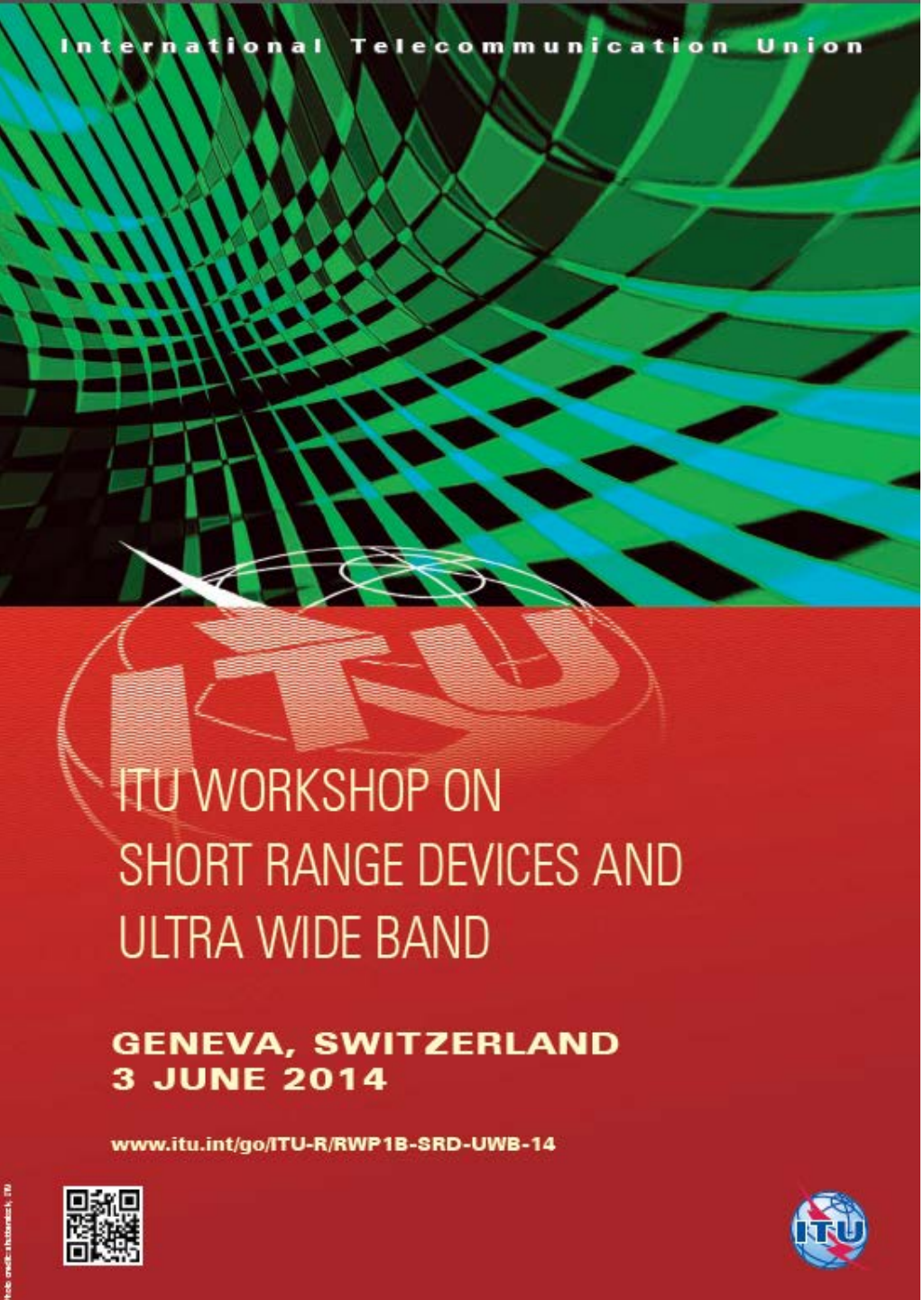

ITU WORKSHOP on
SHORT RANGE DEVICES (SRDs)
AND ULTRA WIDE BAND (UWB)
(Geneva, 3 June 2014*)

International, regional and national regulation of SRDs

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** in conjunction with the June 2014 block of meetings of ITU-R Study Group 1*

ISM Bands: RR

6 765-6 795 kHz	(centre frequency 6 780 kHz)	FN 5.138
13 553-13 567 kHz	(centre frequency 13 560 kHz)*	FN 5.150
26 957-27 283 kHz	(centre frequency 27 120 kHz)	FN 5.150
40.66-40.70 MHz	(centre frequency 40.68 MHz)	FN 5.150
433.05-434.79 MHz	(centre frequency 433.92 MHz)in Region1**	FN 5.138
902-928 MHz	(centre frequency 915 MHz) in Region 2	FN 5.150
2 400-2 500 MHz	(centre frequency 2 450 MHz)	FN 5.150
5 725-5 875 MHz	(centre frequency 5 800 MHz)	FN 5.150
24-24.25 GHz	(centre frequency 24.125 GHz)	FN 5.150
61-61.5 GHz	(centre frequency 61.25 GHz)	FN 5.138
122-123 GHz	(centre frequency 122.5 GHz)	FN 5.138
244-246 GHz	(centre frequency 245 GHz)	FN 5.138

Note: 6.780MHzx2=13.560MHz; 6.780MHz x4=27.120MHz; 6.780x6=40.680MHz; 6.780MHzx32=433,920MHz
61.25 GHz x2= 122.5 GHz; 61.25 GHz x4=234 GHz

* Europe has included recently 2 new 13.56 MHz masks up to 60 dBuA/m in annex 9 of 70-03

** except in the countries mentioned in No. 5.280 (very strange; as 5.280 specifies ISM…) 5.280 In Germany, Austria, Bosnia and Herzegovina, Croatia, The Former Yugoslav Republic of Macedonia, Liechtenstein, Montenegro, Portugal, Serbia, Slovenia and Switzerland, the band 433.05-434.79 MHz (centre frequency 433.92 MHz) is designated for industrial, scientific and medical (ISM) applications. Radiocommunication services of these countries operating within this band must accept harmful interference which may be caused by these applications. ISM equipment operating in this band is subject to the provisions of No. 15.13. (WRC-07)

15.13§ 9 Administrations shall take all practicable and necessary steps to ensure that radiation from equipment used for industrial, scientific and medical **applications is minimal** and that, outside the bands designated for use by this equipment, radiation from such equipment is at a level that does not cause harmful interference to a radiocommunication service and, in particular, to a radionavigation or any other safety service operating in accordance with the provisions of these Regulations.

