MGM240L Wireless Gecko Multi-Protocol Lighting Module Data Sheet

The MGM240L is a module designed and built to meet the performance, security, and reliability requirements of line-powered, smart LED lighting products. Based on the EFR32MG24 SoC, it includes a Bluetooth® Low Energy 5.3 implementation, and 802.15.4-based full stacks to enable applications using industry-standard wireless protocols such as Zigbee® and Thread®, for multiprotocol connectivity and for Matter-ready Smart Home connectivity, delivering best-in-class RF performance, CA Title 20 energy consumption compliance, future-proof capability for feature and OTA firmware updates, enhanced security, and a form factor and temperature rating suited for enclosed operation in lightbulb housings.
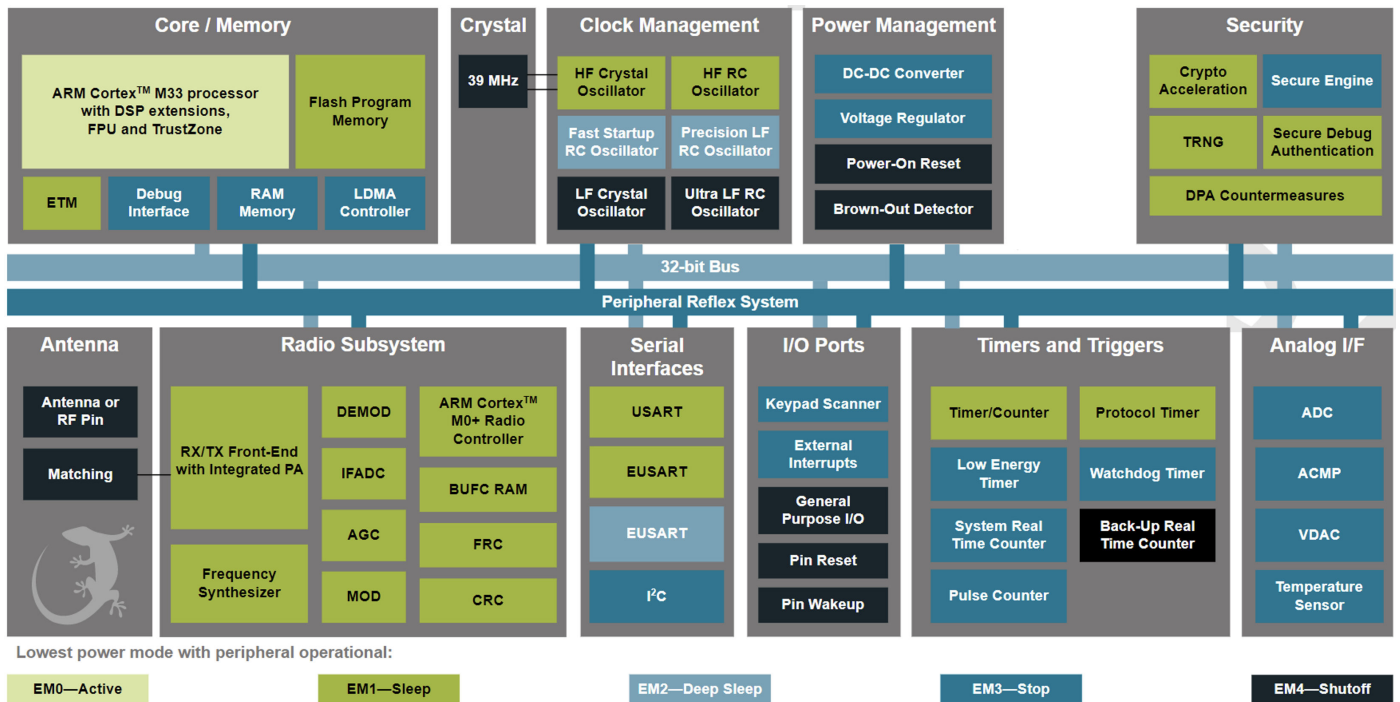
The MGM240L is a complete solution that comes with fully-upgradeable, robust software stacks, world-wide regulatory certifications, advanced development and debugging tools, and support that will simplify and minimize the development cycle and deployment of your product helping to accelerate its time-to-market.

