BGX220S Wireless Gecko Bluetooth Xpress Module Data Sheet

The BGX220S is a wireless cable replacement module that eliminates Bluetooth firmware development complexity with a serial interface that can operate as a raw data stream or control the device through an abstracted command API. The BGX220S can facilitate a device-to-device cable replacement link or communicate with mobile devices through the Xpress Bluetooth mobile library. The device integrates a Bluetooth 5.2 compliant stack to future-proof applications as Bluetooth 5.2 adoption increases.

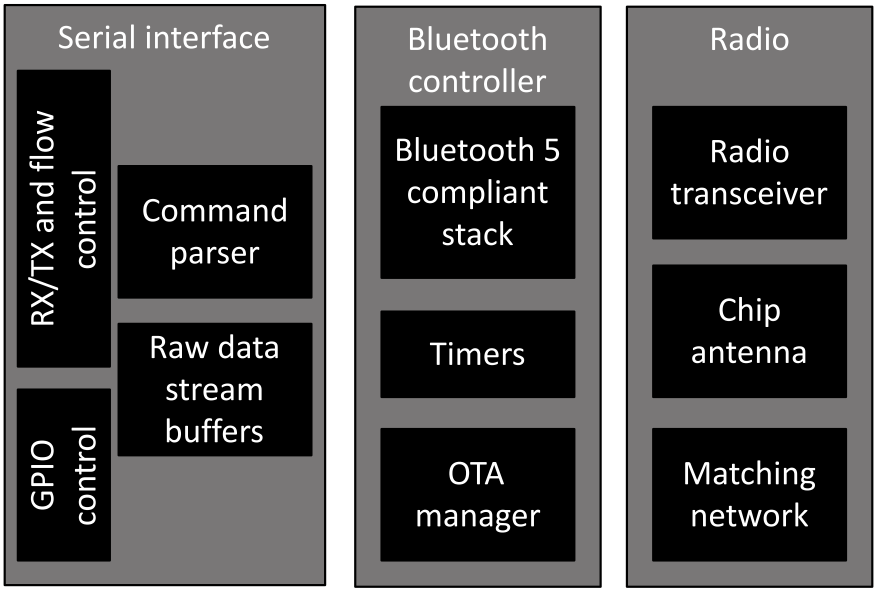
BGX220S modules are a full solution that comes with fully-upgradeable, robust software stacks, world-wide regulatory certifications, and support that will minimize and simplify the engineering and development of your end-products helping to accelerate their time-to-market.

The BGX220S is intended for a broad range of applications, including:

- Health, sports, and wellness devices
- Industrial, home, and building automation
- Smart phone, tablet, and PC accessories

KEY FEATURES

- Bluetooth 5.2 Technologies
- Bluetooth Low Energy
- Built-in antenna
- Up to 6 dBm TX power
- -98.6 dBm BLE RX sensitivity at 1 Mbps
- 8 GPIO pins
- I2C master interface
- Input pin event monitoring and response
- 6.0 mm x 6.0 mm



1. Ordering Information

Table 1.1. Ordering Information

Ordering Code	Protocol Stack	TX Power Rating	Antenna	RF Shield	Flash (kB)	RAM (kB)	GPIO	Temp Range
BGX220S22HNA21	• Bluetooth 5.2	6 dBm	Built-in	Yes	512	32	8	-40 to 105 °C

Note:

1. End-product manufacturers must verify that the module is configured to meet regulatory limits for each region in accordance with the formal certification test reports.
2. Throughout this document, the device in the table above may be referred to by their product family name (e.g. BGX220S), by model name (BGX220S22A), or by full ordering code.

Table of Contents

2. System Overview

2.1 Block Diagram

The BGX220S module combines an energy-friendly MCU with a highly integrated radio transceiver in a SiP module with a robust, integrated antenna. This section gives a short introduction to the features of the module.

Note that features in the module are not directly configurable in this pre-programmed product, and are instead controlled through the abstracted command and variable set.

The block diagram for the BGX220S module is shown in the figure below. The wireless module includes the EFR32BG22 wireless System on a Chip (SoC), required decoupling capacitors and inductors, 38.4 MHz crystal, RF matching circuit, and integrated antenna.

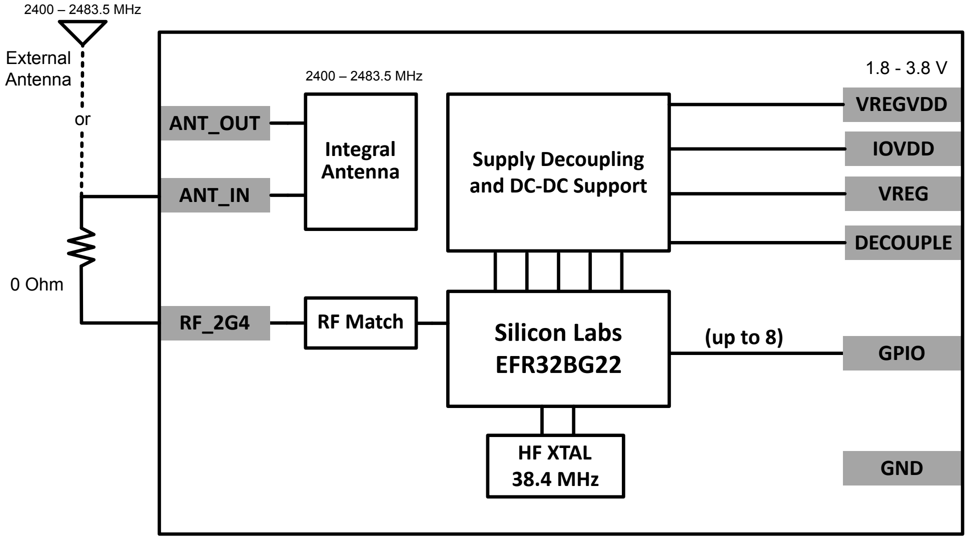


Figure 2.1. BGX220S Block Diagram

A simplified internal schematic for the BGX220S module is shown in Figure 2.2 BGX220S Module Schematic on page 5.

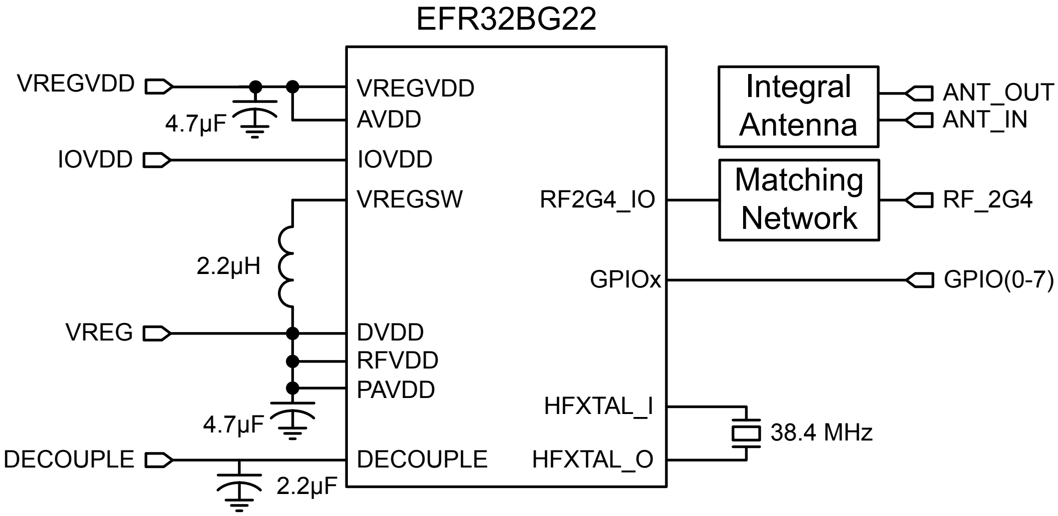


Figure 2.2. BGX220S Module Schematic

2.2 EFR32BG22 SoC

The EFR32BG22 SoC features a 32-bit ARM Cortex M33 core, a 2.4 GHz high-performance radio, 512 kB of flash memory, a rich set of MCU peripherals, and various clock management and serial interfacing options. Consult the EFR32xG22 Wireless Gecko Reference Manual and the EFR32BG22 Data Sheet for details.

Note that the Flash and other features in this product are not directly accessible, and are instead accessed through the product's abstracted command and variable set.

2.3 Antenna

BGX220S modules include an integral antenna on board with the characteristics detailed in the tables below.

Table 2.1. Antenna Efficiency and Peak Gain

Parameter	With optimal layout	Note
Efficiency	-1 to -2 dB	Antenna efficiency, gain and radiation pattern are highly dependent on the application PCB layout and mechanical design. Refer to 7. Design Guidelines for recommendations to achieve optimal antenna performance.
Peak gain	2.3 dBi	

2.4 Power Supply

The BGX220S requires a single nominal supply level of 3.0 V to operate. All necessary decoupling and filtering components are included in the module.

3. Electrical Characteristics

All electrical parameters in all tables are specified under the following conditions, unless stated otherwise:

- Typical values are based on T_A=25 °C and VDD supply at 3.0 V, by production test and/or technology characterization.
- Radio performance numbers are measured in conducted mode, based on Silicon Laboratories reference designs using output power-specific external RF impedance-matching networks for interfacing to a 50 Ω antenna.
- Minimum and maximum values represent the worst conditions across supply voltage, process variation, and operating temperature, unless stated otherwise.

3.1 Absolute Maximum Ratings

Stresses beyond those listed below may cause permanent damage to the device. This is a stress rating only and functional operation of the devices at those or any other conditions beyond those indicated in the operation listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability. For more information on the available quality and reliability data, see the Quality and Reliability Monitor Report at http://www.silabs.com/support/quality/pages/default.aspx.

Table 3.1. Absolute Maximum Ratings

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Storage temperature range	T_{STG}		-50	—	+150	°C
Voltage on any supply pin	V_{DDMAX}		-0.3	—	3.8	V
Junction temperature	T_{JMAX}	-N grade	—	—	+105	°C
Voltage ramp rate on any supply pin	$V_{DDRAMPMAX}$		—	—	1.0	V / µs
DC voltage on any GPIO pin	V_{DIGPIN}		-0.3	—	V_{IOVDD} + 0.3	V
Input RF level on RF pin RF_2G4	$P_{RFMAX2G4}$		—	—	+10	dBm
Absolute voltage on RF pin RF_2G4	V_{MAX2G4}		-0.3	—	V_{VREG} + 0.3	V
Total current into VDD power lines	I_{VDDMAX}	Source	—	—	200	mA
Total current into VSS ground lines	I_{VSSMAX}	Sink	—	—	200	mA
Current per I/O pin	I_{IOMAX}	Sink	—	—	50	mA
		Source	—	—	50	mA
Current for all I/O pins	$I_{IOALLMAX}$	Sink	—	—	200	mA
		Source	—	—	200	mA

3.2 General Operating Conditions

This table specifies the general operating temperature range and supply voltage range for all supplies. The minimum and maximum values of all other tables are specifed over this operating range, unless otherwise noted.

Table 3.2. General Operating Conditions

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Operating ambient temperature range	T_A	-N temperature grade	-40	—	+105	°C
VREGVDD operating supply voltage	$V_{VREGVDD}$	DCDC in regulation[1]	2.2	3.0	3.8	V
		DCDC in bypass	1.8	3.0	3.8	V

Note:

1. The supported maximum $V_{VREGVDD}$ in regulation mode is a function of temperature and 10-year lifetime average load current. See more details in 3.2.1 DC-DC Operating Limits.

3.2.1 DC-DC Operating Limits

The maximum supported voltage on the VDD supply pin is limited under certain conditions. Maximum input voltage is a function of temperature and the average load current over a 10-year lifetime. Figure 3.1 Lifetime average load current limit vs. Maximum input voltage on page 9 shows the safe operating region under specific conditions. Exceeding this safe operating range may impact the reliability and performance of the DC-DC converter.

The average load current for an application can typically be determined by examining the current profile during the time the device is powered. For example, an application that is continuously powered which spends 99% of the time asleep consuming 2 μA and 1% of the time active and consuming 10 mA has an average lifetime load current of about 102 μA.

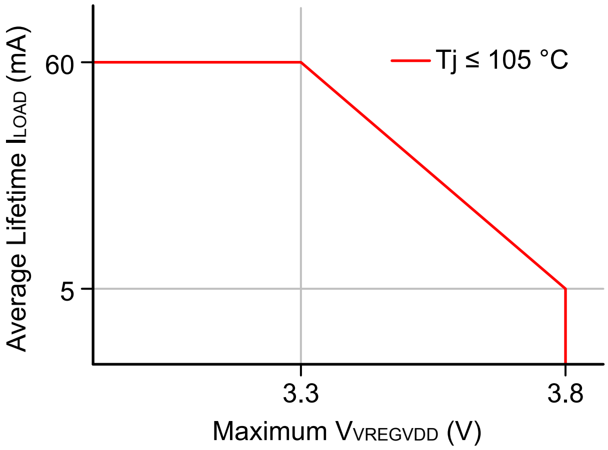


Figure 3.1. Lifetime average load current limit vs. Maximum input voltage

The minimum input voltage for the DC-DC in EM0/EM1 mode is a function of the maximum load current, and the peak current setting. Figure 3.2 Transient maximum load current vs. Minimum input voltage on page 9 shows the max load current vs. input voltage for different DC-DC peak inductor current settings.