Definitions

- The regulatory framework for SRDs, such as the decision on frequency bands for use by SRDs, is a national matter
- ITU RR No. **1.19 -** *radiocommunication service:* A service as defined in this Section involving the transmission, *emission* and/or reception of *radio waves* for specific *telecommunication* purposes
- SRDs are not a "Radio Service" under ITU Radio Regulations (RR); thus they cannot get primary or secondary allocation
- SRDs are emissions without a corresponding frequency allocation in the RR
- SRDs are not ISM applications, as defined in No. 1.15 of RR
- SRD covers radio transmitters, providing either unidirectional or bi-directional communication, with low capability of causing interference to other radio equipment
- For SRDs individual licenses are normally not required
- SRDs are permitted to operate on *non-interference* & non-protected basis
- In general SRDs cannot claim protection from radio services, intentional or unintentional radiator, by ISM equipment, or by an incidental radiator
- SRDs are deployed in both bands designated for **ISM** applications and bands not designated for ISM applications. ISM band is **sufficient** condition **but not obligatory**; SRD band is different than ISM band

Common RF bands for SRDs: ISM & NON-ISM bands

9-148.5 kHz; 3 155-3 400 kHz

72-72.25 MHz

315 MHz

402-405 MHz

ISM bands

6 780 kHz; 13 560 kHz

27 120 kHz; 40.68 MHz

433.92 MHz in Region1

915 MHz in Region2

2 450 MHz; 5 800 MHz

24.125 GHz; 61.25 GHz

122.5 GHz; 245 GHz

864.8-865 MHz

5470-5725 MHz

Non-ISM bands

SRDs: new multiplexing, spreading & modulation techniques, for enhanced data-rate & to avoid interference

- Orthogonal frequency-division multiplexing (OFDM) is the modulation and multiplexing of Wi-Fi 802.11a and g
- Coded Orthogonal Frequency-Division Multiple Access (COFDM) is used in Wi-Fi 5GHz (IEEE802.11.a) as signal modulation technique; COFDM sends a stream of data symbols in a parallel, with multiple subcarriers (i.e. small slices of spectrum within the designated carrier RF band)
- Spread-spectrum techniques:
  - Direct-sequence spread spectrum (DSSS) is used at Wi-Fi IEEE 802.11b and ZigBee IEEE 802.15.4; ZigBee is basically a 10-meter range with transfer rate of 250 kbit/s
  - Frequency-hopping spread spectrum (FHSS) is used for Bluetooth IEEE 802.15.1; Bluetooth enables exchanging data over short distances from fixed and mobile devices
- Complementary Code Keying (CCK) is the modulation scheme used with wireless networks (WLANs) that employ the IEEE 802.11b operating at either 5.5 or 11 Mbit/s

Need of Harmonization

- *So begins Leo Tolstoy's Anna Karenina: 'All happy families are alike; each unhappy family is unhappy in its own way'*
- *Between 2 points in a plane there is only one simple line, but indefinite curves*
- *'Great minds think alike' (Michaelian)*
- *'Stand on the shoulders of giants' (also I. Newton)*
- *'Okham's Razor': 'if you have to choose between competing theories, choose the simplest theory- it is most likely to be true*
- *E Pluribus Unum, Out of many, one; this message is carried by the American Eagle*

Need of SRD Harmonization (cont.)

- Globalization & harmonization create a “connected world, offering free circulation of SRDs & worldwide roaming
- However, the risk in adopting regional harmonisation is contrasted with the harm caused to the independence of decision-making, and to the optimisation of the RF spectrum to local needs; see Recommendations 4.1 to 4.5 Martin Cave Report (2002:35) about the risks of harmonisation
- Administrations may learn from Europe & compromise their sovereignty to achieve regional RF harmonisation
- Don’t invent your national ruling
- Harmonized RF eases scale production, coordination, roaming/ nomadic devices. How non-harmonized RF will enable roaming of Wi-Fi or ITS devices?

Regulating SRDs

Regulators pay most attention to the RF bands of cellular & SRD

Administrations define: RF bands, power, channel spacing & mitigation requirements

Reducing interference: Indoor, Internal antenna, Duty Cycle and Activity Factor, Dynamic Frequency Selection (DFS), Adaptive Frequency Agility (AFA), Listen Before Talk (LBT), Aloha: Carrier Sensing (CS) and Collision Detection (CD), Transmitter Power Control (TPC), One-Time Programmable (OTP), Spread-spectrum techniques such as Frequency-Hopping Spread Spectrum (FHSS)

Risk vs. Risk: delays in allocation, reducing RF power & BW of SRD or UWB may preclude the entry of innovative technologies. Benefit vs. Benefit: more RF resources available to the citizen & more RF power & BW for SRDs advance rapid growth of new technologies and services. More RF, less congestion and less 'tragedy of commons' in the RF 'public park'

SRD is unprotected; we shouldn't evolve interference to SRD, but *Caveat Emptor* (buyer beware): the SRD buyer will decide to buy, even that SRD may be interfered

Will first responders use 'unprotected' RF bands?

