BGM270S Wireless Gecko Module Data Sheet

The BGM270S is a secure, high-performance wireless module optimized for the needs of battery and line-powered IoT devices operating in the 2.4 GHz band.

Based on the Series 2 EFR32BG27 SoC, it enables Bluetooth® Low Energy connectivity, delivering exceptional RF performance and energy efficiency.

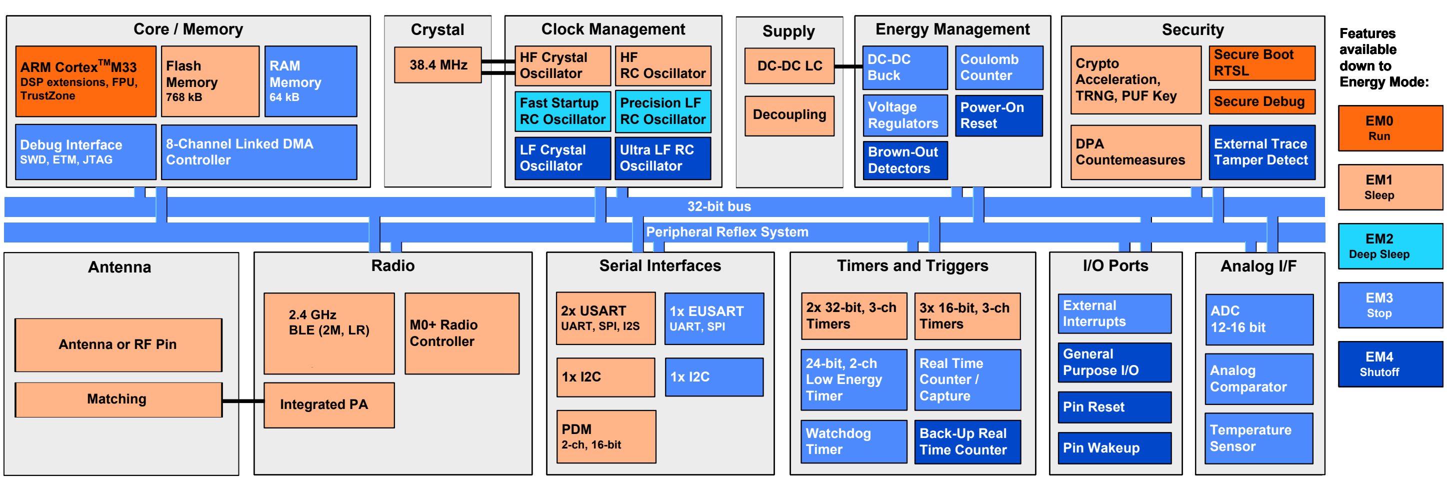
The BGM270S is a complete System in Package solution offered with robust and fully upgradeable software stacks, global regulatory certifications, advanced development and debugging tools, and documentation that simplifies and minimizes the development cycle of your end-product, helping to accelerate its time-to-market.

The BGM270S is targeted for a broad range of applications, including:

- Bluetooth Mesh
- Portable Medical
- Home End Devices
- Fleet/Asset Monitoring
- Industrial Automation
- Access Control
- Sport, Fitness, and Wellness Devices
- Power Tools

KEY FEATURES

- 32-bit ARM® Cortex®-M33 core with 76.8 MHz maximum operating frequency
- 768 kB of flash and 64 kB of RAM
- Energy-efficient radio core with low active and sleep currents
- Integrated PA with 6.5 dBm (2.4 GHz) TX power
- Secure Boot with Root of Trust and Secure Loader (RTSL)
- DC-DC supporting buck (1.8 to 3.8 V)
- 26 GPIO pins
- -40 to 105 °C
- 6.5 x 6.5 x 1.3 mm



1. Feature List

Following are the highlighted features of BGM270S.

- **Low Power Wireless System-on-Chip**
  - High Performance 32-bit 76.8 MHz ARM Cortex®-M33 with DSP instruction and floating-point unit for efficient signal processing
  - 768 kB flash program memory
  - 64 kB RAM data memory
  - 2.4 GHz radio operation
- **Radio Performance**
  - -106.5 dBm sensitivity @ 125 kbps GFSK
  - -102.2 dBm sensitivity @ 500 kbps GFSK
  - -98.8 dBm sensitivity @ 1 Mbit/s GFSK
  - -95.9 dBm sensitivity @ 2 Mbit/s GFSK
  - TX power up to 6.5 dBm
- **Low System Energy Consumption**
  - 3.8 mA RX current (1 Mbps GFSK)
  - 4.7 mA TX current @ 0 dBm output power
  - 11.2 mA TX current @ 6.5 dBm output power
  - 29 μA/MHz in Active Mode (EM0) at 76.8 MHz
  - 2.2 μA EM2 DeepSleep current (RTCC running from LFXO, Full RAM retention)
  - 0.22 μA EM4 current
- **Protocol Support**
  - Bluetooth Low Energy (Bluetooth 6.0)
- **Security Features**
  - Secure Boot with Root of Trust and Secure Loader (RTSL)
  - Hardware Cryptographic Acceleration for AES128/256, SHA-1, SHA-2 (up to 256-bit), ECC (up to 256-bit), ECDSA, and ECDH
  - DPA Countermeasures
  - Key Management with PUF
  - True Random Number Generator (TRNG) compliant with NIST SP800-90 and AIS-31
  - ARM® TrustZone®
  - Secure Debug with lock/unlock
  - External Tamper Detect
- **Wide selection of MCU peripherals**
  - Analog to Digital Converter (ADC)
    - 12-bit @ 1 Msps
    - 16-bit @ 76.9 ksps
  - Analog Comparator (ACMP)
  - Up to 26 General Purpose I/O pins with output state retention and asynchronous interrupts
  - 8 Channel DMA Controller
  - 12 Channel Peripheral Reflex System (PRS)
  - 2 × 32-bit Timer/Counter with 3 Compare/Capture/PWM channels
  - 3 × 16-bit Timer/Counter with 3 Compare/Capture/PWM channels
  - 32-bit Real Time Counter
  - 24-bit Low Energy Timer for waveform generation
  - 1 × Watchdog Timer
  - 2 × Universal Synchronous/Asynchronous Receiver/Transmitter (UART/SPI/SmartCard (ISO 7816)/IrDA/I²S)
  - 1 × Enhanced Universal Synchronous/Asynchronous Receiver/Transmitter (UART/SPI)
  - 2 × I²C interface with SMBus support
  - Digital Microphone interface (PDM)
  - Precision Low-Frequency RC Oscillator to replace 32 kHz sleep crystal
  - Die temperature sensor with +/-1.5 °C accuracy after single-point calibration
  - Coulomb counter integrated into DC-DC
- **Wide Operating Range**
  - 1.8 to 3.8 V power supply
  - -40 to +105 °C
- **Packages**
  - **LGA** 6.5 mm x 6.5 mm 48 Pins
- **Regulatory Certification**
  - CE (EU)
  - UKCA (UK)
  - FCC (USA)
  - ISED (Canada)
  - MIC (Japan)
  - KC (South Korea)

2. Ordering Information

Table 2.1. Ordering Information

Ordering Code	Protocol Stack	Max TX Power	DC-DC	Flash (kB)	RAM (kB)	GPIO	Package	Temp Range	Pack-aging
BGM270SC22SNA4	Bluetooth 6.0 • Direction Finding (AoA Transmitter)	6.5 dBm	Buck	768	64	26	SiP	-40 to +105 °C	Cut Tape
BGM270SC22SNA4R	Bluetooth 6.0 • Direction Finding (AoA Transmitter)	6.5 dBm	Buck	768	64	26	SiP	-40 to +105 °C	Reel

Bluetooth 6.0: As the Bluetooth standard evolves, Silicon Labs is regularly adding new features. For more information on supported Bluetooth capabilities, visit https://www.silabs.com/bluetooth-hardware.

Throughout this document, the module may be referred to by its product family/marketing name (i.e. BGM270S), by its model name (i.e. BGM270S22A), or by its full ordering code as seen in the table above.

Table of Contents

3. System Overview

3.1 Introduction

The BGM270S module is a highly-integrated, high-performance system in package with all the hardware components needed to enable 2.4 GHz wireless connectivity and support robust networking capabilities via multiple wireless protocols.

Built around the EFR32BG27 Wireless SoC, the BGM270S includes a built-in antenna, an RF matching network (optimized for transmit power efficiency), supply decoupling and filtering components, an LC tank for DC-DC conversion, a 38.4 MHz reference crystal, and an RF shield. Also, it supports the use of an external 32 kHz crystal as a low frequency reference signal via GPIO pins for use cases demanding maximum energy efficiency.

For designs where an external antenna solution may be beneficial, a configuration option with a 50 Ω-matched RF pin instead of the built-in antenna is available

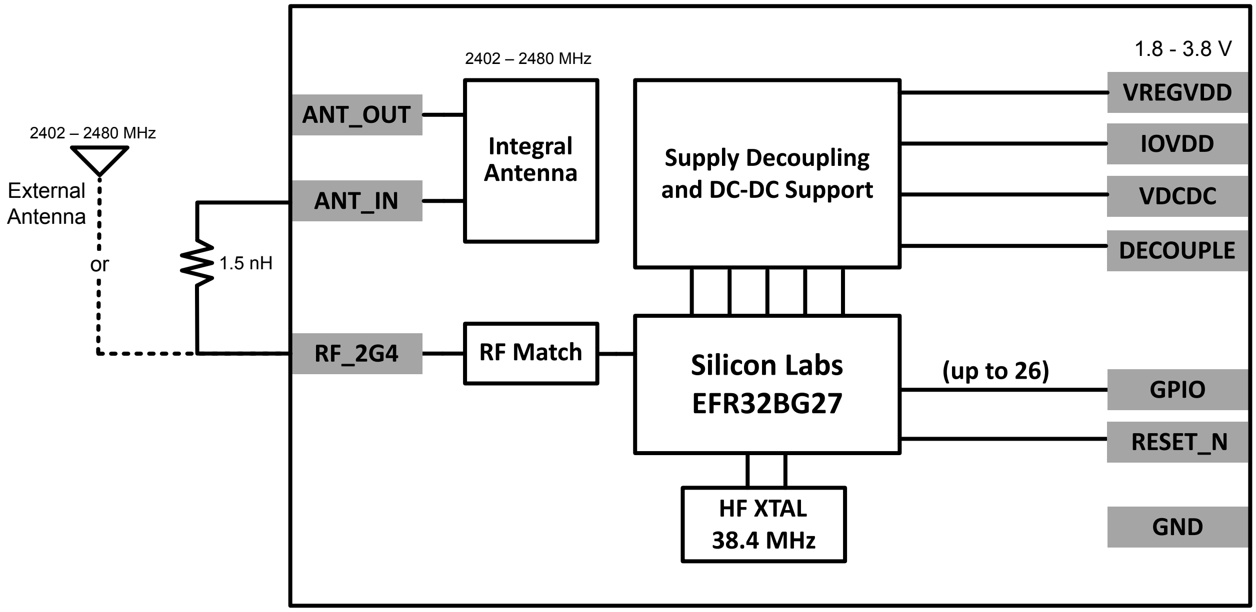


Figure 3.1. BGM270S Block Diagram

A simplified internal schematic for the BGM270S module is shown in the following figure.

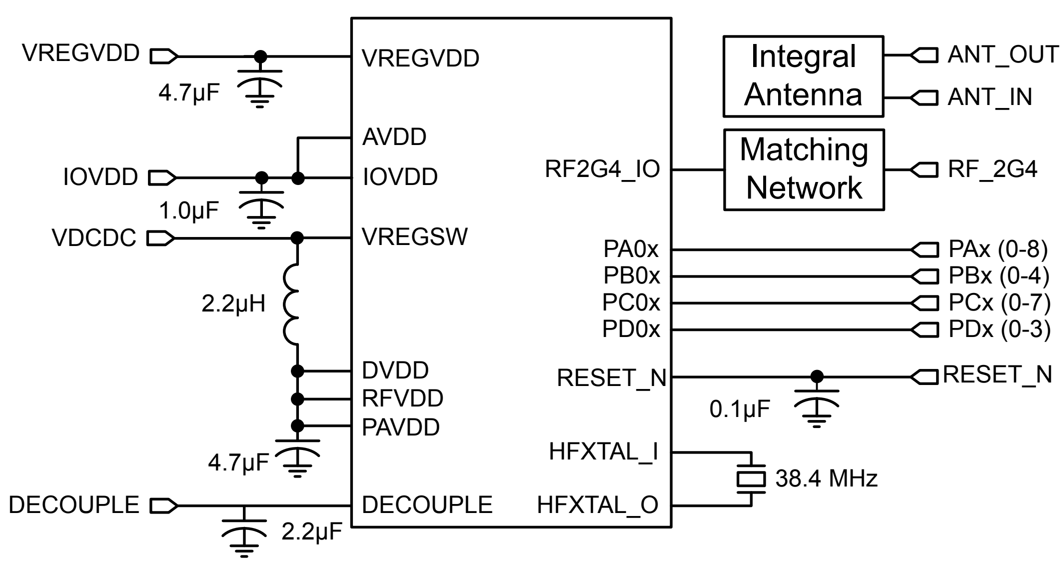


Figure 3.2. BGM270S Module Schematic

3.2 EFR32BG27 SoC

The EFR32BG27 SoC features a 32-bit ARM Cortex M33 core, a 2.4 GHz high-performance radio, 768 kB of flash memory, a rich set of MCU peripherals, and various clock management and serial interfacing options. Consult the EFR32xG27 Wireless Gecko Reference Manual and the EFR32BG27 Wireless Gecko SoC Family Data Sheet for details.

3.3 Antenna

BGM270S support two antenna configurations: a built-in integral ground loop type antenna realized by a PCB trace design, or a 50 Ω-matched RF pin to support an external antenna. Typical performance characteristics for the built-in antenna are detailed in the table below. Refer to , 7.3 Radio Performance vs. Carrier Board Size and 11.1 Qualified Antennas for other relevant details.

Table 3.1. BGM270S antenna specification

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Antenna Frequency Range	F_{RANGE}		2402	—	2480	MHz
Antenna Gain	G_{MAX}	Maximum relative to isotropic	—	—	1.74	dBi
Antenna Efficiency	Efficiency		—	—	-1.79	dB
Reference impedance	Z		—	50	—	
Dielectric Constant Host Board	DI_{CONST}		—	4.3	—	
VSWR	VSWR	Maximum	—	—	2:1	—

Antenna efficiency, gain and radiation pattern are dependent on the application PCB layout and mechanical design. Antenna specification is based on the assumption that the host board design guidelines in 7. Design Guidelines are followed.

3.4 Power Supply

The BGM270S typically requires a primary supply voltage of nominal 3.0 V to VREGVDD, and a IO supply voltage (IOVDD, typically using the primary supply) to operate.

All necessary decoupling, filtering and DC-DC related components are included in the module, and the supply is fully regulated internally.

4. 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 VREGVDD = IOVDD supply at 3.0 V, by production test and/or technology characterization.
- Minimum and maximum values represent the worst conditions across supply voltage, process variation, and operating temperature, unless stated otherwise.
- 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.

4.1 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 https://www.silabs.com/documents/public/corporate/quarterly-reliability-report.pdf.

Table 4.1. Absolute Maximum Ratings

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Storage temperature range	T_{STG}		-40	—	+105	°C
Voltage on any supply pin	V_{DDMAX}		-0.3	—	3.8	V
Junction temperature	T_{JMAX}		—	—	+125	°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

4.2 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 4.2. General Operating Conditions

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Operating ambient temperature range	T_A	-N temperature grade	-40	—	+105	°C
IOVDDx operating supply voltage (All IOVDD pins)	V_{IOVDDx}		1.71	3.0	3.8	V
VREGVDD operating supply voltage	$V_{VREGVDD}$	DC-DC in regulation [1]	2.2	3.0	3.8	V
		DC-DC in bypass	1.8	3.0	3.8	V
HCLK and SYSCLK frequency	f_{HCLK}	VSCALE2, MODE = WS1	—	—	80	MHz
		VSCALE2, MODE = WS0	—	—	40	MHz
		VSCALE1, MODE = WS0	—	—	40	MHz
PCLK frequency	f_{PCLK}	VSCALE2	—	—	40	MHz
		VSCALE1	—	—	40	MHz
EM01 Group A clock frequency	$f_{EM01GRPACLK}$	VSCALE2	—	—	80	MHz
		VSCALE1	—	—	40	MHz
EM01 Group B clock frequency	$f_{EM01GRPBCLK}$	VSCALE2	—	—	80	MHz
		VSCALE1	—	—	40	MHz
Radio HCLK frequency	f_{RHCLK}	VSCALE2 or VSCALE1	—	38.4	—	MHz

Note:

1. The supported maximum VVREGVDD in regulation mode is a function of temperature and 10-year lifetime average load current. See more details in 4.2.1 DC-DC Operating Limits.

