



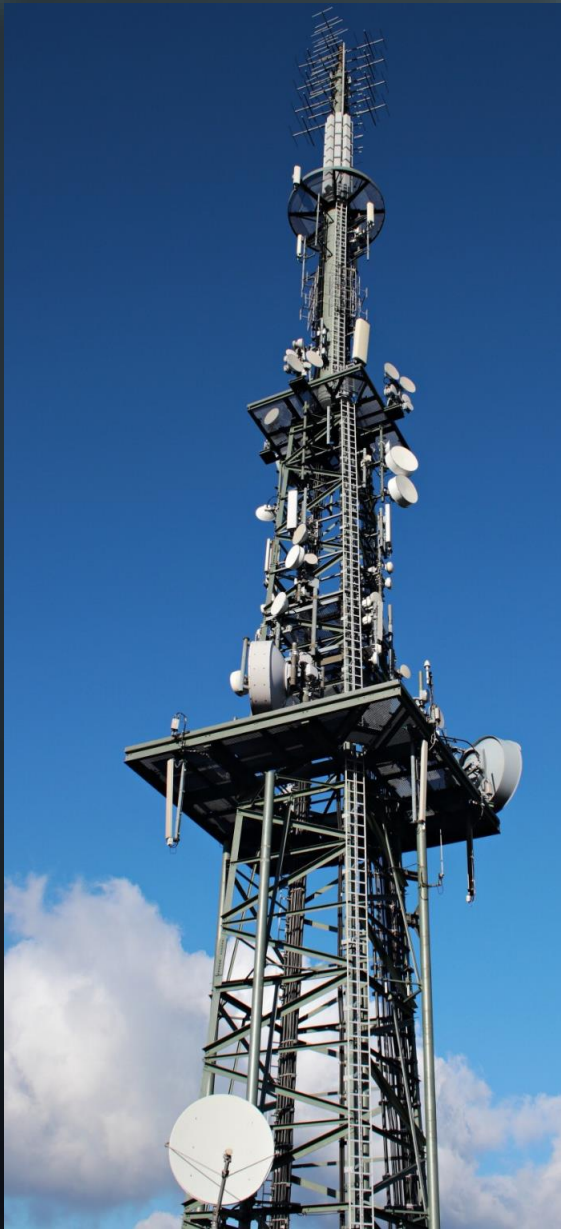
3 WAYS TO FAIL AN RFI EMISSIONS TEST

PRACTICAL EMC EXAMPLES FOR PRODUCT DESIGN

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BACKGROUND



RADIOCOMMUNICATIONS

- Commercial development circa 1900
- Television commercially available in 1930s
- Critical for military applications in WWII
- Critical for emergency response 1950s and 60s
- EMC regulations to prevent interference in 1980s
- Digital communications expansion in 1990s
- Evolved differently in each country