Don't repeat measurements from professional test houses

No need to regulate non-active RFID: *de minimis non curat lex*

Placing on the market, approvals & labeling

- SRDs move thru borders. Administrations should regulate how to place the SRD and label it
- Marking of SRDs indicates its conformance to relevant international, regional and national regulations
- Most administrations require at least that the logo or name of the approval authority is labeled, along with the approval number
- Administrations may establish mutual agreements between countries/regions for the recognition by one country/region of the conformity test results of a recognized/accredited test laboratory in the other country/region
- To use SRDs on board aircraft, regulators may allow usage under conditions; however, for aviation safety aspects, the right bodies to address this matter remains the responsibility of aircraft manufacturers or aircraft owners who should consult with ICAO International Civil Aviation Organization, the relevant regional and national bodies, before installing SRDs on A/C

Placing on the market: Europe

- ETSI has developed harmonized European standards for the majority of SRDs. Other standards or technical specifications are applicable within the framework of the R&TTE Directive for placing on the market.
- R&TTE Article 4.1 defines the equipment two classes; EC Commission Decision 2000/299/EC identifies in Article 1 two classes (see next slide)

Labeling SRD in Europe

- The CE marking indicates compliance with EU legislation and so enables the free movement of products within Europe. By CE marking a manufacturer declares, that the product meets all the legal requirements for the CE marking, & product can be sold throughout the European Economic Area (EEA, 28 Member States of the EU & European Free Trade Association (EFTA) countries Iceland, Norway, Liechtenstein
- The SRD labelling indicates that the equipment operates according to specific requirements

Labeling SRD in Europe

- R&TTE Directive, Article 12 (CE-marking) states that “any other marking may be affixed to the equipment provided that the visibility and legibility of the CE-marking is not hereby reduced”
- The CE-marking has to be placed on the product or affixed to the packaging and the accompanying document. The CE marking shall consist of the initials 'CE' taking the following form

Placing on the market: America

- Any Part 15 ‘‘Radio Frequency Devices’ ’transmitter must be tested and authorized before it may be marketed
- There are two ways to obtain authorization: Certification & Verification. Report ITU-R SM.2153 - pages 37-39 - specifies the two ways
- Certification and Verification procedures require that tests be performed to measure the levels of RF radiated. After these tests have been performed, a report must be produced

Frequency ranges for regional harmonization of SRDs

based on Recommendation SM 1896 (Region 3 Available in some countries)

RF range	Remarks	Region 1	Region 2
7 400-8 800 kHz		Available	Available
312-315 MHz	These bands are exchangeable in terms of applications but not always available at the same time in one country. 433.050-434.790 MHz is an ISM band (RR No. 5.138 in Region 1) except for countries mentioned in RR No. 5.280. Centre frequency 433.92 MHz. The whole of these bands can be considered as a tuning range. However, they may not be completely available in some countries. See national regulations	Available in some countries	Available
433.050-434.790 MHz		Available	Available in some countries
862-875 MHz	The whole of this band can be considered as a tuning range. Only parts of this tuning range are operationally available in each country due to the use by commercial mobile systems. See national regulations	Available	**Not available**
875-960 MHz	902-928 MHz is an ISM band in Region 2 (RR No. 5.150). Centre frequency 915 MHz. The whole band can be considered as a tuning range. Only parts of this tuning range are operationally available in some countries. The band 880-960 MHz is not available for SRDs in a number of countries due to the use by commercial mobile systems	Available in some countries	Available. See remarks

Harmonised RF bands in seven* Asia Pacific countries, based on Table 1 APT Report APT/AWG/REP-07

Typical Applications	RF /RF band (MHz)	Range of the max power level
Cordless Phones/Telemetry	315	25uW to 10mW e.r.p
Medical Implant	402-405	25uW e.r.p
RFID	433.92	1mW to 25m W e.r.p
WLAN	2400-2483.5	10mW to 1000mW e.i.r.p
Vehicle Radar	76000-77000	10mW to 100W e.i.r.p

* Brunei Darussalam, Hong Kong, Japan, Korea, Malaysia, Philippines, New Zealand and Singapore

Harmonised RF bands in five* Asia Pacific countries, based on Table 2 APT Report APT/AWG/REP-07

Typical Applications	RF band (MHz)	Range of maximum power level
RFID	13.553-13.567	100 mW* (e.i.r.p.) / 42 dBµA/m @10m
	26.96-27.28	0.5W to 3W e.r.p./42 dBµA/m @ 10m
Model Control	40.66-40.70	100 mW to 1000mW e.r.p.
	72-72.25	10 mW to 750 mW e.r.p.
Cordless Phones	864.8-865	10 mW to 1000 mW e.r.p.
WLAN	5725-5850	10 mW to 4W e.i.r.p.

Strange! assuming far-field free-space $|\vec{s}|=|\vec{e}|*|\vec{h}|=\frac{e^2}{120\pi}=120\pi h^2=pd=\frac{eirp}{4\pi d^2}$ magnetic field is independent on RF, for 42 dBµA/m at 10 m, ERP = 42-35.38= 6.62 dBm; circa 5 mW; not 100 mW nor 0.5W to 3W

* Hong Kong, Korea, Philippines, New Zealand and Singapore

Possible RF bands to harmonize SRD within Asia-Pacific, based on APT/AWG/REP-35 table 2

Frequency band	Typical Application	Remarks
402-405 MHz	Medical Implant	APT REC-05
433.05-434.79 MHz	RFID	APT REP-07
862-960 MHz	RFID	APT REC-03
5150-5350 MHz	WLAN	APT REC-06
5470-5725 MHz	WLAN	
76-77 GHz	Vehicle Radar	APT REP-07

SRDs regulation & standardisation are divided into 2-3 major camps: Europe, N. America & Asia

Licensing: Part 15 'Radio Frequency Devices'; influence of the European 70-03 and R&TTE on Africa and West Asia is compared to the influence of the US on Canada, Mexico (NAFTA), Brazil and Latin America

