

Survey of Radio Regulations for Murata Transceiver ICs

Introduction

Products incorporating Murata's TRC103, TRC104 and TRC105 transceiver ICs must be certified to local radio regulations in each country or geographical region where they will be marketed. This application note discusses the major regulations that apply, and provides an overview of the certification processes.

TRC103

Region	Authority	Regulation	Band	Notes
United States	FCC	Part 15.249	902-928 MHz	TX field strength up to 50 mV/m @ 3 m, no duty cycle
United States	FCC	Part 15.247	902-928 MHz	FHSS allows max TRC103 TX power, no duty cycle
Canada	IC	RSS-210, A2.9	902-928 MHz	TX field strength up to 50 mV/m @ 3 m, no duty cycle
Canada	IC	RSS-210, A8.1	902-928 MHz	FHSS allows max TRC103 TX power, no duty cycle
Europe	ERC, ETSI	ERC/REC 70-03 ETSI EN 300 220-1	863-870 MHz	10 mW to max TRC103 TX power, FHSS optional, duty cycle/power depend on subband of operation
Australia	ACMA	LIPD Schedule 1, Item 18	915-928 MHz	up to 3 mW TX power, no duty cycle
Australia	ACMA	LIPD Schedule 1, Item 52	915-928 MHz	FHSS allows max TRC103 TX power, no duty cycle
New Zealand	MoED	Notice 2007, Schedule 1	819-824 MHz 864-868 MHz	max TRC103 TX power, no duty cycle, no application restrictions
New Zealand	MoED	Notice 2007, Schedule 1	915-921 MHz, 921-928 MHz	915-921 MHz - up to 3 mW TX power for telemetry & telecommand; 921-928 MHz - max TRC103 TX power, unrestricted use

Table 1

TRC104

Region	Authority	Regulation	Band	Notes
United States	FCC	Part 15.249	2400.0 - 2483.5 MHz	TX field strength up to 50 mV/m @ 3 m, no duty cycle
United States	FCC	Part 15.247	2400.0 - 2483.5 MHz	max TRC104 power, FHSS is optional mode, no duty cycle
Canada	IC	RSS-210, A2.9	2400.0 - 2483.5 MHz	TX field strength up to 50 mV/m @ 3 m, no duty cycle
Canada	IC	RSS-210, A8.1	2400.0 - 2483.5 MHz	max TRC104 power, FHSS is optional mode, no duty cycle
Europe	ERC, ETSI	ERC/REC 70-03, ETSI EN 300 440-1	2400.0 - 2483.5 MHz	max TRC104 power, FHSS is optional mode no duty cycle
China	MII	Low Power Radio Devices Section 2E	2400.0 - 2425 MHz	max TRC104 power, no duty cycle, general applications
Japan	ARIB	STD-T66	2400.0 - 2483.5 MHz	max TRC104 power, no duty cycle
Australia	ACMA	LIPD Schedule 1, Item 19	2400.0 - 2483.5 MHz	max TRC104 power, FHSS is optional mode, no duty cycle
New Zealand	MoED	Notice 2007, Schedule 2	2400.0 - 2483.5 MHz	max TRC104 power, FHSS is optional mode no duty cycle

