licensed
  - Land mobile
- RSS-2xx: Unlicensed
  - Short range, low power

  - "Most" technical requirements harmonized with FCC

RF Safety Issues Human Exposure

ANSI C95.1

OET 65-C (phased out)

IEEE 1528

FCC Part 1.1307

FCC Part 2.1091 Mobile Devices

FCC Part 2.1093 Portable Devices

FCC Part 15.247 (b) (4), etc.

Various KDB Publications

RSS-102

SPR-002

FCC Equipment Authorizations

<u>Two Types of FCC Equipment Authorization</u>

Suppliers Declaration of Conformity (SDoC)
- Class A&B Digital Devices (computers & peripherals)
- Radio receivers (30–960 MHz, radar detectors, CBs)
- Other unintentional radiators (TVID, ISM, etc.)
- Test Lab need not be accredited (*unlike old DoC*)

Certification
- Intentional Transmitters (unlicensed and licensed)
- Everything subject to SDoC

ISED Authorization

Industry Canada (now ISED – Innovation, Science and Economic Development) has overview authority on RF Spectrum

- Similar technical limits and rules to FCC

- "Verification" for digital devices

- Certification for radio transmitters

Wireless Explosion

FCC Certifications in 2000: 4,011 devices (all by FCC)

FCC (+TCB) Certifications in 2017: 20,000 devices

- More than 50% of applications are for 15.247 (BT, ZigBee,11bgn)
- Power levels from mW to hundreds of watts
- Unlicensed low power devices proliferating
- Broadband technologies expanding
- Frequency Allocations expanding (both for 5G, and over 95 GHz)

Today 100% of FCC Certifications are performed by TCBs (and nearly 100% of ISED Certifications)

FCC CFR 47 Regulations

https://www.ecfr.gov/cgi-bin/ECFR?page=browse
http://transition.fcc.gov/oet/info/rules/

Part 2 General Requirements

Part 5 Experimental Radio Service

Part 15 Subparts C, D, E, F, G, H:

       Unlicensed Low Power Transmitters

Part 18 ISM Devices

Part 20 Commercial Mobile Services

Part 22 Public Mobile Service

Part 24 Licensed PCS

FCC CFR 47 Regulations

Part 25 Satellite Communication Services

Part 27 Miscellaneous Wireless Services

Part 30 Upper Microwave Flexible Use Services*

Part 68 Telecom Services

Part 73 Radio Broadcast Services

Part 74 Television Broadcast Services

Part 80 Maritime Services

*much interest for potential 5G usage

FCC and IC Regulations

FCC CFR 47 Regulations

Part 87 Aviation Services

Part 90 Private Land Mobile Radio Services

Part 95 Personal Radio Services

Part 96 Citizens Broadband Radio Services*

Part 97 Amateur Radio Services

Part 101 Fixed Microwave Services

*not your grandfather's CB!

KDB System

FCC's Knowledge Database system

- Most topics have some sort of guidance or KDB publications written about them
https://apps.fcc.gov/oetcf/kdb/index.cfm

- ISED accepts guidance from most of these (see ISED website for lists of accepted KDB Publications: https://www.ic.gc.ca/eic/site/ceb-bhst.nsf/eng/h_tt00080.html)

- KDB Inquiry system is used to ask the FCC about any policy issues, non-standard test methods, Rule interpretations, etc.

Unlicensed versus Licensed

<u>Licensed</u> devices/services are protected

<u>Unlicensed</u> devices are unprotected. Some historical basis in the Industrial Scientific and Medical (ISM) Bands (13.56 MHz, 2.4 GHz, e.g.,)

Unlicensed Device Examples

RFID (NFC)

Bluetooth

Cordless phones

Remote control devices (most)

UWB devices

Spread Spectrum

UNII

Unlicensed operation is <u>UNPROTECTED</u>
(may not cause interference, must accept interference)

Licensed Device Examples

Land mobile radio

Cellular telephones (blanket license)

Broadcast transmitters

Business radio applications

Radars

Licensed operation is <u>PROTECTED</u>
(licensees, e.g., carriers, pay $$$ for interference-free spectrum)

General Rules (CFR 47)

Part 2 of the FCC Rules covers general regulations & filing procedures which apply to all other Rule Parts

- About 20 different radio service Rule Parts which require equipment authorization
- Technical standards for licensed equipment are found in the various radio service Rule Parts (e.g. Part 22, Part 24, Part 25, Part 80, and Part 90, etc.)
- Technical standards for unlicensed equipment are found in Part 15

FCC and IC Regulations

General Rules

Rule Parts are developed by different groups at the FCC for the purpose of allowing different types of operations at various frequency bands across the frequency spectrum.

Each Rule Part may have unique technical requirements which need to be addressed in each application which may differ from the general requirements of Part 2.