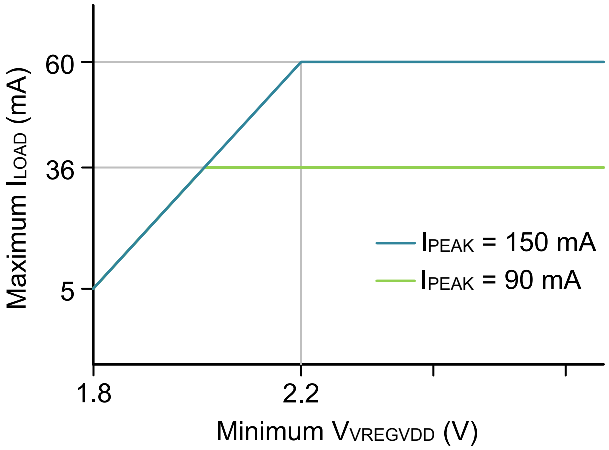


Figure 3.2. Transient maximum load current vs. Minimum input voltage

3.3 Power Consumption

Table 3.3. Power Consumption

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Active supply current, Unconnected, Idle	I_{ACTIVE_IDLE}	Baud rate ≤ 9600 bps	—	TBD	—	µA
		Baud rate > 9600 bps	—	TBD	—	mA
Active supply current, Advertising	I_{ACTIVE_ADV}	Interval = 546.25 ms, Baud rate ≤ 9600 bps	—	TBD	—	µA
		Interval = 20 ms, Baud rate ≤ 9600 bps	—	TBD	—	mA
		Interval = 546.25 ms, Baud rate > 9600 bps	—	TBD	—	mA
		Interval = 20 ms, Baud rate > 9600 bps	—	TBD	—	mA
Active supply current, Connected, 15 ms Interval	I_{ACTIVE_CONN}	Idle, Baud Rate ≤ 9600 bps	—	TBD	—	µA
		TX/RX (acknowledged) at highest throughput, Baud Rate ≤ 9600 bps	—	TBD	—	mA
		TX/RX (unacknowledged) at highest throughput, Baud Rate ≤ 9600 bps	—	TBD	—	mA
		Idle, Baud Rate > 9600 bps	—	TBD	—	mA
		TX/RX (acknowledged) at highest throughput, Baud Rate > 9600 bps	—	TBD	—	mA
		TX/RX (unacknowledged) at highest throughput, Baud Rate > 9600 bps	—	TBD	—	mA
Supply current in low power mode	I_{LPM}	Radio disabled	—	TBD	—	µA
		Radio enabled, Advertising, Interval = 546.25 ms	—	TBD	—	µA
		Radio enabled, Advertising, Interval = 20 ms	—	TBD	—	mA

3.4 RF Transmitter General Characteristics for the 2.4 GHz Band

Unless otherwise indicated, typical conditions are: T_A = 25 °C, VREGVDD = 3.0V. RF center frequency 2.45 GHz.

Table 3.4. RF Transmitter General Characteristics for the 2.4 GHz Band

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
RF tuning frequency range	F_{RANGE}		2400	—	2483.5	MHz
Maximum TX power[1]	$POUT_{MAX}$	6 dBm output power	—	6.0	—	dBm
		0 dBm output power	—	-0.5	—	dBm
Minimum active TX Power	$POUT_{MIN}$		—	-27	—	dBm
Output power variation vs VREGVDD supply voltage variation, frequency = 2450 MHz	$POUT_{VAR\_V}$	6 dBm output power with VREGVDD voltage swept from 1.8 V to 3.0 V	—	0.04	—	dB
		0 dBm output power, with VREGVDD voltage swept from 1.8 to 3.0 V	—	0.04	—	dB
Output power variation vs temperature, Frequency = 2450 MHz	$POUT_{VAR\_T}$	6 dBm output power, (-40 to +105 °C)	—	0.2	—	dB
		0 dBm output power, (-40 to +105 °C)	—	1.3	—	dB
Output power variation vs RF frequency	$POUT_{VAR\_F}$	6 dBm output power	—	0.09	—	dB
		0 dBm output power	—	0.15	—	dB

Note:

1. Supported transmit power levels are determined by the ordering part number (OPN). Transmit power ratings for all devices covered in this data sheet can be found in the Max TX Power column of the Ordering Information Table.

3.5 RF Receiver General Characteristics for the 2.4 GHz Band

Unless otherwise indicated, typical conditions are: T_A = 25 °C, VREGVDD = 3.0V. RF center frequency 2.45 GHz.

Table 3.5. RF Receiver General Characteristics for the 2.4 GHz Band

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
RF tuning frequency range	F_{RANGE}		2400	—	2483.5	MHz

3.6 RF Receiver Characteristics for Bluetooth Low Energy in the 2.4 GHz Band 1 Mbps Data Rate

Unless otherwise indicated, typical conditions are: T_A = 25 °C, VREGVDD = 3.0V. RF center frequency 2.45 GHz.

Table 3.6. RF Receiver Characteristics for Bluetooth Low Energy in the 2.4 GHz Band 1 Mbps Data Rate

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Max usable receiver input level	SAT	Signal is reference signal[1]	—	10	—	dBm
Sensitivity	SENS	Signal is reference signal, 37 byte payload[2]	—	-98.6	—	dBm
		Signal is reference signal, 255 byte payload[1]	—	-97.2	—	dBm
		With non-ideal signals[3] [1]	—	-96.6	—	dBm
Signal to co-channel interferer	C/I_{CC}	(see notes)[1] [4]	—	8.7	—	dB
N ± 1 Adjacent channel selectivity	C/I_1	Interferer is reference signal at +1 MHz offset[1] [5] [4] [6]	—	-6.6	—	dB
		Interferer is reference signal at -1 MHz offset[1] [5] [4] [6]	—	-6.5	—	dB
N ± 2 Alternate channel selectivity	C/I_2	Interferer is reference signal at +2 MHz offset[1] [5] [4] [6]	—	-40.9	—	dB
		Interferer is reference signal at -2 MHz offset[1] [5] [4] [6]	—	-39.9	—	dB
N ± 3 Alternate channel selectivity	C/I_3	Interferer is reference signal at +3 MHz offset[1] [5] [4] [6]	—	-45.9	—	dB
		Interferer is reference signal at -3 MHz offset[1] [5] [4] [6]	—	-46.2	—	dB
Selectivity to image frequency	C/I_{IM}	Interferer is reference signal at image frequency with 1 MHz precision[1] [6]	—	-23.5	—	dB
Selectivity to image frequency ± 1 MHz	C/I_{IM_1}	Interferer is reference signal at image frequency +1 MHz with 1 MHz precision[1] [6]	—	-40.9	—	dB
		Interferer is reference signal at image frequency -1 MHz with 1 MHz precision[1] [6]	—	-6.6	—	dB
Intermodulation performance	IM	n = 3 (see note[7])	—	-17.1	—	dBm

Note:

1. 0.017% Bit Error Rate.
2. 0.1% Bit Error Rate.
3. With non-ideal signals as specified in Bluetooth Test Specification RF-PHY.TS.5.0.1 section 4.7.1
4. Desired signal -67 dBm.
5. Desired frequency 2402 MHz ≤ Fc ≤ 2480 MHz.
6. With allowed exceptions.
7. As specified in Bluetooth Core specification version 5.1, Vol 6, Part A, Section 4.4

3.7 RF Receiver Characteristics for Bluetooth Low Energy in the 2.4 GHz Band 2 Mbps Data Rate

Unless otherwise indicated, typical conditions are: T_A = 25 °C, VREGVDD = 3.0V. RF center frequency 2.45 GHz.

Table 3.7. RF Receiver Characteristics for Bluetooth Low Energy in the 2.4 GHz Band 2 Mbps Data Rate

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Max usable receiver input level	SAT	Signal is reference signal[1]	—	10	—	dBm
Sensitivity	SENS	Signal is reference signal, 37 byte payload[2]	—	-95.9	—	dBm
		Signal is reference signal, 255 byte payload[1]	—	-94.3	—	dBm
		With non-ideal signals[3] [1]	—	-94.0	—	dBm
Signal to co-channel interferer	C/I_{CC}	(see notes)[1] [4]	—	8.8	—	dB
N ± 1 Adjacent channel selectivity	C/I_1	Interferer is reference signal at +2 MHz offset[1] [5] [4] [6]	—	-9.2	—	dB
		Interferer is reference signal at -2 MHz offset[1] [5] [4] [6]	—	-6.6	—	dB
N ± 2 Alternate channel selectivity	C/I_2	Interferer is reference signal at +4 MHz offset[1] [5] [4] [6]	—	-43.3	—	dB
		Interferer is reference signal at -4 MHz offset[1] [5] [4] [6]	—	-44.0	—	dB
N ± 3 Alternate channel selectivity	C/I_3	Interferer is reference signal at +6 MHz offset[1] [5] [4] [6]	—	-48.6	—	dB
		Interferer is reference signal at -6 MHz offset[1] [5] [4] [6]	—	-50.7	—	dB
Selectivity to image frequency	C/I_{IM}	Interferer is reference signal at image frequency with 1 MHz precision[1] [6]	—	-23.8	—	dB
Selectivity to image frequency ± 2 MHz	C/I_{IM_1}	Interferer is reference signal at image frequency +2 MHz with 1 MHz precision[1] [6]	—	-43.3	—	dB
		Interferer is reference signal at image frequency -2 MHz with 1 MHz precision[1] [6]	—	-9.2	—	dB
Intermodulation performance	IM	n = 3 (see note[7])	—	-18.8	—	dBm

Note:

1. 0.017% Bit Error Rate.
2. 0.1% Bit Error Rate.
3. With non-ideal signals as specified in Bluetooth Test Specification RF-PHY.TS.5.0.1 section 4.7.1
4. Desired signal -64 dBm.
5. Desired frequency 2402 MHz ≤ Fc ≤ 2480 MHz.
6. With allowed exceptions.
7. As specified in Bluetooth Core specification version 5.1, Vol 6, Part A, Section 4.4

3.8 RF Receiver Characteristics for Bluetooth Low Energy in the 2.4 GHz Band 500 kbps Data Rate

Unless otherwise indicated, typical conditions are: T_A = 25 °C, VREGVDD = 3.0V. RF center frequency 2.45 GHz.

Table 3.8. RF Receiver Characteristics for Bluetooth Low Energy in the 2.4 GHz Band 500 kbps Data Rate

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Max usable receiver input level	SAT	Signal is reference signal[1]	—	10	—	dBm
Sensitivity	SENS	Signal is reference signal, 37 byte payload[2]	—	-102.3	—	dBm
		Signal is reference signal, 255 byte payload[1]	—	-100.9	—	dBm
		With non-ideal signals[3] [1]	—	-99.8	—	dBm
Signal to co-channel interferer	C/I_{CC}	(see notes)[1] [4]	—	2.7	—	dB
N ± 1 Adjacent channel selectivity	C/I_1	Interferer is reference signal at +1 MHz offset[1] [5] [4] [6]	—	-8.0	—	dB
		Interferer is reference signal at -1 MHz offset[1] [5] [4] [6]	—	-7.9	—	dB
N ± 2 Alternate channel selectivity	C/I_2	Interferer is reference signal at +2 MHz offset[1] [5] [4] [6]	—	-46.5	—	dB
		Interferer is reference signal at -2 MHz offset[1] [5] [4] [6]	—	-49.9	—	dB
N ± 3 Alternate channel selectivity	C/I_3	Interferer is reference signal at +3 MHz offset[1] [5] [4] [6]	—	-48.9	—	dB
		Interferer is reference signal at -3 MHz offset[1] [5] [4] [6]	—	-53.8	—	dB
Selectivity to image frequency	C/I_{IM}	Interferer is reference signal at image frequency with 1 MHz precision[1] [6]	—	-48.3	—	dB
Selectivity to image frequency ± 1 MHz	C/I_{IM_1}	Interferer is reference signal at image frequency +1 MHz with 1 MHz precision[1] [6]	—	-49.9	—	dB
		Interferer is reference signal at image frequency -1 MHz with 1 MHz precision[1] [6]	—	-46.5	—	dB

Note:

1. 0.017% Bit Error Rate.
2. 0.1% Bit Error Rate.
3. With non-ideal signals as specified in Bluetooth Test Specification RF-PHY.TS.5.0.1 section 4.7.1
4. Desired signal -72 dBm.
5. Desired frequency 2402 MHz ≤ Fc ≤ 2480 MHz.
6. With allowed exceptions.

3.9 RF Receiver Characteristics for Bluetooth Low Energy in the 2.4 GHz Band 125 kbps Data Rate

Unless otherwise indicated, typical conditions are: T_A = 25 °C, VREGVDD = 3.0V. RF center frequency 2.45 GHz.