The MGM240L is targeted for key applications that include:

- Smart LED lightbulbs
- Connected lighting

KEY FEATURES

- Multi-protocol connectivity (802.15.4 and Bluetooth Low Energy 5.3)
- PCB Trace antenna
- 10 dBm max TX power
- -105.8 dBm 802.15.4 RX sensitivity
- -98.2 dBm Bluetooth RX sensitivity @ 1 Mbps
- 32-bit ARM® Cortex®-M33 core with 78.0 MHz maximum operating frequency
- Up to 1536 kB of flash and 160 kB of RAM
- Enhanced security features
- Optimal set of MCU peripherals
- 12 GPIO pins
- -40 to 125°C
- 15.5 mm x 22.5 mm (custom form factor)
- AI/ML Hardware Accelerator

Core / Memory

ARM Cortex™ M33 processor with DSP extensions, FPU and TrustZone

Flash Program Memory

ETM | Debug Interface | RAM Memory | LDMA Controller

Crystal

39 MHz

Clock Management

HF Crystal Oscillator | HF RC Oscillator

Fast Startup RC Oscillator | Precision LF RC Oscillator

LF Crystal Oscillator | Ultra LF RC Oscillator

Power Management

DC-DC Converter

Voltage Regulator

Power-On Reset

Brown-Out Detector

Security

Crypto Acceleration | Secure Engine

TRNG | Secure Debug Authentication

DPA Countermeasures

32-bit Bus

Peripheral Reflex System

Antenna

Antenna or RF Pin

Matching

Radio Subsystem

RX/TX Front-End with Integrated PA | DEMOD | ARM Cortex™ M0+ Radio Controller

IFADC | BUFC RAM

AGC | FRC

Frequency Synthesizer | MOD | CRC

Serial Interfaces

USART

EUSART

EUSART

I²C

I/O Ports

Keypad Scanner

External Interrupts

General Purpose I/O

Pin Reset

Pin Wakeup

Timers and Triggers

Timer/Counter | Protocol Timer

Low Energy Timer | Watchdog Timer

System Real Time Counter | Back-Up Real Time Counter

Pulse Counter

Analog I/F

ADC

ACMP

VDAC

Temperature Sensor

Lowest power mode with peripheral operational:

EM0—Active | EM1—Sleep | EM2—Deep Sleep | EM3—Stop | EM4—Shutoff

1. Features

- **Supported Protocols**
  - 802.15.4
    - • Zigbee
      - Open Thread
      - Proprietary
  - Bluetooth Low Energy (BLE) 5.3
  - Bluetooth Mesh
  - Matter-ready Smart Home Connectivity
  - Multi-protocol
- **Wireless System-on-Chip**
  - High Performance 32-bit 78.0 MHz ARM Cortex®-M33 with the following:
    - DSP instruction and floating-point unit for efficient signal processing
    - Up to 1536 kB flash program memory
    - Up to 160 kB RAM data memory
    - 2.4 GHz radio operation
  - Matrix Vector Processor for AI/ML acceleration
- **Receiver Performance**
  - -105.8 dBm sensitivity (1% PER) at 250 kbps O-QPSK DSSS
  - -106.2 dBm sensitivity (0.1% BER) at 125 kbps GFSK
  - -101.9 dBm sensitivity (0.1% BER) at 500 kbps GFSK
  - -98.2 dBm sensitivity (0.1% BER) at 1 Mbps GFSK
  - -95.4 dBm sensitivity (0.1% BER) at 2 Mbps GFSK
- **Current Consumption**
  - 7.7 mA RX current at 250 kbps O-QPSK DSSS
  - 6.6 mA RX current at 1 Mbps GFSK
  - 7.4 mA TX current at 0 dBm
  - 29.8 mA TX current at 10 dBm
  - 47.1 µA/MHz in Active Mode (EM0) at 39.0 MHz
  - 1.9 µA EM2 DeepSleep current (160 kB RAM retention and RTC running from LFRCO)
- **Regulatory Certifications**
  - EU (CE)
  - UK (UKCA)
  - USA (FCC)
  - Canada (ISED)
  - Australia (ACMA)
  - Dominican Republic (INDOTEL)
  - Hong Kong (OFCA)
  - Serbia (RATEL)
  - Israel (MOC)
  - Jordan (TRC)
  - Kuwait (CITRA)
  - Morocco (ANRT)
  - Qatar (CRA)
  - Singapore (IMDA)
  - Bahrain (BTRA)
  - Egypt (NTRA)
  - Japan (MIC)
  - South Korea (KC)