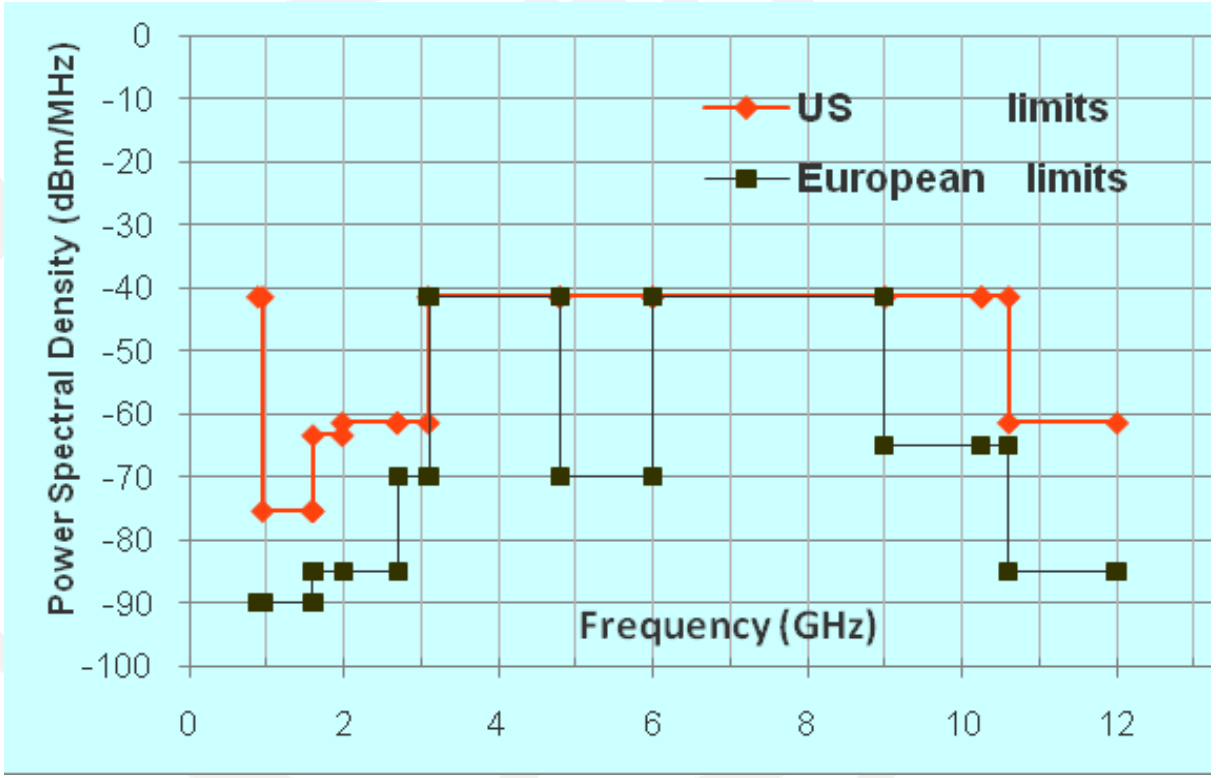
Part 15 *Licence-Exempt Devices vs. Short Range Devices*

FCC Part 15 originated in 1938, inspired the European SRD concept (~1990) and ERC/REC 70-03; In US and Canada most of the RF is available to SRD Europe permits lower emissions: e.g., e.i.r.p. 0.1W versus 4W at 2.4 GHz Europe constrains Wideband Data Transmission in 5150–5350 MHz, to only indoor use; EU R&TTE is more liberal: self-conformity not FCC *ex-ante* certification; *laissez passer;* tests *ex-post* . Different processes to update the 70-03 and part 15; e.g. periodic updates of 70-03 and First Report and Order (First R&O) Released: April 1, 2014, adding over 100 MHz to the U-NII at 5.725-5.85 GHz

Neutrality (?): 70-03 specifies 13 annexes detailing different applications; Part 15 normally doesn't specify application (except U-NII (Unlicensed-National Information Infrastructure operating); technology is enforced, such as 75 frequency hopping systems employing at least 75 non-overlapping hopping channels'. Neutrality will advance the SRD use and harmonization

UHF RFID: Americas versus Europe

	RF band (MHz)	Max e.i.r.p. power (Watts)	Channels (kHz)	Total RF BW(MHz)	Approval process
Europe	865-868	up to 2 (e.r.p.) x 1.64=3.28	15 x 200	3	*R&TTE*
Americas	902-928	4*	52 x 500	26	US tests every RFID



UWB emission masks in Europe and the US

Differences up to 49 dB@900-960MHz; Europe allowed UWB in 2005, US in 2001

Foreign influence revealed via units of electric & magnetic fields, thresholds and technology