Table 3.9. RF Receiver Characteristics for Bluetooth Low Energy in the 2.4 GHz Band 125 kbps Data Rate

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Max usable receiver input level	SAT	Signal is reference signal[1]	—	10	—	dBm
Sensitivity	SENS	Signal is reference signal, 37 byte payload[2]	—	-106.4	—	dBm
		Signal is reference signal, 255 byte payload[1]	—	-106.0	—	dBm
		With non-ideal signals[3] [1]	—	-105.6	—	dBm
Signal to co-channel interferer	C/I_{CC}	(see notes)[1] [4]	—	0.9	—	dB
N ± 1 Adjacent channel selectivity	C/I_1	Interferer is reference signal at +1 MHz offset[1] [5] [4] [6]	—	-13.6	—	dB
		Interferer is reference signal at -1 MHz offset[1] [5] [4] [6]	—	-13.4	—	dB
N ± 2 Alternate channel selectivity	C/I_2	Interferer is reference signal at +2 MHz offset[1] [5] [4] [6]	—	-52.6	—	dB
		Interferer is reference signal at -2 MHz offset[1] [5] [4] [6]	—	-55.8	—	dB
N ± 3 Alternate channel selectivity	C/I_3	Interferer is reference signal at +3 MHz offset[1] [5] [4] [6]	—	-53.7	—	dB
		Interferer is reference signal at -3 MHz offset[1] [5] [4] [6]	—	-59.0	—	dB
Selectivity to image frequency	C/I_{IM}	Interferer is reference signal at image frequency with 1 MHz precision[1] [6]	—	-52.7	—	dB
Selectivity to image frequency ± 1 MHz	C/I_{IM_1}	Interferer is reference signal at image frequency +1 MHz with 1 MHz precision[1] [6]	—	-53.7	—	dB
		Interferer is reference signal at image frequency -1 MHz with 1 MHz precision[1] [6]	—	-52.6	—	dB

Note:

1. 0.017% Bit Error Rate.
2. 0.1% Bit Error Rate.
3. With non-ideal signals as specified in Bluetooth Test Specification RF-PHY.TS.5.0.1 section 4.7.1
4. Desired signal -79 dBm.
5. Desired frequency 2402 MHz ≤ Fc ≤ 2480 MHz.
6. With allowed exceptions.

3.10 Non-Volatile Configuration Storage

Table 3.10. Non-volatile Configuration Storage

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Supply voltage during update	VFLASH		1.71	—	3.8	V

3.11 High-Frequency Crystal

Table 3.11. High-Frequency Crystal

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Crystal frequency	f_{HFXTAL}		—	38.4	—	MHz
Initial calibrated accuracy	ACC_{HFXTAL}		-10	+/-5	10	ppm
Temperature drift	$DRIFT_{HFXTAL}$	Across specified temperature range	-20	—	20	ppm

3.12 GPIO Pins

Unless otherwise indicated, typical conditions are: IOVDD = 3.0 V.

Table 3.12. GPIO Pins

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Leakage current	I_{LEAK_IO}	MODEx = DISABLED, IOVDD = 1.71 V	—	1.9	—	nA
		MODEx = DISABLED, IOVDD = 3.0 V	—	2.5	—	nA
Input low voltage[1]	V_{IL}	Any GPIO pin	—	—	0.3*IOVDD	V
		RESETn	—	—	0.3*DVDD	V
Input high voltage[1]	V_{IH}	Any GPIO pin	0.7*IOVDD	—	—	V
		RESETn	0.7*DVDD	—	—	V
Hysteresis of input voltage	V_{HYS}	Any GPIO pin	0.05*IOVDD	—	—	V
		RESETn	0.05*DVDD	—	—	V
Output high voltage	V_{OH}	Sourcing 20mA, IOVDD = 3.0 V	0.8 * IOVDD	—	—	V
		Sourcing 8mA, IOVDD = 1.71 V	0.6 * IOVDD	—	—	V
Output low voltage	V_{OL}	Sinking 20mA, IOVDD = 3.0 V	—	—	0.2 * IOVDD	V
		Sinking 8mA, IOVDD = 1.71 V	—	—	0.4 * IOVDD	V
GPIO rise time	T_{GPIO_RISE}	IOVDD = 3.0 V, C_{load} = 50pF, SLEWRATE = 4, 10% to 90%	—	8.4	—	ns
		IOVDD = 1.71 V, C_{load} = 50pF, SLEWRATE = 4, 10% to 90%	—	13	—	ns
GPIO fall time	T_{GPIO_FALL}	IOVDD = 3.0 V, C_{load} = 50pF, SLEWRATE = 4, 90% to 10%	—	7.1	—	ns
		IOVDD = 1.71 V, C_{load} = 50pF, SLEWRATE = 4, 90% to 10%	—	11.9	—	ns
Pull up/down resistance[2]	R_{PULL}	Any GPIO pin. Pull-up to IOVDD: MODEn = DISABLE DOUT=1. Pull-down to VSS: MODEn = WIREDORPULLDOWN DOUT = 0.	35	44	55	kΩ
		RESETn pin. Pull-up to DVDD	35	44	55	kΩ
Maximum filtered glitch width	T_{GF}	MODE = INPUT, DOUT = 1	—	27	—	ns

Note:

1. GPIO input thresholds are proportional to the IOVDD pin. RESETn input thresholds are proportional to DVDD.
2. GPIO pull-ups connect to IOVDD supply, pull-downs connect to VSS. RESETn pull-up connects to DVDD.

3.13 Typical Performance Curves

Typical performance curves indicate typical characterized performance under the stated conditions.

3.13.1 Antenna Typical Characteristics

Typical BGX220S radiation patterns for the on-board chip antenna under optimal operating conditions are plotted in the figures that follow. Antenna gain and radiation patterns have a strong dependence on the size and shape of the application PCB the module is mounted on, as well as on the proximity of any mechanical design to the antenna.

Top Left: Phi 0°, Top Right: Phi 90°, Bottom Left: Theta 90°

Figure 3.3. BGM220S22A Typical 2D Antenna Radiation Patterns on 55 mm x 20 mm board

4. Reference Diagrams

4.1 Typical Connections

The BGX220S can be controlled over the UART interface as a peripheral to an external host processor. Typical power supply and host interface connections are shown in the figure below.

Note that an external pull-up should not be placed on the reset pin.

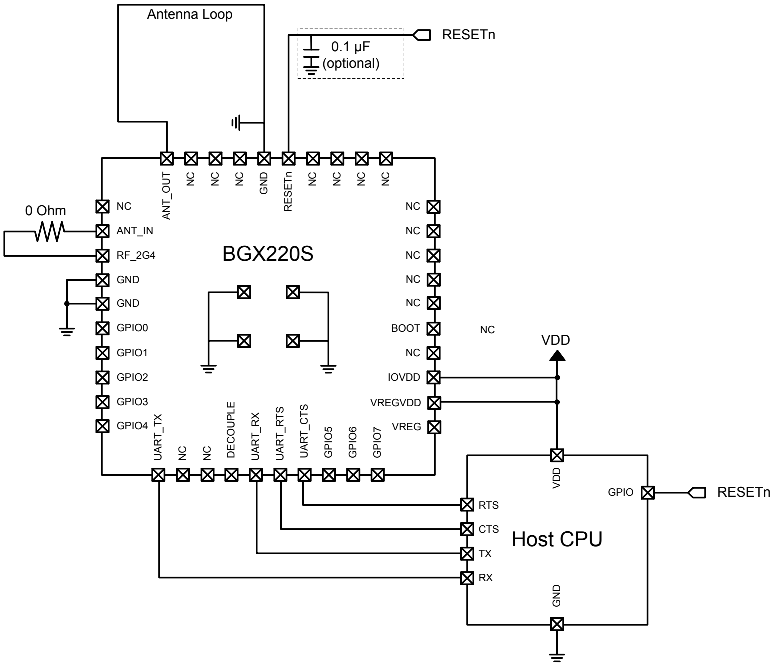


Figure 4.1. Typical Connection Diagram

5. 44-Pin SiP Module Device Pinout

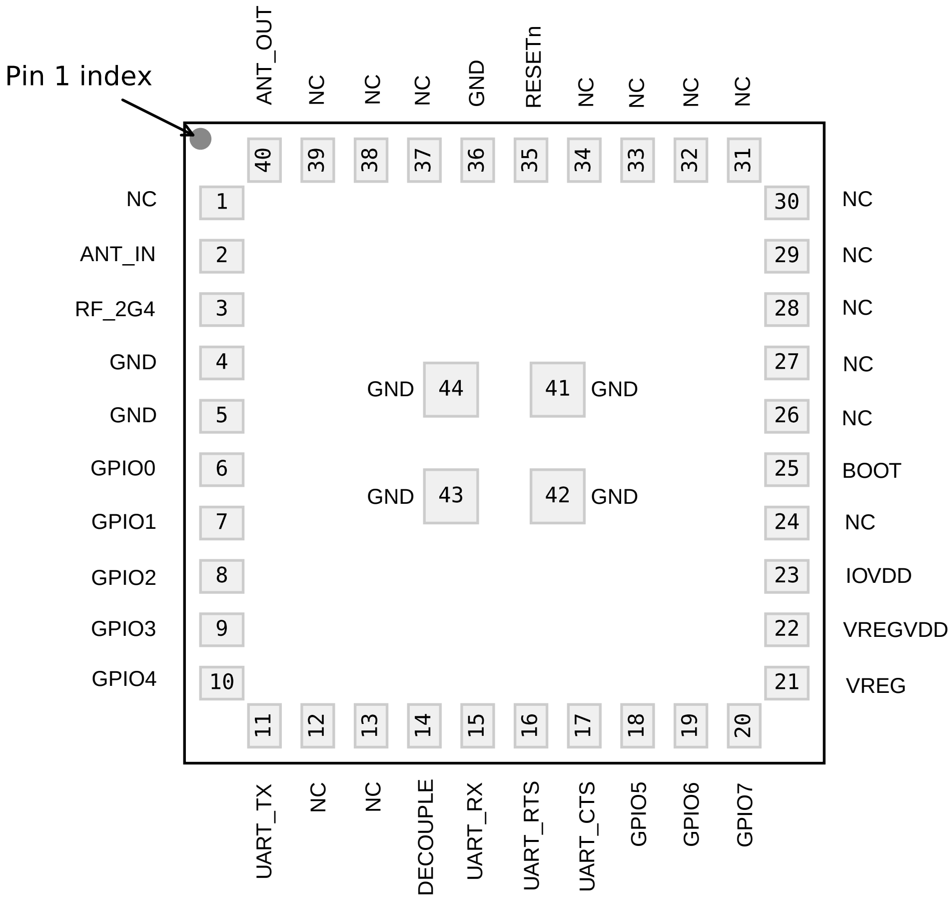


Figure 5.1. 44-Pin SiP Module Device Pinout

Table 5.1. 44-Pin SiP Module Device Pinout

Pin Name	Pin(s)	Description	Pin Name	Pin(s)	Description
NC	1	No connect	ANT_IN	2	Antenna In
RF_2G4	3	2.4 GHz RF input/output	GND	4	Ground
GND	5	Ground	GPIO0	6	Pin with input/output functionality configured through the command API.
GPIO1	7	Pin with input/output functionality configured through the command API.	GPIO2	8	Pin with input/output functionality configured through the command API.
GPIO3	9	Pin with input/output functionality configured through the command API.	GPIO4	10	Pin with input/output functionality configured through the command API.
UART_TX	11	Digital output	NC	12	No connect

Pin Name	Pin(s)	Description	Pin Name	Pin(s)	Description
NC	13	No connect	DECOUPLE	14	Decouple output for on-chip voltage regulator. This pin is internally decoupled, and should be left disconnected.
UART_RX	15	Digital input	UART_RTS	16	Digital output
UART_CTS	17	Digital input	GPIO5	18	Pin with input/output functionality configured through the command API.
GPIO6	19	Pin with input/output functionality configured through the command API.	GPIO7	20	Pin with input/output functionality configured through the command API.
VREG	21	Regulated supply voltage. This pin is internally connected to the SoC DVDD, RFVDD, and PAVDD supply lines. It is not intended to power external circuitry.	VREGVDD	22	Module input power supply. This pin is internally connected to the SoC AVDD and VREGVDD supply lines.
IOVDD	23	I/O power supply	NC	24	No connect
BOOT	25	Active-low digital input to force module entrance into DFU bootloader state upon device reset. See command API documentation for functional details.	NC	26	No connect
NC	27	No connect	NC	28	No connect
NC	29	No connect	NC	30	No connect
NC	31	No connect	NC	32	No connect
NC	33	No connect	NC	34	No connect
RESETn	35	Reset Pin. The RESETn pin is internally pulled up to VREG (DVDD).	GND	36	Ground
NC	37	No connect	NC	38	No connect
NC	39	No connect	ANT_OUT	40	Antenna Out
GND	41	Ground	GND	42	Ground
GND	43	Ground	GND	44	Ground

6. Functional overview

6.1 Introduction

The BGX220S creates a Bluetooth 5.2 compliant Bluetooth Low Energy cable replacement interface, facilitating a Bluetooth Low Energy link to a second embedded device or a mobile device. An embedded MCU controls the device and communicates across the Bluetooth Low Energy link through a serial interface and control signals. Parameters stored in non-volatile memory and configurable through the serial interface adjust performance characteristics of the device. Silicon Labs offers iOS and Android mobile libraries for Bluetooth Xpress devices to speed mobile development and simplify communication with the device. This library also controls OTA management, facilitating secure and reliable updates to the device’s embedded stack.

This functional overview does not cover each command supported by the command API. The complete command API specification is available at docs.silabs.com.

6.2 Communication Use Cases

The BGX220S family facilitates two types of Bluetooth Low Energy communication links:

- BGX-to-mobile
- BGX-to-BGX

In the BGX-to-mobile communication use case, the BGX220S operates as a peripheral that is discoverable and connectable when configured to that state through either the command API or the pin states driven by the embedded MCU. Using the Xpress mobile library, mobile applications can scan for BGX220S devices, connect, and communicate with the device in both streaming and remote command modes, where the mobile app can execute command API functions remotely.

