SPARK SR1010/SR1020 - Worldwide UWB Regulations

Spark Microsystems

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Rev 1.3

Acronyms

ARIB	Association of Radio Industries and Business
BW	Bandwidth
CEPT	European Conference of Postal and Telecommunications
CFR	Code of Federal Regulations
DAA	Detect and Avoid
ECC	Electronic Communications Committee
ETSI	European Telecommunications Standard Institute
FCC	Federal Communications Commission
GHz	Giga Hertz
IC	Industry Canada
LDC	Low Duty Cycle
LDR	Low Data Rate
Mbps	Mega bits per second
MIIT	Ministry of Industry and Information Technology
RAPA	Korea Radio Promotion Association
RF	Radio frequency
TBA	To be Announced
UWB	Ultra-Wideband

1 Introduction

This document summarizes the global regulatory situation relating to the Ultra-Wideband (UWB) communications frequency range from 3.1 GHz to 10.6 GHz. First, the SPARK Microsystems SR1010/1020 series transceivers are presented. Then a list of important wireless emissions regulatory bodies are shown.

In the third section, graphical outlines of the emissions spectra in select regulatory regions are shown along with the operational bandwidths of the SPARK Microsystems SR1010/1020 series transceivers within those regions.

In the fourth section, the demographics of the standards are presented.

This document primarily focuses on UWB as a communications medium. Other UWB applications such as ground penetrating radar, through wall imaging systems or automotive radar applications for example may have additional regulations that are not considered here.

2 SPARK SR1010 and SR1020 series UWB Transceivers

The SPARK SR1010 and SR1020 are a ultra-low power digitally programmable UWB wireless transceivers operating in the license-free UWB spectrum from 3.1 to 5.75 GHz (SR1010) and 6 to 9.25 GHz (SR1020) bandwidths. They achieve highly robust and energy efficient communications using short impulses and a dynamic shaping of the output spectrum for easy compliance with international UWB emission limits and regulatory bodies.

The flexible spectral shaping allows for bandwidth tuning as illustrated in figure 1

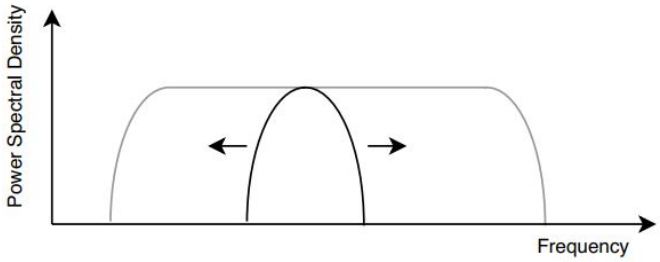

Figure 1: Spectral shaping for a tunable bandwidth

The radio can therefore occupy a tunable amount of the UWB spectrum.

The data rate of the SR1010/1020 series radios are configurable up to 10 Mb/s, where higher data rates require more bandwidth.

3 Wireless emissions regulatory bodies

The main regions covered in this whitepaper include the USA, Europe, Canada, Japan, South Korea, and China. These countries and their main regulatory bodies are shown in Table 1.

Table 1: National wireless emissions regulatory bodies

Country/Region	Regulatory Body
United States of America	Federal Communications Commission (FCC)
Europe	European Telecommunications Standards Institute (ETSI)
Canada	Industry Canada
Japan	Association of Radio Industries and Business (ARIB)
South Korea	RAPA – Korea Radio Promotion Association
China	Ministry of Industry and Information Technology (MIIT)

A number of other countries follow regulations set forth by the FCC and ETSI. These are listed in Section 5.

3.1 North America

3.1.1 United States of America

The wireless emissions regulations in the USA are governed by the Federal Communications Commission (FCC), and the full UWB regulations can be found in the *Code of Federal Regulations (CFR) 47 Part 15.* The most relevant sections of this document are:

- Section 15.517 technical requirements for indoor UWB systems
- Section 15.519 technical requirements for handheld UWB systems
- Section 15.521 technical requirements applicable to all UWB devices

The FCC's most stringent requirements for UWB communications applications are for handheld UWB systems. Shown in Figure 2 are the maximum mean emission limits, where the SR1010/1020 transceivers have full operational bandwidth over the allotted spectrum of 3.1 to 10.6 GHz.