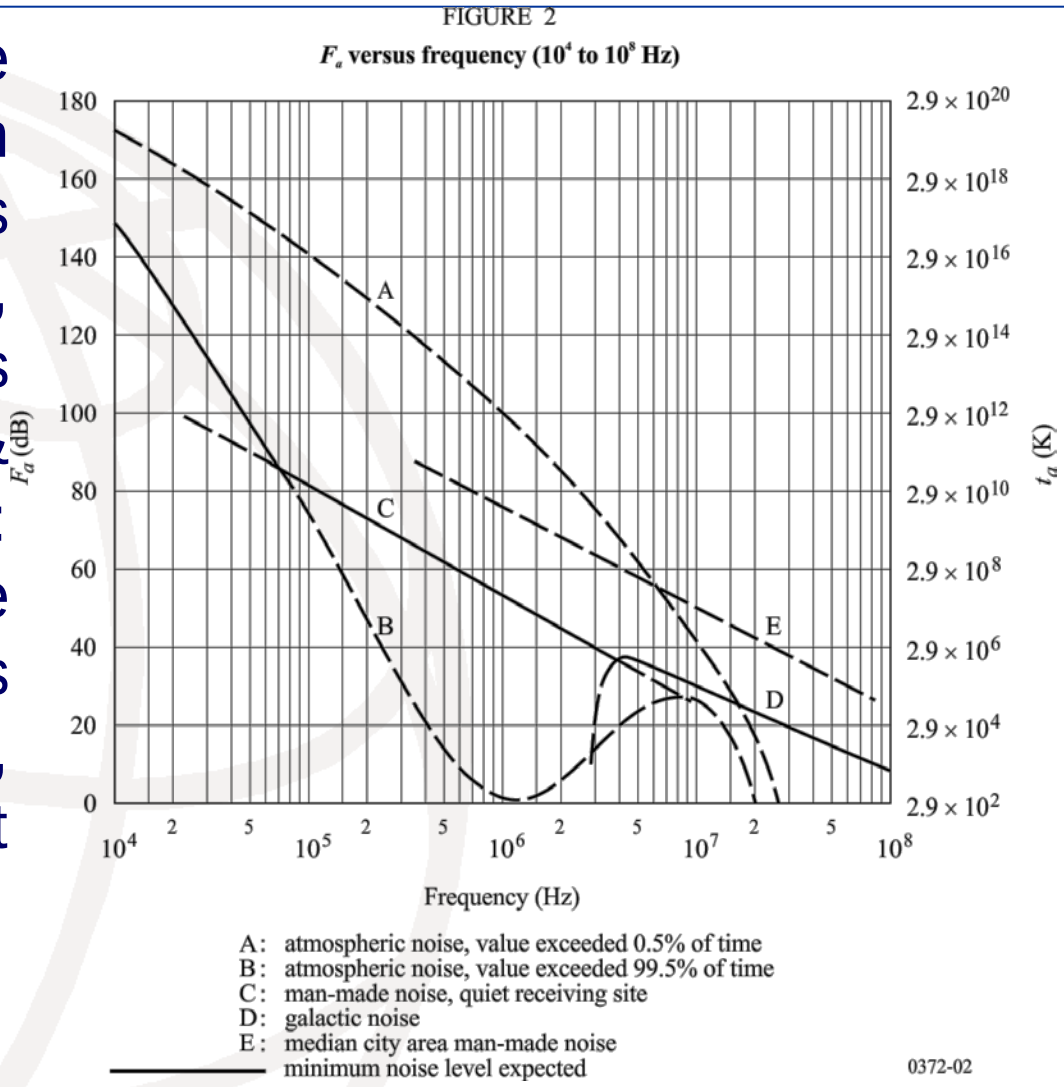
- For RF lower than 30 MHz, power limits are usually converted to magnetic fields at 10 m; see Rec. 70-03. The magnetic field strength (*h*) unit is the A/m. The magnetic field strength may be expressed in µA/m or dB(µA/m)
- 70-03 uses logarithmic dB µA/m magnetic-fields at 10 m. Use of dB µA/m unit globally reveals European 70-03 influence. Examples: first 2 rows at Table 2 APT Report APT/AWG/REP-07 and Chinese SRD equipment A, 10 to 190 KHz 72 dB(µA/m) at 10 m
- Below 1,000 MHz, ERP is used; see as example Table 1 APT Report APT/AWG/REP-07
- Most of Part 15 of the American FCC Regulation 47 CFR emission limits are specified in field strength; numeric units V/m, mV/m and µV/m; and not the logarithmic dB V/m, dB mV/m or dB µV/m; mainly at 3 m distance; 30 m (at 490 to 30,000 kHz) and 300 m (at 9 to 490 kHz) are also used. Japan, Korea, some Latin Americas and many other countries follow this procedure for SRDs; it reveals the Part 15 influence
- 70-03 influence into Chinese ruling: 'automotive radars' (collision avoidance radars) RF 76 to 77 GHz, limit 55 dBm (peak e.i.r.p.); see RF and limit at 70-03 Annex 5- Transport and Traffic Telematics (TTT)
- Chinese 'Digital cordless telephone 2 400-2 483.5 MHz band should use at least 75 hopping frequencies' is influenced by FCC 47CFR§15.247

Rec. SM.1896 annex1: RF for global harmonization of SRDs

RF Range	Remarks
9-148.5 kHz	Inductive SRD applications
3 155-3 400 kHz	Inductive SRD applications RR No. 5.116 (wireless hearing aids)
6 765-6 795 kHz	Inductive SRD applications **ISM band** (RR No. 5.138) Centre frequency 6 780 kHz
13.553-13.567 MHz	Inductive SRD applications; **ISM band** (RR No. 5.150); Centre frequency 13.560 MHz; level of side band suppression is dependent on national regulations
26.957-27.283 MHz	Inductive SRD applications/non-specific SRDs; **ISM** band (RR No. 5.150); Centre frequency 27 120 kHz
40.66-40.7 MHz	**ISM** band (RR No. 5.150); Centre frequency 40.68 MHz
2 400-2 500 MHz	**ISM** band (RR No. 5.150); Centre frequency 2 450 MHz
5 725-5 875 MHz	**ISM** band (RR No. 5.150); Centre frequency 5 800 MHz
24.00-24.25 GHz	**ISM** band(RR No. 5.150); Centre frequency 24.125 GHz
61.0-61.5 GHz	**ISM** band (RR No. 5.138); Centre frequency 61.25 GHz
122-123 GHz	**ISM** band (RR No. 5.138); Centre frequency 122.5 GHz
244-246 GHz	**ISM** band (RR No. 5.138); Centre frequency 245 GHz

Interference of SRDs to Radiocommunications services
At low RF no significant degradation