4.2.1 DC-DC Operating Limits

The maximum supported voltage on the VREGVDD 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 4.1 Lifetime average load current limit vs. Maximum input voltage on page 10 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.

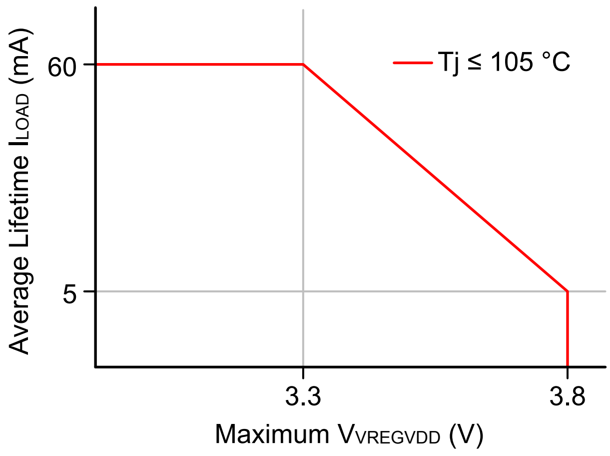


Figure 4.1. Lifetime average load current limit vs. Maximum input voltage

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 4.2 Transient maximum load current vs. Minimum input voltage on page 10 shows the max load current vs. input voltage for different DC-DC peak inductor current settings.

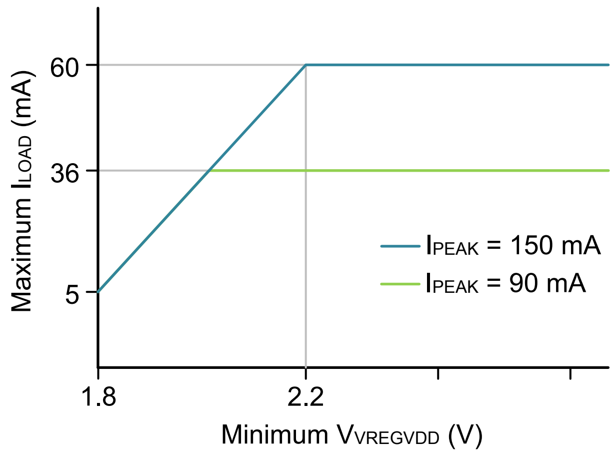


Figure 4.2. Transient maximum load current vs. Minimum input voltage

4.3 Thermal Characteristics

Table 4.3. Thermal Characteristics

Package	Board	Parameter	Symbol	Test Condition	Value	Unit
44 parameter pads, 4 center pads,SIP, 6.5 mm x 6.5 mm	JEDEC - Low Thermal Cond. (2s)[1]	Thermal Resistance, Junction to Ambient	Θ_{JA}	Still Air (JESDS1 -2A)	92.7	°C/W
		Thermal Resistance, Junction to Top Center	Ψ_{JT}	Still Air (JESDS1 -2A)	0.6	°C/W
		Thermal Resistance, Junction to Board	Ψ_{JB}	Still Air (JESDS1 -2A)	38.3	°C/W
44 parameter pads, 4 center pads,SIP, 6.5 mm x 6.5 mm	JEDEC - High Thermal Cond. (2s2p)[2]	Thermal Resistance, Junction to Ambient	Θ_{JA}	Still Air (JESD51-2A)	56.1	°C/W
		Thermal Resistance, Junction to Top Center	Ψ_{JT}	Still Air (JESD51-2A)	0.06	°C/W
		Thermal Resistance, Junction to Board	Ψ_{JB}	Still Air (JESD51-2A)	35.6	°C/W
		Thermal Resistance, Junction to Board	Θ_{JB}	Junction to Board (JESD51-8)	43.5	°C/W
44 parameter pads, 4 center pads,SIP, 6.5 mm x 6.5 mm	No Board	Thermal Resistance, Junction on to Top Center of Case	Θ_{JC}	Temperature controlled heat sink on top of package, all other sides of package insulated to prevent heat flow, per JESD51-4	18.3	°C/W

Note:

1. Based on 2 layer PCB with dimension 3" x 4.5", PCB Thickness of 1.6 mm, per JED51-3.
2. Based on 4 layer PCB with dimension 3" x 4.5", PCB Thickness of 1.6 mm, per JED51-7. Substrate has 4 Land pads with thermal Vias to top internal plane of PCB, per JESD51-5.

4.4 MCU Current Consumption with 3.0 V Supply

Unless otherwise indicated, typical conditions are: VREGVDD = IOVDD = 3.0 V, DC-DC in regulation. Voltage scaling level = VSCALE1. T_A = 25 °C. Minimum and maximum values in this table represent the worst conditions across process variation at T_A = 25 °C.

Table 4.4. MCU Current Consumption with 3.0 V Supply

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Current consumption in EM0 mode with all peripherals disabled	I_{ACTIVE}	76.8 MHz HFRCO w/ DPLL referenced to 38.4 MHz crystal, CPU running while loop from flash, VSCALE2	—	29	—	µA/MHz
		76.8 MHz HFRCO w/ DPLL referenced to 38.4 MHz crystal, CPU running CoreMark loop from flash, VSCALE2	—	42	—	µA/MHz
		38.4 MHz crystal, CPU running Prime from flash	—	30	—	µA/MHz
		38.4 MHz crystal, CPU running while loop from flash	—	30	—	µA/MHz
		38.4 MHz crystal, CPU running CoreMark loop from flash	—	43	—	µA/MHz
		38 MHz HFRCO, CPU running while loop from flash	—	25	—	µA/MHz
		76.8 MHz HFRCO w/ DPLL referenced to 38.4 MHz crystal, CPU running Prime from flash, VSCALE2	—	32	—	µA/MHz
Current consumption in EM1 mode with all peripherals disabled	I_{EM1}	76.8 MHz HFRCO w/ DPLL referenced to 38.4 MHz crystal, VSCALE2	—	19	—	µA/MHz
		38.4 MHz crystal	—	20	—	µA/MHz
		38 MHz HFRCO	—	16	—	µA/MHz
Current consumption in EM2 mode, VSCALE0	I_{EM2_VS}	Full RAM retention and RTC running from LFXO	—	2.2	—	µA
		Full RAM retention and RTC running from LFRCO	—	2.2	—	µA
		24 kB RAM retention and RTC running from LFXO	—	1.4	—	µA
		24 kB RAM retention and RTC running from LFRCO in precision mode	—	1.8	—	µA
		8 kB RAM retention and RTC running from LFXO	—	1.3	—	µA
		8 kB RAM retention and RTC running from LFRCO	—	1.3	—	µA
Current consumption in EM3 mode, VSCALE0	I_{EM3_VS}	8 kB RAM retention and RTC running from ULFRCO	—	1.1	—	µA
Current consumption in EM4 mode	I_{EM4}	No BURTC, no LF oscillator, DC-DC bypassed	—	0.22	—	µA

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Additional current in EM2 or EM3 when any peripheral in PD0B is enabled[1]	I_{PD0B_VS}		—	1.2	—	µA

Note:

1. Extra current consumed by power domain. Does not include current associated with the enabled peripherals. See for a list of the peripherals in each power domain.

4.5 Radio Current Consumption with 3.0 V Supply

RF current consumption measured with MCU in EM1, HCLK = 38.4 MHz, and all MCU peripherals disabled. Unless otherwise indicated, typical conditions are: VREGVDD = IOVDD = 3.0 V, DC-DC in regulation. T_A = 25 °C. Minimum and maximum values in this table represent the worst conditions across process variation at T_A = 25 °C.

Table 4.5. Radio Current Consumption with 3.0 V Supply

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
System current consumption in receive mode, active packet reception	I_{RX_ACTIVE}	125 kbit/s, 2GFSK, f = 2.4 GHz, VSCALE1, EM1P	—	4.0	—	mA
		125 kbit/s, 2GFSK, f = 2.4 GHz, VSCALE2, EM1	—	4.5	—	mA
		500 kbit/s, 2GFSK, f = 2.4 GHz, VSCALE1, EM1P	—	4.0	—	mA
		500 kbit/s, 2GFSK, f = 2.4 GHz, VSCALE2, EM1	—	4.5	—	mA
		1 Mbit/s, 2GFSK, f = 2.4 GHz, VSCALE1, EM1P	—	3.8	—	mA
		1 Mbit/s, 2GFSK, f = 2.4 GHz, VSCALE2, EM1	—	4.3	—	mA
		2 Mbit/s, 2GFSK, f = 2.4 GHz, VSCALE1, EM1P	—	4.2	—	mA
		2 Mbit/s, 2GFSK, f = 2.4 GHz, VSCALE2, EM1	—	4.7	—	mA
System current consumption in receive mode, listening for packet	I_{RX_LISTEN}	125 kbit/s, 2GFSK, f = 2.4 GHz, VSCALE1, EM1P	—	4.0	—	mA
		125 kbit/s, 2GFSK, f = 2.4 GHz, VSCALE2, EM1	—	4.4	—	mA
		500 kbit/s, 2GFSK, f = 2.4 GHz, VSCALE1, EM1P	—	4.0	—	mA
		500 kbit/s, 2GFSK, f = 2.4 GHz, VSCALE2, EM1	—	4.5	—	mA
		1 Mbit/s, 2GFSK, f = 2.4 GHz, VSCALE1, EM1P	—	3.8	—	mA
		1 Mbit/s, 2GFSK, f = 2.4 GHz, VSCALE2, EM1	—	4.3	—	mA
		2 Mbit/s, 2GFSK, f = 2.4 GHz, VSCALE1, EM1P	—	4.3	—	mA
		2 Mbit/s, 2GFSK, f = 2.4 GHz, VSCALE2, EM1	—	4.8	—	mA
System current consumption in transmit mode	I_{TX}	f = 2.4 GHz, CW, 0 dBm output power	—	4.7	—	mA
		f = 2.4 GHz, CW, 6.5 dBm output power	—	11.2	—	mA

4.6 RF Transmitter General Characteristics for the 2.4 GHz Band

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

Table 4.6. RF Transmitter General Characteristics for the 2.4 GHz Band

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
RF tuning frequency range	F_{RANGE}		2402	—	2480	MHz
Maximum TX power	$POUT_{MAX}$	6.5 dBm output power	—	6.5	—	dBm
		0 dBm output power	—	-1.5	—	dBm
Minimum active TX power	$POUT_{MIN}$	6.5 dBm output power	—	-29.7	—	dBm
		0 dBm output power	—	-26.2	—	dBm
Output power variation vs supply voltage variation, frequency = 2450 MHz	$POUT_{VAR\_V}$	6.5 dBm output power with VREGVDD swept from 1.8 to 3.0 V	—	0.01	—	dB
		0 dBm PA output power, with VREGVDD swept from 1.8 to 3.0 V	—	0.01	—	dB
Output power variation vs temperature, Frequency = 2450 MHz	$POUT_{VAR\_T}$	6.5 dBm output power, (-40 to +105 °C)	—	1.1	—	dB
		0 dBm output power, (-40 to +105 °C)	—	1.1	—	dB
Output power variation vs RF frequency	$POUT_{VAR\_F}$	6.5 dBm output power	—	0.1	—	dB
		0 dBm output power	—	0.5	—	dB

4.7 RF Receiver General Characteristics for the 2.4 GHz Band

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

Table 4.7. RF Receiver General Characteristics for the 2.4 GHz Band

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
RF tuning frequency range	F_{RANGE}		2402	—	2480	MHz

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

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

Table 4.8. 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
Rx Max Strong Signal Input Level for 0.1% BER	RX_{SAT}	Signal is reference signal[1]	—	10	—	dBm
Sensitivity	SENS	Signal is reference signal, 37 byte payload[2]	—	-98.8	—	dBm
		Signal is reference signal, 255 byte payload[1]	—	-97.2	—	dBm
		With non-ideal signals[3] [1]	—	-96.7	—	dBm
Signal to co-channel interferer	C/I_{CC}	(see notes)[1] [4]	—	8.6	—	dB
N ± 1 Adjacent channel selectivity	C/I_1	Interferer is reference signal at +1 MHz offset[1] [5] [4] [6]	—	-6.7	—	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]	—	-40.5	—	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]	—	-47.0	—	dB
		Interferer is reference signal at -3 MHz offset[1] [5] [4] [6]	—	-46.9	—	dB
Selectivity to image frequency	C/I_{IM}	Interferer is reference signal at image frequency with 1 MHz precision[1] [6]	—	-23.7	—	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]	—	-40.8	—	dB
		Interferer is reference signal at image frequency -1 MHz with 1 MHz precision[1] [6]	—	-6.7	—	dB
Intermodulation performance	IM	n = 3 (see note[7])	—	-19.0	—	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.

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

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

Table 4.9. 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
Rx Max Strong Signal Input Level for 0.1% BER	RX_{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]	—	8.7	—	dB
N ± 1 Adjacent channel selectivity	C/I_1	Interferer is reference signal at +2 MHz offset[1] [5] [4] [6]	—	-6.5	—	dB
		Interferer is reference signal at -2 MHz offset[1] [5] [4] [6]	—	-6.9	—	dB
N ± 2 Alternate channel selectivity	C/I_2	Interferer is reference signal at +4 MHz offset[1] [5] [4] [6]	—	-41.4	—	dB
		Interferer is reference signal at -4 MHz offset[1] [5] [4] [6]	—	-45.1	—	dB
N ± 3 Alternate channel selectivity	C/I_3	Interferer is reference signal at +6 MHz offset[1] [5] [4] [6]	—	-50.3	—	dB
		Interferer is reference signal at -6 MHz offset[1] [5] [4] [6]	—	-51.6	—	dB
Selectivity to image frequency	C/I_{IM}	Interferer is reference signal at image frequency with 1 MHz precision[1] [6]	—	-23.1	—	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]	—	-42.5	—	dB
		Interferer is reference signal at image frequency -2 MHz with 1 MHz precision[1] [6]	—	-6.3	—	dB
Intermodulation performance	IM	n = 3 (see note[7])	—	-18.4	—	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.

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

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

Table 4.10. 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
Rx Max Strong Signal Input Level for 0.1% BER	RX_{SAT}	Signal is reference signal[1]	—	10	—	dBm
Sensitivity	SENS	Signal is reference signal, 37 byte payload[2]	—	-102.2	—	dBm
		Signal is reference signal, 255 byte payload[1]	—	-101.0	—	dBm
		With non-ideal signals[3] [1]	—	-99.9	—	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]	—	-7.8	—	dB
		Interferer is reference signal at -1 MHz offset[1] [5] [4] [6]	—	-7.8	—	dB
N ± 2 Alternate channel selectivity	C/I_2	Interferer is reference signal at +2 MHz offset[1] [5] [4] [6]	—	-45.9	—	dB
		Interferer is reference signal at -2 MHz offset[1] [5] [4] [6]	—	-50.2	—	dB
N ± 3 Alternate channel selectivity	C/I_3	Interferer is reference signal at +3 MHz offset[1] [5] [4] [6]	—	-46.5	—	dB
		Interferer is reference signal at -3 MHz offset[1] [5] [4] [6]	—	-55.1	—	dB
Selectivity to image frequency	C/I_{IM}	Interferer is reference signal at image frequency with 1 MHz precision[1] [6]	—	-48.2	—	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]	—	-48.5	—	dB
		Interferer is reference signal at image frequency -1 MHz with 1 MHz precision[1] [6]	—	-46.6	—	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 -72 dBm.
5. Desired frequency 2402 MHz ≤ Fc ≤ 2480 MHz.
6. With allowed exceptions.

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

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

Table 4.11. 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
Rx Max Strong Signal Input Level for 0.1% BER	RX_{SAT}	Signal is reference signal[1]	—	10	—	dBm
Sensitivity	SENS	Signal is reference signal, 37 byte payload[2]	—	-106.5	—	dBm
		Signal is reference signal, 255 byte payload[1]	—	-106.1	—	dBm
		With non-ideal signals[3] [1]	—	-105.7	—	dBm
Signal to co-channel interferer	C/I_{CC}	(see notes)[1] [4]	—	1.0	—	dB
N ± 1 Adjacent channel selectivity	C/I_1	Interferer is reference signal at +1 MHz offset[1] [5] [4] [6]	—	-13.3	—	dB
		Interferer is reference signal at -1 MHz offset[1] [5] [4] [6]	—	-13.2	—	dB
N ± 2 Alternate channel selectivity	C/I_2	Interferer is reference signal at +2 MHz offset[1] [5] [4] [6]	—	-51.8	—	dB
		Interferer is reference signal at -2 MHz offset[1] [5] [4] [6]	—	-55.5	—	dB
N ± 3 Alternate channel selectivity	C/I_3	Interferer is reference signal at +3 MHz offset[1] [5] [4] [6]	—	-50.3	—	dB
		Interferer is reference signal at -3 MHz offset[1] [5] [4] [6]	—	-60.9	—	dB
Selectivity to image frequency	C/I_{IM}	Interferer is reference signal at image frequency with 1 MHz precision[1] [6]	—	-51.4	—	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]	—	-52.3	—	dB
		Interferer is reference signal at image frequency -1 MHz with 1 MHz precision[1] [6]	—	-52.1	—	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.