UNITED STATES FREQUENCY ALLOCATIONS THE RADIO SPECTRUM

RADIO SERVICES COLOR LEGEND

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ACTIVITY CODE

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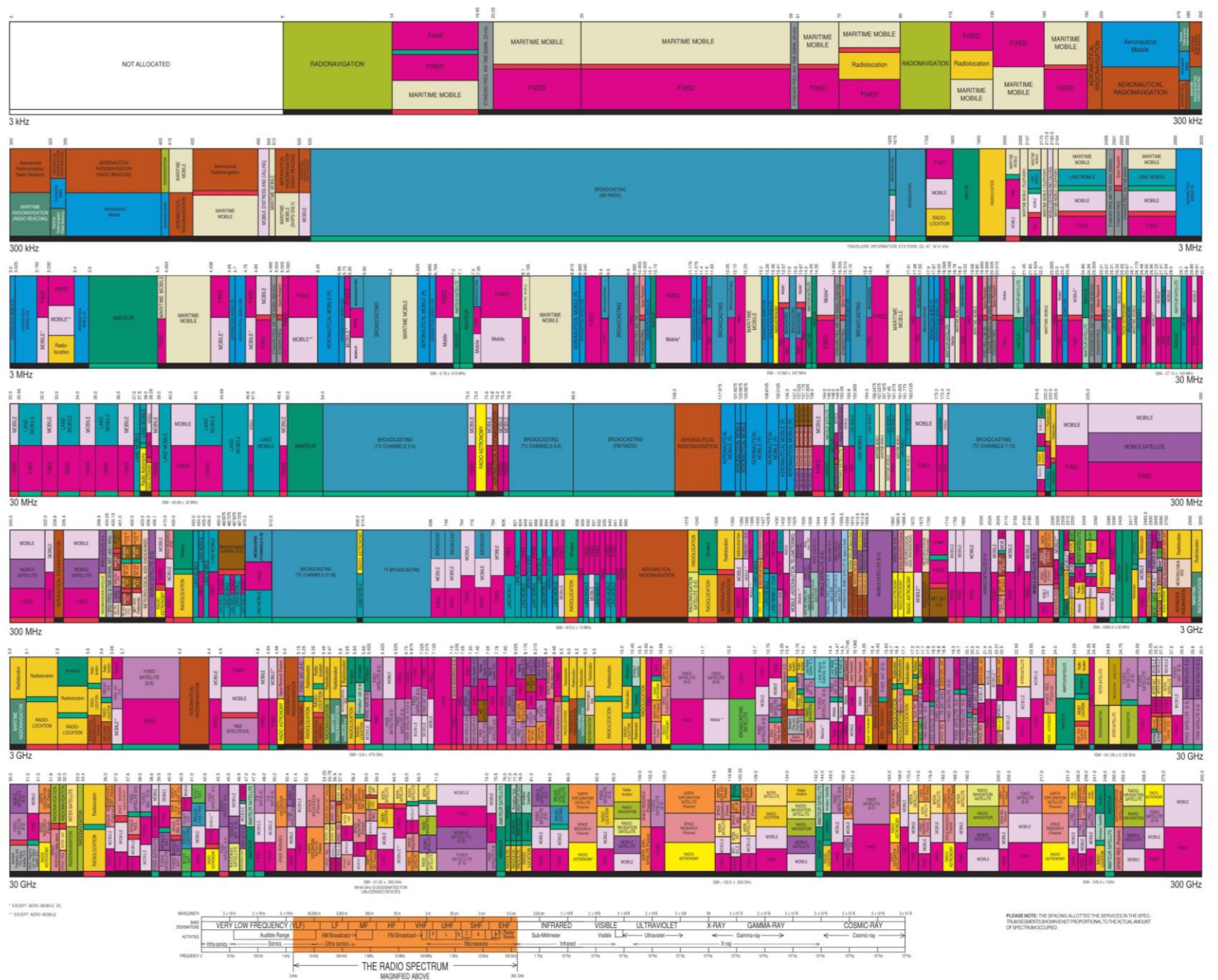
ALLOCATION USAGE DESIGNATION

SERVICE	EXAMPLE	DESCRIPTION
Primary	FIXED	Capital Letters
Secondary	Mobile	1st Capital with lower case letters

This chart is a graphic single point-in-time portrayal of the Table of Frequency Allocations used by the FCC and NRTA. As such, it does not completely reflect all aspects, i.e., transitions and recent changes made in the Table of Frequency Allocations. Transition, for example, information, users should consult the Table to determine the current state of U.S. allocations.



U.S. DEPARTMENT OF COMMERCE
National Telecommunications and Information Administration
Office of Spectrum Management
October 2003



EMC GOVERNING BODIES



JURISDICTION	ITE	RADIO	APPLIANCE	MEDICAL
UNITED STATES	FCC	FCC	Exempt	FDA/CDRH
CANADA	Industry Canada	Industry Canada	Exempt	Health Canada
BRAZIL	INMETRO	ANATEL	INMETRO	ANVISA
EUROPEAN UNION	EMC Authority Verification	Spectrum Authority Verification	EMC Authority Verification	Medical Authority Verification
JAPAN	VCCI	MIC	METI	MHLW
CHINA	CNCA	CNCA	CNCA	SFDA, MOH
TAIWAN	BSMI	NCC	BSMI	DOH