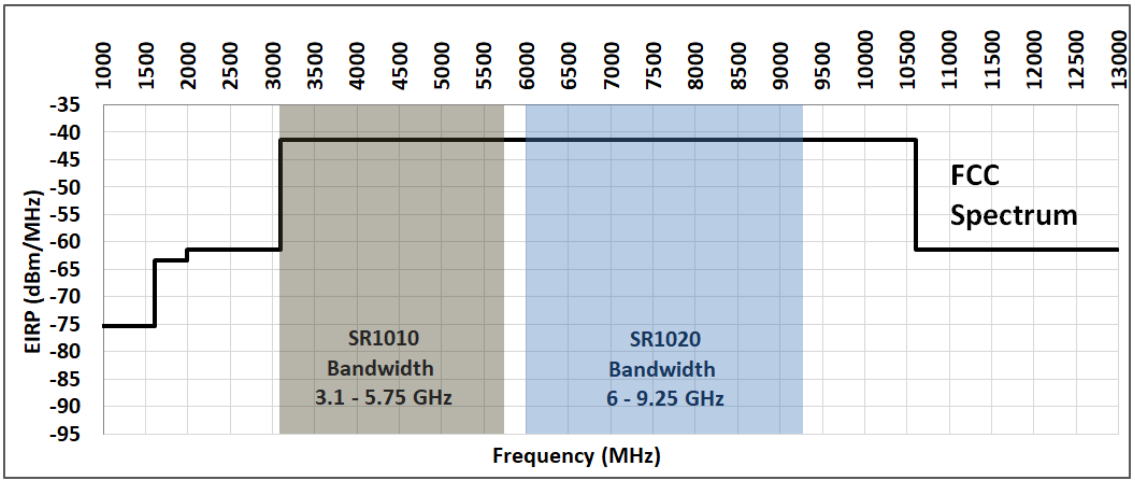

Figure 2: Maximum mean emission levels for handheld UWB devices by the FCC.

In regions regulated by the FCC

- the SPARK SR1010 enables 2.65 GHz of unlicensed spectrum usage (3.1 - 5.75 GHz),
- the SPARK SR1020 enables 3.25 GHz of unlicensed spectrum usage (6 - 9.25 GHz).

3.1.2 Canada

The wireless emissions regulations in Canada are governed by Industry Canada, and the full UWB regulations can be found in *RSS-220 – Devices Using Ultra-Wideband Technology*.

Industry Canada's most stringent requirements for UWB communications applications are for handheld UWB systems. Shown in Figure 3 are the maximum mean emission limits, where the SR1020 transceiver has full operational bandwidth over the allotted spectrum of 4.75 to 10.6 GHz.

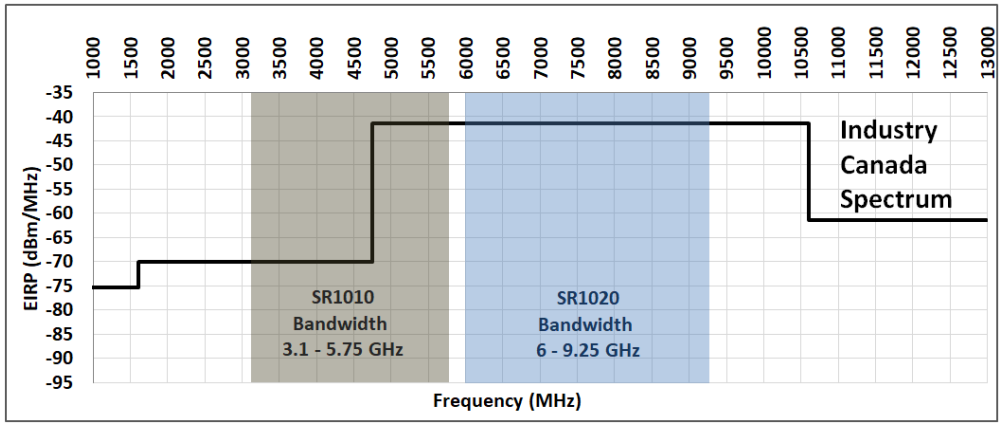

Figure 3: Maximum mean emission limits for handheld UWB devices by Industry Canada.

In regions regulated by Industry Canada

- the SPARK SR1010 enables 1.0 GHz of unlicensed spectrum usage (4.75 - 5.75 GHz),
- the SPARK SR1020 enables 3.25 GHz of unlicensed spectrum usage (6 - 9.25 GHz).

3.2 Europe

3.2.1 European Union

The wireless emissions regulations for countries in the European Union are governed by the European Commission and CEPT/ECC, with ETSI being the standards authority. The applicable harmonized standard is *ETSI EN 302065 for Generic UWB Devices*. Shown in Figure 4 are the maximum mean emission limits for UWB communication devices, where the SR1020 has full operational bandwidth over the allotted spectrum of 6 to 8.5 GHz.