4.12 High-Frequency Crystal

Table 4.12. High-Frequency Crystal

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

4.13 Low Frequency Crystal Oscillator

Table 4.13. Low Frequency Crystal Oscillator

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Crystal frequency	F_{LFXO}		—	32.768	—	kHz
Supported crystal equivalent series resistance (ESR)	ESR_{LFXO}	GAIN = 0	—	—	80	kΩ
		GAIN = 1 to 3	—	—	100	kΩ
Supported range of crystal load capacitance [1]	C_{L_LFXO}	GAIN = 0	4	—	6	pF
		GAIN = 1	6	—	10	pF
		GAIN = 2 (see note[2])	10	—	12.5	pF
		GAIN = 3 (see note[2])	12.5	—	18	pF
Current consumption	I_{CL12p5}	ESR = 70 kΩ, C_L = 12.5 pF, GAIN[3] = 2, AGC[4] = 1	—	254	—	nA
Startup time	$T_{STARTUP}$	ESR = 70 kΩ, C_L = 7 pF, GAIN[3] = 1, AGC[4] = 1	—	43	—	ms
On-chip tuning cap step size	SS_{LFXO}		—	0.26	—	pF
On-chip tuning capacitor value at minimum setting[5]	C_{LFXO_MIN}	CAPTUNE = 0	—	4	—	pF
On-chip tuning capacitor value at maximum setting[5]	C_{LFXO_MAX}	CAPTUNE = 0x4F	—	24.5	—	pF

Note:

1. Total load capacitance seen by the crystal.
2. Crystals with a load capacitance of greater than 12 pF require external load capacitors.
3. In LFXO_CAL Register.
4. In LFXO_CFG Register.
5. The effective load capacitance seen by the crystal will be $C_{LFXO}/2$. This is because each XTAL pin has a tuning cap and the two caps will be seen in series by the crystal.

4.14 Precision Low Frequency RC Oscillator (LFRCO)

Table 4.14. Precision Low Frequency RC Oscillator (LFRCO)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Nominal oscillation frequency	F_{LFRCO}		—	32.768	—	kHz
Frequency accuracy	F_{LFRCO_ACC}	Normal mode	-3	—	3	%
		Precision mode[1], across operating temperature range[2]	-500	—	500	ppm
Startup time	$t_{STARTUP}$	Normal mode	—	211	—	µs
		Precision mode[1]	—	11.7	—	ms
Current consumption	I_{LFRCO}	Normal mode	—	183	—	nA
		Precision mode[1], T = stable at 25 °C [3]	—	664	—	nA

Note:

1. The LFRCO operates in high-precision mode when CFG_HIGHPRECEN is set to 1. High-precision mode is not available in EM4.
2. Includes ± 40 ppm frequency tolerance of the HFXO crystal.
3. Includes periodic re-calibration against HFXO crystal oscillator.

4.15 GPIO Pins

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

Table 4.15. GPIO Pins

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Leakage current	I_{LEAK_IO}	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 20 mA, IOVDD = 3.0 V	0.8 * IOVDD	—	—	V
		Sourcing 8 mA, IOVDD = 1.71 V	0.6 * IOVDD	—	—	V
Output low voltage	V_{OL}	Sinking 20 mA, IOVDD = 3.0 V	—	—	0.2 * IOVDD	V
		Sinking 8 mA, IOVDD = 1.71 V	—	—	0.4 * IOVDD	V
GPIO rise time	T_{GPIO_RISE}	IOVDD = 3.0 V, C_{load} = 50 pF, SLEWRATE = 4, 10% to 90%	—	8.4	—	ns
GPIO fall time	T_{GPIO_FALL}	IOVDD = 3.0 V, C_{load} = 50 pF, SLEWRATE = 4, 90% to 10%	—	7.1	—	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	34	44	60	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.

4.16 Microcontroller Peripherals

The MCU peripherals set available in BGM270S modules includes:

- Analog to Digital Converter: 12-bit at 1 Msps, 16-bit at 76.9 ksps (IADC)
- 16-bit and 32-bit Timers/Counters (TIMER)
- 24-bit Low Energy Timer for Waveform Generation (LETIMER)
- 32-bit Counter for Real Time Clock with Capture (RTCC)
- Pulse Density Modulation interface for Digital Microphone (PDM)
- 12 Channel Peripheral Reflex System (PRS)
- Analog Comparator (ACMP)
- Up to 26 GPIO pins
- 8 Channel Linked Direct Memory Access Controller (LDMA)
- Watchdog Timer (WDOG)
- Precision Low-Frequency RC Oscillator to replace 32 kHz sleep crystal (LFRCO)
- Die Temperature Sensor with +/-1.5 ^{o}C accuracy after single-point calibration
- USART (UART/SPI/SmartCards/IrDA/I^2S)
- EUSART (UART/SPI)
- I^2C peripheral interfaces
- Coulomb counter integrated into DC-DC

For details on their electrical performance, consult the relevant portions of Section 4 in the SoC data sheet.

To learn which GPIO ports provide access to every peripheral, consult Analog Peripheral Connectivity and Digital Peripheral Connectivity.

4.17 Antenna Radiation Patterns

Typical BGM270S 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.

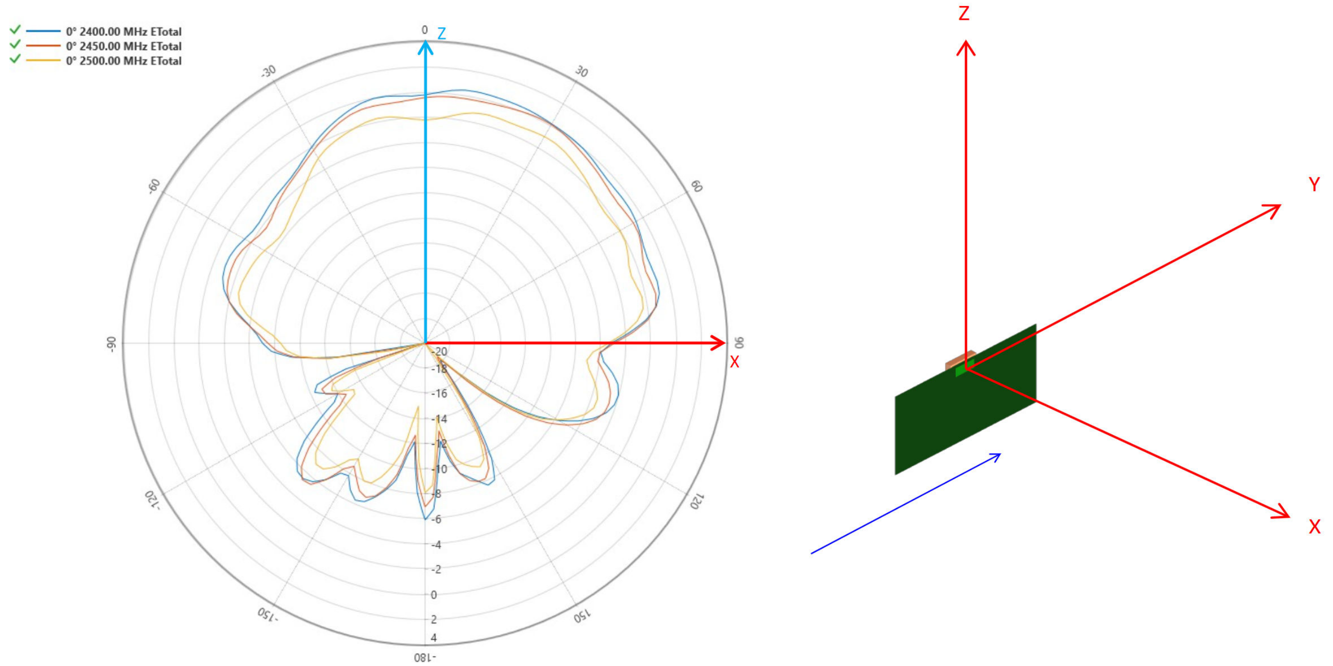


Figure 4.3. BGM270S Typical 2D Antenna Radiation Patterns on 55 mm x 30 mm board - Phi 0º Gain (dBi)

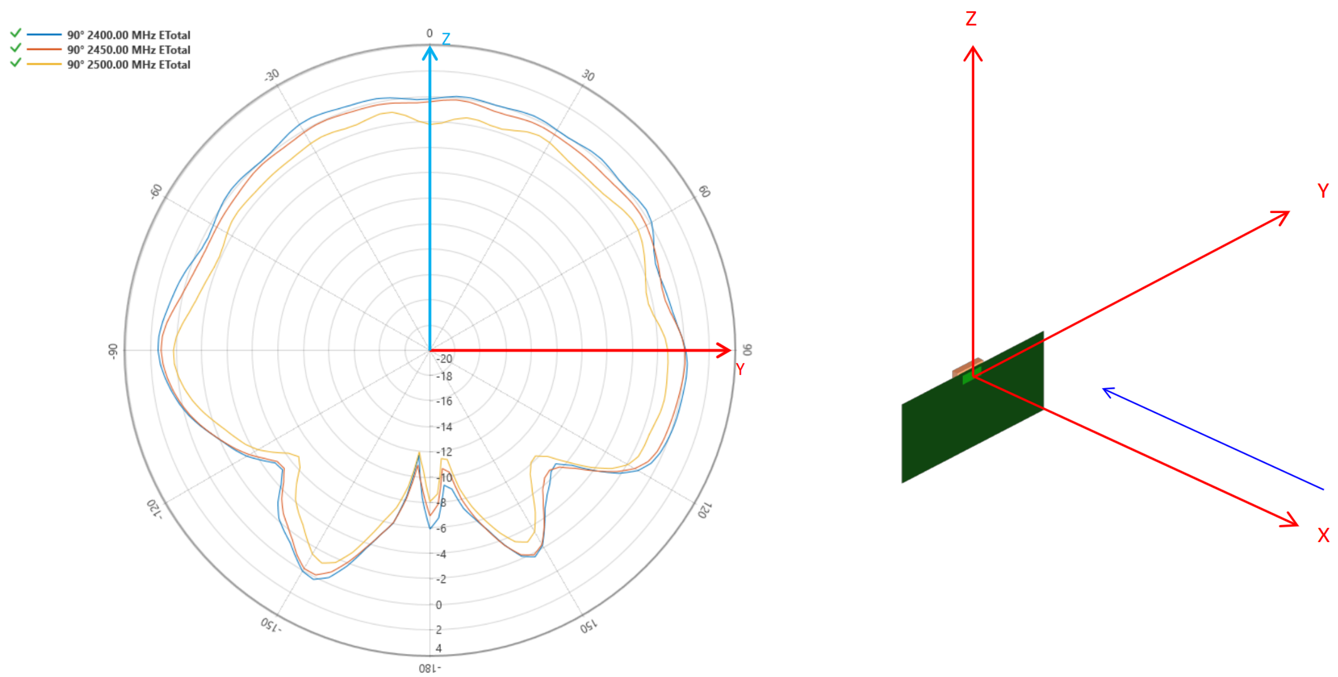


Figure 4.4. BGM270S Typical 2D Antenna Radiation Patterns on 55 mm x 30 mm board - Phi 90º Gain (dBi)

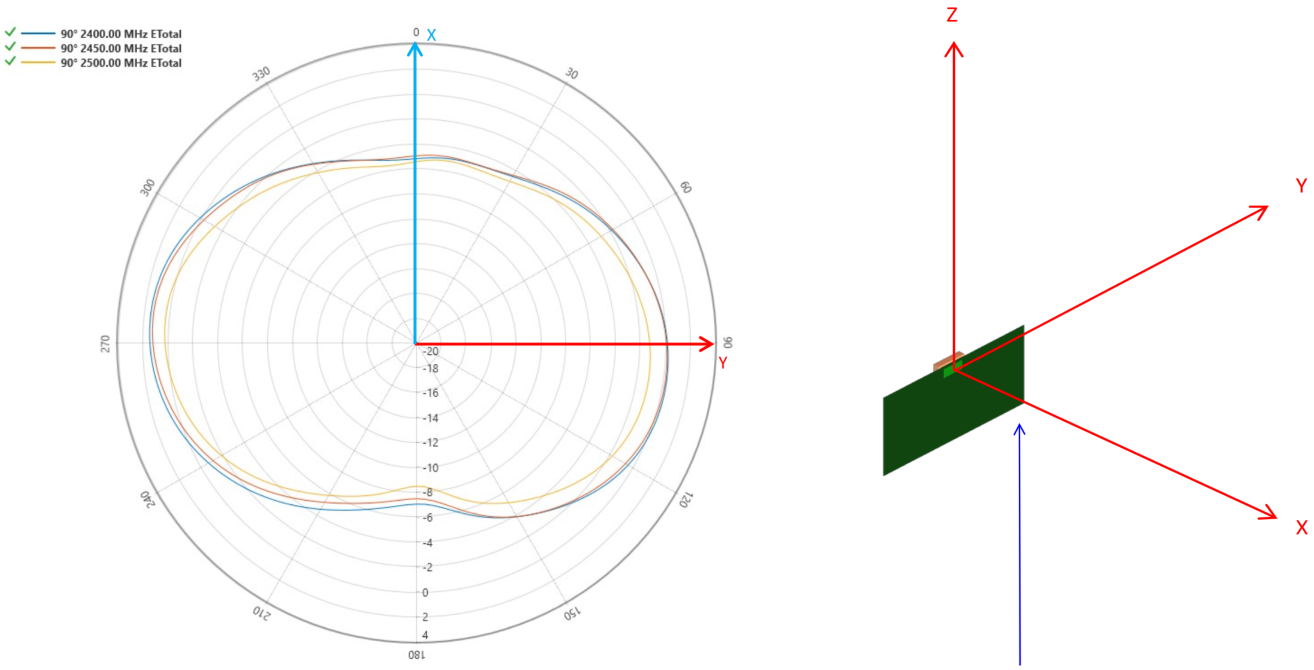


Figure 4.5. BGM270S Typical 2D Antenna Radiation Patterns on 55 mm x 30 mm board - Theta 90º Gain (dBi)

5. Reference Diagrams

5.1 Network Co-Processor (NCP) Application with UART Host

The BGM270S can be controlled over the UART interface as a peripheral to an external host processor. Typical power supply, programming/debug interface, and host interface connections are shown in the figure below. For more details, refer to *AN958: Debugging and Programming Interfaces for Custom Designs*.

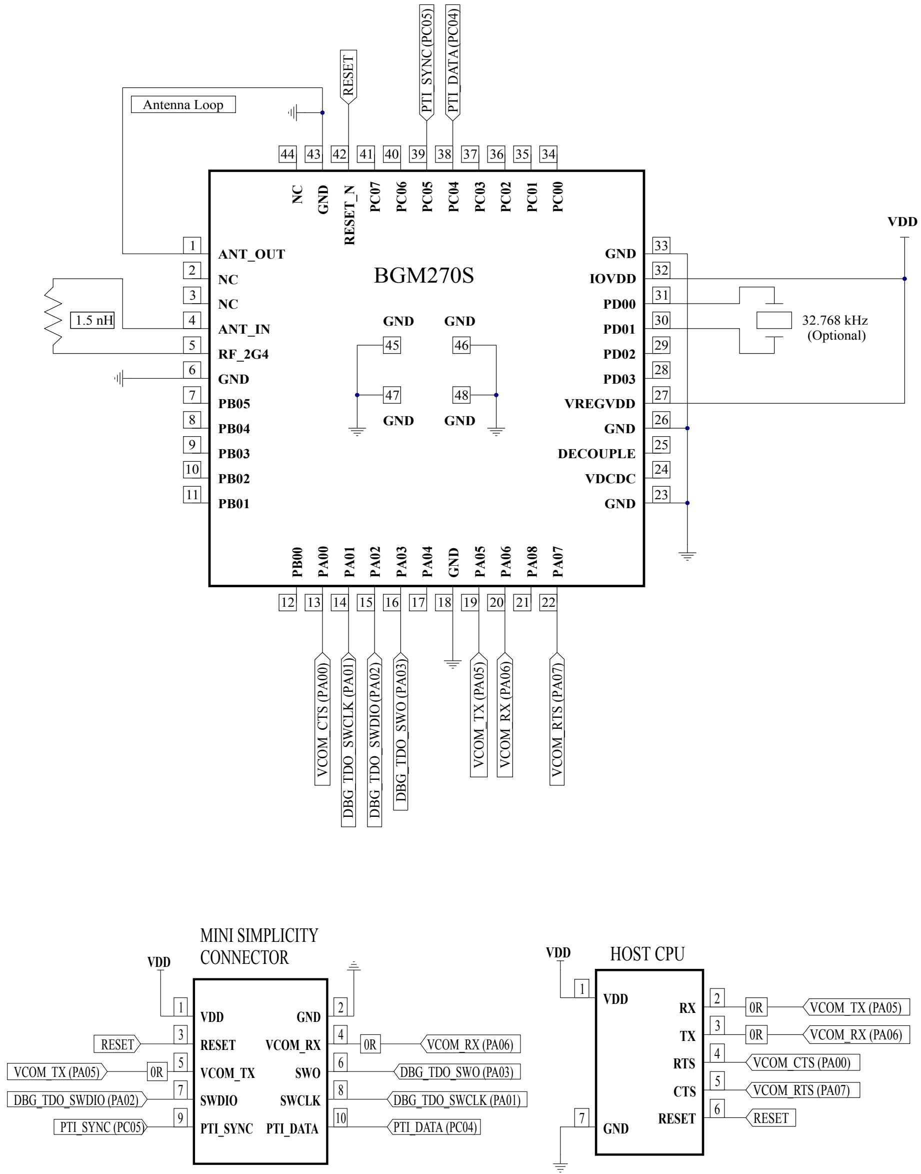


Figure 5.1. UART NCP Configuration

5.2 SoC Application

The BGM270S can be used in a stand-alone SoC configuration without an external host processor. Typical power supply and programming/debug interface connections are shown in the figure below. For more details, refer to *AN958: Debugging and Programming Interfaces for Custom Designs*.