- **Regulatory Certifications (cont.)**
  - China (SRRC)
  - Taiwan (NCC)
  - Thailand (NBTC)
  - Oman (OTRA)
  - Saudi Arabia (CITC)
- **Operating Range**
  - 1.8 to 3.8 V
  - -40 to +125°C
- **Dimensions**
  - 15.5 mm x 22.5 mm (custom form factor)
- **Secure Vault**
  - Hardware Cryptographic Acceleration for AES128/192/256, ChaCha20-Poly1305, SHA-1, SHA-2/256/384/512, ECDSA+ECDH(P-192, P-256, P-384, P-521), Ed25519 and Curve25519, J-PAKE, PBKDF2
  - True Random Number Generator (TRNG)
  - ARM® TrustZone®
  - Secure Boot (Root of Trust Secure Loader)
  - Secure Debug Unlock
  - DPA Countermeasures
  - Secure Key Management with PUF
  - Anti-Tamper
  - Secure Attestation
- **MCU Peripherals**
  - Analog to Digital Converter (IADC), 12-bit @ 1 Msps or 16-bit @ 76.9 ksps
  - 2 × Analog Comparator (ACMP)
  - 2 × Digital to Analog Converter (VDAC)
  - 12 General Purpose I/O pins with output state retention and asynchronous interrupts
  - 8 Channel DMA Controller (LDMA)
  - 16 Channel Peripheral Reflex System (PRS)
  - 3 × 16-bit Timer/Counter with 3 Compare/Capture/PWM channels (TIMER2/3/4)
  - 2 × 32-bit Timer/Counter with 3 Compare/Capture/PWM channels (TIMER0/1)
  - 2 × 32-bit Real Time Counter (SYSRTC/BURTC)
  - 24-bit Low Energy Timer for waveform generation (LETIM-ER)
  - 16-bit Pulse Counter with asynchronous operation (PCNT)
  - 2 × Watchdog Timer (WDOG)
  - 1 × Universal Synchronous/Asynchronous Receiver/Transmitter (USART), supporting UART/SPI/SmartCard (IS7816)/IrDA/I2S
  - 2 × Enhanced Universal Synchronous/Asynchronous Receiver/Transmitter (EUSART) supporting UART/SPI/DALI/IrDA
  - 2 × I2C interface with SMBus support
  - Low-Frequency RC Oscillator with precision mode to replace 32 kHz sleep crystal (LFRCO)
  - Die temperature sensor with +/-1.5 °C accuracy after single-point calibration

2. Ordering Information

Table 2.1. Ordering Information

Ordering Code	Protocol Stack	Max TX Power	Freq Band	Antenna	Flash (kB)	RAM (kB)	GPIO	Temp Range	Pack-aging
MGM240LA22UIF2	• 802.15.4 • Zigbee • Bluetooth 5.3	10 dBm	2.4 GHz	Inverted-F PCB Trace	1536	192	12	-40 to 125 °C	Cut Tape
MGM240LA22UIF2R	• 802.15.4 • Zigbee • Bluetooth 5.3	10 dBm	2.4 GHz	Inverted-F PCB Trace	1536	192	12	-40 to 125 °C	Reel
MGM240LA22VIF2	• 802.15.4 • Zigbee • Thread • Bluetooth 5.3	10 dBm	2.4 GHz	Inverted-F PCB Trace	1536	256	12	-40 to 125 °C	Cut Tape
MGM240LA22VIF2R	• 802.15.4 • Zigbee • Thread • Bluetooth 5.3	10 dBm	2.4 GHz	Inverted-F PCB Trace	1536	256	12	-40 to 125 °C	Reel
MGM240LD22VIF2	• 802.15.4 • Zigbee • Thread • Bluetooth 5.3	10 dBm	2.4 GHz	Inverted-F PCB Trace	1536	256	12	-40 to 125 °C	Cut Tape
MGM240LD22VIF2R	• 802.15.4 • Zigbee • Thread • Bluetooth 5.3	10 dBm	2.4 GHz	Inverted-F PCB Trace	1536	256	12	-40 to 125 °C	Reel

The maximum RF TX power allowed by different regional regulatory authorities may differ from the maximum output power a module can produce. End-product manufacturers must then verify that the module is configured to meet the regulatory limits for each region in accordance with the local rules and the formal certification test reports.