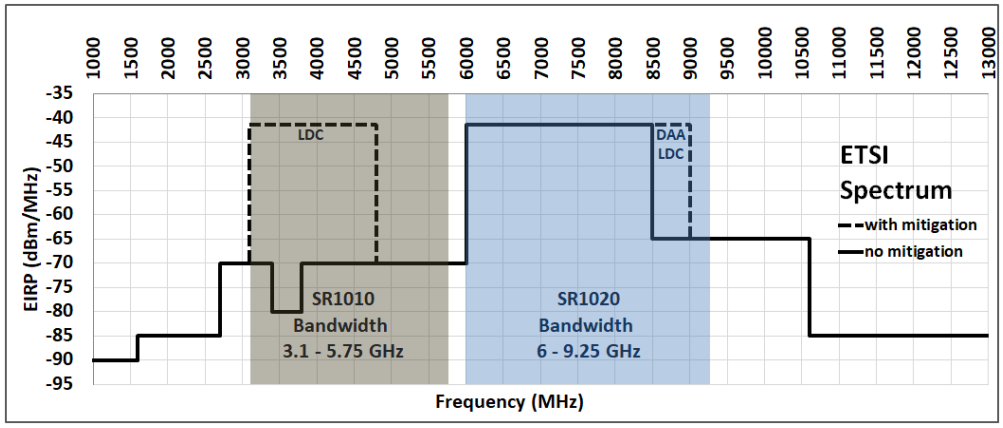

Figure 4: Maximum mean emission levels for UWB communications devices by ETSI.

In regions regulated by the ETSI

- the SPARK SR1010 enables 1.4 GHz of unlicensed spectrum usage with LDC mitigation techniques (3.4 - 4.8 GHz),
- the SPARK SR1020 enables 2.5 GHz of unlicensed spectrum usage (6 - 8.5 GHz).

***Europe does NOT allow any fixed outdoors UWB infrastucture unless it is running below 4.8GHz in which case low data rate applications with the SR1010 can be done outdoors using LDC and DAA.

Additional spectrum access
Additional UWB communications spectrum is available in the 3.4 - 4.8 GHz and 8.5- 9 GHz ranges for devices using a Low Duty Cycle (LDC) or a Detect and Avoid (DAA) mitigation technique.

A low data rate of up to 100 kb/s with non-continuous transmission between 3.4 and 4.8 GHz is possible with LDC mitigation, and a full output power (-41.3 dBm/MHz) can be used if the conditions defined in Table 2 are met.

Table 2: Baseline limits for Low Duty Cycle (LDC) mitigation

Parameter		Limit
Maximum transmitter on time	$T_{on,max}$	5 ms per transmission
Mean transmitter off time	$T_{off,mean}$	= 38 ms (averaged over 1 s)
Sum transmitter off time	$\sum T_{off}$	> 950 ms per second
Sum transmitter on time	$\sum T_{on}$	< 18 s per hour

With DAA mitigation, transmission at full output power (-41.3 dBm/MHz) in the 3.1 GHz - 4.8 GHz and 8.5 GHz - 9 GHz bands is allowed.

3.3 Asia

3.3.1 China

The wireless emissions regulations for China are governed by the Ministry of Industry and Information Technology (MITT). Shown in Figure 5 are the maximum mean emission limits, where the SR1020 transceiver has full operational bandwidth over the allotted spectrum of 6 to 9 GHz.

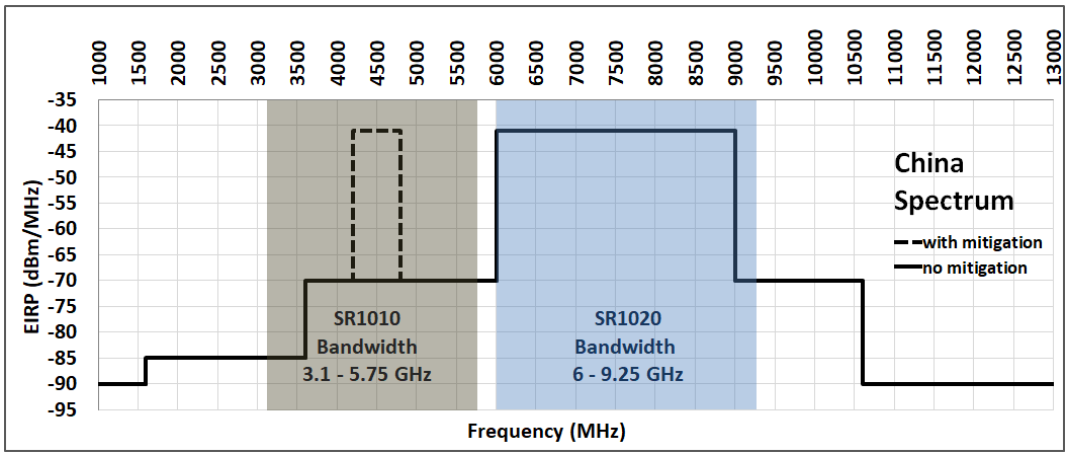

Figure 5: Maximum mean emission levels for UWB communications devices by the MITT.