Table 2

TRC105

Region	Authority	Regulation	Band	Notes
United States	FCC	Part 15.231 (a) & (e)	300-451 MHz ¹	manual/periodic transmissions; for remote control and security max TX field strength @ 3 m = $41.6667(F_{MHz}) - 7083.3333$, for general periodic transmissions (e) max TX field strength @ 3 m = $16.6667(F_{MHz}) - 2833.3333$
Canada	IC	RSS-210, A1.1	300-451 MHz ¹	manual/periodic transmissions; for remote control and security max TX field strength @ 3 m = $41.67*(F_{MHz}) - 7083.33$, for general periodic transmissions (e) max TX field strength @ 3 m = $16.67*(F_{MHz}) - 2833.33$
Europe	ERC, ETSI	ERC/REC 70-03 ETSI EN 300 220-1	433.05- 434.79 MHz	up to 1 mW without duty cycle, up to 10 mW with 10% duty cycle
China	MII	Low Power Radio Devices Section 11	315.00- 316.00 MHz, 430.00- 432.00 MHz	up to 6000 μ V/m @ 3m, for alarm systems, panic buttons, gate and door controls
Japan	ARIB	STD-T93	312.00- 315.25 MHz	manual/periodic transmissions for remote control, telemetry or data, 25 μ W TX power
Australia	ACMA	LIPD Schedule1, Items 33 & 43	303.60- 304.05 MHz, 344.80- 345.20 MHz	alarm and personal security transmitters, 100 μ W in the 303.60 MHz band, alarm transmitters, 1 mW in the 344.80 MHz band
Australia	ACMA	LIPD Schedule1, Item 34	314.075- 314.325 MHz	home detention monitors, 200 μ W
Australia	ACMA	LIPD Schedule 1, Item 17	433.05- 434.79 MHz	max TRC105 TX power, no duty cycle, no application restrictions
New Zealand	MoED	Notice 2007, Schedule 1	300.0- 322.0 MHz	10 mW max TX power, no duty cycle, remote control and telemetry
New Zealand	MoED	Notice 2007, Schedule 1	433.05- 434.79 MHz	max TRC105 TX power, no duty cycle, remote control and telemetry
Internationally Coordinated	-	FCC Part 47 CFR 95.601-95.673, ETSI EN 301-839-2, etc.	402-405 MHz	medical implant communications, 25 μ W

1. TRC105 covers 300 to 451 MHz, 15.231 & A1.1 regulations covers a larger range.

Table 3

Tables 1-3 above summarize the primary regulations that apply to TRC103, TRC104 and TRC105. A discussion of each regulation listed in the tables is provided below.

United States FCC Part 15 Regulations

In the United States, use of the TRC103, TRC104 and TRC105 fall under various sections of the Federal Communications Commission 47 CFR Part 15 Regulations. A copy of these regulations can be downloaded at http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&tpl=/ecfrbrowse/Title47/47cfrv1_02.tpl.

The TRC103 can operate in the 902-928 MHz band under either Section 15.249 or 15.247. There are no on-to-off duty cycle restrictions or spread spectrum transmission requirements under 15.249, but radiated field strength is limited to 50 mV/m @ 3 meters. This equates to roughly 1 mW of transmitter power, depending on the gain and efficiency of the antenna being used. Section 15.249 is chosen as the operating authority for many applications that operate over relatively short distances - typically less than 300 ft outdoors or 50 to 100 ft indoors.

Operating the TRC103 in the 902-928 MHz band as a frequency hopping spread spectrum (FHSS) radio under 15.247 allows the radio to run maximum transmitter power, providing about three times more indoor and outdoor range than operation under 15.249. There are no on-to-off duty cycle restrictions under 15.247 other than the maximum FHSS channel dwell time. The FHSS operating mode also mitigates the effects of interference and signal fading due to multipath propagation. While frequency hopping synchronization overhead increases the latency of communications in many situations, it is a good choice for TRC103 applications that require more operating range and/or greater communication robustness.

The TRC104 can operate under either Section 15.249 or 15.247 in the 2400.0-2483.5 MHz band. There are no on-to-off duty cycle restrictions or spread spectrum transmission requirements under 15.249. Radiated field strength is limited to 50 mV/m @ 3 meters. This is approximately the field strength that can be obtained with the TRC104 when operating at maximum transmitter power with a typical antenna. Most applications for the TRC104 are relatively short range, such as wireless computer peripherals for a single PC, where high data rate and long battery life are more important than long range. The TRC104 can be operated in FHSS mode to improve resistance to interference and multipath fading under 15.249 so long as the radiated field strength is limited to 50 mV/m @ 3 m. Operation under 15.247 is only necessary if the TRC104 is used with a transmitter power amplifier that raises its transmitted field strength above 50 mV/m @ 3 m.