MGM240L modules are pre-programmed with UART XMODEM bootloader.

The modules may be referred to by their product family name (MGM240L), model name (MGM240L) or full ordering code throughout this document.

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3. System Overview

3.1 Block Diagram

The MGM240L module is a highly-integrated, high-performance system with all the hardware components needed to enable 2.4 GHz wireless connectivity and support robust networking capabilities via multiple protocols.

Built around the EFR32MG24 Wireless SoC, the MGM240L includes a built-in PCB trace antenna, an RF matching network (optimized for transmit power efficiency), supply decoupling and filtering components, a 39 MHz reference crystal, and an RF shield. A general block diagram of the module is shown below.
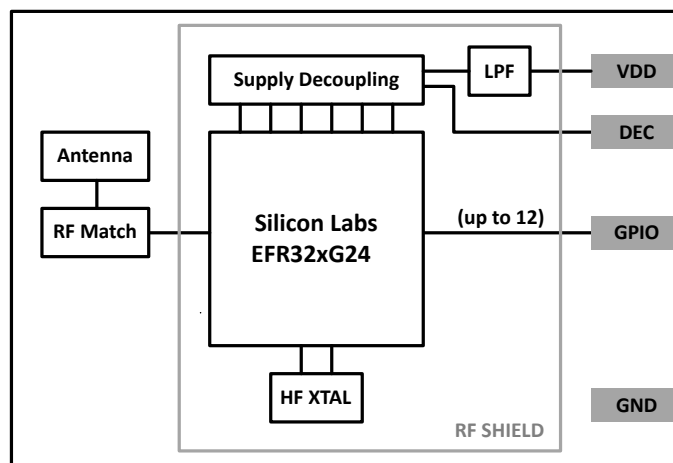

Figure 3.1. MGM240L Block Diagram

3.2 EFR32MG24 SoC

The EFR32MG24 SoC is a Cortex®-M33 running up to 78.0 MHz and up to 1536 kB of Flash and 160 kB of RAM provides resources for demanding applications while leaving room for future growth, a rich set of MCU peripherals, and various clock management and serial interfacing options. See the EFR32xG24 Wireless Reference Manual and the EFR32MG24 Data Sheet for details.

3.3 Antenna

MGM240L modules include a meandered inverted-F antenna (MIFA) with the characteristics seen below.

Table 3.1. Antenna Efficiency and Peak Gain

Parameter	With optimal layout	Note
Efficiency	–2.8 dB to –2.21 dB	Antenna efficiency, gain and radiation pattern are highly dependent on the application PCB layout and mechanical design. Refer to Section 7. Design Guidelines for PCB layout and antenna integration guidelines to achieve optimal performance.
Peak gain	0.64 dBi	

3.4 Power Supply

The MGM240L requires a single nominal supply level of 3.0 V. All the necessary decoupling and filtering components are included in the module. The module can tolerate supply voltage noise of up to 700 mVpp.

The supply voltage is filtered internally in the module with a 100 kHz low-pass filter to guarantee operation across the full supply range of 1.8 to 3.8 V. Additional external filtering is neither required nor recommended as it may cause voltage drops below the minimum level tolerable by the SoC (1.71 V) during transmit bursts.

For typical use cases, the decouple pin (DEC) should be left disconnected.

4. Electrical Specifications

4.1 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 = 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.