In regions regulated by the MITT, the SPARK SR1020 enables 3.0 GHz of unlicensed spectrum usage (6 - 9.0 GHz).
Additional spectrum access

With mitigation techniques, additional UWB communications spectrum at full output power (-41 dBm/MHz) is available in the 4.2 - 4.8 GHz range.

3.3.2 Japan

The wireless emissions regulations for Japan are governed by the Ministry of Internal Affairs and Communication. The standard for UWB devices is produced by the Association of Radio Industries and Businesses (ARIB), and the relevant standard is *ARIB STD-T91*. Shown in Figure 6 are the maximum mean emission limits, where the SR1020 transceiver has 2.0 GHz of operational bandwidth over the allotted spectrum of 7.25 to 10.25 GHz.

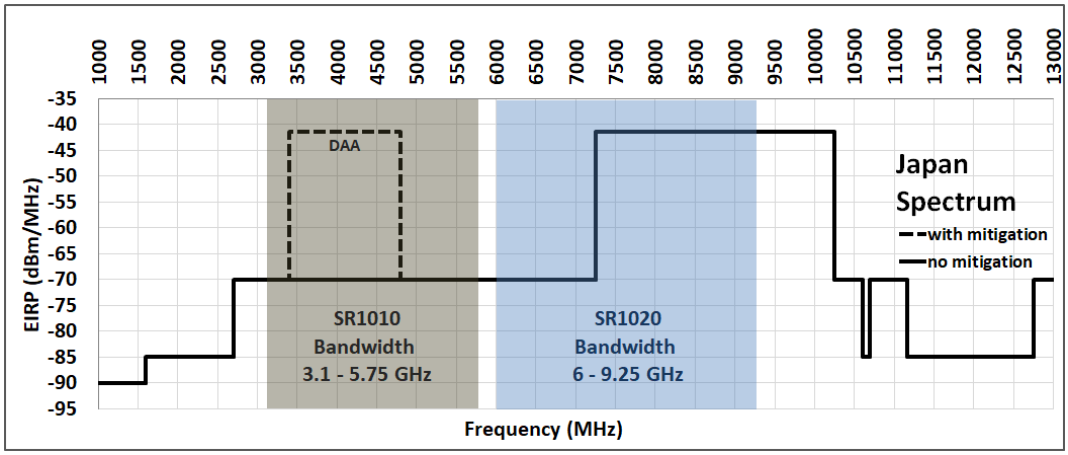

Figure 6: Maximum mean emission levels for UWB communications devices by the ARIB.

In regions regulated by the ARIB, the SPARK SR1020 enables 2.0 GHz of unlicensed spectrum usage (7.25 - 9.25 GHz). Note: communication with UWB devices in Japan is restricted to indoor usage.

Additional spectrum access
With Detect and Avoid (DAA) mitigation techniques, additional UWB communications spectrum at full output power (-41.3 dBm/MHz) is available in the 3.4 - 4.8 GHz range.

3.3.3 South Korea

The wireless emissions regulations for South Korea are governed by RAPA – Korea Radio Promotion Association. Shown in Figure 7 are the maximum mean emission limits, where the SR1020 transceiver has 2.05 GHz of operational bandwidth over the allotted spectrum of 7.2 to 10.2 GHz.

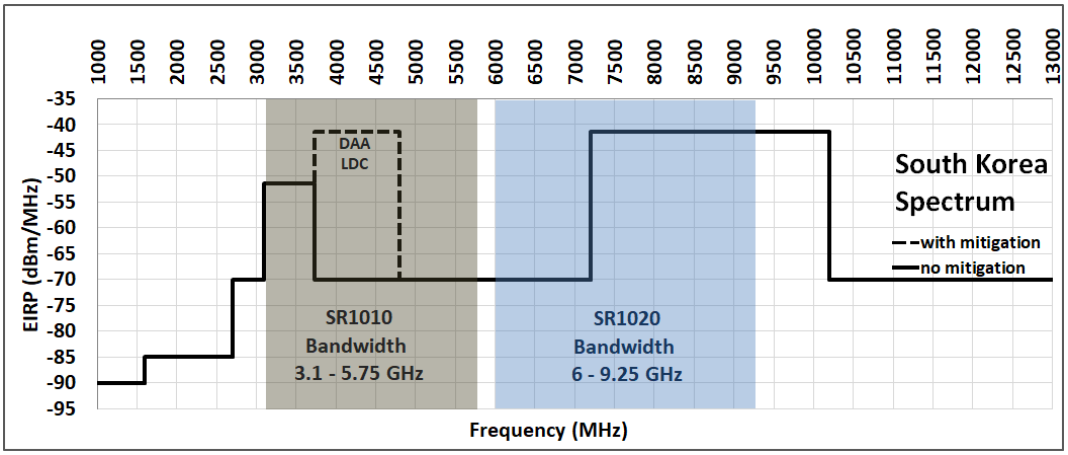

Figure 7: Maximum mean emission levels for UWB communications devices in South Korea.