In the BGX-to-BGX communication use case, one BGX220S must be configured as the central device and one or more other BGX devices should be configured as a peripheral. Devices can be configured at runtime through the command API, or those settings can be saved to non-volatile memory so that each device wakes from power-on or low power states as either a peripheral or central. For more information on advertising and connection options, please see the command API documentation.

6.3 Embedded Interface

The BGX220S family uses an 8-N-1 USART interface for data and flow control signaling. The interface is used both for a raw data streaming interface and a command interface, depending on additional hardware pin configuration.

UART_TX and UART_RX are defined with flow directions relative to the BGX. Bytes sent from the embedded host to the BGX use the UART_RX pin. Bytes sent from the BGX to the embedded host appear on the UART_TX pin.

UART_CTS is a digital input that controls the state of the UART_RTS digital output on the other end of the wireless link. Assertion of a CTS/RTS pair signals that the embedded MCU driving its respective UART_CTS is available to receive bytes.

The baud rate of the BGX220S is a configurable parameter. For information on the process by which a baud rate change gets processed and executed by the device, please see the command API documentation.

State control signals and visual indicators described below can be assigned to any of the GPIO pins through the command API. These settings can be stored in non-volatile memory and take effect during the next power cycle. For information on configuration of standard GPIO and available special function I/O available on the device, please see the command API documentation.

6.4 Command Mode and Streaming Mode

The BGX220S is designed to wake and offer optimized serial interface with hardware flow control. Hardware flow control signaling is disabled by default. When operating in a peripheral role and when flow control signals are monitored, the device may never need to leave streaming mode during operation.

However, when use cases require more advanced runtime configuration, the device can switch to command interface through pin or escape sequence. Commands defined here can control scanning, advertising, connection state, and GPIO settings.

The command interface is also used to configure and store customizable parameters.

Streaming mode can be switched to command mode through an escape sequence of characters if the sequence has been previously saved in the device's configuration. A command can be issued in command mode to switch to streaming mode. Stream mode and command mode entrance can be controlled through a device port pin state, if a pin has been previously defined for that purpose.

6.5 Command API

Each command begins with a command name followed by arguments, and the syntax of each command is defined in the command API documentation.

The command interface saves settings as key-value pairs. These values can be used at runtime to modify the operational state, and they can also be stored in non-volatile memory. Values stored in non-volatile memory function to configure the device's startup/default state.

6.6 GPIO Control

The BGX220S offers 8 GPIO pins. These pins can be configured as state control pins or visual indicator pins. Alternatively, they can be used as general purpose I/O pins. Digital output settings can be set and digital input state can be read through the command interface locally or remotely through the remote command execution using the mobile libraries.

6.7 Device Configuration

Device configuration is handled through the command API, where commands are executed when the serial interface is set to operate in command mode. These commands can also be executed remotely through the mobile library unless prohibited through previous configuration.

Additionally, a device configuration can be generated and saved using Simplicity Studio's Xpress Configurator tool. A generated configuration can be submitted to Silicon Labs through the process defined in that application. Silicon Labs will then validate the configuration request, generate a custom orderable part number, and deliver first article samples for testing. Developers should contact sales representatives for more information about this process. Once first article samples have been validated by the customer, this custom orderable part number can be ordered directly from Silicon Labs.

6.8 Security Features

BGX220S devices communicate with LE secure connections, establishing encrypted communication upon connection.

Device OTA requires an encrypted image signed by Silicon Laboratories. Only firmware developed, signed, and encrypted by Silicon Labs can be bootloaded successfully on the device.

6.9 OTA

The BGX220S supports secure OTA of the embedded stack and the command interface. Images are encrypted and signed by Silicon Laboratories. OTA can be performed through the mobile library APIs. Specific device firmware versions can be selected and programmed through these APIs. See command API documentation for more information.

For information on new functionality including firmware updates to BGX220S, please see docs.silabs.com. BGX220S module OPN firmware will not be updated to include newly released features available through OTA and DFU updates provided by Silicon Labs. Module OPN firmware will only be updated at manufacturing time to provide security-related enhancements.

Contact Silicon Labs technical support for information on customer factory programming options for custom OPN ordering with a specified device firmware version and for customer factory programming options.

6.10 Direct Test Mode Support

The BGX220S's command API offers a command set that configures the device to support the Direct Test Mode (DTM) protocol as defined in the Bluetooth Core Specification Version 4.2, Volume 6, part F.

See the command API for information about commands to support specific DTM test procedures.

7. Design Guidelines

7.1 Layout and Placement

For optimal performance of the BGX220S the following guidelines are recommended:

- Place the module 1.50 mm from the edge of the copper “keep-in” area at the middle of the long edge of the application PCB, as illustrated in Figure 7.1 Recommended Layout for BGX220S on page 24.
- Copy the exact antenna design from Figure 7.2 Antenna Layout With Coordinates on page 25 with the values for coordinates A to L given in Table 7.1 Antenna Polygon Coordinates, Referenced to Center of BGX220S on page 25.
- Make a cutout in all lower layers aligned with the right edge and the bottom edge of the antenna as indicated by the yellow box in Figure 7.3 Antenna Clearance in Inner and Bottom Layers on page 26.
- Connect all ground pads directly to a solid ground plane in the top layer.
- Connect RF_2G4 to ANT_IN through a 0-ohm resistor.
    - The 0-ohm gives the ability to test conducted and to evaluate the antenna impedance in the design.
- Place ground vias as close to the ground pads of the BGX220S as possible.
- Place ground vias along the antenna loop right and bottom side.
- Place ground vias along the edges of the application board.
- Do not place plastic or any other dielectric material in contact with the antenna.
    - A minimum clearance of 0.5 mm is advised.
    - Solder mask, conformal coating and other thin dielectric layers are acceptable directly on top of the antenna region.

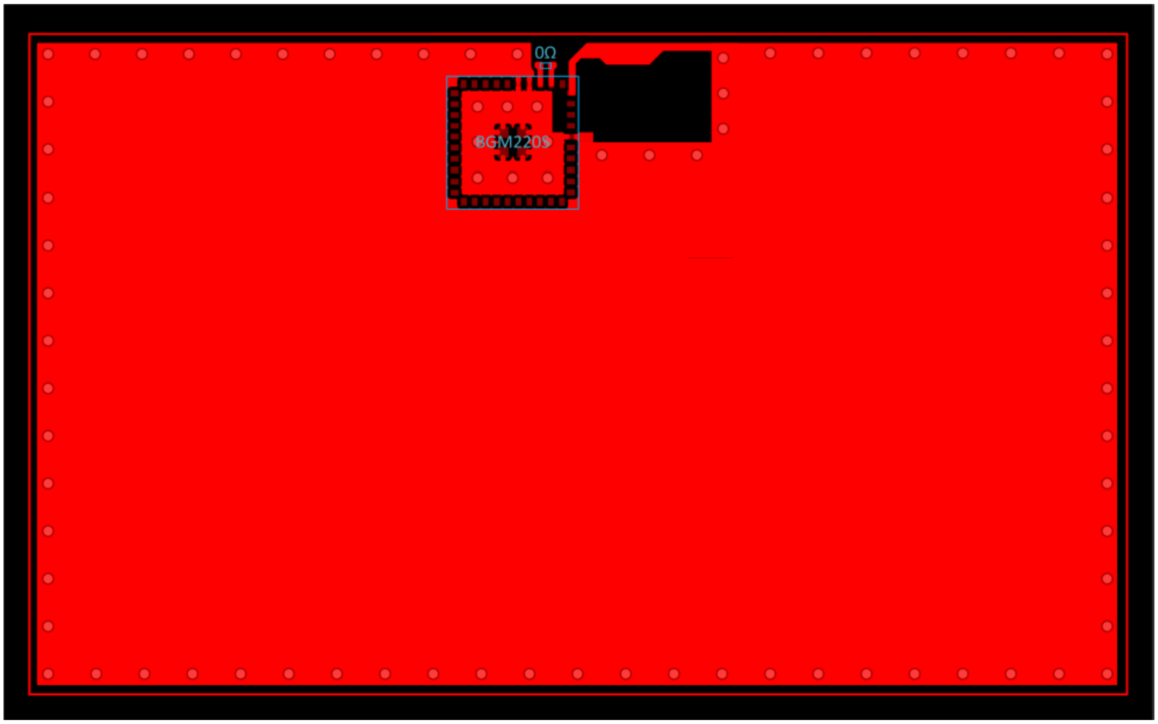


Figure 7.1. Recommended Layout for BGX220S

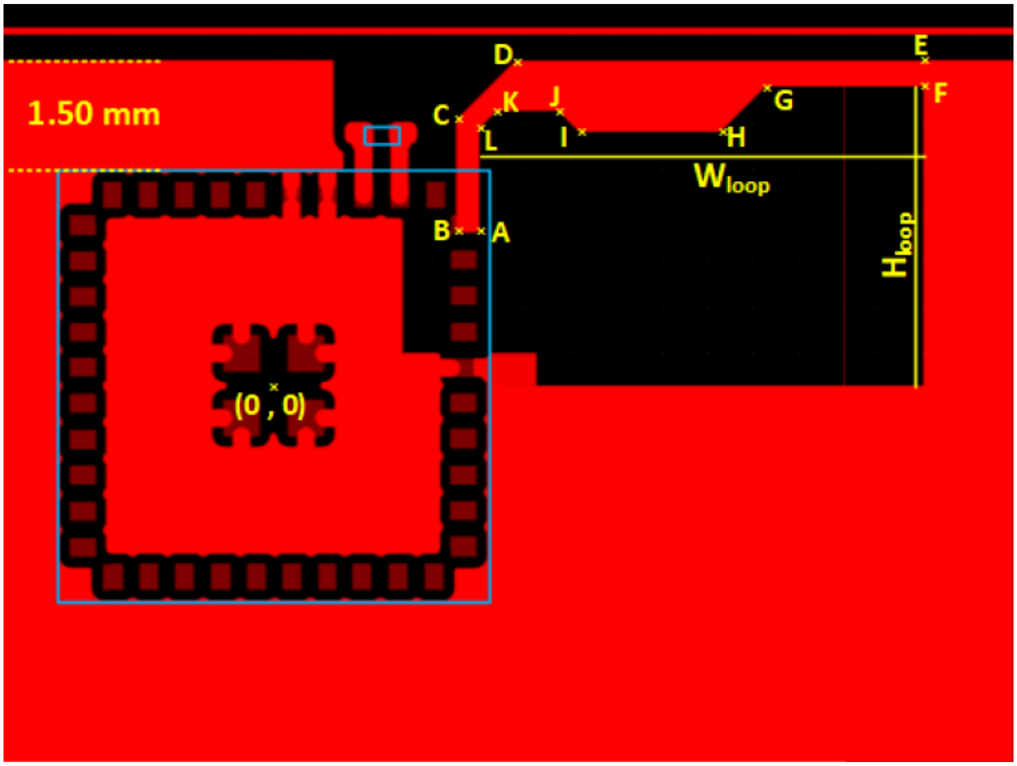


Figure 7.2. Antenna Layout With Coordinates

Table 7.1. Antenna Polygon Coordinates, Referenced to Center of BGX220S

Point	BGM220SC12WGA2	BGM220SC22WGA2 BGM220SC22HNA2
A	(2.87, 2.13)	(2.87, 2.13)
B	(2.54, 2.13)	(2.54, 2.13)
C	(2.54, 3.69)	(2.54, 3.69)
D	(3.36, 4.51)	(3.36, 4.51)
E	(8.85, 4.51)	(7.75, 4.51)
F	(8.85, 4.15)	(7.75, 4.15)
G	(6.84, 4.15)	(6.84, 4.15)
H	(6.21, 3.52)	(6.21, 3.52)
I	(4.26, 3.52)	(4.26, 3.52)
J	(3.97, 3.81)	(3.97, 3.81)
K	(3.10, 3.81)	(3.10, 3.81)
L	(2.87, 3.58)	(2.87, 3.58)
W_{loop}	5.98	4.88
H_{loop}	4.15	4.15

Note:

1. All coordinates and dimensions listed in mm.

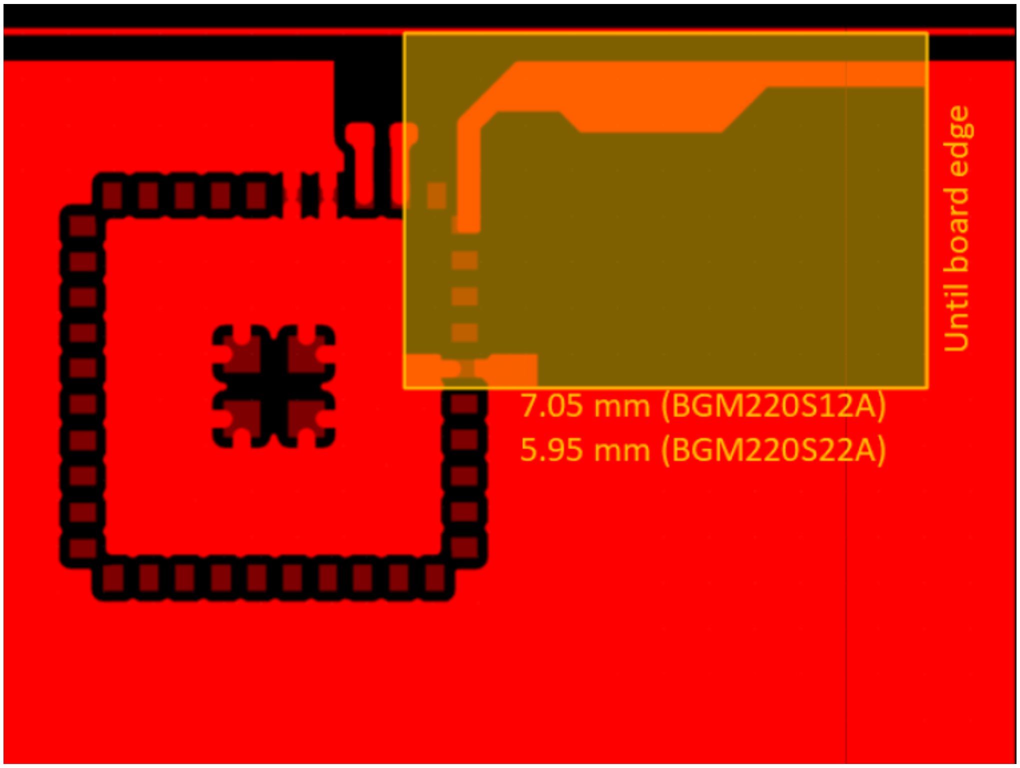


Figure 7.3. Antenna Clearance in Inner and Bottom Layers

7.2 Best Design Practices

The design of a good RF system relies on thoughtful placement and routing of the RF signals. The following guidelines are recommended:

- Place the BGX220S and antenna close to the center of the longest edge of the application board.
- Do not place any circuitry between the board edge and the antenna.
- Make sure to tie all GND planes in the application board together with as many vias as can be fitted.
- Generally ground planes are recommended in all areas of the application board except in the antenna keep-out area shown in Figure 7.3 Antenna Clearance in Inner and Bottom Layers on page 26.
- Open-ended stubs of copper in the outer layer ground planes must be removed if they are more than 5 mm long to avoid radiation of spurious emissions.
- The width of the GND plane to the sides of the BGX220S will impact the efficiency of the on-board chip antenna.
  - To achieve optimal performance, a GND plane width of 55 mm for BGX220S is recommended as seen on Figure 7.4 Illustration of Recommended Board Width on page 27.
  - See 3.13.1 Antenna Typical Characteristics for reference.