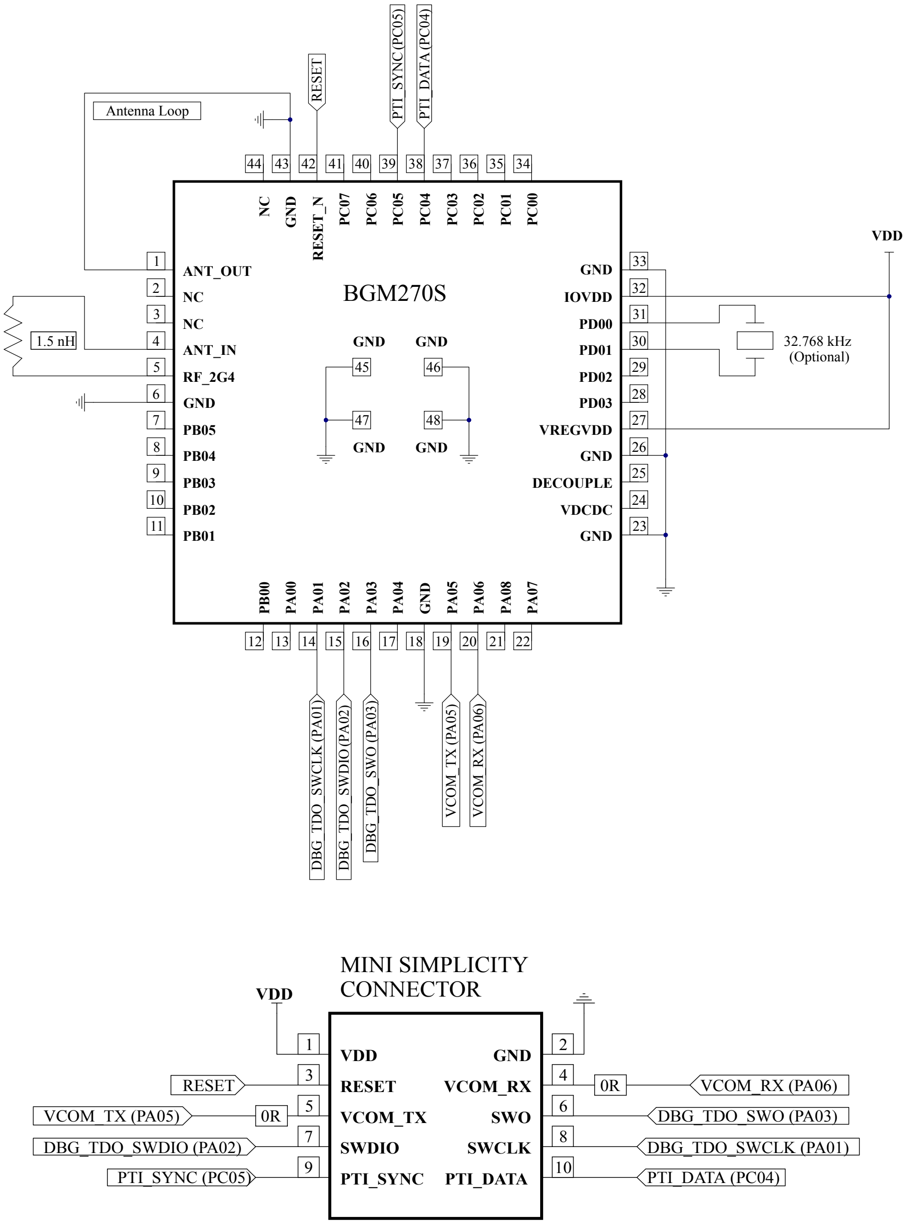


Figure 5.2. Stand-Alone SoC Configuration

6. Pin Definitions

6.1 48-Pin SiP Module Device Pinout

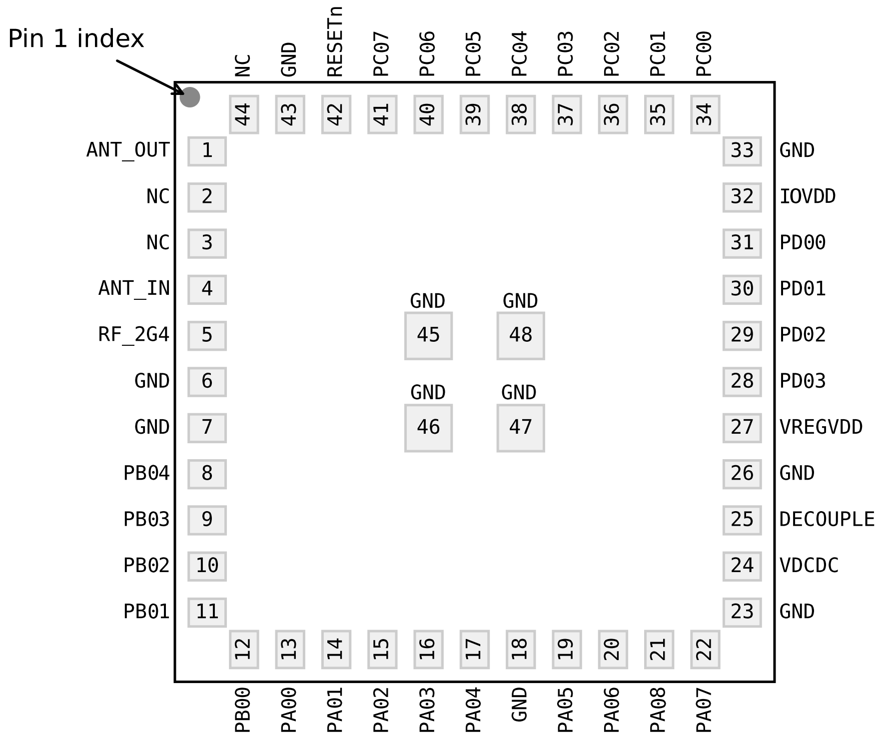


Figure 6.1. 48-Pin SiP Module Device Pinout

The following table provides package pin connections and general descriptions of pin functionality. For detailed information on the supported features for each GPIO pin, see 6.2 Alternate Function Table, 6.3 Analog Peripheral Connectivity, and 6.4 Digital Peripheral Connectivity.

Table 6.1. 48-Pin SiP Module Device Pinout

Pin Name	Pin(s)	Description	Pin Name	Pin(s)	Description
ANT_OUT	1	Integral Antenna Output	NC	2	Do Not Connect
NC	3	Do Not Connect	ANT_IN	4	Integral Antenna Input
RF_2G4	5	2.4 GHz RF Input/Output	GND	6	Ground
GND	7	Ground	PB04	8	GPIO
PB03	9	GPIO	PB02	10	GPIO
PB01	11	GPIO	PB00	12	GPIO

Pin Name	Pin(s)	Description	Pin Name	Pin(s)	Description
PA00	13	GPIO	PA01	14	GPIO
PA02	15	GPIO	PA03	16	GPIO
PA04	17	GPIO	GND	18	Ground
PA05	19	GPIO	PA06	20	GPIO
PA08	21	GPIO	PA07	22	GPIO
GND	23	Ground	VDCDC	24	Test pin (internal pin usage)
DECOUPLE	25	Decouple output for on-chip voltage regulator. This pin is internally decoupled, and should be left disconnected.	GND	26	Ground
VREGVDD	27	Module input power supply	PD03	28	GPIO
PD02	29	GPIO	PD01	30	GPIO
PD00	31	GPIO	IOVDD	32	I/O power supply
GND	33	Ground	PC00	34	GPIO
PC01	35	GPIO	PC02	36	GPIO
PC03	37	GPIO	PC04	38	GPIO
PC05	39	GPIO	PC06	40	GPIO
PC07	41	GPIO	RESETn	42	Reset Pin. The RESETn pin is internally pulled up to VDCDC (DVDD).
GND	43	Ground	NC	44	Do Not Connect
GND	45	Ground	GND	46	Ground
GND	47	Ground	GND	48	Ground

6.2 Alternate Function Table

Some GPIOs support alternate functions like debugging, wake-up from EM4, external low frequency crystal access, etc. The following table shows both which module pins have alternate capabilities and the functions they support. Refer to the SoCs reference manual for more details.

Table 6.2. GPIO Alternate Function Table

GPIO	Alternate Functions
PA00	IADC0.VREFP
PA01	GPIO.SWCLK
PA02	GPIO.SWDIO
PA03	GPIO.SWV
	GPIO.TDO
	GPIO.TRACEDATA0
PA04	GPIO.TDI
	GPIO.TRACECLK
PA05	GPIO.TRACEDATA1
	GPIO.EM4WU0
PA06	GPIO.TRACEDATA2
PA07	GPIO.TRACEDATA3
PB01	ETAMPDET.ETAMPIN0
	GPIO.EM4WU3
PB03	GPIO.EM4WU4
PC00	ETAMPDET.ETAMPIN1
	GPIO.EM4WU6
	GPIO.THMSW_EN
	GPIO.THMSW_HALFSWITCH
PC01	ETAMPDET.ETAMPOUT0
	GPIO.EFP_TX_SDA
PC02	ETAMPDET.ETAMPOUT1
	GPIO.EFP_TX_SCL
PC05	GPIO.EFP_INT
	GPIO.EM4WU7
PC07	GPIO.EM4WU8
PD00	LFXO.LFXTAL_O
PD01	LFXO.LFXTAL_I
	LFXO.LF_EXTCLK
PD02	GPIO.EM4WU9

6.3 Analog Peripheral Connectivity

Many analog resources are routable and can be connected to numerous GPIO's. The following table indicates which peripherals are avaliable on each GPIO port. When a differential connection is being used Positive inputs are restricted to the EVEN pins and Negative inputs are restricted to the ODD pins. When a single ended connection is being used positive input is avaliable on all pins. See the device Reference Manual for more details on the ABUS and analog peripherals.

Table 6.3. ABUS Routing Table

Peripheral	Signal	PA		PB		PC		PD	
		EVEN	ODD	EVEN	ODD	EVEN	ODD	EVEN	ODD
ACMP0	ANA_NEG	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	ANA_POS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
IADC0	ANA_NEG	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	ANA_POS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

6.4 Digital Peripheral Connectivity

Many digital resources are routable and can be connected to numerous GPIO's. The table below indicates which peripherals are available on each GPIO port.

Table 6.4. DBUS Routing Table

Peripheral.Resource	PORT			
	PA	PB	PC	PD
CMU.CLKIN0			Available	Available
CMU.CLKOUT0			Available	Available
CMU.CLKOUT1			Available	Available
CMU.CLKOUT2	Available	Available		
EUART0.CTS	Available	Available	Available	Available
EUART0.RTS	Available	Available	Available	Available
EUART0.RX	Available	Available	Available	Available
EUART0.TX	Available	Available	Available	Available
FRC.DCLK			Available	Available
FRC.DFRAME			Available	Available
FRC.DOUT			Available	Available
I2C0.SCL	Available	Available	Available	Available
I2C0.SDA	Available	Available	Available	Available
I2C1.SCL			Available	Available
I2C1.SDA			Available	Available
LETIMER0.OUT0	Available	Available		
LETIMER0.OUT1	Available	Available		
MODEM.ANT0	Available	Available	Available	Available
MODEM.ANT1	Available	Available	Available	Available
MODEM.ANT_ROLL_OVER			Available	Available
MODEM.ANT_RR0			Available	Available
MODEM.ANT_RR1			Available	Available
MODEM.ANT_RR2			Available	Available
MODEM.ANT_RR3			Available	Available
MODEM.ANT_RR4			Available	Available
MODEM.ANT_RR5			Available	Available
MODEM.ANT_SW_EN			Available	Available
MODEM.ANT_SW_US			Available	Available
MODEM.ANT_TRIG			Available	Available
MODEM.ANT_TRIG_STOP			Available	Available
MODEM.DCLK	Available	Available		

Peripheral.Resource	PORT			
	PA	PB	PC	PD
MODEM.DIN	Available	Available		
MODEM.DOUT	Available	Available		
PDM.CLK	Available	Available	Available	Available
PDM.DAT0	Available	Available	Available	Available
PDM.DAT1	Available	Available	Available	Available
PRS.ASYNCH0	Available	Available		
PRS.ASYNCH1	Available	Available		
PRS.ASYNCH10			Available	Available
PRS.ASYNCH11			Available	Available
PRS.ASYNCH2	Available	Available		
PRS.ASYNCH3	Available	Available		
PRS.ASYNCH4	Available	Available		
PRS.ASYNCH5	Available	Available		
PRS.ASYNCH6			Available	Available
PRS.ASYNCH7			Available	Available
PRS.ASYNCH8			Available	Available
PRS.ASYNCH9			Available	Available
PRS.SYNCH0	Available	Available	Available	Available
PRS.SYNCH1	Available	Available	Available	Available
PRS.SYNCH2	Available	Available	Available	Available
PRS.SYNCH3	Available	Available	Available	Available
TIMER0.CC0	Available	Available	Available	Available
TIMER0.CC1	Available	Available	Available	Available
TIMER0.CC2	Available	Available	Available	Available
TIMER0.CDTI0	Available	Available	Available	Available
TIMER0.CDTI1	Available	Available	Available	Available
TIMER0.CDTI2	Available	Available	Available	Available
TIMER1.CC0	Available	Available	Available	Available
TIMER1.CC1	Available	Available	Available	Available
TIMER1.CC2	Available	Available	Available	Available
TIMER1.CDTI0	Available	Available	Available	Available
TIMER1.CDTI1	Available	Available	Available	Available
TIMER1.CDTI2	Available	Available	Available	Available
TIMER2.CC0	Available	Available		
TIMER2.CC1	Available	Available		
TIMER2.CC2	Available	Available		

Peripheral.Resource	PORT			
	PA	PB	PC	PD
TIMER2.CDTI0	Available	Available		
TIMER2.CDTI1	Available	Available		
TIMER2.CDTI2	Available	Available		
TIMER3.CC0			Available	Available
TIMER3.CC1			Available	Available
TIMER3.CC2			Available	Available
TIMER3.CDTI0			Available	Available
TIMER3.CDTI1			Available	Available
TIMER3.CDTI2			Available	Available
TIMER4.CC0	Available	Available		
TIMER4.CC1	Available	Available		
TIMER4.CC2	Available	Available		
TIMER4.CDTI0	Available	Available		
TIMER4.CDTI1	Available	Available		
TIMER4.CDTI2	Available	Available		
USART0.CLK	Available	Available	Available	Available
USART0.CS	Available	Available	Available	Available
USART0.CTS	Available	Available	Available	Available
USART0.RTS	Available	Available	Available	Available
USART0.RX	Available	Available	Available	Available
USART0.TX	Available	Available	Available	Available
USART1.CLK	Available	Available		
USART1.CS	Available	Available		
USART1.CTS	Available	Available		
USART1.RTS	Available	Available		
USART1.RX	Available	Available		
USART1.TX	Available	Available		

7. Design Guidelines

7.1 Layout and Placement

For optimal performance of the BGM270S 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 BGM270S (Integral Antenna) on page 35.
- Copy the exact design from Figure 7.2 TOP Layer Antenna Layout With Coordinates on page 36 with the values for coordinates A to M given in Table 7.1 Antenna Polygon Coordinates, Referenced to Center of BGM270S on page 36.
- Make a cutout in all lower layers aligned with the right edge and the bottom edge of the integral loop antenna as indicated by the red box in Figure 7.3 Antenna Clearance in Inner and Bottom Layers on page 37.
- Connect all ground pads directly to a solid ground plane in the top layer.
- Connect RF_2G4 to ANT_IN through a 1.5 nH inductor for obtaining the expected internal antenna performance.
- 1.5 nH inductor is not to be used in the case of external antenna configurations and when taking conducted measurement.
- Place ground vias as close to the ground pads of the BGM270S 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.
- Proper module placement and electrical connection should be ensured by measuring radiated output power from antenna.
- Impedance of the antenna can be verified by measuring S11 at ANT_IN pin that is corresponding antenna specification.
- With an external antenna, use a 50Ω trace to connect RF signal to the antenna, as it is illustrated in Figure 7.4 Recommended Layout for BGM270S (External Antenna) on page 37.