In regions regulated by the RAPA, the SPARK SR1020 enables 2.05 GHz of unlicensed spectrum usage (7.2 - 9.25 GHz).

Additional spectrum access
With DAA or LDC mitigation techniques, additional UWB communications spectrum at full output power (-41.3 dBm/MHz) is available in the 3.1 - 4.8 GHz range.

4 Countries following FCC or ETSI

A number of countries follow the UWB regulations set forth by either the FCC or ETSI. Some countries do this directly, while others have a history of following these regulatory bodies.

4.1 UWB Standards by Continent

This section refers to Table 3 that describes the UWB landscape (by continent) and brings the standards and specifications into perspective.

Countries under the FCC's jurisdiction for example, are labeled FCC and those referring to it or that generally accept FCC compliant devices are defined as such in the *Regulatory Body* column of Table 3. Adjacent columns specify the *Unlicensed Spectrum Range* and *Bandwidth* where communications devices can operate, whereas the *SPARK Operational BW* column takes into account the operational bandwidth of the SPARK transceiver within that unlicensed spectrum.

Table 3: UWB Regulatory bodies and their specifications classified by continent

Continent	Country	Regulatory Body	Unlicensed UWB spectrum			SPARK Operational BW		Max EIRP (dBm/MHz)	Lower/Upper out-of-band EIRP limit (dBm/MHz)
			Range (GHz)		BW (GHz)	SR1010 (GHz)	SR1020 (GHz)		
North America	2 countries [1]	FCC	3.1	10.6	7.5	2.65	3.25	-41.3	-61.3 / -61.3
	16 countries [1]	Refers to FCC or FCC compliant	3.1	10.6	7.5	2.65	3.25	-41.3	-61.3 / -61.3
	8 countries [1]	Refers to FCC (or ETSI) or FCC (or ETSI) compliant	3.1	10.6	7.5	2.65	3.25	-41.3	-61.3 / -61.3
	2 countries [2]	ETSI	6	8.5	2.5	1.4 DAA/LDC[13]	2.5	-41.3	-70 / -65
	Canada	Industry Canada	4.75	10.6	5.85	1.0	3.25	-41.3	-70 / -61.3
Europe	44 countries [3]	ETSI	6	8.5	2.5	1.4 DAA/LDC[13]	2.5	-41.3	-70 / -65
	4 countries [3]	Refers to ETSI or ETSI compliant	6	8.5	2.5	1.4 DAA/LDC[13]	2.5	-41.3	-70 / -65
	Russia	GRFC	6	8.1	2.1	-	2.1	-47	-63 / -73
	2 countries [4]	To be confirmed					TBA		
South America	4 countries [5]	Refers to FCC or FCC compliant	3.1	10.6	7.5	2.65	3.25	-41.3	-61.3 / -61.3
	5 countries [5]	Refers to FCC (or ETSI) or FCC (or ETSI) compliant	3.1	10.6	7.5	2.65	3.25	-41.3	-61.3 / -61.3
	Brazil [5]	Anatel (same as FCC limits but with its own regulatory body)	3.1	10.6	7.5	2.65	3.25	-41.3	-61.3 / -61.3
	Falkland Islands	Refers to ETSI or ETSI compliant	6	8.5	2.5	1.4 DAA/LDC[13]	2.5	-41.3	-70 / -65
	Argentina	To be confirmed					TBA		
Middle East	9 countries [6]	Refers to ETSI or ETSI compliant	6	8.5	2.5	1.4 DAA/LDC[13]	2.5	-41.3	-70 / -65
	3 countries [6]	Same as ETSI but with their own regulatory body	6	8.5	2.5	1.4 DAA/LDC[13]	2.5	-41.3	-70 / -65
	Iraq	To be confirmed					TBA		
Africa	25 countries [7]	Refers to FCC (or ETSI) or FCC (or ETSI) compliant	3.1	10.6	7.5	2.65	3.25	-41.3	-61.3 / -61.3
	13 countries [8]	Refers to ETSI or ETSI compliant	6	8.5	2.5	1.4 DAA/LDC[13]	2.5	-41.3	-70 / -65
	5 countries [9]	To be confirmed					TBA		
Asia Pacific	Guam [10]	FCC	3.1	10.6	7.5	2.65	3.25	-41.3	-61.3 / -61.3
	P.N. Guniea [10]	Refers to FCC or FCC compliant	3.1	10.6	7.5	2.65	3.25	-41.3	-61.3 / -61.3
	6 countries [10]	Refers to FCC (or ETSI) or FCC (or ETSI) compliant	3.1	10.6	7.5	2.65	3.25	-41.3	-61.3 / -61.3
	2 countries [11]	ETSI	6	8.5	2.5	1.4 DAA/LDC[13]	2.5	-41.3	-70 / -65
	6 countries [11]	Refers to ETSI or ETSI compliant	6	8.5	2.5	1.4 DAA/LDC[13]	2.5	-41.3	-70 / -65
	4 countries [11]	Same as ETSI but with their own regulatory body	6	8.5	2.5	1.4 DAA/LDC[13]	2.5	-41.3	-70 / -65
	Hong Kong [11]	Historically follows ETSI (proposed: 3.4 to 8.5 unlicensed)	6	8.5	2.5	1.4 DAA/LDC[13]	2.5	-41.3	-70 / -65
	India [11]	Historically follows ETSI (proposed: 6 to 7.25 unlicensed)	6	8.5	2.5	1.4 DAA/LDC[13]	2.5	-41.3	-70 / -65
	Japan **	ARIB	7.25	10.25	3	1.4 DAA[14]	2.0	-41.3	-70 / -70
	South Korea	RAPA	7.2	10.2	3	1.7 DAA/LDC[15]	2.05	-41.3	- 70 / -70
	Australia	ACMA	6	8.4	2.4	(TBA)[13]	2.4	-41.3	
	China	MIIT	6	9	3	0.6 (TBA)[16]	3.0	-41	-70 / -70
	13 countries [12]	To be confirmed					TBA		