Figure 7.5 Non-Optimal Layout Examples on page 28 illustrates layout scenarios that will lead to severely degraded RF performance for the application board.

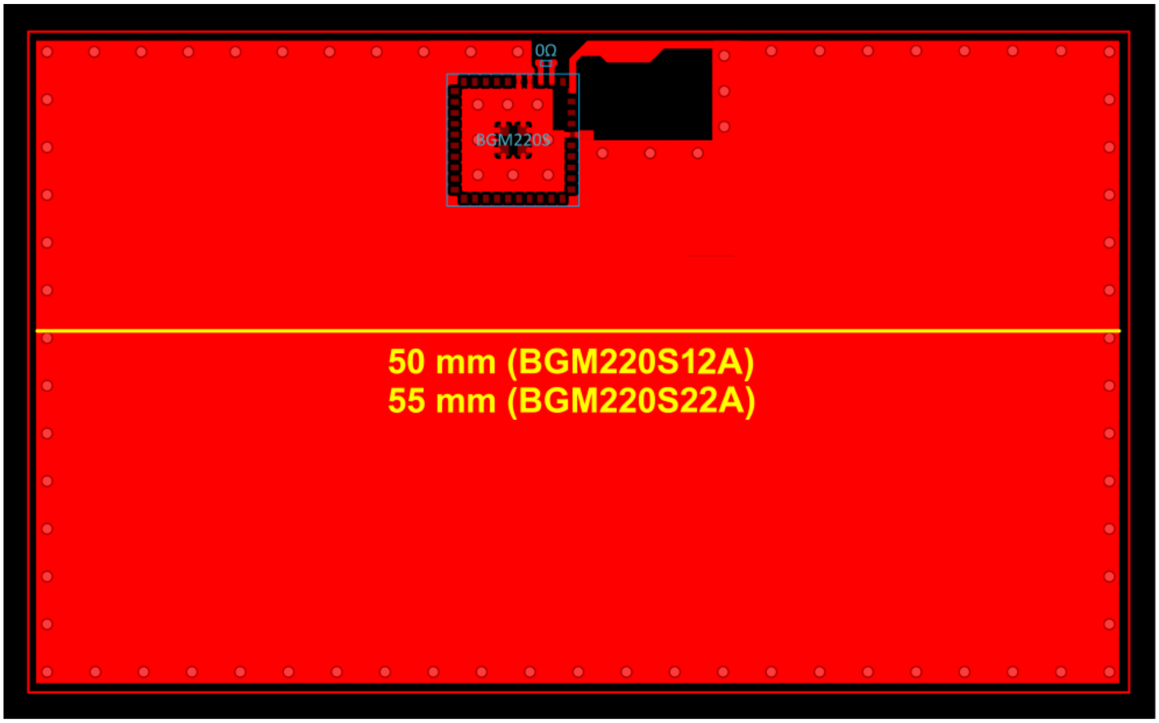


Figure 7.4. Illustration of Recommended Board Width

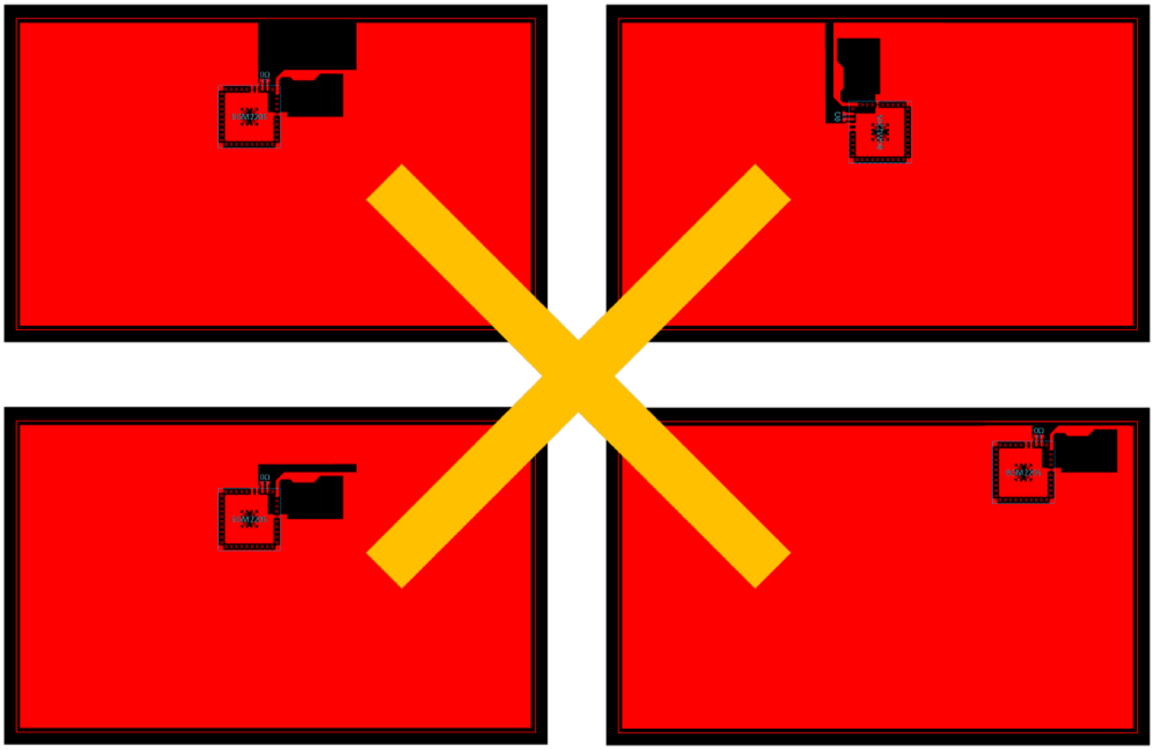


Figure 7.5. Non-Optimal Layout Examples

7.3 Radio Performance vs. Carrier Board Size

For many applications, the carrier board size is determined by the overall form factor or size of the additional circuitry. The recommended carrier board width of 55 mm for the BGM220S22A, upon which the BGX220S is based, is thus not always possible in the end-application. If another form factor is required, the antenna performance of the integrated antenna will be compromised but it may still be sufficiently good for providing the required link quality and range of the end-application. Figure 7.6 Efficiency of the Integrated Antenna as Function of the Carrier Board Size for BGX220S-equivalent BGM220S22A on page 29, which is also representative of antenna efficiency of the BGX220S, show the total efficiency of the integrated antenna for different carrier board sizes. As can be seen the best performance is achieved for the carrier board size of 55 mm x 25 mm for the BGM220S22A and BGX220S, with relatively constant performance for larger boards and rapidly declining performance for smaller boards.

The performance of all the sizes tested will be adequate for more than 15 m line-of-sight range and all of the sizes are thus usable.

WARNING: Any antenna tuning or change of the loop dimensions will void the modular certification of modules with modular certification. In that case, a Permissions Change to the modular approval is required.

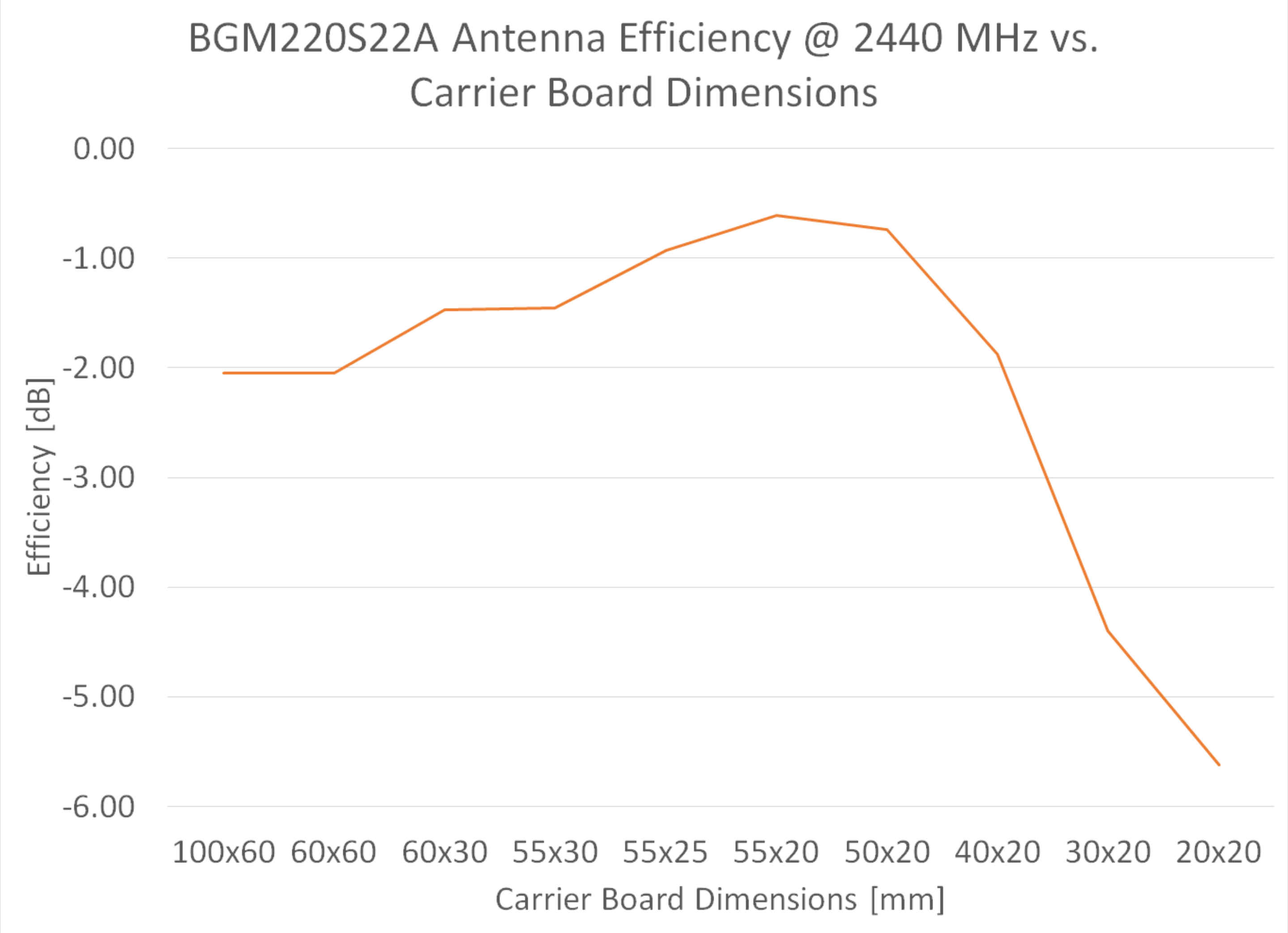


Figure 7.6. Efficiency of the Integrated Antenna as Function of the Carrier Board Size for BGX220S-equivalent BGM220S22A

7.4 Proximity to Other Materials

Placing plastic or any other dielectric material directly in contact with the antenna may cause performance degradation. A clearance of minimum 0.5 mm is recommended to avoid excessive detuning of the antenna. Solder mask, conformal coating, and other thin dielectric layers are acceptable directly on top of the antenna region. Any metallic objects in close proximity to the antenna will prevent the antenna from radiating freely. The minimum recommended distance of metallic and/or conductive objects is 10 mm in any direction from the antenna except in the directions of the application PCB ground planes.

7.5 Proximity to Human Body

Placing the module in contact with or very close to the human body will negatively impact antenna efficiency and reduce range. Furthermore, additional certification may be required if the module is used in a wearable device.