The TRC105 can operate on various frequencies in the 300 to 400 MHz frequency range under Part 15.231 (a) and (e). Part 15.231 covers periodic transmissions suitable for applications such as wireless remote control, wireless security systems and periodic telemetry/data transmissions. 15.231(a) covers remote control and alarms; 15.231(e) covers other non-specific applications. The specific applications covered by 15.231(a) can transmit a higher field strength than non-specific applications covered under 15.231(e). The maximum allowed field strength measured at 3 m is a function of operating frequency:

for 15.231(a), the maximum field strength in $\mu\text{V/m}$ is $41.6667 \cdot (F_{\text{MHz}}) - 7083.3333$

for 15.231(e), the maximum field strength in $\mu\text{V/m}$ is $16.6667 \cdot (F_{\text{MHz}}) - 2833.3333$

Averaging can be applied to the field strength under certain circumstances to allow a higher peak field strength level. Typical operating ranges under 15.213(a) are 300 ft outdoors and 100 ft indoors. Typical operating ranges under 15.213(e) are 100 ft outdoors and 30 ft indoors.

Individual automatic transmissions under 15.231(a) can not exceed five seconds. Manual transmissions must cease within five seconds of the remote control button being released. Provisions for longer transmissions are allowed in certain emergency situations. Under 15.231(e), transmissions may not exceed one second. A 1 to 30 on-off minimum duty cycle applies, with the off time at least 10 seconds regardless of the transmission time.

There are other Sections in Part 15 that can apply to the TRC103, TRC104 and TRC105 in addition to the basic operating authorities given in 15.231, 15.247 and 15.249. These include, but are not limited to 15.33, 15.35, 15.107, 15.109, 15.205 and 15.209. In particular, 15.205 covers restricted bands where no Part 15 transmissions are allowed and only low level spurious emissions can be accepted. Due to the requirements of 15.205, operation under 15.231 tends to aggregate around specific frequencies including 303.825 MHz, 315 MHz, 418 MHz, 434 MHz and several other frequencies where transmitter harmonics do not fall in the restricted bands.

A FCC Part 15 *Certificate of Compliance* must be obtained before a product using a TRC103, TRC104 or TRC105 can be marketed in the United States. The certification process consists of two parts. The first part is a laboratory test to confirm compliance with the relevant technical specifications in Part 15. The second part is a review of the laboratory test results, the product labeling, the user manual and several other submittal items for overall Part 15 compliance by an FCC certification contractor, referred to as a TCB. A number of companies offer both laboratory testing and TCB review, and most laboratories routinely work with one or more TCBs. Many laboratories provide forms or check lists to assist customers in compiling items needed for a certification submission. The FCC publishes a list of laboratories that are registered to conduct compliance testing at www.FCC.gov.

Even when testing is contracted to an outside laboratory, it is important for a company developing a product using a TRC103, TRC104 or TRC105 to take the time to become familiar with Part 15 regulations, so as to avoid a system level design issue that would prevent a Part 15 certification.

Industry Canada RSS-210 Regulations

Industry Canada (IC) Spectrum Management and Telecommunications RSS-210 Regulations apply to products using the TRC103, TRC104 and TRC015 in Canada. IC RSS-210 and FCC Part 15 regulations have been coordinated so that with some planning (differences in restricted bands, etc.) the same product can be certified in both Canada and the United States. Many laboratories and TCBs can process both certifications at the same time. The parallels in the RSS-210 and Part 15 regulations will be apparent in the discussion below. A copy of RSS-210 can be downloaded at:

<https://www.fcc.gov/search/#q=part%2015%20title%2047>

The TRC103 can operate in the 902-928 MHz band under either Annex A2.9 or A8.1. There are no on-to-off duty cycle restrictions or spread spectrum transmission requirements under A2.9, but radiated field strength is limited to 50 mV/m @ 3 meters. This equates to roughly 1 mW of transmitter power, depending on the gain and efficiency of the antenna being used. A2.9 is chosen as the operating authority for many applications that operate over relatively short distances - typically less than 300 ft outdoors or 50 to 100 ft indoors.

Operating the TRC103 in the 902-928 MHz band as a frequency hopping spread spectrum (FHSS) radio under Annex A8.1 allows the radio to run maximum transmitter power, providing about three times more indoor and outdoor range than operation under A2.9. There are no on-to-off duty cycle restrictions under A8.1 other than the maximum FHSS channel dwell time. The FHSS operating mode also mitigates the effects of interference and signal fading due to multipath propagation. While frequency hopping synchronization overhead increases the latency of communications in many situations, it is a good choice for TRC103 applications that require more operating range and/or greater communication robustness.