[1] **Regulated by FCC**: USA, US Virgin Islands. **Refers to FCC or FCC compliant**: Antigua & Barbuda, Aruba, Bahamas, Barbados, Bermuda, British Virgin Islands, Costa Rica, Curacao, Dominica, Dominican Republic, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Trinidad & Tobago. **Refers to FCC (or ETSI) or FCC (or ETSI) compliant**: Cayman Islands, El Salvador, Grenada, Guatamela, Panama, St Kitts & Nevis, St Lucia, St Vincent & the Grenadines.

[2] **Telecom matters overseen by the government of France**: Guadeloupe, Martinique. **To be confirmed**: Cuba.

[3] **Regulated by ETSI**: Albania, Austria, Belgium, Bosnia & Herzegovina, Bulgaria, Canary Islands, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Moldova, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, San Marino, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom. **Refers to ETSI**: Andorra, Belarus, Gibraltar, Monaco.

[4] **To be confirmed**: Macedonia, Ukraine.

[5] **Refers to FCC or FCC compliant**: Guyana, Paraguay, Uruguay, Venezuela. **Refers to FCC (or ETSI), or FCC (or ETSI) compliant**: Bolivia, Chile, Colombia, Ecuador, Peru. **Same as FCC limits but with its own regulatory body**: Brazil.

[6] **Refers to ETSI or ETSI compliant**: Bahrain, Iran, Israel, Jordan, Kuwait, Lebanon, Oman, Syria, Yemen. **Independent regulatory body but ETSI specs in unlicensed range**: Qatar, Saudi Arabia, UAE.

[7] **Refers to FCC (or ETSI), or FCC (or ETSI) compliant**: Benin, Burkina Faso, Cape Verde, Central African Republic, Democratic Republic of the Congo, Ethiopia, Gabon, Gambia, Ghana, Guinea Bissau, Kenya, Liberia, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Swaziland, Tanzania, Uganda, Zambia, Zimbabwe.

[8] **Refers to ETSI or ETSI compliant**: Algeria, Angola, Algeria, Angola, Cameroon, Chad, Ivory Coast, Kenya, Lesotho, Libya, Madagascar, Mauritius, South Africa, Togo, Tunisia.

[9] **To be confirmed**: Djibouti, Egypt, Morocco, Somalia, Sudan.

[10] **Regulated by FCC**: Guam. **Refers to FCC or FCC compliant**: Papua New Guniea. **Refers to FCC (or ETSI) or FCC (or ETSI) compliant**: Fiji, Thailand, Myanmar, Pakistan, Philippines, Samoa (Independent State of).

[11] **Independent regulatory body but ETSI specs**: Malaysia, New Zealand, Signapore, Vietnam**. **Refers to ETSI or ETSI compliant**: Armenia, Bangladesh, Brunei, French Polynesia, Kazakhstan, New Zealand. **Historically following ETSI**: Hong Kong, India. **Telecom matters overseen by the government of France**: New Caledonia, Reunion.

[12] **To be confirmed**: Afghanistan, Azerbaijan, Cambodia, Cook Islands, Georgia, North Korea, Kyrgyzstan, Laos, Macau, Nepal, Sri Lanka, Turkmenistan, Uzbekistan.