8. Package Specifications

8.1 Package Dimensions

The package dimensions are shown in Figure 8.1 Package Dimensions - Full on page 31 and Figure 8.2 Package Dimensions - Detail on page 31.

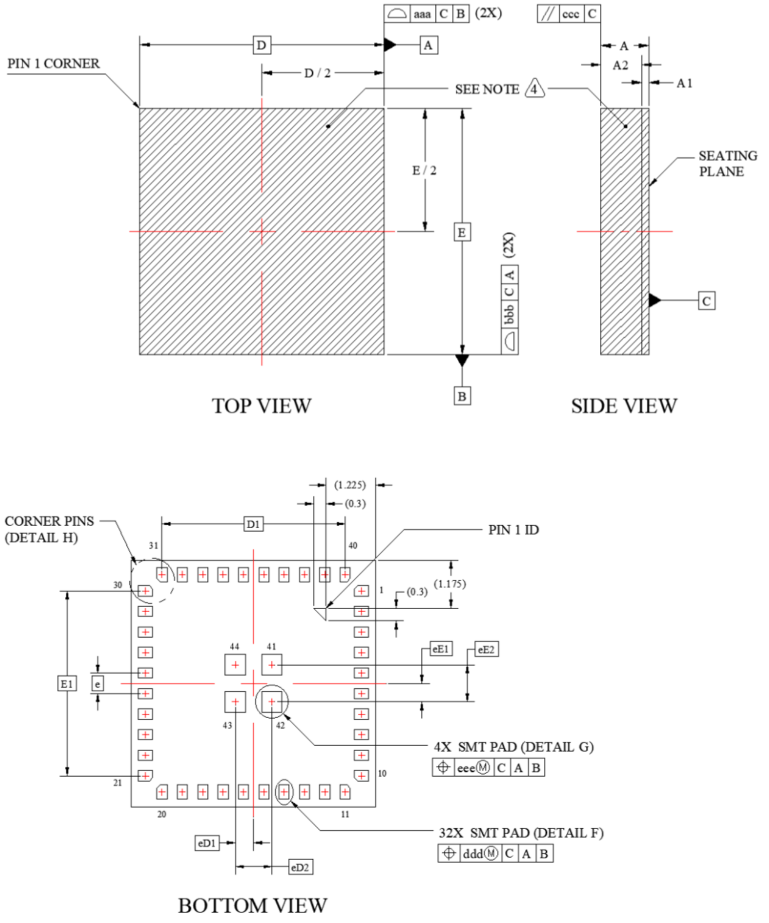


Figure 8.1. Package Dimensions - Full

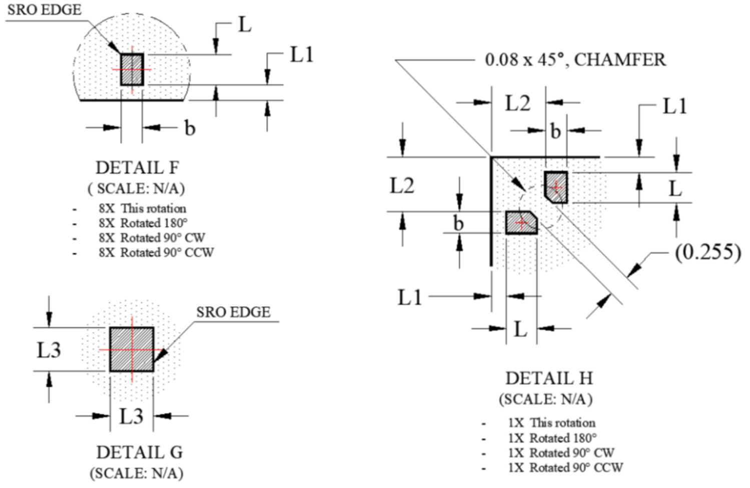


Figure 8.2. Package Dimensions - Detail

Table 8.1. Package Dimensions

Dimension	MIN	NOM	MAX
A	1.080	1.180	1.280
A1	0.140	0.180	0.220
A2	0.950	1.000	1.050
b	0.200	0.250	0.300
D	6.000 BSC		
D1	4.500 BSC		
e	0.500 BSC		
E	6.000 BSC		
E1	4.500 BSC		
L	0.300	0.350	0.400
L1	0.125	0.175	0.225
L2	0.575	0.625	0.675
L3	0.450	0.500	0.550
eD1	0.450 BSC		
eD2	0.900 BSC		
eE1	0.450 BSC		
eE2	0.900 BSC		
aaa	0.100		
bbb	0.100		
ccc	0.100		
ddd	0.100		
eee	0.100		

Note:

1. The dimensions in parenthesis are reference.
2. All dimensions in millimeters (mm).
3. Unless otherwise specified, tolerances are:
    a. Decimal: X.X = +/- 0.1

       X.XX = +/- 0.05

       X.XXX = +/- 0.03
    b. Angular: +/- 0.1 (In Deg)
4. Hatching lines means package shielding area.

8.2 Recommended PCB Land Pattern

The recommended PCB Land Pattern is shown in Figure 8.3 Module Land Pattern on page 33

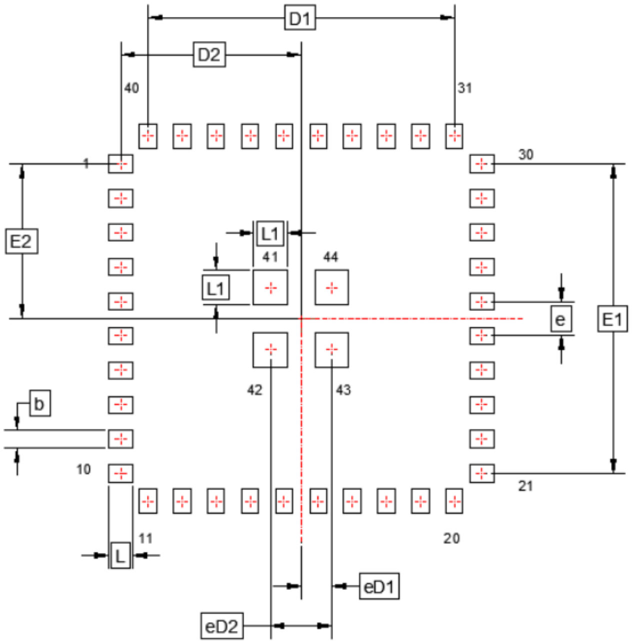


Figure 8.3. Module Land Pattern

Table 8.2. PCB Land Pattern Dimensions

Dimension	Typ (mm)
D1	4.50
D2	2.65
E1	4.50
E2	2.25
eD1	0.45
eD2	0.90
b	0.25
e	0.50
L	0.35
L1	0.50

Note:

1. All feature sizes shown are at Maximum Material Condition (MMC) and a card fabrication tolerance of 0.05mm is assumed.
2. Dimensioning and Tolerancing is per the ANSI Y14.5M-1994 specification.
3. A stainless steel, laser-cut and electro-polished stencil with trapezoidal walls should be used to assure good solder paste release.
4. The stencil thickness should be 0.100 mm (4 mils).
5. The stencil aperture to land pad size recommendation is 80% paste coverage.
6. ***Above notes and stencil design are shared as recommendations only. A customer or user may find it necessary to use different parameters and fine tune their SMT process as required for their application and tooling.***

8.3 Top Marking

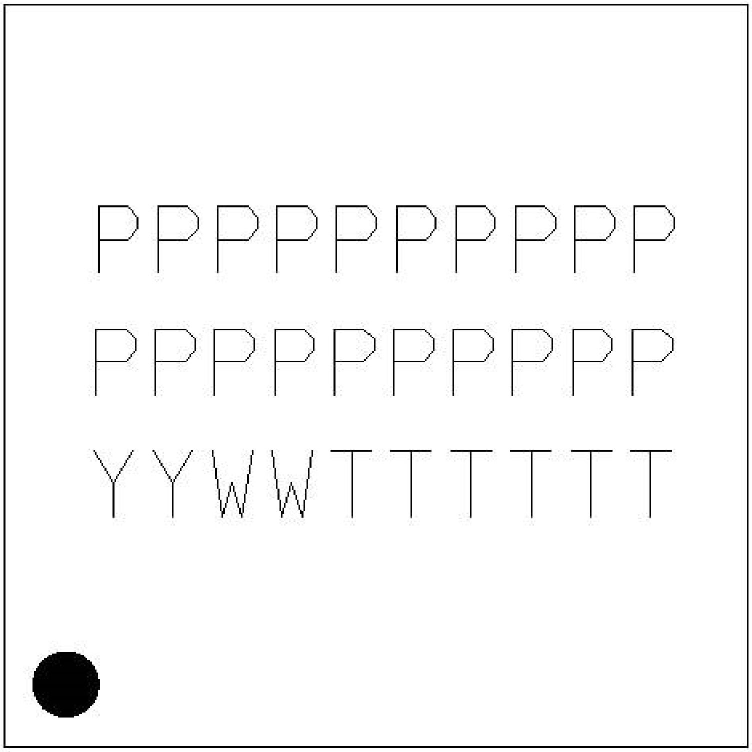


Figure 8.4. BGX220S Top Marking

Table 8.3. Top Marking Definition

OPN	Line 1 Marking	Line 2 Marking	Line 3 Marking
BGX220S22HNA21	BGM220S22A	SC22HNA2	See note below
Note: YY = Year. WW = Work Week, TTTTTTT = Trace Code			

9. Soldering Recommendations

It is recommended that final PCB assembly of the BGX220S follows the industry standard as identified by the Institute for Printed Circuits (IPC). This product is assembled in compliance with the J-STD-001 requirements and the guidelines of IPC-AJ-820. Surface mounting of this product by the end user is recommended to follow IPC-A-610 to meet or exceed class 2 requirements.

CLASS 1 General Electronic Products

Includes products suitable for applications where the major requirement is function of the completed assembly.

CLASS 2 Dedicated Service Electronic Products

Includes products where continued performance and extended life is required, and for which uninterrupted service is desired but not critical. Typically the end-use environment would not cause failures.

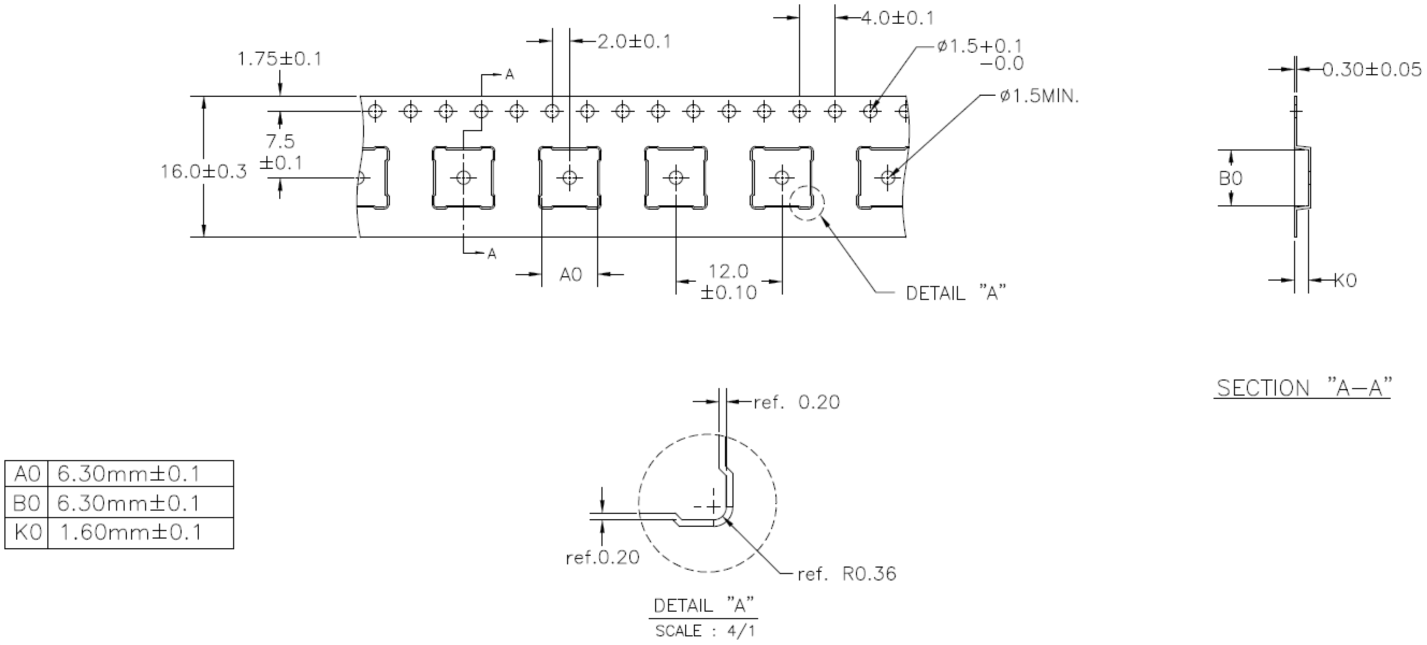
CLASS 3 High Performance/Harsh Environment Electronic Products

Includes products where continued high performance or performance-on-demand is critical, equipment downtime cannot be tolerated, end-use environment may be uncommonly harsh, and the equipment must function when required, such as life support or other critical systems.

Note: General SMT application notes are provided in the AN1223 document.