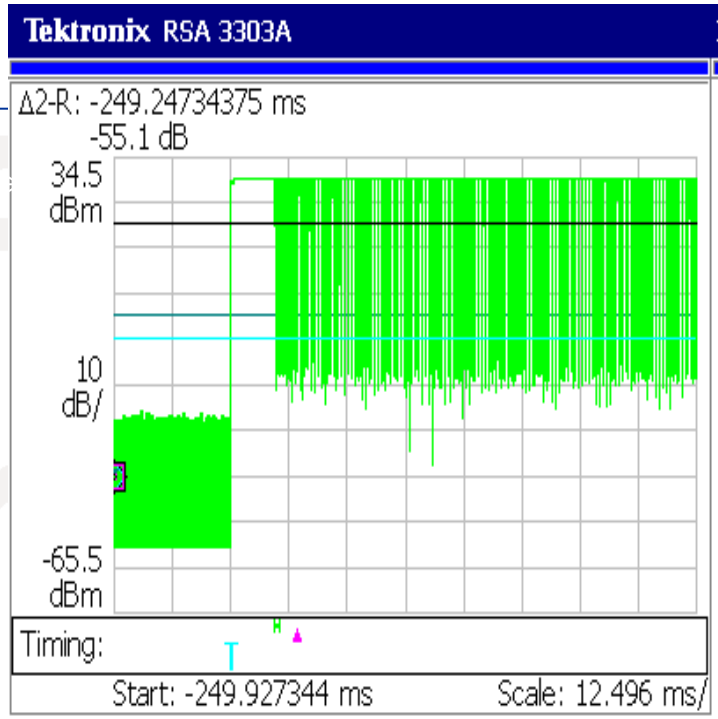
Below 30 MHz, external noise is most influential at victim receiver. Thus, as atmospheric, man-made, galactic noises and emissions from atmospheric gases & hydrometeors are dominant: they are stronger than the KTBF power. Therefore, SRDs operating below 30 MHz, interfere less than SRDs at higher frequencies

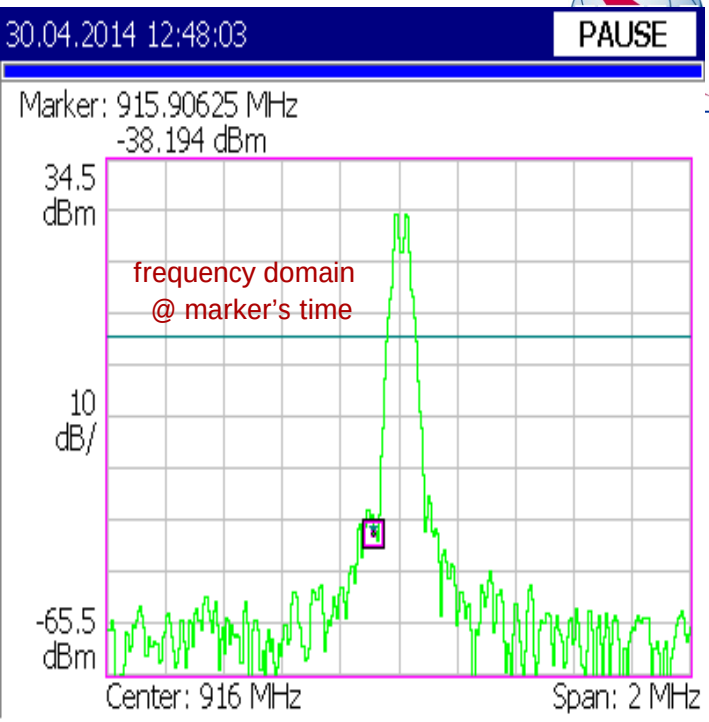


Atmospheric and man-made noise, 10 kHz to 100 MHz (P.372 Fig. 2)

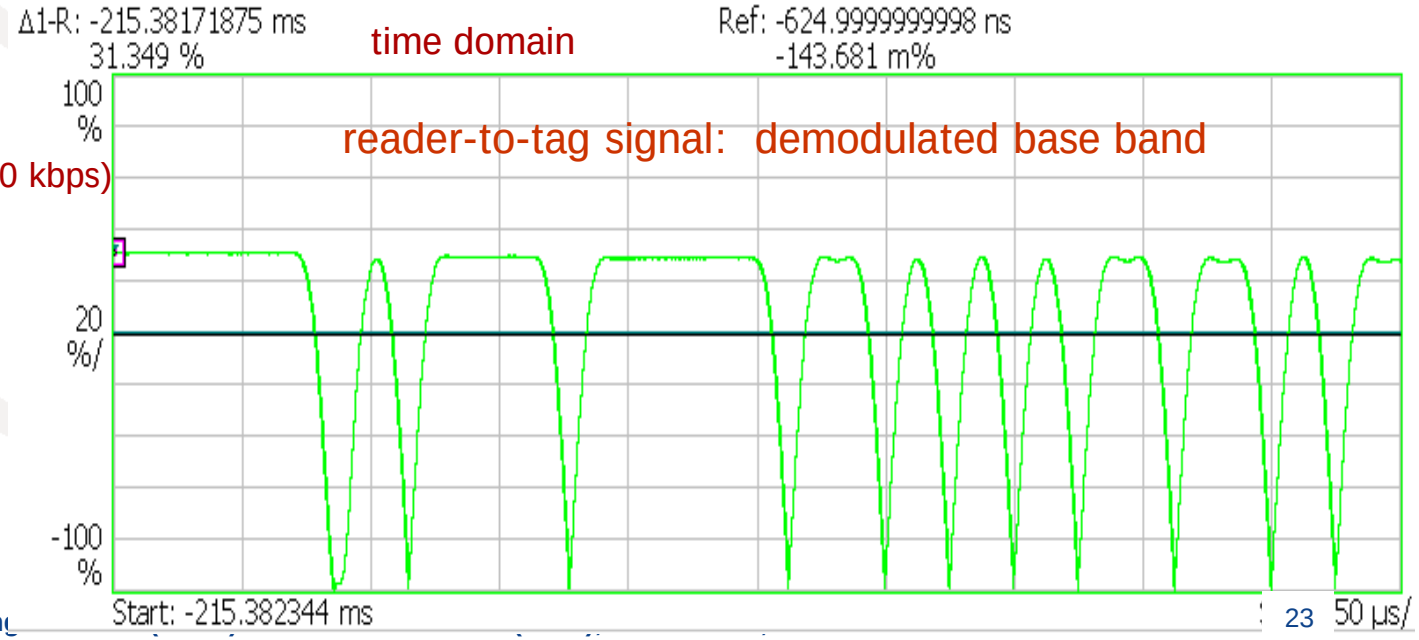
UHF RFID Reader; real time analyzer: time & RF domains view

power up phase, CW carrier & the modulation starting after about 10 ms





time domain



Tari 25 µs (40 kbps)