4.1.1 Absolute Maximum Ratings

Stresses above 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 above those indicated in the operation listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

Table 4.1. Absolute Maximum Ratings

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Storage temperature range	T_{STG}		-40	—	+125	°C
Voltage on any supply pin	V_{DDMAX}		-0.3	—	3.8	V
Voltage ramp rate on any supply pin	$V_{DDRAMPMAX}$		—	—	1.0	V / µs
DC voltage on any GPIO pin	V_{DIGPIN}		-0.3	—	V_{VDD} + 0.3	V
DC voltage on RESETn pin[1]	V_{RESETn}		-0.3	—	3.8	V
Total current into VDD pin	I_{VDDMAX}	Source	—	—	200	mA
Total current into GND pin	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
Junction Temperature	T_{JMAX}		—	—	+125	°C

Note:
1. The RESETn pin has a pull-up device to the internal VDD supply. For minimum leakage, RESETn should not exceed the voltage at VDD.

4.1.2 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		-40	—	125	°C
VDD operating supply voltage	V_{VDD}		1.8	3.0	3.8	V
HCLK and SYSCLK frequency	f_{HCLK}	VSCALE2, MODE = WS1	—	—	78	MHz
		VSCALE2, MODE = WS0	—	—	40	MHz
		VSCALE1, MODE = WS1	—	—	40	MHz
		VSCALE1, MODE = WS0	—	—	20	MHz
EM01 Group A clock frequency	$f_{EM01GRPACLK}$	VSCALE2	—	—	78	MHz
		VSCALE1	—	—	40	MHz
EM01 Group C clock frequency	$f_{EM01GRPCCLK}$	VSCALE2	—	—	78	MHz
		VSCALE1	—	—	40	MHz
Radio HCLK frequency	f_{RHCLK}	VSCALE2 or VSCALE1	—	39.0	—	MHz

4.1.3 Thermal Characteristics

Table 4.3. Thermal Characteristics

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Thermal Resistance, Junction to Ambient	$THETA_{JA}$	2-Layer PCB, Natural Convection[1]	—	56.6	—	°C/W
		4-Layer PCB, Natural Convection[1]	—	40.3	—	°C/W
Junction to board	Psi_{JB}	2-Layer PCB, Natural Convection[1]	—	38.5	—	°C/W
		4-Layer PCB, Natural Convection[1]	—	25.3	—	°C/W

Note:

1. Measured according to JEDEC standard JESD51-2A. Integrated Circuit Thermal Test Method Environmental Conditions - Natural Convection (Still Air).
2. The device may operate continuously at the maximum allowable ambient T_A rating as long as the absolute maximum T_{JMAX} is not exceeded. For an application with significant power dissipation, the allowable T_A may be lower than the maximum T_A rating. T_A = T_{JMAX} - ($THETA_{JA}$ x PowerDissipation). Refer to the Absolute Maximum Ratings table and the Thermal Characteristics table for T_{JMAX} and $THETA_{JA}$.

4.1.4 MCU current consumption at 3.0 V

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

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Current consumption in EM0 mode with all peripherals disabled	I_{ACTIVE}	78 MHz HFRCO w/ DPLL referenced to 39 MHz crystal, CPU running Prime from flash, VSCALE2	—	47.3	—	µA/MHz
		78 MHz HFRCO w/ DPLL referenced to 39 MHz crystal, CPU running while loop from flash, VSCALE2	—	46.1	—	µA/MHz
		78 MHz HFRCO w/ DPLL referenced to 39 MHz crystal, CPU running CoreMark loop from flash, VSCALE2	—	69.5	—	µA/MHz
		39 MHz crystal, CPU running Prime from flash	—	48.4	—	µA/MHz
		39 MHz crystal, CPU running while loop from flash	—	47.1	—	µA/MHz
		39 MHz crystal, CPU running CoreMark loop from flash	—	69.6	—	µA/MHz
		38 MHz HFRCO, CPU running while loop from flash	—	39.4	62	µA/MHz
Current consumption in EM1 mode with all peripherals disabled	I_{EM1}	78 MHz HFRCO w/ DPLL referenced to 39 MHz crystal, VSCALE2	—	32.2	—	µA/MHz
		39 MHz crystal	—	34.5	—	µA/MHz
		38 MHz HFRCO	—	26.8	49	µA/MHz
Current consumption in EM2 mode, VSCALE0	I_{EM2_VS}	256 kB RAM and full Radio RAM retention, RTC running from LFRCO[1]	—	4.2	9.2	µA
		16 kB RAM and full Radio RAM retention, RTC running from LFRCO[1]	—	1.9	—	µA
		16 kB RAM and full Radio RAM retention, RTC running from LFRCO in precision mode[1]	—	2.8	—	µA
Current consumption in EM3 mode, VSCALE0	I_{EM3_VS}	256 kB RAM and full Radio RAM retention, RTC running from ULFRCO[1]	—	3.9	—	µA
		16 kB RAM and full Radio RAM retention, RTC running from ULFRCO[1]	—	1.5	2.5	µA
Current consumption in EM4 mode	I_{EM4}	No BURTC, no LF oscillator	—	0.26	0.65	µA
		BURTC with LFXO	—	0.64	—	µA