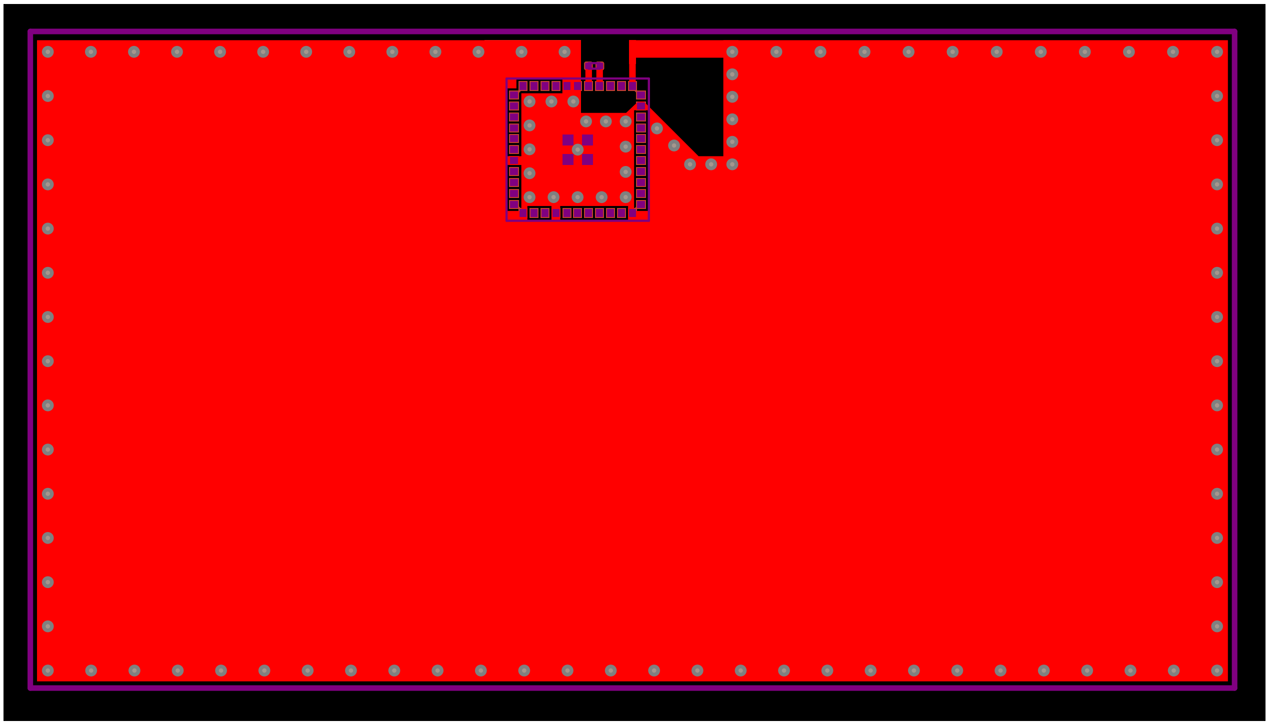


Figure 7.1. Recommended Layout for BGM270S (Integral Antenna)

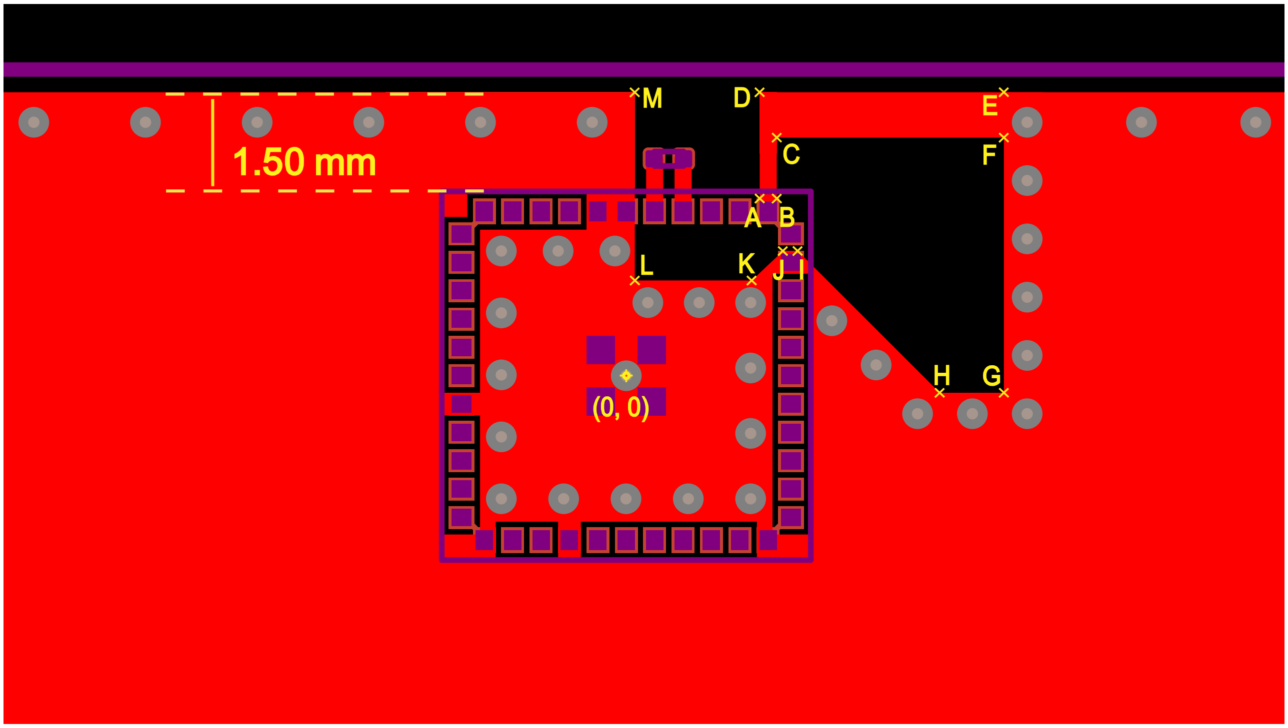


Figure 7.2. TOP Layer Antenna Layout With Coordinates

Table 7.1. Antenna Polygon Coordinates, Referenced to Center of BGM270S

Point	Coordinate
A	(2.35, 3.15)
B	(2.65, 3.15)
C	(2.65, 4.20)
D	(2.35, 5.00)
E	(6.65, 5.00)
F	(6.65, 4.20)
G	(6.65, -0.30)
H	(5.52,-0.30)
I	(3.02, 2.20)
J	(2.76, 2.20)
K	(2.21, 1.68)
L	(0.15, 1.68)
M	(0.15, 5.00)

Tolerance for the coordinates is +/- 0.05 mm.

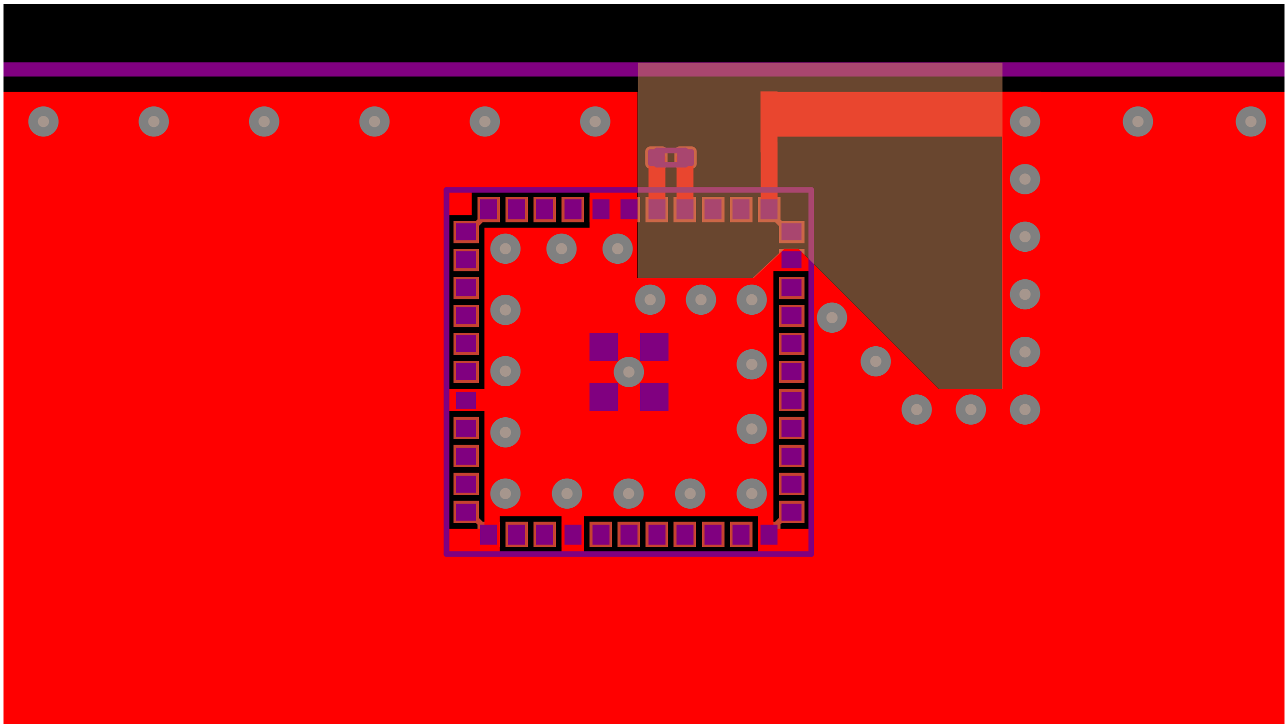


Figure 7.3. Antenna Clearance in Inner and Bottom Layers

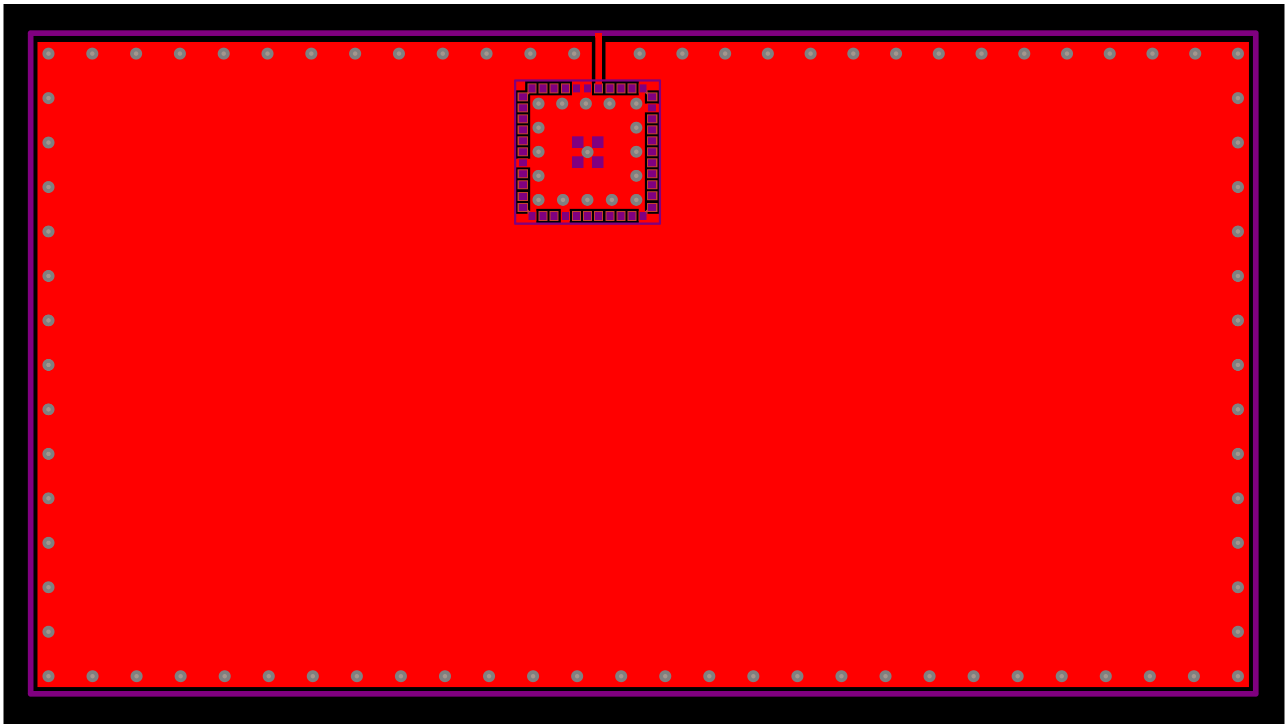


Figure 7.4. Recommended Layout for BGM270S (External Antenna)

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 BGM270S 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 37.
- 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 BGM270S will impact the efficiency of the on-board integral loop antenna.
  - To achieve optimal performance, a GND plane width of 55 mm is recommended as seen on Figure 7.5 Illustration of Recommended Board Width on page 38.
  - See for reference.
  - Figure 7.6 Non-Recommended Layout Examples on page 39 illustrates layout scenarios that will lead to severely degraded RF performance for the application board.