Phase-Reversal ASK (PR-ASK)

Siemens SIMATIC RF680R

Typical SRDs Applications

1. Wideband data transmission: RLAN/Wi-Fi, UWB, White Space Devices (in the USA, white space devices are to operate on a non-protected, non-interference basis), Wideband Low Activity Mode (WLAM), short range video. The WiFi achievement can be only compared to the GSM triumph
2. RF IDentification (RFID), active medical implants, health monitoring, personal identification, inductive systems, proximity sensors
3. Car door openers, Transport and Traffic Telematics (TTT), road tolling, Intelligent transportation systems (ITS), Automatic Meter Reading (AMR), Street Lamp Monitoring and Control, railway applications, car immobilisers; devices for Smart Sustainable Cities (SSC): profitable use of our resources
4. Logistics, livestock, Electronic Article Surveillance (EAS)
5. Radiodetermination: Automotive Short Range Radar (SRR), RF level gauges, radar sensor, Level Probing Radar (LPR)
6. Near Field Communication (NFC) & voice like: walkie-talkie, baby monitoring, remote control, radio microphone, cordless loudspeakers and telephones, aids for the hearing impaired, voice enabled data collection
7. Telemetry, tracking, tracing and data acquisition, machine-to-machine (m2m) model control, home automation, automotive industry, sensor monitoring
8. Alarm, social alarms, anti-theft (in houses and shops)...

Typical Emerging technology: Z-Wave

designed mainly for remote controls, smoke alarms and security sensors

- Z-Wave uses a single frequency FSK
- Data rate up to 100 Kbps; unlike IEEE 802.11, designed primarily for high-bandwidth data flow
- Range between controllers & slave devices up to 100 ft

Country/Region	Standard	Z-Wave RF
Australia	AS/NZS 4268	921.4 MHz
Brazil	ANATEL Resolution 506	921.4 MHz
CEPT	EN 300 220	868.4 MHz
Chile	FCC CFR47 Part 15.249	908.4 MHz
China	CNAS/EN 300 220	868.4 MHz
Hong Kong	HKTA 1035	919.8 MHz
India	CSR 564 (E)	865.2 MHz
Israel	MoC Wireless Act	915-917 MHz
Japan 950 (obsolete by end of 2015)	ARIB T96	951-956 MHz
Japan 920 (since Feb 2012)	ARIB STD-T108	922-926 MHz
Malaysia	SKMM WTS SRD/EN 300 220	868.1 MHz
Mexico	FCC CFR47 Part 15.249	908.4 MHz
New Zealand	AS/NZS 4268	921.4 MHz
Russia	GKRCh/EN 300 220	869.0 MHz
Singapore	TS SRD/EN 300 220	868.4 MHz
South Africa	ICASA/EN 300 220	868.4 MHz
Taiwan	NCC/LP0002	922-926 MHz
UAE	EN 300 220	868.4 MHz
USA/Canada	FCC CFR47 Part 15.249	908.4 MHz

SRD to track (& preserve) short-toed snake-eagle

SRD applications are increasing, which result in increasing spectrum demands

Water meter with built-in AMR radio module

Solar-powered wireless relay for AMR

Wireless wastewater & sewage level monitoring unit with tilt sensors

Wi-Fi Global: derived from revised Rec. ITU-R M.1450

Characteristics associated with broadband RLAN standards

Characteristics	IEEE Std 802.11-2012 (Clause 17, commonly known as 802.11b)	IEEE Std 802.11-2012 (Clause 18, commonly known as 802.11a)	IEEE Std 802.11-2012 (Clause 19, commonly known as 802.11g)	IEEE Std 802.11-2012 (Clause 18, Annex D and Annex E, commonly known as 802.11j)	IEEE Std 802.11-2012 (Clause 20, commonly known as 802.11n)	IEEE P802.11ac	IEEE Std 802.11ad-2012	ETSI EN 300 328	ETSI EN 301 893	ARIB HiSWANa,	ETSI EN 302 567
Frequency band	2 400-2 483.5 MHz	5 150-5 250 MHz 5 250-5 350 MHz(4) 5 470-5 725 MHz 5 725-5 825 MHz	2 400-2 483.5 MHz	4 940-4 990 MHz 5 030-5 091 MHz 5 150-5 250 MHz 5 250-5 350 MHz 5 470-5 725 MHz 5 725-5 825 MHz	2 400-2 483,5 MHz 5 150-5 250 MHz 5 250-5 350 MHz 5 470-5 725 MHz 5 725-5 825 MHz	5 150-5 250 MHz 5 250-5 350 MHz 5 470-5 725 MHz 5 725-5 825 MHz	57-66 GHz	2 400-2 483.5 MHz	5 150-5 350 and 5 470-5 725 MHz	4 900 to 5 000 MHz 5 150 to 5 250 MHz	57-66 GHz
Interference mitigation	LBT	LBT/DFS/TPC	LBT	LBT	LBT/DFS/TPC	LBT/DFS/TPC	LBT	DAA/LBT, DAA/non-LBT, MU	LBT/DFS/TPC	LBT	
Channel indexing	5 MHz				5 MHz in 2.4 GHz 20 MHz in 5 GHz	20 MHz	2 160 MHz		20 MHz	20 MHz channel spacing 4 channels in 100 MHz	