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Current consumption during reset	I_{RST}	Hard pin reset held	—	457	—	µA
Note:						
1. CPU cache retained, EM0/1 peripheral states retained						

4.1.5 Radio Current Consumption with 3.0 V Supply

RF current consumption measured with MCU in EM1, HCLK = 39 MHz, and all MCU peripherals disabled. Unless otherwise indicated, typical conditions are: VDD = 3.0 V. T_A = 25 °C.

Table 4.5. Radio Current Consumption with 3.0 V Supply

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Current consumption in receive mode, active packet reception, VSCALE1, EM1P	I_{RX_ACTIVE}	125 kbit/s, 2GFSK, f = 2.4 GHz	—	7.0	—	mA
		500 kbit/s, 2GFSK, f = 2.4 GHz	—	7.0	—	mA
		1 Mbit/s, 2GFSK, f = 2.4 GHz	—	6.6	—	mA
		2 Mbit/s, 2GFSK, f = 2.4 GHz	—	7.6	—	mA
		802.15.4 receiving frame, f = 2.4 GHz, 802.15.4	—	7.7	—	mA
Current consumption in receive mode, listening for packet, VSCALE1, EM1P	I_{RX_LISTEN}	125 kbit/s, 2GFSK, f = 2.4 GHz	—	7.0	—	mA
		500 kbit/s, 2GFSK, f = 2.4 GHz	—	7.0	—	mA
		1 Mbit/s, 2GFSK, f = 2.4 GHz	—	6.5	—	mA
		2 Mbit/s, 2GFSK, f = 2.4 GHz	—	7.6	—	mA
		802.15.4, f = 2.4 GHz, 802.15.4	—	7.5	—	mA
Current consumption in transmit mode	I_{TX}	f = 2.4 GHz, CW, 10 dBm output power	—	29.8	—	mA
		f = 2.4 GHz, CW, 0 dBm output power	—	7.4	—	mA

4.1.6 RF Transmitter General Characteristics for the 2.4 GHz Band

Unless otherwise indicated, typical conditions are: VDD = 3.0 V. 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[1]	$POUT_{MAX}$	10 dBm	—	10.3	—	dBm
		0 dBm	—	-0.8	—	dBm
Minimum active TX power	$POUT_{MIN}$	10 dBm	—	-30.5	—	dBm
		0 dBm	—	-23.8	—	dBm
Output power step size	$POUT_{STEP}$	0 dBm	—	1.6	—	dB
		10 dBm, -5 dBm < Output power < 0 dBm	—	1.5	—	dB
		10 dBm, 0 dBm < Output power < 10 dBm	—	1.0	—	dB
Output power variation vs supply voltage variation, frequency = 2450 MHz	$POUT_{VAR\_V}$	10 dBm output power with VDD voltage swept from 1.8 V to 3.8 V	—	0.03	—	dB
		0 dBm output power with VDD voltage swept from 1.8 V to 3.8 V	—	0.03	—	dB
Output power variation vs temperature, Frequency = 2450 MHz	$POUT_{VAR\_T}$	10 dBm, (-40 to +125 °C)	—	0.5	—	dB
		0 dBm, (-40 to +125 °C)	—	1.1	—	dB
Output power variation over RF tuning range	$POUT_{VAR\_F}$	10 dBm	—	0.1	—	dB
		0 dBm	—	0.12	—	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 TX Power column of the Ordering Information Table.