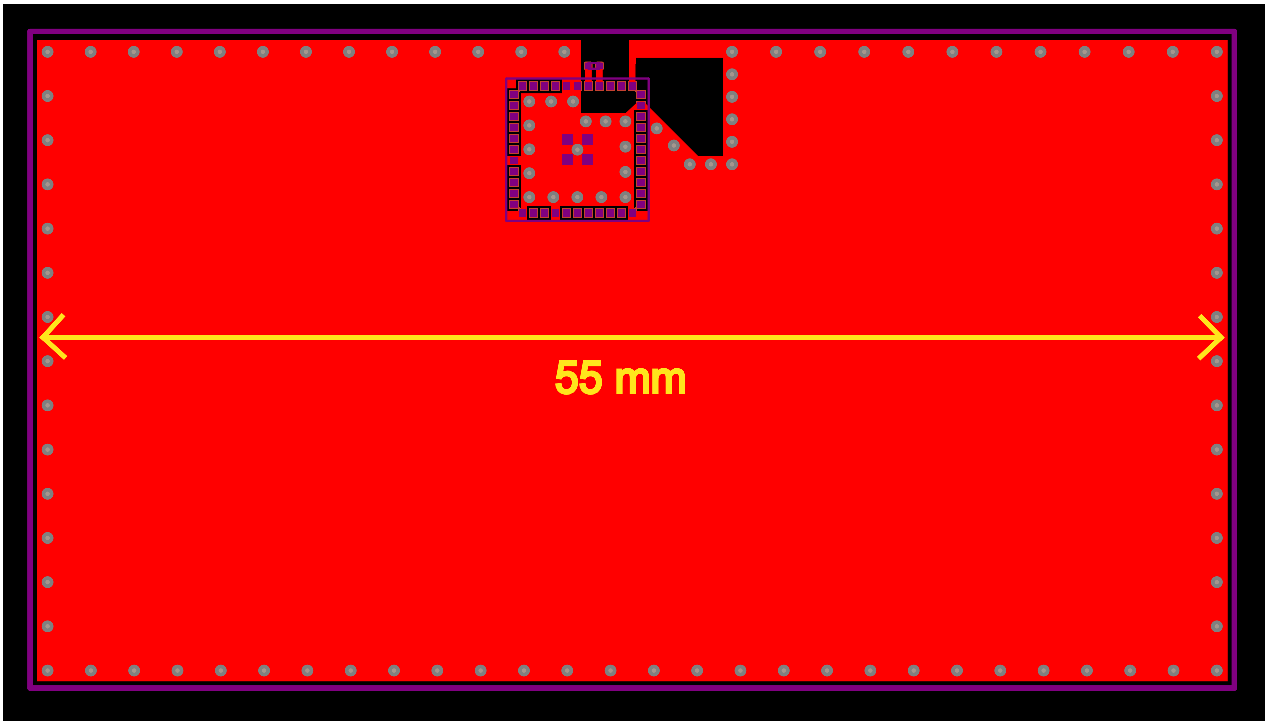


Figure 7.5. Illustration of Recommended Board Width

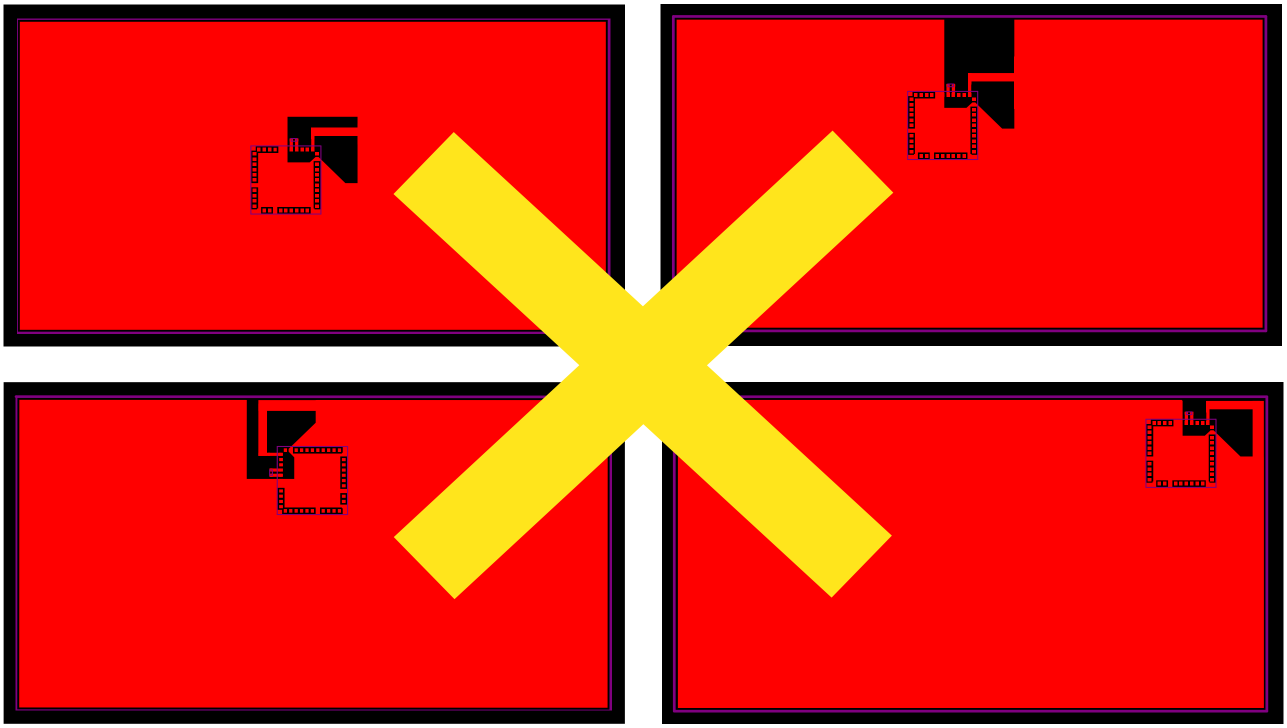


Figure 7.6. Non-Recommended Layout Examples

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. A carrier board width of 55 mm is recommended for the BGM270S. However, the ideal width is not always possible in the end-application, and another form factor might be required. In this case, the antenna performance of the integral antenna will possibly become compromised, but it may still be sufficiently good for providing the required link quality and range of the end-application. As can be seen in Figure 7.7 Efficiency of the Integrated Antenna as Function of the Carrier Board Size for BGM270S on page 40, the best performance is achieved for a carrier board size of 55 mm x 30 mm, with relatively constant performance for larger boards and rapidly declining performance for smaller boards. Notice that carrier PCB thickness and relative permittivity might also have an impact on the antenna impedance and/or resonance frequency.

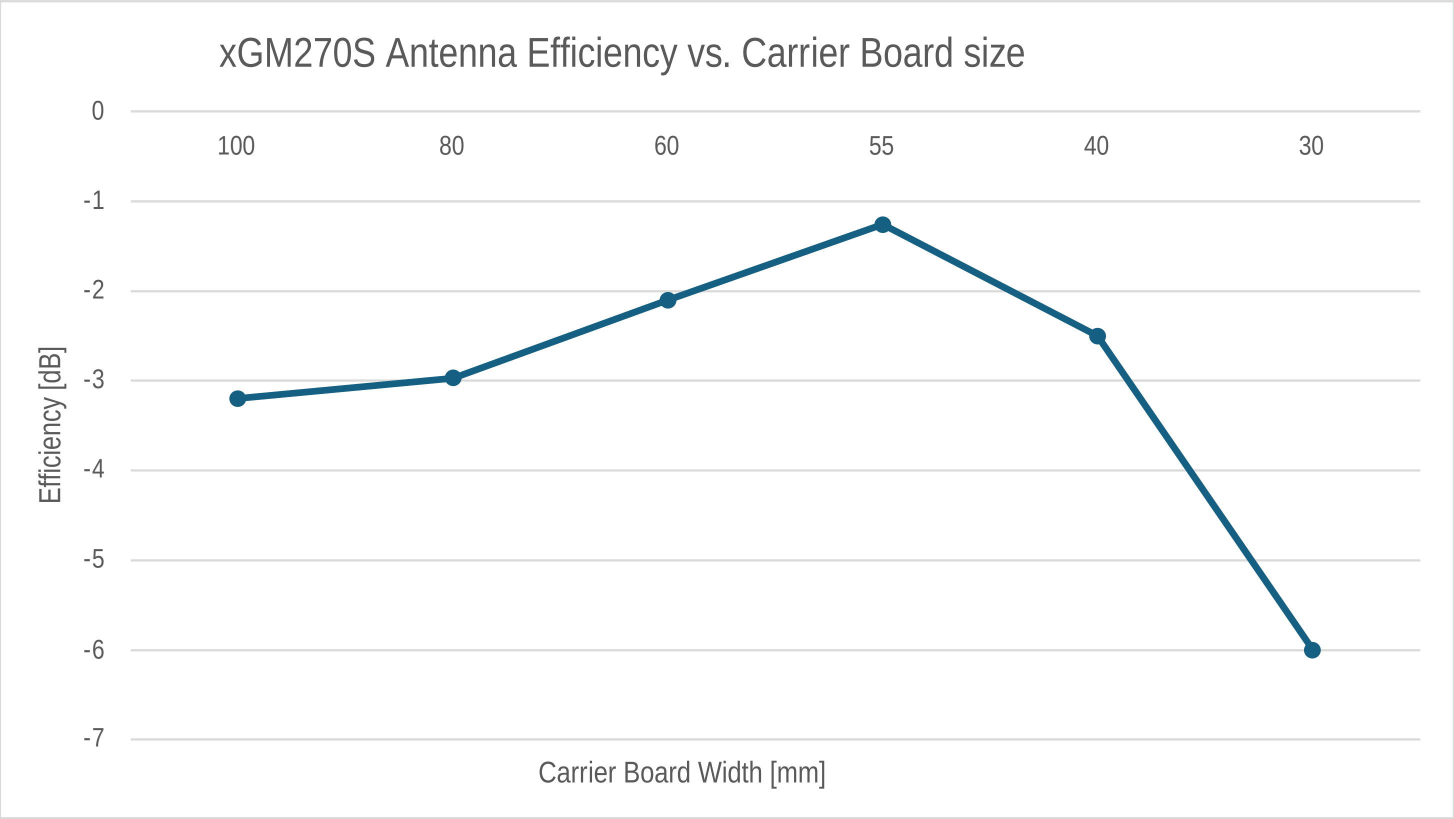


Figure 7.7. Efficiency of the Integrated Antenna as Function of the Carrier Board Size for BGM270S

7.4 Proximity to Other Materials

Placing plastic and/or any other dielectric material directly in contact with (or in very close proximity to) the antenna is likely to cause RF performance degradation. A clearance of minimum 0.5 mm is recommended to avoid excessive detuning of the antenna. Solder mask, conformal coating, and/or other thin dielectric layers are acceptable directly on top of the antenna region, however these might also negatively impact antenna efficiency and reduce range. 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 work may be required if the module is integrated into a wearable device: refer to 11.7 RF Exposure and Proximity to Human Body.

7.6 Antenna Tuning and Validity of Modular Certifications

A modular certification is valid if all the design guidelines from the manufacturer with regards to carrier Printed Circuit Board (PCB) size, thickness, relative permittivity, module placement, and antenna loop dimensions are followed. In particular, the modular certification is still valid if no antenna tuning is applied to compensate for the reduced performance in terms of range, which may result from sub-optimal carrier PCB size, thickness, relative permittivity, module placement, and/or proximity to other materials such as assembly housing.

Conversely, any antenna tuning or change of the antenna loop dimensions might invalidate a modular certification, unless it is done to compensate for the degradation caused by a PCB deviating from the manufacturer's best-case reference in size, thickness, relative permittivity, and/or module placement, or to compensate for the degradation caused by the proximity of assembly housing.

Class 1 Permissive Change (C1PC) is considered if the host PCB modifications do not increase emissions. Class 2 Permissive Change (C2PC) is considered if the modifications degrade the emissions, but remain below regulatory limits. In any case, the required spot-checking by the end-product manufacturer becomes even more relevant here to identify the path forward.

Whether antenna tuning is applied or not, it is strongly recommended that spot-checking is performed in any case with the end-product having the transmitter(s) operating, so to confirm that the host product meets all regulatory requirements under any circumstance.

The emission levels established in the module certification are limits for the end device too, and determine whether or not a *Permissive Change* should be considered. Since this is evaluated on a case-by-case basis, customers must consult with the company providing certification services for their product to identify the best approach. Additional information on module certification and *Permissive Changes* is provided in AN1048: Regulatory RF Module Certifications.

8. Package Specifications

8.1 Package Dimensions

The package dimensions are shown in Figure 8.1 Package Dimensions - Full on page 42 and Figure 8.2 Package Dimensions - Detail on page 42.

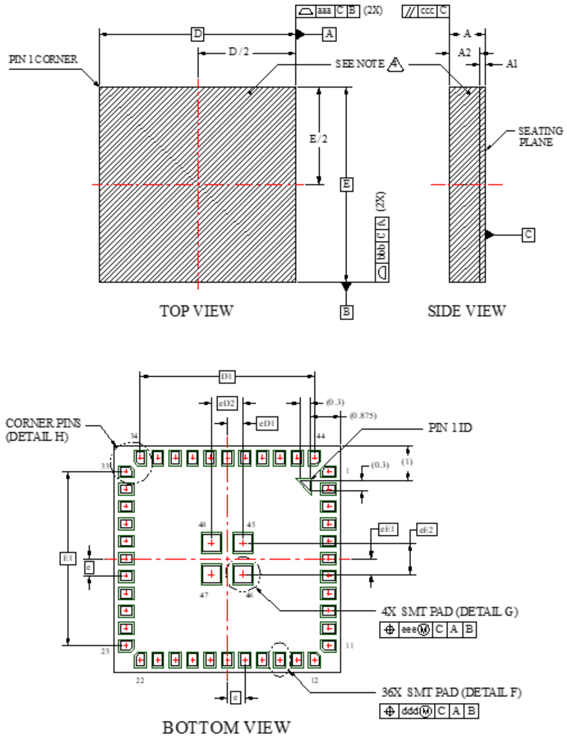


Figure 8.1. Package Dimensions - Full

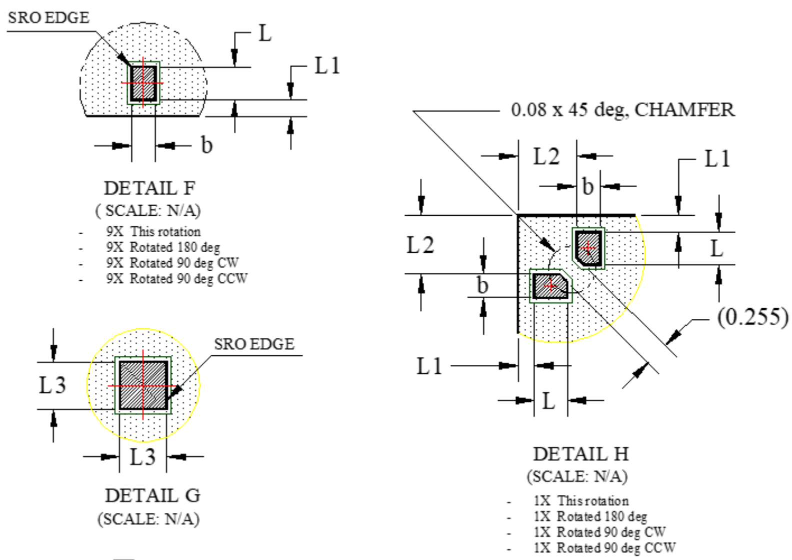


Figure 8.2. Package Dimensions - Detail

Table 8.1. Package Dimensions

Dimension	MIN	NOM	MAX
A	1.200	1.300	1.400
A1	0.260	0.300	0.340
A2	0.950	1.000	1.050
b	0.200	0.250	0.300
D		6.000 BSC	
D1		5.000 BSC	
e		0.500 BSC	
E		6.500 BSC	
E1		5.000 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 44

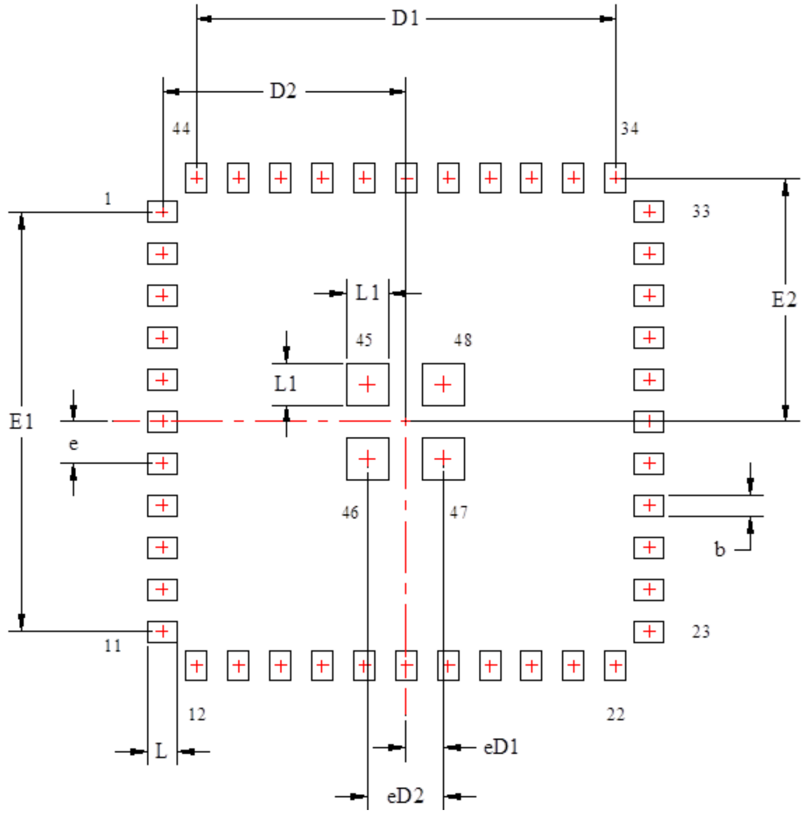


Figure 8.3. Module Land Pattern

Table 8.2. PCB Land Pattern Dimensions

Dimension	Typ (mm)
D1	5.00
D2	2.90
E1	5.00
E2	2.90
eD1	0.45
eD2	0.90
b	0.25
e	0.50
L	0.35

Dimension	Typ (mm)
L1	0.50

Note: General

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.

Stencil Design

1. A stainless steel, laser-cut and electro-polished stencil with trapezoidal walls should be used to assure good solder paste release.
2. The stencil thickness should be 0.100 mm (4 mils).
3. The stencil aperture to land pad size recommendation is 80% paste coverage.

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

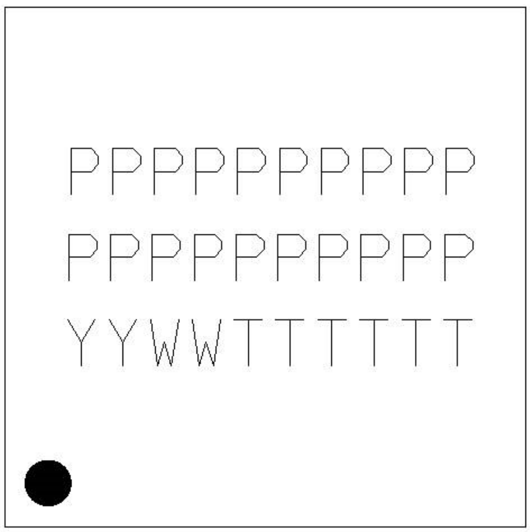


Figure 8.4. BGM270S Top Marking

Table 8.3. Top Marking Definition

OPN	Line 1 Marking	Line 2 Marking	Line 3 Marking
BGM270SC22SNA4	BGM270S22A	SC22SNA4	See note below
Note: YY = Year. WW = Work Week, TTTTTTT = Trace Code			

9. Soldering Recommendations

It is recommended that final PCB assembly of the BGM270S 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

BGM270S 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.