Wi-Fi offload improves cellular capacity

1. More unlicensed (license-exempt) spectrum means more Wi-Fi
2. 'Spectrum crunch', since 2011, much data traffic is generated by mobile handsets and tablets (generally indoor)
3. Mobile services may rely on extensive network of Wi-Fi (BT uses its 5.4m Wi-Fi hotspots) and 4G network
4. Heterogeneous networks management: traffic steering across all 3GPP and Wi-Fi access technologies and frequency bands (including 2G, 3G and LTE)
5. Wi-Fi integration as seamless extension of the mobile network: faster data connections; hot zone for a superior mobile video experience
6. Wireless Gigabit Alliance (WiGig) (part of WiFi alliance) IEEE 802.11ad provides data transfer rates of up to 7 Gbit/s, operating over the ISM unlicensed band 61-61.5 GHz

Wi-Fi improves cellular capacity(2)

(Sources: KDDI May 2013 and Alvarion October 2013)

- In congested areas (outdoors & indoors), the growing need of mobile data exceeds the available cellular capacity
- Main usage: city centers, big malls, airports, train station, stadiums
- WiFi is the most cost effective solution for data offloading
  - RF Spectrum free of charge (at 2.4 GHz and 5 GHz)
  - Embedded in all smartphones and tablets

~150 access points (APs) & more than 1800 stations (STAs) were observed in Ch1 in 2.4GHz band, in Shibuya Metro

In Seoul KTX train station, 351 APs and 1101 STAs were observed in 2.4 GHz band
In underground COEX mall, 277 APs and 917 STAs were observed in 2.4 GHz band

Shibuya station of Tokyo Metro; 15 April 2013

RFID UHF regulation in Israel

1. RF 915 -917 MHz
2. Spectrum mask of interrogators:
   - EiRP: 2 Watts
   - Out Of Band (OoB) below 915 MHz, -74 dBm per 100 KHz; above 917 MHz -63.6 dBm per 25 KHz;
   - the duty cycle (DC) provides a linear release only at 915 MHz; e.g. for DC 1 % (- 20 dB) OoB below 915 MHz is -54 dBm per 100 KHz, and not -74 dBm per 100 KHz
3. One-Time Programmable (OTP)- not allowed to change RF
4. The manufacturer should mark the product (model not type) by suffix in order to emphasize the specific national RF band and Out of Bands

More info at UHF RFID's global & regional ruling- the case of different allocations to Short Range Devices (SRDs) & electronic devices

Case Study: ISM & Citizen Band (CB) 26.96-27.28 MHz

- Used around the world also as Citizen Band
- Applications: voice like walkie-talkie, baby monitoring, remote control, model control (in the air, on land or over or under the water surface), telecommand, anti-theft and car alarms

Global technical parameters of SRDs at 26.957-27.283 MHz

See also Report ITU-R SM.2153

Region/Country	Type of use		Specific Frequencies (MHz)	Emission limit	Reference
CEPT and many other countries	annex 1: non-specific SRD		26.957-27.283	42 dB(μA/m) at 10 m; 10 mW e.r.p.	ERC Recommendation 70-03
			26.995, 27.045, 27.095, 27.145, 27.195	100 mW e.r.p. < 0.1 % duty cycle	
	annex 8: model control			100 mW e.r.p.	
	annex 9: inductive applications		26.957-27.283 (as in annex 1)	42 dB(μA/m) at 10 m	
Americas	any		26.965, 26.975, 26.985, 27.005, 27.015, 27.025, 27.035, 27.055, 27.065, 27.075, 27.085, 27.105, 27.115, 27.125, 27.135, 27.155, 27.165, 27.175, 27.185, 27.205, 27.215, 27.225, 27.255, 27.235, 27.245, 27.265, 27.275, 27.285, 27.295, 27.305, 27.315, 27.325, 27.335, 27.345, 27.355, 27.365, 27.375, 27.385, 27.395, 27.405 : 40 channels	10 mV/m at 3 m equiv. to 30 μW (e.i.r.p.)	15.227 Operation within 26.96-27.28 MHz § 95.407 On what channels may I operate?
China	model & toy remote-control devices		26.975, 26.995, 27.025, 27.045, 27.075, 27.095, 27.125, 27.145, 27.175, 27.195, 27.225, 27.255 max bandwidth: 8 kHz	750 mW (e.r.p.)	Report ITU-R SM.2153
	other SRDs		26.957 to 27.283	42 dB(μA/m) at 10 m	
Korea	simplex		See Americas	3 W	Report ITU-R SM.2153
	Radio controller for	model automobile and ship craft	26.995, …, 27.195 MHz (5 channels, 50 kHz space	10 mV/m @10 m Equiv to 333 μW (e.i.r.p.)	
		toy, security alarm or telecommand	26.958-27.282 MHz		
Russia	car alarm		26.939-26.951 MHz	2 W. Duty cycle < 10%. Max ant gain 3 dB	
	security alarm		26.954-26.966 MHz		
Belarus, Kazakhstan, Russia	anti-theft alarm		26.945	2 W	SM.2153
	alarm & distress		26.960		

List of Acronyms and Abbreviations

AFA	Adaptive Frequency Agility
AMR	Automatic Meter Reading
APT	Asia Pacific Telecommunity
bps	Bits per Second
CB	Citizen Band
CEPT	European Conference of Postal and Telecommunications Administrations
CFR	Code of Federal Regulations
DAA	Detect and Avoid
DFS	Dynamic Frequency Selection
ECC	Electronic Communications Committee
EPC	Electronic Product Code
ERC	European Radiocommunications Committee
ERM	Electromagnetic Compatibility and Radio Spectrum Matters
ETSI	European Telecommunications Standard Institute
EU	European Union
FHSS	Frequency Hopping Spread Spectrum
FSK	Frequency Shift Keying
ISM	Industrial, Scientific and Medical applications
LBT	Listen Before Talk
R&TTE	Directive 1999/5/EC on radio equipment & telecommunications terminal equipment
RF	Radio Frequency
RR	ITU Radio Regulations
RFID	Radio Frequency Identification
RLAN	Radio Local Area Network
SRD	Short Range Devices
TPC	Transmitter Power Control
UWB	Ultra Wide Band
WLAN	Wireless Local Area Network

Thank You for Listening

Any Qs?

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