[13] **ETSI LDC/DAA mitigation**: LDC mitigation with the SR1010 enables operation in the 3.4 - 4.8 GHz and 8.5 - 9 GHz bands. DAA mitigation enables operation in the 3.4 - 4.8 GHz band.

[14] **ARIB DAA mitigation** with the SR1010 enables operation in the 3.4 - 4.8 GHz band.

[15] **RAPA DAA mitigation** with the SR1010 enables operation in the 3.1 - 4.8 GHz band.

[16] **MIIT mitigation** with the SR1010 enables operation in the 4.2 - 4.8 GHz band.

** not covered for outdoor use

Note 1: The in-band mean output power (or EIRP) limits are 5.3 dB lower in Russia, or -47 dBm/MHz, when compared to all other regions which are regulated at -41.3 dBm/MHz.

Note 2: Countries giving no information relating to UWB or that are in the process of making regulatory decisions are labeled with a *To be confirmed* memo in Table 3.

Note 3: A low data rate of up to 100 kb/s with non-continuous transmission is generally possible with LDC mitigation.

4.2 Number of countries covered by the SR1010 and SR1020

Regulatory jurisdictions can be further grouped by

- countries directly regulated by the FCC or that refer or comply to it, combined under FCC,
- countries directly regulated by the ETSI or that refer or comply to it, combined under ETSI,
- countries referring or complying to FCC or ETSI, combined as FCC -the less limiting one.

The SR1010, with an operational bandwidth of 2.65 GHz, can be used in high bandwidth / high data rate applications, as well as in low data rate or IoT applications in 69 countries within the FCC's unlicensed spectrum of 3.1 - 10.6 GHz. This is shown in Figure 8.

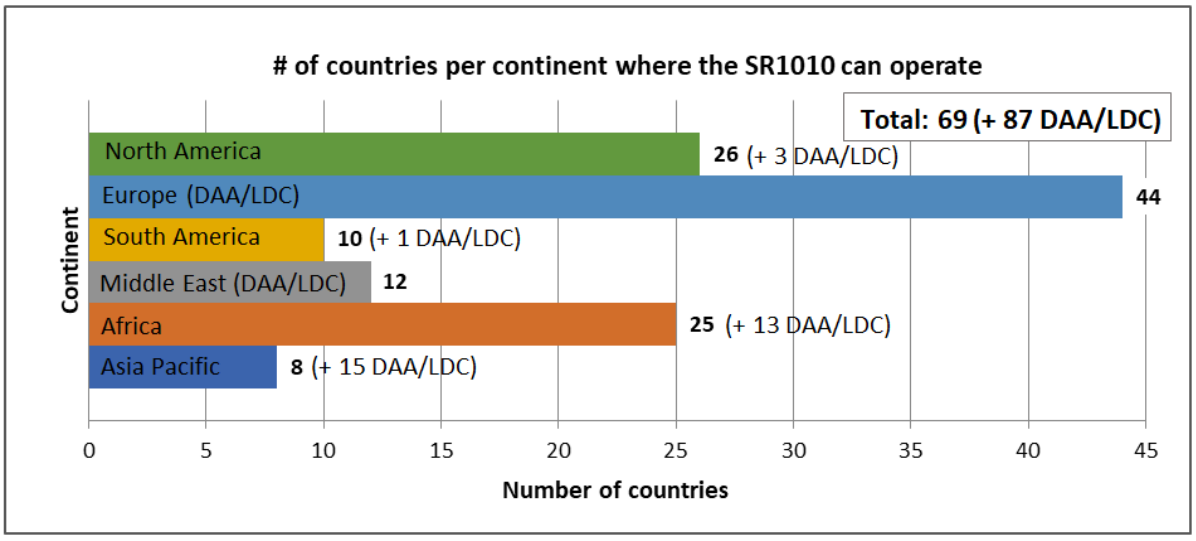

Figure 8: Number of countries where the SR1010 UWB transceiver can operate, split by continent

The SR1010 can be used in 87 more countries when detect and avoid (DAA) and low duty cycling (LDC) mitigation modes are activated. Note that a low data rate of up to 100 kb/s with non-continuous transmission is generally possible with LDC mitigation.

The SR1020, with an operational bandwidth of 3.25 GHz, can be used in high bandwidth / high data rate applications in a total of 162 countries including Japan and South Korean, as well as in low data rate or IoT applications. This is shown in Figure 9.