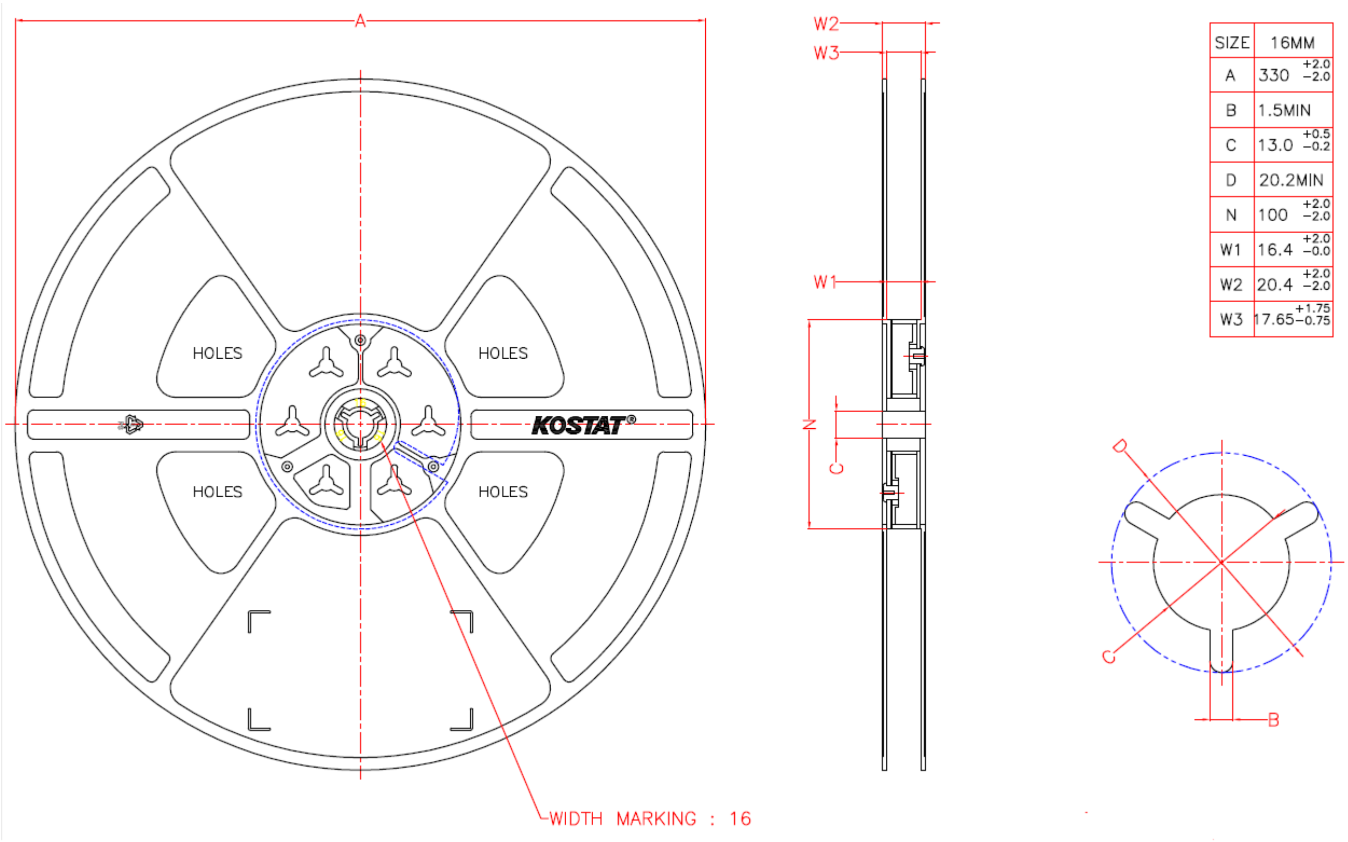
10. Tape and Reel

BGX220S modules are delivered to the customer in tray (490 pcs / tray) or reel (2500 pcs / reel) packaging with the dimensions below. All dimensions are given in mm unless otherwise indicated.



A0	6.30mm±0.1
B0	6.30mm±0.1
K0	1.60mm±0.1

Figure 10.1. Carrier Tape Dimensions



SIZE	16MM
A	$330^{+2.0}_{-2.0}$
B	1.5MIN
C	$13.0^{+0.5}_{-0.2}$
D	20.2MIN
N	$100^{+2.0}_{-2.0}$
W1	$16.4^{+2.0}_{-0.0}$
W2	$20.4^{+2.0}_{-2.0}$
W3	$17.65^{+1.75}_{-0.75}$

Figure 10.2. Reel Dimensions

11. Certifications

This section details the regulatory certification status of the module in various regions.

The address for the module manufacturer and certification applicant is:

SILICON LABORATORIES FINLAND OY
Alberga Business Park, Bertel Jungin aukio 3,
02600 Espoo, Finland

11.1 Regulatory Certifications

11.1.1 Qualified Antennas

Note that regulatory information for BGX220S modules in this section refers to BGM220S22A because this is the module upon which BGX220S is based.

BGX220S modules have been tested and certified both with the on-board antennas and with external antennas attached to the RF pin (RF_2G4). Performance characteristics for the integral antennas are presented in and . Details for the external qualified reference antennas are summarized in the table below.

Table 11.1. Qualified External Antennas for BGX220S

Model	Antenna Type	Maximum Gain	Impedance
BGM220S22A	Connectorized Coaxial Dipole	2.8 dBi	50 Ω

Any external antenna of the same general type and of equal or less directional gain as listed in the above table, and having similar in-band and out-of-band characteristics, can be used in the regulatory areas that have a full modular radio approval, such as USA and Canada, as long as spot-check testing is performed to verify that no performance changes compromising compliance have been introduced. In the particular FCC case, in order to comply with e-CFR Title 47, Part 15, Subpart C, Section 15.203 the module integrator using an external antenna must ensure it has a unique connector or it is undetachable. In countries applying the ETSI standards, like the EU countries, the radiated emissions are always tested with the end-product and the antenna type is not critical, but antennas with higher gain may violate some of the regulatory limits.

When using instead an external antenna of a different type (such as a chip antenna, a PCB trace antenna or a patch) or having non-similar in-band and out-of-band characteristics, but still with a gain less than or equal to the maximum gain listed in the table above, it can be added as a permissive change to the existing grant/certificate. In most of these cases, some radiated emission testing is demanded, but no modular or end-product re-certification is required.

On the other hand, all products with antennas having more gain than the maximum gain listed in the table above are very likely to require a full new end-product certification. Since the exact permissive change procedure is chosen on a case by case basis, please consult your test house and/or a certification body for understanding the correct approach based on your unique design. You might also want or need to get in touch with Silicon Labs for any authorization letter that your certification body might ask for.

11.1.2 EU - CE

The BGX220S modules have been tested against the relevant harmonized standards and are in conformity with the essential requirements and other relevant requirements of the Radio Equipment Directive (RED) (2014/53/EU).

Please note that every application using the BGX220S module will need to perform the radio EMC tests on the end product, according to EN 301 489-17.

It is ultimately the responsibility of the manufacturer to ensure the compliance of the end-product as a whole. The specific product assembly may have an impact to RF radiated characteristics, and manufacturers should carefully consider RF radiated testing with the end-product assembly.

A formal Declaration of Conformity (DoC) is available at the product web page which is reachable starting from https://www.silabs.com/.

11.1.3 USA - FCC

This device complies with FCC's e-CFR Title 47, Part 15, Subpart C, Section 15.247 (and related relevant parts of the ANSI C63.10.2013 standard) when operating with the embedded antenna or with the antenna type(s) listed in 11.1.1 Qualified Antennas. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesirable operation.

Any changes or modifications not expressly approved by Silicon Labs could void the user's authority to operate the equipment.

FCC RF Radiation Exposure Statement

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. End users must follow the specific operating instructions for satisfying RF exposure compliance.

This transmitter meets the Mobile requirements at a distance of 20 cm and above from the human body, in accordance to the limit(s) exposed in the RF Exposure Analysis.

This transmitter also meets the Portable requirements at distances equal or above those listed for convenience in Table 11.2 Minimum Separation Distances for SAR Evaluation Exemption (BGM220S22A) on page 43.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter except in accordance with FCC multi-transmitter product procedures.

OEM Responsibilities to comply with FCC Regulations

This module has been tested for compliance to FCC Part 15.

OEM integrators are responsible for testing their end-product for any additional compliance requirements needed with this module installed (for example, digital device emissions, PC peripheral requirements, etc.). Additionally, investigative measurements and spot checking are strongly recommended to verify that the full system compliance is maintained when the module is integrated, in accordance to the "Host Product Testing Guidance" in FCC's KDB 996369 D04 Module Integration Guide V01.

- **General Considerations**

  This transmitter module is tested as a subsystem and its certification does not cover the FCC Part 15 Subpart B (unintentional radiator) rule requirement, which is applicable to the final host. The final host will need to be assessed for compliance to this portion of rule requirements, if applicable.
- **Manual Information to the End User**

  The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module, or how to change RF related parameters, in the user's manual of the end product which integrates this module.

  The end user manual shall include all required regulatory information/warnings as shown in this manual.
- **OEM / Host Manufacturer Responsibilities**

  OEM/Host manufacturers are ultimately responsible for the compliance of the host system.

  The BGX220S is a shielded design, and comes with full modular approval.

Separation

- To meet the SAR exemption for portable conditions, the minimum separation distance indicated in

  Table 11.2 Minimum Separation Distances for SAR Evaluation Exemption (BGM220S22A) on page 43 must be maintained between the human body and the radiator (antenna) at all times.
- This transmitter module is tested in a standalone mobile RF exposure condition, and in case of any co-located radio transmitter being allowed to transmit simultaneously, or in case of portable use at closer distances from the human body than those allowing the exceptions rules to be applied, a separate additional SAR evaluation will be required, ultimately leading to a Class II Permissive Change, or more rarely to a new grant.
- **Important Note:** In the event that these conditions cannot be met, the final product will have to undergo additional testing to evaluate the RF exposure in order for the FCC authorization to remain valid, and a permissive change will have to be applied. The evaluation (SAR) is in the responsibility of the end-product's manufacturer, as well as the permissive change that can be carried out with the help of the customer's own Telecommunication Certification Body as the grant holder's agent.

End Product Labeling

BGX220S modules are not labeled with their own FCC ID due to their size. Instead, the packaging label contains the FCC ID. In all cases when the FCC ID is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. In that case, the final end product must be labeled in a visible area with the following:

For BGM220S22A

"Contains Transmitter Module FCC ID: "

Or

"Contains FCC ID: "

Final note: As long as all the conditions in this and all the above sections are met, further RF testing of the transmitter with full modular approval is not required. However, OEMs are still supposed to follow the good practice and the FCC recommendation to ensure the compliance of the host by spot checking.

Nevertheless, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements which might be mandatory with this module installed.

Class B Device Notice - BGM220S22A Only

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio / TV technician for help.

11.1.4 ISED Canada

ISED

This radio transmitter (IC: for the BGX220S) has been approved by *Innovation, Science and Economic Development Canada (ISED Canada, formerly Industry Canada*) to operate with the embedded antenna and with the antenna type(s) listed in 11.1.1 Qualified Antennas, with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain listed, are strictly prohibited for use with this device.

This device complies with ISED's license-exempt RSS standards. Operation is subject to the following two conditions:

1. This device may not cause interference; and
2. This device must accept any interference, including interference that may cause undesired operation of the device

RF Exposure Statement

Exception from routine SAR evaluation limits are given in RSS-102 Issue 5.

For the Portable use case, RF exposure or SAR evaluation is not required in all cases, at any distance from the human body, except when the BGX220S is used at full power with the external reference dipole antenna, in which case the separation distance from the human body must be of 13 mm or more for the exemption.

For more details, refer to the values stated in Table 11.2 Minimum Separation Distances for SAR Evaluation Exemption (BGM220S22A) on page 43: if the separation distances from the human body are less than the distances mentioned in the tables, then the OEM integrator is responsible for evaluating the SAR.

The module meets the requirements for Mobile use cases when the minimum separation distance from the human body is 20 cm or greater, in accordance to the limit(s) exposed in the RF Exposure Analysis.

OEM Responsibilities to comply with IC Regulations

The module has been certified for integration into products only by OEM integrators under the following conditions:

- The antenna must be installed such that a minimum separation distance as stated above is maintained between the radiator (antenna) and all persons at all times.
- The transmitter module must not be co-located or operating in conjunction with any other antenna or transmitter.

Important Note: In the event that these conditions cannot be met, the final product will have to undergo additional testing to evaluate the RF exposure in order for the ISED authorization to remain valid, and a permissive change will have to be applied with the help of the customer's own Telecommunication Certification Body typically acting as the certificate holder's agent.

In the case of the BGX220S , this variant is a shielded design, and consequently comes with a full modular approval.

End Product Labeling

The BGX220S modules are not labeled with their own IC ID due to their size. Instead, the packaging label contains the IC ID. In all cases when the IC ID is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. In that case, the final end product must be labeled in a visible area with the following:

For BGX220S

"**Contains Transmitter Module IC:** "

or

"**Contains IC: "**

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module or change RF related parameters in the user manual of the end product.

Final note: As long as all the conditions above are met, further RF testing of the transmitter with full modular approval is not required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.).

CAN ICES-003 (B) - BGX220S Only

This Class B digital apparatus complies with Canadian ICES-003.