The TRC104 can operate under either Annex A2.9 or A8.1 in the 2400.0-2483.5 MHz band. There are no on-to-off duty cycle restrictions or spread spectrum transmission requirements under A2.9. Radiated field

strength is limited to 50 mV/m @ 3 m. This is approximately the field strength that can be obtained with the TRC104 when operating at maximum transmitter power with a typical antenna. Most applications for the TRC104 are relatively short range, such as wireless computer peripherals for a single PC, where high data rate and long battery life are more important than long range. The TRC104 can be operated in FHSS mode to improve resistance to interference and multipath fading under A2.9 so long as the radiated field strength is limited to 50 mV/m @ 3 m. Operation under A8.1 is only necessary if the TRC104 is used with a transmitter power amplifier that raises its transmitted field strength above 50 mV/m @ 3 m.

The TRC105 can operate on various frequencies in the 300 to 400 MHz frequency range under Annex 1 which covers periodic transmissions suitable for applications such as wireless remote control, wireless security systems and periodic telemetry/data transmissions. A1.1.1 covers remote control and alarms; A1.1.5 covers other non-specific applications. The specific applications covered by A1.1.1 can transmit a higher field strength than non-specific applications covered under A1.1.5. The maximum allowed field strength measured at 3 m is a function of operating frequency:

for A1.1.1, the maximum field strength in $\mu\text{V/m}$ is $41.67 \cdot (F_{\text{MHz}}) - 7083.33$

for A1.1.5, the maximum field strength in $\mu\text{V/m}$ is $16.67 \cdot (F_{\text{MHz}}) - 2833.33$

Averaging can be applied to the field strength under certain circumstances to allow a higher peak field strength level. Typical operating ranges under A1.1.1 are 300 ft outdoors and 100 ft indoors. Typical operating ranges under A1.1.5 are 100 ft outdoors and 30 ft indoors.

Individual automatic transmissions under A1.1.1 can not exceed five seconds. Manual transmissions must cease within five seconds of initiation. Provisions for longer transmissions are allowed in certain emergency situations. Under A1.1.5, transmissions may not exceed one second. A one to 30 on-off minimum duty cycle applies, with the off time at least 10 seconds regardless of the transmission time.

There are other Sections in RSS-210 that can apply to the TRC103, TRC104 and TRC105 in addition to the basic operating authorities given in Annexes 1, 2 and 8. In particular, Section 2.2 covers restricted bands where no transmissions are allowed and only low level spurious emissions can be accepted. As with Part 15, RSS-210 transmissions aggregate around specific frequencies including 303.825 MHz, 315 MHz, 418 MHz, 434 MHz and several other frequencies where transmitter harmonics do not fall in the restricted bands. Note there are some differences in the Canadian and US restricted bands, so check both when selecting an operating frequency for use in both countries.

European SRD Regulations

The TRC103, TRC104 and TRC105 are referred to as short range devices (SRDs) in Europe. SRD technical regulations are issued by the European Telecommunications Standards Institute (ETSI). Regulations can be downloaded at <http://www.etsi.org/technologies-clusters/technologies/radio/short-range-devices>. Key ETSI regulations related to the TRC103, TRC104 and TRC105 include:

- EN 300 220-1 (SRDs up to 1 GHz)
- EN 300 440-1 (SRDs 1 to 40 GHz)
- EN 301 489-3 (SRD EMC compatibility)

European SDR frequency allocations and related information is published by the European Radiocommunications Office (ERO) The primary SRD document is

ERC/REC 70-03

This document can be downloaded at <http://www.eroocdb.dk/docs/doc98/official/pdf/rec7003e.pdf>

The ERO coordinates with several other European Agencies including ETSI, the European Conference of Postal and Telecommunications Administrations (CEPT), etc. In most cases, the information needed to test a product using a TRC103, TRC104 or TRC105 is found in ERC/REC 70-03 and the applicable ETSI technical regulations. Rather than being issued a Certification as in the US or Canada, SRD manufacturers publish a *Declaration of Conformity* - see <https://cemarking.net/declaration-conformity/>. However, it is recommended that an independent test lab (referred to as a notified body) conduct testing to the relevant ETSI regulations for credibility. A number of the test labs that conduct Part 15/RSS-210 tests can provide notified body testing for European SRDs.