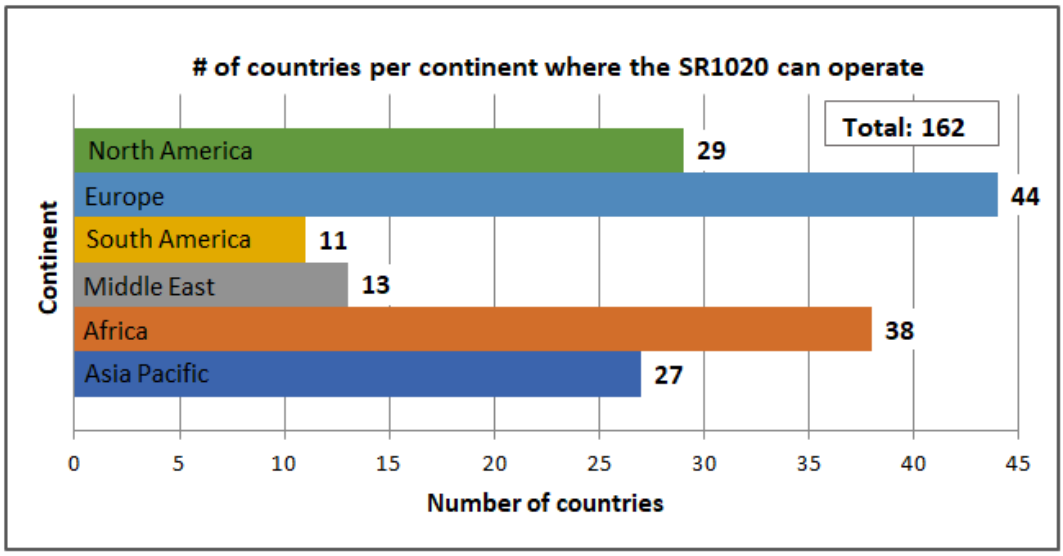

Figure 9: Number of countries where the SR1020 UWB transceiver can operate per continent

5 Applications

Due to its ability to occupy a very wide operating band during data transmission, the SPARK UWB radio can be used in high bandwidth / high data rate applications, as well as in low data rate or IoT applications.

5.1 Audio

One example of a high bandwidth / high data rate application is the transmission of high quality uncompressed (or CD-quality) audio over the air using SPARK UWB.

5.1.1 Audio data rates

SPARK audio applications use the following data rates:

- Full quality stereo: 1.536 Mbps payload data rate, or 3 Mbps over-the-air
- Half quality stereo: 0.768 Mbps payload data rate, or 1.58 Mbps over-the-air
- Full quality mono: 0.768 Mbps payload data rate, or 1.5 Mbps over-the-air
- Half quality mono: 0.384 Mbps payload data rate, or 0.790 Mbps over-the-air

5.1.2 Bandwidth requirements for uncompressed audio

Operational requirements for full quality stereo links are:

- A 1.1 GHz center-to-center operational bandwidth .
- Additional guard bands reserved for out-of-band filtering on each side of the spectrum.

5.1.3 Number of concurrent uncompressed audio links

This allows SPARK devices to operate the following audio links:

- One (1) link at full quality stereo
- Two (2) concurrent links at full quality stereo
- Four (4) concurrent links at half quality stereo
- More than four (> 4) concurrent links at full quality mono
- More than four (> 4) concurrent links at half quality mono

5.1.4 Which device to use?

Both the SR1010 and SR1020 UWB transceivers can be used in uncompressed audio applications in FCC regulated regions, whereas the SR1020 can be used for audio applications worldwide.

6 Maximum bandwidths

Operational bandwidths of SPARK devices are shown in Table 4 within the limits of each regulatory region. The table also includes cases where DAA and LDC mitigation can be used.

Table 4: SPARK UWB device bandwidths per regulated region

	FCC countries	ETSI countries	Australia	Canada	China	Hong Kong	Japan	South Korea	Russia
SR1010	2.65	1.4 DAA/LDC	(TBA)	1.0	(TBA)	1.4 DAA/LDC	1.4 DAA	1.7 DAA/LDC	(TBA)
SR1020	3.25	2.5	2.4	3.25	3.0	2.5	2.0	2.05	2.1

With their larger unlicensed UWB spectra, regions under the jurisdiction of Industry Canada and FCC benefit from 3.25 GHz of operational bandwidth when using SR1020 devices, allowing for higher data rates compared to the other jurisdictions.

Note 4: In Russia, there are limitations to offering a robust link while meeting the GRFC's compliance standards, due to the very low in band emissions (-47 dBm/MHz) limits combined with tight out-of-band filtering requirements.

References

ETSI - Generic UWB Devices - en_30206501v020101p
ETSI WordWide Regulations - 2019 - tr_10318103v020101p
FCC - April 2015 - eCFR - Code of Federal Regulations
Industry Canada - RS 220 - Devices Using UWB Technology
Japan - sample-std-t91-2.0
Australia - Planning for UWB technology

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