ISEDC (Français)

Le présent émetteur radio (IC: pour le BGM220S22A) a été approuvé par Innovation, Sciences et Développement Économique Canada (ISED Canada, anciennement Industrie Canada) pour fonctionner avec l'antenne intégrée et le ou les types d'antenne énumérés à la section 11.1.1 Qualified Antennas, avec le gain maximal admissible indiqué. Les types d'antenne non inclus dans cette liste, ayant un gainsupérieur au gain maximal indiqué, sont strictement interdits d'utilisation avec cet appareil. .

Ce composant est conforme aux normes RSS, exonérées de licence d'ISED. Son mode de fonctionnement est soumis aux deux conditions suivantes:

1. Ce composant ne doit pas générer d'interférences.
2. Ce composant doit pouvoir être soumis à tout type de perturbation y compris celle pouvant nuire à son bon fonctionnement.

Déclaration d'exposition RF

L'exception tirée des limites courantes d'évaluation SAR est donnée dans le document RSS-102 Issue 5.

Pour le cas d'utilisation Portable, l'exposition RF ou l'évaluation SAR n'est pas nécessaire dans tous les cas, à n'importe quelle distance du corps humain, sauf lorsque le BGM220S22A est utilisé à pleine puissance avec l'antenne dipôle de référence externe, auquel cas la distance de séparation du le corps humain doit être de 13 mm ou plus pour l'exemption.

Pour plus de détails, reportez-vous aux valeurs indiquées dans Table 11.2 Minimum Separation Distances for SAR Evaluation Exemption (BGM220S22A) on page 43: si les distances de séparation du corps humain sont inférieures aux distances mentionnées dans les tableaux, alors l'intégrateur OEM est responsable de l'évaluation du SAR.

Le module répond aux exigences des cas d'utilisation mobile lorsque la distance de séparation minimale du corps humain est de 20 cm ou plus, conformément aux limites exposées dans l'analyse d'exposition RF.

Responsabilités des OEM pour une mise en conformité avec le Règlement du Circuit Intégré

Le module a été approuvé pour l'intégration dans des produits finaux exclusivement réalisés par des OEM sous les conditions suivantes:

- L'antenne doit être installée de sorte qu'une distance de séparation minimale indiquée ci-dessus soit maintenue entre le radiateur (antenne) et toutes les personnes avoisinante, ce à tout moment.
- Le module émetteur ne doit pas être localisé ou fonctionner avec une autre antenne ou un autre transmetteur que celle indiquée plus haut.

Tant que les deux conditions ci-dessus sont respectées, il n'est pas nécessaire de tester ce transmetteur de façon plus poussée. Cependant, il incombe à l'intégrateur OEM de s'assurer de la bonne conformité du produit fini avec les autres normes auxquelles il pourrait être soumis de fait de l'utilisation de ce module (par exemple, les émissions des périphériques numériques, les exigences de périphériques PC, etc.).

Remarque Importante: Dans le cas où ces conditions ne peuvent être satisfaites (pour certaines configurations ou co-implantation avec un autre émetteur), l'autorisation ISED n'est plus considérée comme valide et le numéro d'identification ID IC ne peut pas être apposé sur le produit final. Dans ces circonstances, l'intégrateur OEM sera responsable de la réévaluation du produit final (y compris le transmetteur) et de l'obtention d'une autorisation ISED distincte.

Dans le cas du BGM220S12A, l'approbation de cette variante est limitée car la partie radio du module n'est pas incluse dans son propre blindage RF: par conséquent, chaque nouvel hôte est requis dans tous les cas pour réévaluer les émissions rayonnées et le bureau doit être informé par un C4PC.

Dans le cas du BGM220S22A, cette variante est une conception blindée et est par conséquent livrée avec une approbation modulaire complète.

Étiquetage des produits finis

Les modules BGX220S ne sont pas étiquetés avec leur propre ID IC en raison de leur taille. Au lieu de cela, l'étiquette d'emballage contient l'ID IC. Dans tous les cas, lorsque l'ID IC n'est pas visible lorsque le module est intégré au sein d'un autre produit, cet autre produit dans lequel le module est installé devra porter une étiquette faisant apparaitre les référence du module intégré. Dans un tel cas, sur le produit final doit se trouver une étiquette aisément lisible sur laquelle figurent les informations suivantes:

Pour le BGM220S12A

“**Contient le module transmetteur: 5123A-BGM220S** ”

or

“**Contient le circuit: 5123A-BGM220S”**

Pour le BGM220S12A

“**Contient le module transmetteur:** ”

or

“**Contient le circuit: ”**

Note finale: L'intégrateur OEM doit être conscient qu’il ne doit pas fournir, dans le manuel d’utilisation, d'informations relatives à la façon d'installer ou de d’enlever ce module RF ainsi que sur la procédure à suivre pour modifier les paramètres liés à la radio.

CAN ICES-003 (B) - BGM220S22A uniquement

Cet appareil numérique de classe B est conforme à la norme canadienne ICES-003.

11.1.5 Proximity to Human Body

When using the BGX220S modules in an application where the radio is located close to the human body, the human RF exposure must be taken into account. FCC, ISED, and CE all have different standards and rules for evaluating the RF exposure. In particular, each regulator has different requirements when it comes to the exemption from having to perform RF exposure and SAR (Specific Absorption Rate) measurements, and the minimum separation distances between the module and human body varies accordingly. The properties of the BGX220S modules allows for the minimum separation distances detailed in the tables below for SAR evaluation exemption in portable use cases (less than 20 cm from human body). The module is approved for the Mobile use case (more than 20 cm) without any need for RF Exposure evaluation.

Table 11.2. Minimum Separation Distances for SAR Evaluation Exemption (BGM220S22A)

Certification	BGM220S22A
FCC	0 mm
ISED	13 mm with the reference external antenna 12 mm for integral antenna
CE	The RF exposure must always be evaluated using the end-product when transmitting with power levels higher than 20 mW (13 dBm).

For FCC and ISED, using the module in end-products where the separation distance from the human body is smaller than that listed above is allowed but requires evaluation of the RF exposure in the final assembly and applying for a *Class 2 Permissive Change* or *Change of ID* to be applied to the existing FCC/ISED approvals of the module. For CE, RF exposure must be evaluated using the end-product in all cases when transmitting at more than the power level indicated in the table.

Note: Placing the module in touch or very close to the human body will have a negative impact on the efficiency of the antenna thus a reduced range is to be expected.

11.1.6 Japan - MIC

The are certified in Japan with certification number .

It is the end-product manufacturer's responsibility to ensure that the module is configured to meet the limits documented in the formal certification test report available at https://www.silabs.com/. If needed, refer to the API reference manual(s) to learn how to configure the maximum RF TX power for the normal operations.

Since September 1, 2014 it is allowed (and highly recommended) that a manufacturer who integrates a radio module in their host equipment places the certification mark and certification number on the outside of the host equipment. This combination of mark and number, and their relative placement, is depicted in figure 11.1, and depending on the size of the module it might also appear on the top shield markings of the radio module. The certification mark and certification number must be placed close to the text in the Japanese language which is provided below. This change in the Radio Law has been made in order to enable users of the combination of host and radio module to verify if they are actually using a radio device which is approved for use in Japan

Certification Text to be Placed on the Outside Surface of the Host Equipment:

当該機器には電波法に基づく、技術基準適合証明等を受けた特定無線設備を装着している。

Translation of the text:

“This equipment contains specified radio equipment that has been certified to the Technical Regulation Conformity Certification under the Radio Law.”

The "Giteki" marking shown in the figures below must be affixed to an easily noticeable section of the specified radio equipment.

Note that additional information may be required if the device is also subject to a telecom approval.

Figure 11.1. GITEKI Mark and ID (BGM220S22A)

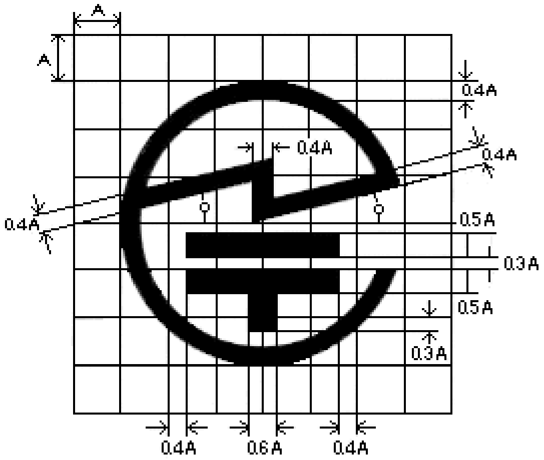


Figure 11.2. GITEKI Mark

11.1.7 South Korea - KC

The TBD modules have a RF certification for import and use in South-Korea.

Certification number is: TBD

When integrating the RF-certified module, an end-product is exempted from doing the RF emission testing, as long as the recommended design guidance is followed, and the approved antennas are used.

EMC testing, and any other relevant test, might still be required for full compliance.

11.2 Standards-Based Certifications

11.2.1 Bluetooth Qualification

The BGX220S modules come at launch with a pre-qualified Bluetooth Low Energy RF-PHY Tested Component having Declaration ID of TBD and QDID of TBD, and having a listing date of 2020-09-04.

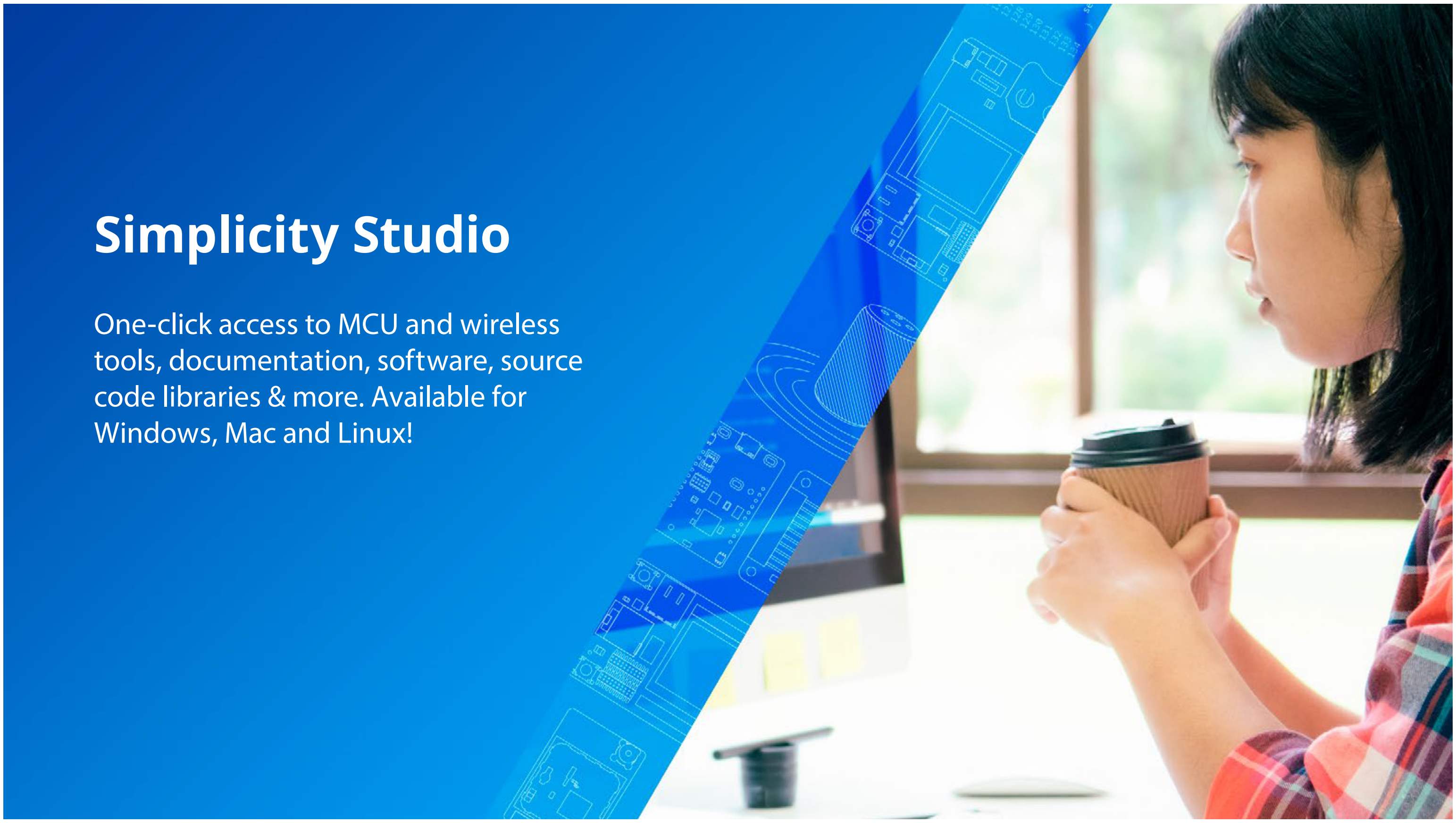
Because the validity set by the SIG for Tested Components is currently of 3 years, during the product lifetime Silicon Labs will renew this Component as it expires, whenever applicable. Renewed Tested Components will come with new DIDs and QDIDs, and these will be then referred to in end-product listings. Such new DIDs and QDIDs can be discovered starting from the original ones.

This module’s RF-PHY Tested Component should be combined with the latest Wireless Gecko Link Layer and Host pre-qualified Components by Silicon Labs, when in the process of qualifying an end-product embedding the BGX220S via the SIG’s Launch Studio.

12. Revision History

Revision 1.0

Initial release.



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SILICON LABS

Silicon Laboratories Inc.
400 West Cesar Chavez
Austin, TX 78701
USA

http://www.silabs.com