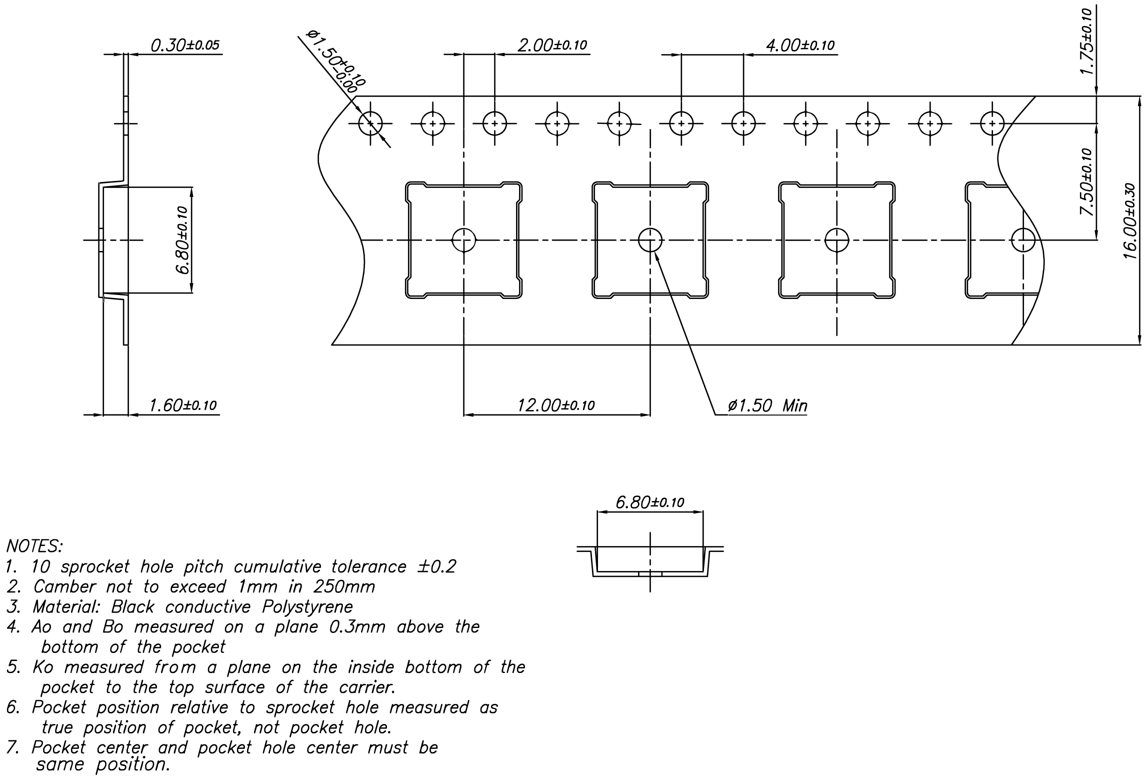
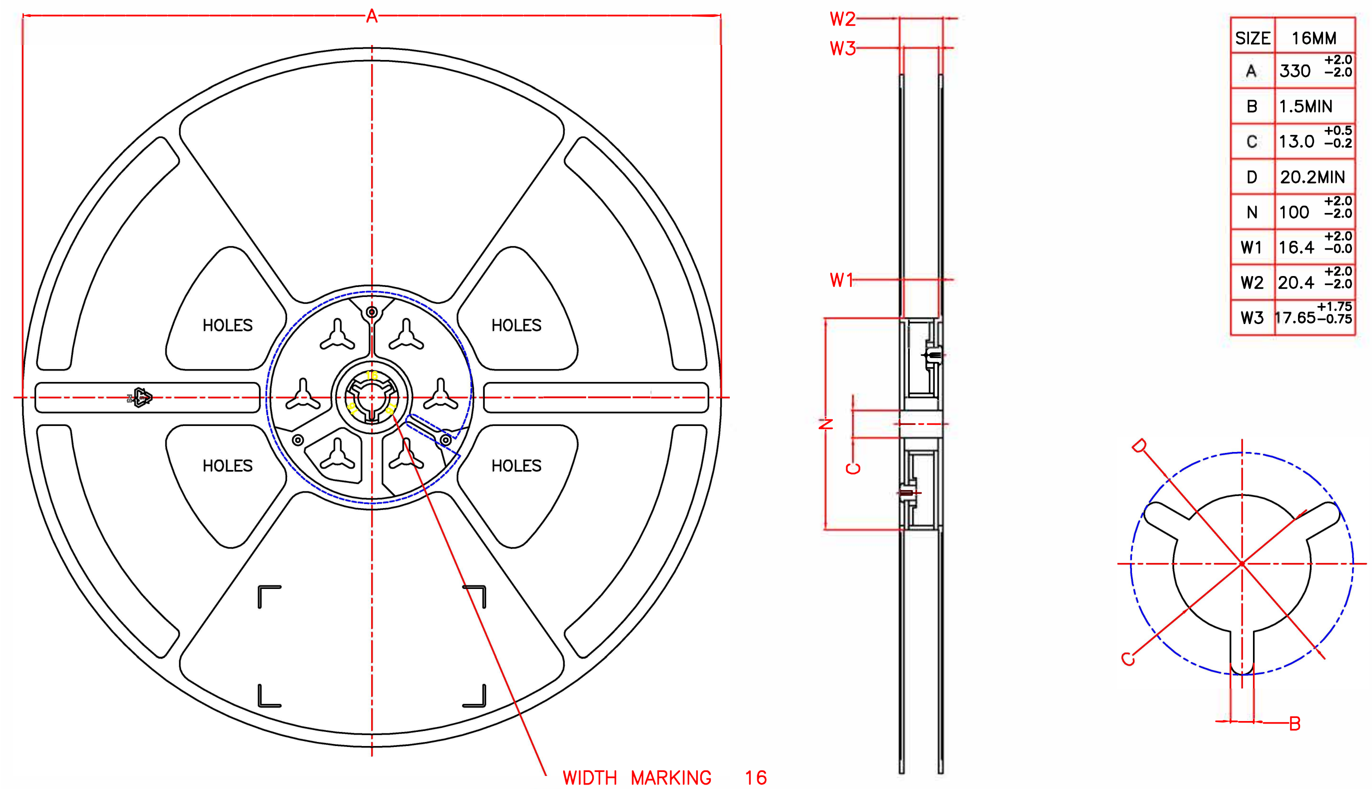


Figure 10.1. Carrier Tape Dimensions



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 certification status of the BGM270S modules with regards to regional regulatory radio type approvals. Where applicable, the status with the qualifications against the specifications of the supported global industrial wireless standards is also provided.

The address of the legal manufacturer (technology owner) and certifications applicant/holder is:

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

The BGM270S modules have brand name of "SILICON LABS". For certifications and qualifications purposes, the modules are referred to by their formal Model Name of "BGM270S22A".

"SILICON LABS" (and "Silicon Labs") is a trademark globally owned by the Silicon Laboratories Inc. corporation, and all branches and subsidiaries, including the above applicant, holds the right to use it.

For any clarification on regulatory certifications, or if you need to discuss topics such as Permissive Changes or Change in ID requests, please contact your Sales Representative or our Technical Support. You can get started by visiting Contact Us.

11.1 Qualified Antennas

The BGM270S22A module have been tested and certified for the use with either the built-in integral antenna or a reference external antenna attached to the module's RF pin denoted as RF_2G4. The intended antenna impedance is 50 Ω.

Performance characteristics for the built-in antenna are presented in 3.3 Antenna, 7.3 Radio Performance vs. Carrier Board Size and . The details of the qualified external antenna(s) are summarized in the table below. The qualified external antenna(s) is(are) meant to be directly connected to the module's RF pin, with no active/non-linear component(s) along the RF path in between.

Table 11.1. Qualified External Antennas for BGM270S22A Modules

Brand and Model	Antenna Type	Maximum Gain	Impedance
Linx Technologies Inc., ANT-2.4-CW-CT-RPS	Connectorized Coaxial Dipole	+2.8 dBi	50 Ω

Any external antenna of the same general type and of equal or less peak directional gain compared to the one(s) listed in the above table, and having similar in-band and out-of-band characteristics, can be used in the regulatory areas that have modular radio approvals, such as USA and Canada, as long as spot-check testing of the host is performed to verify that no performance changes compromising compliance have been introduced. In the particular FCC case, to comply with e-CFR Title 47, Part 15, Subpart C, Section 15.203, the module integrator must additionally consider the use of an external antenna having a unique connector or being non-detachable.

When using instead an external antenna of a different type (such as a chip antenna, a host PCB trace antenna, or a patch) and/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, in principle it can be added to the existing modular grant/certificate by means of a Permissive Change, for example with FCC and ISED. Typically, some radiated emission testing is demanded, but no modular or end-product re-certification is required. Please consult your certification house and/or a certification body and/or the module manufacturer for a confirmation on the correct procedures and for any authorization to perform a FCC's *Change in ID* and/or a ISED's *Multiple Listing*, to be followed by the intended Permissive Changes.

On the other hand, products designed to be used with an external antenna having higher peak gain than the maximum gain listed in the table above are very likely to require full new end-product's radio type approvals, with certification IDs under the host manufacturer's ownership. Since the exact Permissive Change or registration or re-certification procedure is chosen on a case-by-case basis, consult your certification house and/or a certification body for understanding the correct approach based on your unique design.

In countries applying the ETSI standards, where manufacturers issue a self-Declaration of Conformity before placing their products in the market (like in the EU countries, as well as in the UK or AU and NZ), the radiated emissions are always evaluated with the end-product and the external antenna type is not critical, but antennas with higher gain may violate some of the EIRP regulatory limits.

For Japan, where compliance testing is done conductively, a list of allowed external antennas is found in the certificate(s) and/or test report(s). These qualified external antennas are meant to be directly connected to the module's RF pin, with no active/non-linear component along the RF path in between. For the use of any other external antenna, it will have to be formally added to the list of approved antennas by the certificate holder: in this case, please reach out to the module manufacturer to discuss such addition, or consider certifying the end-product itself as an alternative.

11.2 CE and UKCA - EU and UK

The BGM270S22A modules have been tested against the relevant applicable harmonized/designated standards (in relation to RF, EMC, Safety) and are in conformity with the essential requirements and other relevant requirements of the EU's Radio Equipment Directive (RED) (2014/53/EU) and of the UK's Radio Equipment Regulations (RER) (S.I. 2017/1206).

The modules are thus entitled to carry the CE and UKCA compliance marks in their labels and/or accompanying documentation, while the related manufacturer's formal Declarations of Conformity (DoC) are available at the product web page, which is reachable starting from silabs.com.

Note that every final product integrating the BGM270S22A module will need to go through full Safety and EMC assessments, for example in accordance with the ETSI 301 489-x applicable standards. In fact, Safety and EMC tests performed on a bare radio module are generally not supposed to provide confidence of Safety and EMC compliance of the final radio-equipped product as a whole assembly.

Furthermore, it is ultimately the responsibility of the manufacturers to ensure the compliance of their complete final products also with respect to the RF performance. The specific product assembly is likely to have an impact on RF radiated characteristics, when compared to the bare module. Hence, manufacturers should carefully consider RF radiated testing with the final product assembly, especially taking into account the gain of the external antenna if any, and the possible deviations in the PSD, EIRP and spurious emissions measurements, as defined in the ETSI EN 300 328 standard.

OEMs must also consider the importance of applying the compliance mark(s) to a visible location on their final products, on top of the need to writing down and signing the legal manufacturer's Declaration of Conformity for the final product itself. More in general, module customers assume full responsibility with regards to learning the guidelines and meeting the requirements for the compliance in each region where their end-products are marketed.

11.3 FCC - USA

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 standard) when operating with the built-in integral antenna or with an external antenna type as discussed in chapter 11.1.

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 the RF exposure compliance.

In particular, this transmitter meets the Mobile requirements at a distance of 20 cm and above from the human body, in accordance with the evaluation exposed in the RF Exposure test report(s). This transmitter also meets the Portable requirements at distances equal or above those being reported in Table 11.2 Minimum Separation Distances for SAR Evaluation Exemption on page 58.

This transmitter must not be co-located or operated 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-check testing, covering at least max power and spurious emission and band-edge (with all transmitters active, if other co-located radios than the module itself exist on the host), are strongly recommended in order to verify that the full system's compliance is maintained when the module is integrated and active, even with the module having a full modular approval, in accordance with the "Host Product Testing Guidance" in FCC's KDB 996369 D04 Module Integration Guide.

- **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 typically applicable to the final host. The final host will still need to be assessed for compliance to this portion of the rule requirements, if applicable.

- **Manual Information to the End User**

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

  The end user's manual shall include all required regulatory information/warnings as shown in this manual.

- **Host Manufacturer Responsibilities**

  Each host manufacturer is ultimately responsible for the full compliance of their host system as a whole. The final product is supposed to be assessed against all the essential requirements of the FCC rules, such as FCC Part 15 Subpart B, before it can be placed on the US market. This includes re-assuring the compliance of the radio transmitter with the RF and EMF essential requirements of the FCC rules.

  The modular radio transmitter must not be incorporated into any other radio-equipped device or system without retesting for compliance as multi-radio and combined equipment.

  For more details about integrating the Single Modular Transmitter, refer to the following FCC document:

  • KDB 996369 D04 Module Integration Guide

  For a better understanding of the process leading to obtaining a Full Modular Approval, see the following documents instead:

  • KDB 996369 D01 Transmitter Module Equipment Authorization Guide

  • KDB 996369 D02 Frequently Asked Questions and Answers about Modules

  The two documents above provide insight into the FCC requirements from the module manufacturer's perspective, and emphasize why integrators must follow the integration instructions and design guidance, including accounting for the RF Exposure limitations, if any. Should a deviation occur, integrators might need to work with the module manufacturer in order to proceed with a Permissive Change (following a *Change in ID*), in accordance with the FCC guidelines described in the following documents:

  • KDB 178919 D01 Permissive Change Policy

  • KDB 178919 D02 Permissive Change Frequently-Asked Questions

Separation

- To meet the SAR exemption for portable conditions, the minimum separation distances indicated in Table 11.2 Minimum Separation Distances for SAR Evaluation Exemption on page 58 must be maintained between the human body and the radiator (antenna) at all times.
- This transmitter module is tested in a standalone 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, or a reduction in the max output power or in the duty-cycle, might be required for the host, ultimately leading to a Class II Permissive Change, or more rarely to a new grant.
- **Important Note:** In the event that the conditions for the exemption cannot be met, the final product will likely have to undergo additional testing to evaluate the RF Exposure, or go through some re-configuration of the max output power and/or duty-cycle, for the FCC authorization to remain valid, and a Permissive Change will have to be applied. The SAR evaluation (and/or reconfiguration) 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, following a *Change in ID* authorization by the module's original grant holder.

End Product Labeling

The BGM270S22A modules are not labeled with their own FCC ID due to their very small size. Instead, the anti-static bags containing the reels or trays come with a special label displaying the FCC ID. Consequently, the outside of the device into which the module is installed must have a label with a reference to the embedded module. In particular, the final product must be labeled in a visible area with the following:

"Contains Transmitter Module FCC ID: QOQ-GM270S"

or

"Contains FCC ID: QOQ-GM270S"

Final note:

As long as all the conditions in this and all the above chapters are met, further RF testing of the transmitter will not be strictly required. However, still consider the good practice and the FCC strong 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.

11.4 ISED - Canada

This radio transmitter (with IC: 5123A-GM270S) has been approved by *Innovation, Science and Economic Development Canada* (*ISED Canada*, formerly *Industry Canada*) to operate with the built-in integral antenna or with one of the external antenna type(s) listed in 11.1 Qualified Antennas, having the maximum permissible gain as indicated in the table. External antennas of other types not found in this list, or having a peak gain greater than the maximum gain listed, are strictly prohibited for use with this device.

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

1. This device may not cause interference.
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 6.

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.

For Portable use cases, RF exposure or SAR evaluation is not required when the separation distances from the human body are equal or above those reported in Table 11.2.

If the separation distance from the human body is less than the values stated in Table 11.2 Minimum Separation Distances for SAR Evaluation Exemption on page 58, then the OEM integrator is responsible for evaluating the SAR with the end-product, or for the re-configuration of the radio module in the host in terms of lowering the max RF TX power and/or the duty-cycle. A Permissive Change would be required too, under the responsibility of the host manufacturer, following a *Multiple Listing* authorization by the module's original certificate holder.