4.1.7 RF Transmitter General Characteristics for the 2.4 GHz Band

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

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

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Error vector magnitude per 802.15.4-2011	EVM	10 dBm, Average across frequency, signal is DSSS-OQPSK reference packet	—	3.6	—	% rms
		0 dBm, Average across frequency, signal is DSSS-OQPSK reference packet	—	3.6	—	% rms

4.1.8 RF Receiver General Characteristics for the 2.4 GHz Band

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

Table 4.8. 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

4.1.9 Receiver Characteristics for 802.15.4 DSSS-OQPSK in the 2.4 GHz Band

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

Table 4.9. Receiver Characteristics for 802.15.4 DSSS-OQPSK in the 2.4 GHz Band

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Max usable receiver input level, 1% PER	SAT	Signal is reference signal[1]. Packet length is 20 octets	—	10	—	dBm
Sensitivity, 1% PER	SENS	10 dBm Module, Signal is reference signal. Packet length is 20 octets	—	-105.8	—	dBm
Co-channel interferer rejection, 1% PER	CCR	Desired signal +3 dB above sensitivity limit	—	-0.7	—	dB
High-side adjacent channel rejection, 1% PER. Desired is reference signal at 3 dB above reference sensitivity level[2]	ACR_{P1}	Interferer is reference signal at +1 channel-spacing	—	38.0	—	dB
Low-side adjacent channel rejection, 1% PER. Desired is reference signal at 3 dB above reference sensitivity level[2]	ACR_{M1}	Interferer is reference signal at -1 channel-spacing	—	38.4	—	dB
Alternate channel rejection, 1% PER. Desired is reference signal at 3 dB above reference sensitivity level[2]	ACR_2	Interferer is reference signal at ± 2 channel-spacing	—	49.9	—	dB
Image rejection , 1% PER. Desired is reference signal at 3 dB above reference sensitivity level[2]	IR	Interferer is CW in image band[3]	—	53.5	—	dB
Blocking rejection of all other channels, 1% PER. Desired is reference signal at 3 dB above reference sensitivity level[2]. Interferer is reference signal	BLOCK	Interferer frequency < Desired frequency - 3 channel-spacing	—	55.3	—	dB
		Interferer frequency > Desired frequency + 3 channel-spacing	—	55.1	—	dB
RSSI resolution	$RSSI_{RES}$	-100 dBm to +5 dBm	—	0.25	—	dB
RSSI accuracy in the linear region as defined by 802.15.4-2003	$RSSI_{LIN}$		—	+/-6	—	dB

Note:
1. Reference signal is defined as O-QPSK DSSS per 802.15.4, Frequency range = 2400-2483.5 MHz, Symbol rate = 62.5 ksymbols/s.
2. Reference sensitivity level is -85 dBm.
3. Due to low-IF frequency, there is some overlap of adjacent channel and image channel bands. Adjacent channel CW blocker tests place the Interferer center frequency at the Desired frequency ± 5 MHz on the channel raster, whereas the image rejection test places the CW interferer near the image frequency of the Desired signal carrier, regardless of the channel raster.

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

Unless otherwise indicated, typical conditions are: VDD = 3.0 V. 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 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	10 dBm Module, Signal is reference signal, 37 byte payload[1]	—	-98.2	—	dBm
		10 dBm Module, Signal is reference signal, 255 byte payload[1]	—	-96.6	—	dBm
		10 dBm Module, With non-ideal signals[2] [1]	—	-96.2	—	dBm
Signal to co-channel interferer	C/I_{CC}	(see notes)[1] [3]	—	8.7	—	dB
N ± 1 Adjacent channel selectivity	C/I_1	Interferer is reference signal at +1 MHz offset[1] [4] [3] [5]	—	-5.6	—	dB
		Interferer is reference signal at -1 MHz offset[1] [4] [3] [5]	—	-5.3	—	dB
N ± 2 Alternate channel selectivity	C/I_2	Interferer is reference signal at +2 MHz offset[1] [4] [3] [5]	—	-41.3	—	dB
		Interferer is reference signal at -2 MHz offset[1] [4] [3] [5]	—	-39.6	—	dB
N ± 3 Alternate channel selectivity	C/I_3	Interferer is reference signal at +3 MHz offset[1] [4] [3] [5]	—	-46.1	—	dB
		Interferer is reference signal at -3 MHz offset[1] [4] [3] [5]	—	-46.0	—	dB
Selectivity to image frequency	C/I_{IM}	Interferer is reference signal at image frequency with 1 MHz precision[1] [5]	—	-23.3	—	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] [5]	—	-40.9	—	dB
		Interferer is reference signal at image frequency -1 MHz with 1 MHz precision[1] [5]	—	-5.4	—	dB
Intermodulation performance	IM	n = 3 (see note[6])	—	-17.3	—	dBm