General Rules

2.1046 to 2.1055 are the basic minimum requirements that apply to ALL Rule Parts

- Specifies types of data required, while the actual LIMITS are found in the Specific Rule Parts

Example: Part 90 device, Part 2 specifies frequency stability vs voltage and temperature from -30 to +50C, while Part 90 specifies limit at 2.5 ppm

General Rules

47 CFR Part 2.1046 - 2.1055

Tests required for all Devices*

2.1046 - RF power output
2.1047 - Modulation Characteristics
2.1049 - Occupied Bandwidth
2.1051 - Conducted Spurious Emissions
2.1053 - Radiated Spurious Emissions
2.1055 - Frequency Stability: Temperature & Voltage

*unless the specific Rule Part doesn't call these out
For example, there are no limits for Stability in much of Part 15

IC Radio Standard Specifications

RSS-GEN

RSS-102: RF Exposure

SPR-002 (Nerve Stimulation)

RSS-HAC

RSS 1xx: Licensed Devices

RSS 2xx: License Free Devices

http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/h_sf06129.html

Approximately fifty Titles in all

Measurement Standards

ANSI C63.4–2012: "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz"

ANSI C63.10—2012: "Standard for testing Unlicensed Wireless Devices"

ANSI C63.26—2015: "Standard for Testing of Transmitters Used in Licensed Radio Services"

*TIA-603D: "Land Mobile FM Or PM Communications Equipment Measurement And Performance Standards" – **Phased Out***

FCC Rules

KDB Publications (special procedures for DTS, UNII, DFS, mmWave, FHSS procedures etc.)

- FCC e-mail service for publications and notices. subscribe@info.fcc.gov

Status here: http://www.c63.org/documents/misc/matrix/c63_standards.htm

FCC and IC Regulations

FCC Application Process

- Device is tested at test lab that is both accredited to ISO/IEC 17025 for the testing performed **and** is <u>recognized by the FCC</u> ,i.e., listed on their Recognized Test Lab website:
https://apps.fcc.gov/oetcf/eas/reports/TestFirmSearch.cfm

- Collect all the technical documents required for certification and submit them, with the test report, to a TCB

- TCB reviews the application and uploads all the technical information and documentation to the FCC website

- TCB issues FCC Grant

  - A copy of the FCC Grant shown on the FCC site

FCC Application Process

Certification types:

- New Certification for a final product
- Permissive Change (c2pc or c3pc)
- Modular Approval
- Limited Modular Approval

Application Items

- Form 731
- Cover Letters (e.g., Agent Authorization)
- Request for Confidentiality (Long-term or Short-term, if desired)
- Test Report from Lab
- Modifications Performed During the Testing
- User's Manual
- Theory of Operation, Schematics and Block Diagram
- Test Setup Photographs & Internal / External Photographs
- FCC ID Label Artwork & Position on Device
- Attestation Statements (such as conditions of installation)

IC Application Process

- Device is tested at test lab that is both accredited to ISO/IEC 17025 for the testing performed **and** is <u>recognized by ISED</u>, i.e., listed on their Recognized Test Lab website: https://www.ic.gc.ca/eic/site/mra-arm.nsf/eng/nj00160.html

- Collect all the technical documents required for certification and submit them, with the test report, to a CB

- CB reviews the application and uploads all the technical information and documentation to the ISED website

- ISED places details of the certification on their own website, after they have completed their review, and lists the device on the Radio Equipment List (REL)

- TCB issues ISED Certification

  • Device can be seen on the REL

IC Application Process

Certification types:

- New Certification for a final product
- Permissive Change (c2pc, c3pc, or c4pc)
- Modular Approval
- Limited Modular Approval

Permissive Changes

- If you change the transmitter, you need a new authorization, perhaps a new Certification

- If you change the supporting electronics or other (non tx) aspects of the device, you may be eligible for a **Permissive Change**
  - Class I Permissive Change: Changes that do not degrade the RF characteristics
  - Class II Permissive Change: Changes that do degrade the RF characteristics (application required, c2pc grant issued)

Permissive Changes

<u>Section 2.932 and KDB Pub.178919</u>:

Changes to the basic **frequency determining** and **stabilizing circuitry** (including clock and data rates), frequency multiplication stages, basic modulator circuit or maximum power or field strength ratings…

<u>will always require a new FCC ID and a new equipment authorization application</u>.

Permissive Changes

<u>Fundamental emission</u> - Any increase in the fundamental emission for output power rated devices (i.e., those that list output power on the grant) requires authorization under a new FCC ID.

<u>Spurious emissions</u> - an increase of up to 3 dB from the original authorization may be considered a c1pc, if the emission level remains compliant. An increase of more than 3 dB triggers a c2pc.