European SRDs regulations cover operation with and without duty cycle restrictions, and with or without spread spectrum modulation. However, the allocations are quite different in Europe compared to the US and Canada. For example, the TRC103 can operate with no duty cycle restrictions in the 902-928 MHz band in North America, but must operate on a duty-cycled or listen-before-talk basis in many of the 863-870 MHz sub-bands in Europe. The TRC105 must operate on an intermittent basis in the bands it covers in North America, but can operate with no duty cycle restriction with 1 mW of transmit power in the 434 MHz SRD allocation in Europe.

The European frequency band for TRC105 SRD operation is 433.050-434.790 MHz. When the transmitter power is limited to 1 mW, there are no duty cycle restrictions. Up to 10 mW of transmitter power is allowed with a 10% duty cycle limit. EN 300 220-1 provides details for both wideband and channelized operation. The TRC105 is usually operated as a wideband radio. SRD receiver testing is more extensive under ETSI regulations than North American regulations, and is based on the type of SRD application (see EN 300 220-1 Section 9.3.3). The TRC105 provides Class 2 receiver performance. Typical operating ranges for the 433.050-434.790 MHz band at 10 mW is 300 m outdoors and 100 m indoors. At 1 mW, typical operating ranges are 100 m outdoors and 30 m indoors.

The European frequency band for TRC103 operation is 863-870 MHz. Annex 1 in the ERC/REC 70-03 document details several sub-band allocations between 868-870 MHz. Each sub-band includes a maximum transmitter power and duty cycle limit. Sub-bands that have a duty cycle limit less than 100% allow the use of listen-before-talk (LBT) channel access as an alternative. See EN 300 220-1 Section 8.1 for LBT details. While single-channel or frequency-agile operation is used predominately in this band, EN 300 220-1 also includes provisions for spread spectrum operation. It is possible to operate the TRC103 as a FHSS radio in the 863-870 MHz band, subject to either a duty cycle restriction or LBT operation. Typical operating ranges for the 863-870 MHz band at 10 mW is 270 m outdoors and 75 m indoors. At 1 mW, typical operating ranges are 90 m outdoors and 25 m indoors. The TRC103 provides Class 2 receiver performance.

The TRC104 can operate as a SRD in the 2400.0 - 2483.5 MHz band under ETSI EN 300 440-1 technical regulations. There are no duty cycle restrictions in this band.

China MII Regulations

The Ministry of Information Industry publishes the specifications for Low Power Radio Devices in China that apply to the TRC104 and TRC105.

TRC105 operation is under Section 11, Radio Burglar Alarm System and Remote Control Devices, in the frequency ranges of 315-316 MHz and 430-432 MHz, and is similar to operation under FCC 15.231, except that no duty cycle is specified. Applications listed in Section 11 include alarm systems, panic buttons and door controls. The maximum allowed transmitter field strength is 6,000 $\mu\text{V}/\text{m}$ at 3 meters, with spurious emissions not to exceed 600 $\mu\text{V}/\text{m}$ at 3 m. Typical operating ranges under Section 11 are 100 m outdoors and 30 m indoors.

TRC104 operation in the 2400.0-2425 MHz band is specified in Section 2E, Low Power General Use Radio Transmission Devices. There are no duty cycle restrictions in this case, and the TRC104 can run maximum output power.

Products utilizing the TRC105 or TRC104 in China require a *Type Approval Certificate* issued by the Office of State Radio Regulatory Commission of the People's Republic of China (SRRC Office). An application for type approval along with a sample for testing is submitted to the SRRC. The Low Power Radio Devices in China Specification plus detailed information on type approval submissions can be obtained through the China Compulsory Certification Online Service Centre. The US web site URL is www.ccc-us.com. Also see <http://www.ccc-cn.org/ccindex.htm>.