Source: [https://www.ieee.li/pdf/essay/guide to global emc requirements 2007.pdf](https://www.ieee.li/pdf/essay/guide%20to%20global%20emc%20requirements%202007.pdf)

THREE COMMON EMC FAILURES





FAIL #1

NOT UNDERSTANDING THE REQUIREMENTS OF THE SALES REGION

EVERY COUNTRY IS DIFFERENT

WORLDWIDE REQUIREMENTS



- Products must show compliance with local EMC laws before being placed on the market
- Some countries require in-country testing, e.g.: Brazil, Russia, and China
- Regulatory compliance includes verification, declaration, certification, documentation, and labeling
- Product development specifications should include sales region



FAIL #2

UNINTENTIONAL RADIATION

TRANSMITTING EXCESSIVE ELECTRICAL NOISE

UNINTENTIONAL RADIATOR (FCC)

REQUIRES FCC EQUIPMENT AUTHORIZATION

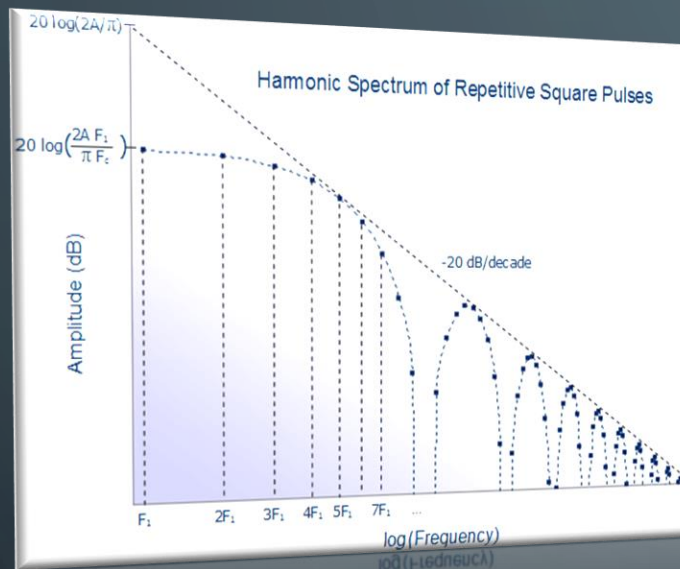
UNINTENTIONAL RADIATORS (Part 15, Subparts B and G)

An unintentional radiator (defined in [Section 15.3 \(z\)](#)) is a device that by design uses digital logic, or electrical signals operating at radio frequencies for use within the product, or sends radio frequency signals by conduction to associated equipment via connecting wiring, but is not intended to emit RF energy wirelessly by radiation or induction.

Today the majority of electronic-electrical products use digital logic, operating between 9 kHz to 3000 GHz and are regulated under [47 CFR Part 15 Subpart B](#).

Source: FCC Equipment Authorization Approval Guide

FAST SWITCHING CIRCUITS



- Fast switching circuits (high slew-rate) represent an impulse response with high harmonic energy
- Switching harmonics will find conductors of appropriate length and radiate

Image provided by Mosaic Industries: <http://www.mosaic-industries.com/embedded-systems/microcontroller-projects/reducing-emi/slew-rate-limiter>

MOTORS

- Direct broadband radiation from brushes
- Direct radiation through speed modulation
- Conducted broadband noise from commutation



SHIELD TERMININATION

- 360 degree termination is required at both ends
- Never use pigtailed to terminate a shield