Permissive Changes

Class I: Change in non-RF portion of circuitry that doesn't affect output characteristics or **conditions** on the GRANT, e.g.,

- Power Regulator
- Baseband digital circuit
- Housing change that doesn't affect shielding
- Software change (depends)

Class II:

- Software changes adding frequencies
- Additional antenna (possibly)
- Filter/layout change on output
- Layout change in RF portion of board

Permissive Changes

Hardware Changes (replacements) Allowed

- The new chip component is pin-for-pin compatible.

- The new chip has the same basic function as the old chip, from an external perspective (internal circuitry may differ).

- No change in radio parameters has occurred.

- The same conditions apply when a small are(approximately the same area as the chip) of the PCB is replaced with an equivalent chip.

Permissive Changes

Hardware Changes Not Allowed

- Versions of a device with different internal active hardware components (e.g., amplifiers and crystals) that result in different radio parameters (e.g., output power, frequency) or that result in the device not being electrically identical

- Adding or subtracting an on-board amplifier component (except exact replacements)

- Depopulated version of transmitter

New FCC ID Required

What is a Modular Approval?

- The intent of modular approvals for Part 15 devices
    - Approval of modular transmitter circuitry that could be used in a variety of devices without requiring those devices to obtain subsequent and separate FCC approvals.
    - To afford relief to equipment manufacturers by eliminating the requirement for a new FCC ID when the same transmitter is installed in a new device.
    - Current requirements specified in Section 15.212 and KDB Publication 996369, and RSP-100)5), Annex D

What is a Modular Approval?

– The intent of modular approvals has never been to eliminate the need for the host manufacturer to perform testing on their host device with the module installed. Rather, the intent is to reduce the number of re-certifications required for re-use of the same transmitter.

– At a minimum, various spotcheck tests must be performed to ensure that installation in a specific host does not cause the module to operate outside of its certified parameters.

Modular Approvals

KDB Publication 996369:

<u>D01</u> - Module Certification Guide (general requirements)

<u>D02</u> - Module Q&A (FAQ's)

<u>D03</u> - OEM Manual (Installation Guide requirements for module manufacturers)

<u>D04</u> – Module Integration Guide (guidance and requirements for host product manufacturers, including required testing guidance)

Modular Approvals

- The module is certified for the operation shown in the application

- Module Grantee or Certificate holder **always remains responsible for module compliance**

- In case of ix complaint, FCC begins by assuming equal responsibility for module **and** host manufacturers

- Host device must reference the certified module and its ID or Certification Number ("Contains FCC ID: ABCnnnnnnnnn"), so the end-user can identify both the host and the module manufacturers.

Full Modular Approval

Tested alone for use in any host

- FCC Certification to Part 15.212
- ISED Certification to RSP-100 section 5 & Annex D

Must meet 8 important criteria:

- RF Shielding
- Voltage Regulator(s)
- Data Buffers
- Antenna requirements
- Correct Labelling
- RF Exposure requirements
- Tested Stand-Alone
- Comply with rule part or RSS

Limited Modular Approval

Tested with a host

- This is used if the device does not meet one of the 8 requirements and therefore cannot achieve Modular Approval, however it can be used with specific host(s) identified during certification

- Installation is controlled (usually own host)

  • Often used by manufacturers to deal with variations in products

Licensed Modules

Licensed modular transmitters are not the same as Part 15 Modular Approvals.

- While having many items in common, licensed modules are not specifically subject to the Modular Approval rules in 15.212.

- These are licensed transmitters and are not subject to the requirements of Part 15 wrt output power, field strength, etc., but to the specific licensed Rule Part.

- Nevertheless, the FCC (strongly) encourages licensed module manufacturers to follow the (8) requirements specified for unlicensed modules

Modular Approval Common Problems

The most common issues are:

- Understanding the 8 requirements.

- Understanding that the original grantee is always responsible for the module in the final host.

- • Compliance of the module in any device (host) into which it is installed remains the responsibility of the module grant holder, and is shared with the host device manufacturer.

- • Consequently, original grant holder of the module must be able to have some control over how it is installed in any host device (typically contractual).

Problems continued

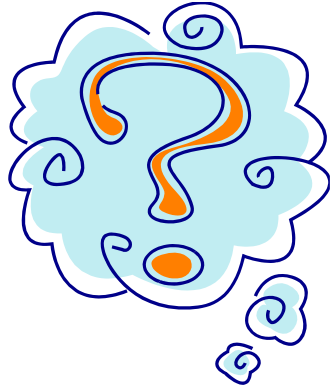- Determining how to address RF exposure issues in each and every device in which the module is installed.

- Not understanding RF shielding is necessary, even if the module meets the limits in a stand alone configuration without any shielding (intent is also to protect module).

- Not understanding that the antenna reference trace design is authorized as part of the module.

QUESTIONS

FCC and IC Regulations