Japanese ARIB Regulations

The Association of Radio Industries and Businesses (ARIB) publishes the standards that apply to the TRC104 and TRC105. ARIB STD-T93 covers TRC105 operation in the 312-315.25 MHz band, and ARIB STD-T66 covers the TRC104 operation in the 2400.0-2483.5 MHz band. The ARIB web site URL is www.arib.or.jp. Many of the ARIB regulations available on this site are in Japanese. Often an English version can be purchased by contacting the ARIB, as discussed on their web site.

TRC105 operation in the 312-315.25 MHz band under ARIB STD-T93 is generally similar to operation under FCC 15.231, making it well suited for remote control, alarm and low-bandwidth telemetry applications. The maximum allowed transmitter power is 25 μW , with a tolerance of +20%, -100%. One-way and two-way transmissions are allowed. Transmissions must be periodic. Manual transmissions (button) must be limited to a maximum of 90 s. Automatic transmissions cannot exceed 10 s. The interval between transmissions must be at least 30 times the transmission interval except under emergency conditions where a 1:1 duty cycle is allowed. STD-T93 also includes limits on transmission bandwidth and receiver and transmitter spurious emissions. Typical ranges under STD-T93 are 60 m outdoors and 20 m indoors.

TRC104 operation in the 2400.0-2483.5 MHz band under ARIB STD-66 falls into the non-specific modulation category. There are no duty cycle restrictions, and the TRC104 can run maximum output power.

Products utilizing the TRC105 or TRC104 in Japan must be Telecom Engineering Center (TELEC) *Type Certified*. Products may be submitted to TELEC directly for testing or to a test lab recognized by TELEC. See the TELEC web site at www.telec.or.jp for submission and type certification details.

Australian ACMA Regulations

A product incorporating a TRC103, TRC104 and TRC105 operates in Australia under a Radiocommunications Low Interference Potential Devices (LPID) *Class License* as issued by the Australian Communications and Media Authority (ACMA) as a notice in the *Commonwealth of Australia Gazette*. Details of the class license can be downloaded from www.acma.gov.au. Referring to Schedule 1 in the LPID Class License Document, Item 19 covers TRC103 operation in the 915-928 MHz band at a power level up to 3 mW, and Item 52 covers FHSS TRC103 operation in the same band at the TRC103's full rated power. Item 19 covers TRC104 operation in the 2400-2483.5 MHz band at the TRC104's full rated power. Optionally, the TRC104 can be operated in FHSS mode to improve resistance to interference and multipath fading under Item 19 so long as its output power is not amplified beyond 10 dBm.

Items 17, 33, 34 and 43 cover TRC105 operation in various 300 and 400 MHz allocations. Maximum allowed transmitter power varies from item to item. Item 17 allows TRC105 operation at full rated power in the 433.05-434.79 MHz frequency band that parallels European SRD operation. Refer to Schedule 1 for additional details. Also see the current version of AS/NZS 4268 - *Radiocommunications equipment and systems - Short range devices - Limits and methods of measurement*. The latest version of AS/NZS 4268 can be obtained through www.standards.com.au.

New Zealand MoED Regulations

A product incorporating a TRC103, TRC104 and TRC105 operates in New Zealand under the Ministry of Economic Development Radiocommunications Regulations (General User Radio License for Short Range Devices) Notice 2007. This document can be downloaded <http://www.rsm.govt.nz/about-rsm/spectrum-policy/gazette/gurl>. Also see the current version of AS/NZS 4268 - *Radio-communications equipment and systems - Short range devices - Limits and methods of measurement*. The latest version of AS/NZS 4268 can be obtained through www.standards.com.au or through www.standards.co.nz.

Murata Technical Support

Murata's Application Engineering staff offers technical support related to designing with the TRC103, TRC104 and TRC105 transceiver ICs. See the footer on this document for e-mail and phone contact information.

Disclaimer

Murata offers the information in this application note as a general guide without guarantee of total accuracy or completeness. All low power radio regulation are subject to revision and supplemental interpretation. Murata strongly recommends establishing a working relationship with an experienced, recognized test lab for each region where a Certification or Declaration of Conformity is required to market products using Murata TRC103, TRC104 or TRC105 IC transceivers.