OEM Responsibilities to Comply with IC Regulations

The BGM270S22A modules have been certified for integration into products only by OEM integrators, under the following conditions:

- The module must be installed in such a way that the intended minimum separation distances are maintained between the radiator (antenna) and all persons at all times. Table 11.2 Minimum Separation Distances for SAR Evaluation Exemption on page 58 indicates the distances in accordance to the use cases.
- The transmitter module must not be co-located or operating in conjunction with any other antenna or transmitter.

Important Note: In the event that the above two conditions cannot be met, the final product will have to undergo additional testing to evaluate the RF Exposure, or go through some re-configuration of the max output power and/or duty-cycle in order for the ISED authorization to remain valid; a Permissive Change will have to be applied too. The RF Exposure evaluation (SAR, or possibly a re-configuration) 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, following a *Multiple Listing* authorization by the module's original certificate holder.

End Product Labeling

The BGM270S22A modules are not labeled with their own IC ID due to their very small size. Instead, the anti-static bags containing the reels or trays come with a special label displaying the IC ID. Consequently, the outside of the device into which the module is installed must have a label with a reference to the embedded module. In particular, the final product must be labeled in a visible area with the following:

“**Contains Transmitter Module IC: 5123A-GM270S**”

or

“**Contains IC: 5123A-GM270S**"

Final notes:

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

As long as all the conditions in this and all the above sections are met, further transmitter testing will not be required. However, the OEM integrators are still responsible for testing their end-products for the fulfillment of any additional compliance requirements, such as digital device emissions, PC peripheral requirements, etc.

ISED (Français)

Le présent émetteur radio (IC: 5123A-GM270S) a été approuvé par *Innovation, Sciences et Développement Économique Canada* (*IS-ED Canada*, anciennement *Industrie Canada*) pour fonctionner avec l'antenne intégrée ou avec l'un des antennes externes énumérés à la section 11.1 Qualified Antennas, ayant le gain maximum permis comme indiqué dans le tableau. Les types d'antenne non inclus dans cette liste, ou ayant un gain de crête supérieur au gain maximal indiqué, sont strictement interdits d'utilisation avec cet appareil.

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

1. L'appareil ne doit pas produire de brouillage;
2. L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Déclaration d'exposition RF

Les exceptions aux limites de l'évaluation SAR sont données dans le numéro 6 de la publication RSS-102.

Le module répond aux exigences pour les cas d'utilisation Mobile lorsque la distance minimale de séparation du corps humain est de 20 cm ou plus, conformément à la (aux) limite(s) exposée(s) dans l'analyse de l'exposition RF.

Pour les cas d'utilisation Portables, l'évaluation de l'exposition RF ou l'évaluation SAR n'est pas requise lorsque les distances de séparation du corps humain sont égales ou supérieures à celles indiquées dans Table 11.2 Minimum Separation Distances for SAR Evaluation Exemption on page 58.

Si la distance de séparation du corps humain est inférieure aux valeurs indiquées dans Table 11.2 Minimum Separation Distances for SAR Evaluation Exemption on page 58, l'intégrateur OEM est responsable de l'évaluation du SAR avec le produit final, ou de la reconfiguration du module radio dans l'hôte en termes de réduction de la puissance RF TX maximale et/ou du rapport cyclique. Une modification permise au matériel serait également nécessaire, sous la responsabilité du fabricant de l'hôte, suite à une autorisation de inscription multiple par le titulaire du certificat du module d'origine.

Responsabilités du fabricant de se conformer à la réglementation IC

Le module a été certifié pour l'intégration dans les produits uniquement par les intégrateurs OEM dans les conditions suivantes:

- Le module doit être installée de manière à maintenir une distance de séparation minimale entre le radiateur (antenne) et toutes les personnes à tout moment. Le tableau 11.2 indique les distances en fonction des cas d'utilisation.
- Le module émetteur ne doit pas être localisé ou fonctionner conjointement avec une autre antenne ou un autre émetteur.

Remarque Importante: au cas où ces deux conditions ci-dessus ne pourraient pas être remplies, le produit final devra être soumis à des tests supplémentaires pour évaluer l'exposition RF, ou passer par une reconfiguration de la puissance de sortie maximale et/ou du rapport cyclique, afin que l'autorisation ISED reste valable; une modification permis au matériel devra également être appliqué. L'évaluation de l'exposition aux radiofréquences (SAR, ou éventuellement une reconfiguration) est sous la responsabilité du fabricant du produit final, ainsi que le modification permis qui peut être effectué avec l'aide de l'organisme de certification des télécommunications du client, après autorisation de inscription multiple par le titulaire de la certification du module.

Étiquetage des produits finis

Les modules BGM270S22A ne sont pas étiquetés avec leur propre IC ID en raison de leur taille. Au lieu de cela, l'étiquette d'emballage contient l'ID IC. Par conséquent, l'extérieur de l'appareil dans lequel le module est installé doit également afficher une étiquette faisant référence au module inclus. Dans ce cas, le produit final doit être étiqueté dans une zone visible avec les éléments suivants:

"**Contient le module transmetteur IC: 5123A-GM270S**"

ou

"**Contient IC: 5123A-GM270S**"

Remarques finales:

L'intégrateur OEM ne doit pas fournir aux utilisateurs finaux d'informations sur la procédure d'installation ou de retrait de ce module RF, ni sur la modification des paramètres liés à la RF dans le manuel d'utilisation du produit final intégrant le module.

Tant que toutes les conditions de cette section et de toutes les sections précédentes sont remplies, aucun test RF supplémentaire de l'émetteur ne sera nécessaire. Toutefois, les intégrateurs OEM restent responsables de tester leurs produits finaux afin de garantir leur conformité à toute exigence de conformité supplémentaire, telle que les émissions des appareils numériques, les exigences relatives aux périphériques PC, etc.

11.5 MIC - Japan

The BGM270S22A module are certified in Japan with following certification number:

- 203-JN1426

While the module manufacturer takes all reasonable steps to prevent non-compliant operation, it is still the end-product manufacturer's responsibility to ensure that a module is configured to meet the compliance requirements, for example in relation to the maximum allowed RF TX power. When applicable, refer to the SDK documentation and/or API reference manuals and/or integration and certification guides, to learn how to configure (limit) the maximum RF TX power for ensuring the compliance of the end-product during regular operation, if need be. Refer as well to the power setting table(s) and measurements in the test report(s) in order to realize the maximum output power levels allowed for the regulatory compliance in Japan.

Manufacturers integrating a certified radio module into their host equipment are supposed to make the Technical Conformity Mark and the certification number visible on the outside of their radio-equipped device, typically in the device's own label. This combination of mark and number, and their relative placement, is depicted in the Figure 11.1 Example of "Giteki" Mark with Placeholder for Actual Certification Number on page 56 below, and depending on the overall size it might also appear among the markings of the radio module (not the case with the BGM270S modules, due to the small size). The Technical Conformity Mark and the certification number must be placed close to the text in the Japanese language which is provided below. This requirement in the Radio Law enables users of the combination of host and radio module to verify if they are actually using a radio-equipped device which is approved for use in Japan.

Certification-related 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" Technical Conformity Mark, together with the actual module's certification number, as shown in the following example figures, must be affixed to an easily noticeable section of the specified radio-enabled host equipment. Notice that such section may be required to contain additional information if the end-device embedding the module is also subject to a Telecom approval.

The manufacturer of the final product is also responsible to provide a Japanese language version of the User Manual and/or Installation Instructions as a companion document coming with the final product when placed on the market in Japan. Such a document will have to mention the integrated radio component and the related certification information.

Figure 11.1. Example of "Giteki" Mark with Placeholder for Actual Certification Number

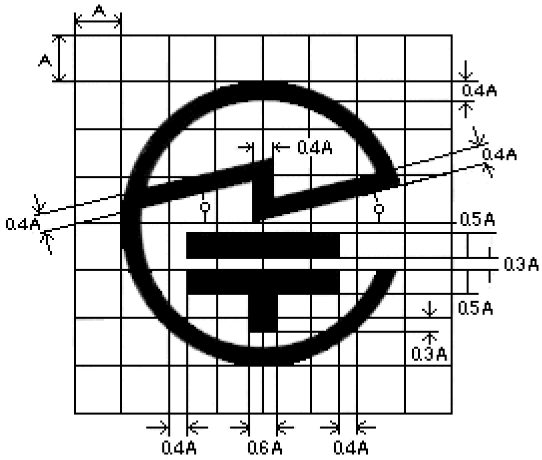


Figure 11.2. Detail of "Giteki" Technical Conformity Mark

11.6 KC - South Korea

The BGM270S22A module have a RF registration for import and use in South Korea.

Registration number is KC ID: R-R-BGT-GM270S

These modules are meant to be integrated into end-products, which then become exempted from doing the RF emission testing, as long as the recommended design guidance is followed, and as long as, where applicable, the approved external antennas are used and any additional transmit power backoff is implemented in accordance to the measurements and configurations seen in the formal test report(s).

EMC testing and any other relevant test applicable to the end-product as a whole, plus appropriate labeling of the end-product, might still be required for the full regulatory compliance in the country.

11.7 RF Exposure and Proximity to Human Body

When using the BGM270S22A modules in an application where the radio-equipped end-product is located close to the human body, the human RF Exposure must be taken into account. FCC, ISED, and CE/UKCA 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 evaluation and/or SAR (Specific Absorption Rate) measurements, and the minimum separation distances between the module's antenna and the human body varies accordingly. The properties of the BGM270S22A modules allow the minimum separation distances detailed in the table below for the SAR measurement exemption in the Portable use cases (less than 20 cm from the human body). These modules are 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

Certification	BGM270S22A
FCC	Integral Antenna: 7 mm External Reference Dipole Antenna: 7 mm
ISED	Integral Antenna: 15 mm External Reference Dipole Antenna: 15 mm
CE / UKCA	The RF exposure should always be evaluated with the end-product when transmitting with power levels higher than 20 mW (13 dBm) while operating at distances closer than 20 cm from the human body. Not to be evaluated with this module, since it is inherently compliant due to the max RF TX output power level being below the exclusion limit at all times.

The exemption minimum distances above, calculated for reference in the full output power use-case, are based on the rules in force at the time of originally writing this data sheet. Even though changes happen rarely, always ensure to apply the rules in force at the time of placing the end-product into the market.

FCC and ISED rules allow use of a module at its max RF TX power in an end-product where the typical separation distance from the human body is smaller than mentioned above, but it requires evaluating the RF Exposure in the final assembly and applying for a *Class 2 Permissive Change* to the FCC and ISED approvals of the module. To proceed with the Permissive Changes, first the module manufacturer should be asked for an authorization to do an FCC's *Change in ID* and an ISED's *Multiple Listing*; then, the new Portable condition will be added to the new parallel grants owned by the end-product manufacturer, for extending the approvals to their unique host under their unique configuration and mode of use.

For those end-products where the embedded module is configured to implement only a single wireless protocol which would allow for the exemption at a shorter distance than the overall minimum distance, there would be no need the evaluate the RF Exposure at such a shorter distance and above. However, a Permissive Change would still be needed as a mean to notify the FCC / ISED of the reason why in the field the module is allowed to operate at a shorter distance than the overall minimum distance seen in the table above.

An example of another use case where the module could operate at a shorter distance than indicated in the table above, without having to do the RF Exposure evaluation / SAR measurement, is when the power or the duty-cycle is reduced during normal operation. However, the new minimum distance for the exemption should be re-calculated, and still a permissive change would be needed to notify the regulators of the new conditions.

For the CE/UKCA compliance, RF Exposure must be considered and evaluated by the OEM in all cases (if any) when the end-product is transmitting at higher power level than mentioned in the table above.

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.

11.8 Bluetooth Qualification

The BGM270S22A modules are qualified as a Core-Controller Configuration design based on the Bluetooth Low Energy Core Specification 6.0, with Design Number (DN) Q375771. To qualify a product that embeds the BGM270S22A as a Core-Complete Configuration Design for Bluetooth Low Energy Core Specification 6.0, the Core-Controller Configuration design (DN Q375771) should be combined with the Core-Host Configuration design (DN Q333162), which combines the BGM270S22A modules with Silicon Labs' Wireless Simplicity Link Layer and Host based on BLE SDK versions 9.0.0 and above, using the Bluetooth SIG's Qualification Workspace tool.

For more information on Bluetooth Qualification, visit docs.silabs.com.

12. Revision History

Revision 1.0

November, 2025

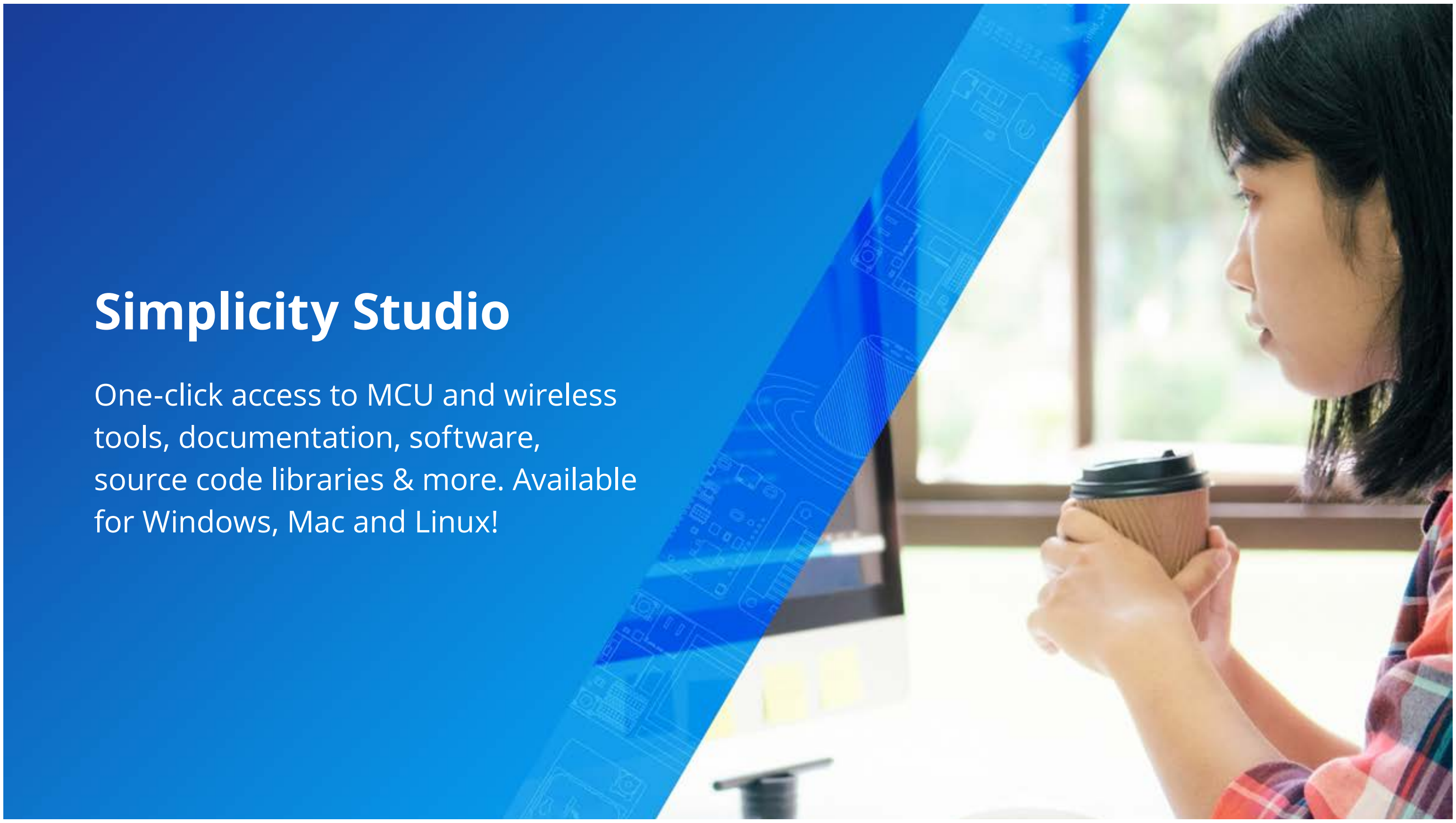
- Updated 4. Electrical Characteristics.

Revision 0.5

August, 2025

The following sections and sub-sections were updated:

- Updated FrontPage.
- Updated 1. Feature List.
- Updated 2. Ordering Information.
- Updated 3. System Overview.
- Updated 4. Electrical Characteristics.
- Updated 5. Reference Diagrams.
- Updated 7. Design Guidelines.
- Updated 8. Package Specifications.
- Updated 9. Soldering Recommendations.
- Updated 10. Tape and Reel.
- Updated 11. Certifications.



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