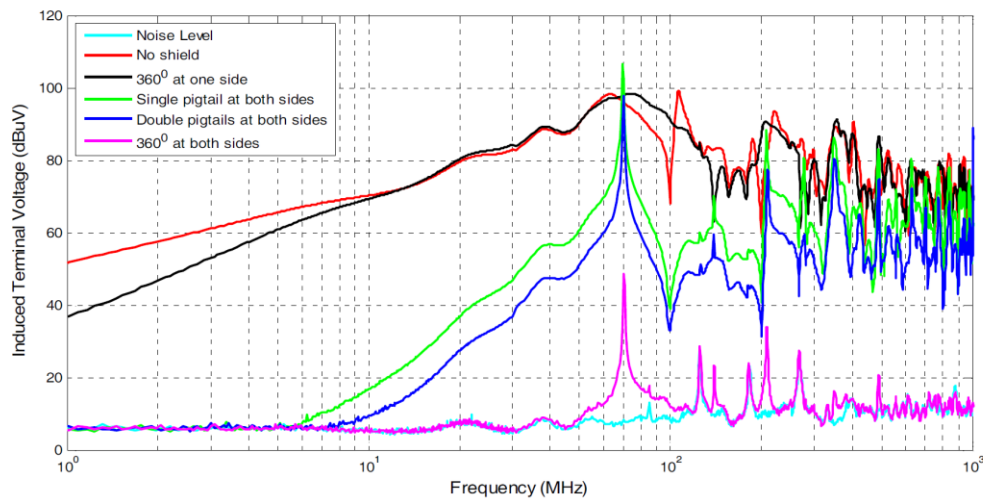
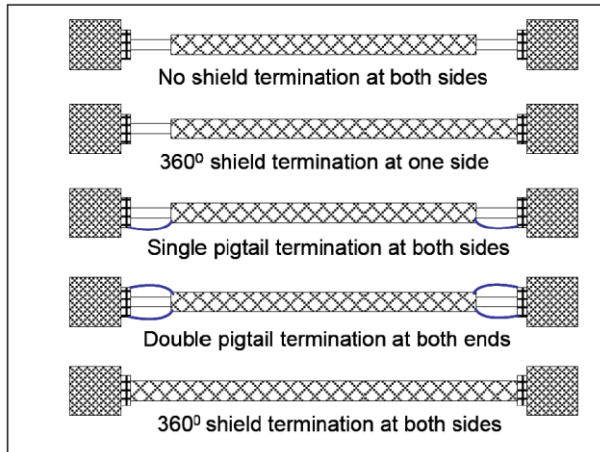
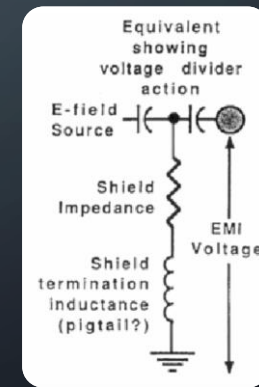


Figure 3: Measurement results on RG-223 coaxial cable for different shield terminations.





COMPLIANT COMPONENTS

- Using compliant components does not mean the final product will be compliant
- Components are tested under specialized conditions with specific power supply and cabling requirements

FAIL #3

TRANSMITTERS

CELLULAR, WIFI, BLUETOOTH, ETC.

A TRANSMITTER MUST BE CERTIFIED FOR SPECIFIC USE



INTENTIONAL RADIATOR (FCC)

REQUIRES FCC LICENSE

INTENTIONAL RADIATORS (Part 15, Subparts C through F and H)

An intentional radiator (defined in [Section 15.3 \(o\)](#)) is a device that intentionally generates and emits radio frequency energy by radiation or induction that may be operated without an individual license.

Examples include: wireless garage door openers, wireless microphones, RF universal remote control devices, cordless telephones, wireless alarm systems, Wi-Fi transmitters, and Bluetooth radio devices.

Source: FCC Equipment Authorization Approval Guide

TRANSMITTERS



Features

- Qualcomm® Snapdragon™ Wear 2100 processor (APQ8009W)
- 31.5mm x 15mm
- 2x 100 pin board to board connectors
- 512MB LPDDR3 RAM, 4GB eMMC FLASH
- Qualcomm® PMIC (PM8916-1)
- Pre-Certified (planned) Qualcomm® WiFi/BT (WCN3620)
- Gen 8C GNSS (WGR7640)
- Android 7 Customized for Wearable products



- Products with intentional radiators must be certified for operation by the FCC
- Certification is granted for only for specific types of operation and operating conditions
- Transmitting components with ‘modular’ compliance allow their license to be used by the end-product when applied according to specific rules established by the manufacturer and the FCC
- When using a module, all licensing and host requirements should be investigated *before* designing into the product