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

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

Unless otherwise indicated, typical conditions are: VDD = 3.0 V. 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 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	10 dBm Module, Signal is reference signal, 37 byte payload[1]	—	-95.4	—	dBm
		10 dBm Module, Signal is reference signal, 255 byte payload[1]	—	-93.9	—	dBm
		10 dBm Module, With non-ideal signals[2][1]	—	-93.6	—	dBm
Signal to co-channel interferer	C/I$_{CC}$	(see notes)[1][3]	—	8.8	—	dB
N ± 1 Adjacent channel selectivity	C/I$_1$	Interferer is reference signal at +2 MHz offset[1][4][3][5]	—	-5.4	—	dB
		Interferer is reference signal at -2 MHz offset[1][4][3][5]	—	-5.8	—	dB
N ± 2 Alternate channel selectivity	C/I$_2$	Interferer is reference signal at +4 MHz offset[1][4][3][5]	—	-42.3	—	dB
		Interferer is reference signal at -4 MHz offset[1][4][3][5]	—	-44.6	—	dB
N ± 3 Alternate channel selectivity	C/I$_3$	Interferer is reference signal at +6 MHz offset[1][4][3][5]	—	-48.7	—	dB
		Interferer is reference signal at -6 MHz offset[1][4][3][5]	—	-50.7	—	dB
Selectivity to image frequency	C/I$_{IM}$	Interferer is reference signal at image frequency with 1 MHz precision[1][5]	—	-22.8	—	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][5]	—	-42.2	—	dB
		Interferer is reference signal at image frequency -2 MHz with 1 MHz precision[1][5]	—	-5.3	—	dB
Intermodulation performance	IM	n = 3 (see note[6])	—	-18.3	—	dBm

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

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

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

Table 4.12. 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	10 dBm Module, Signal is reference signal, 37 byte payload[1]	—	-101.9	—	dBm
		10 dBm Module, Signal is reference signal, 255 byte payload[1]	—	-100.0	—	dBm
		10 dBm Module, With non-ideal signals[2][1]	—	-99.0	—	dBm
Signal to co-channel interferer	C/I$_{CC}$	(see notes)[1][3]	—	2.6	—	dB
N ± 1 Adjacent channel selectivity	C/I$_1$	Interferer is reference signal at +1 MHz offset[1][4][3][5]	—	-7.2	—	dB
		Interferer is reference signal at -1 MHz offset[1][4][3][5]	—	-7.3	—	dB
N ± 2 Alternate channel selectivity	C/I$_2$	Interferer is reference signal at +2 MHz offset[1][4][3][5]	—	-48.3	—	dB
		Interferer is reference signal at -2 MHz offset[1][4][3][5]	—	-50.1	—	dB
N ± 3 Alternate channel selectivity	C/I$_3$	Interferer is reference signal at +3 MHz offset[1][4][3][5]	—	-50.6	—	dB
		Interferer is reference signal at -3 MHz offset[1][4][3][5]	—	-55.4	—	dB
Selectivity to image frequency	C/I$_{IM}$	Interferer is reference signal at image frequency with 1 MHz precision[1][5]	—	-49	—	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][5]	—	-49.4	—	dB
		Interferer is reference signal at image frequency -1 MHz with 1 MHz precision[1][5]	—	-46.8	—	dB

Note:

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

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

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

Table 4.13. 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	10 dBm Module, Signal is reference signal, 37 byte payload[1]	—	-106.2	—	dBm
		10 dBm Module, Signal is reference signal, 255 byte payload[1]	—	-105.8	—	dBm
		10 dBm Module, With non-ideal signals[2][1]	—	-105.3	—	dBm
Signal to co-channel interferer	C/I$_{CC}$	(see notes)[1][3]	—	0.6	—	dB
N ± 1 Adjacent channel selectivity	C/I$_1$	Interferer is reference signal at +1 MHz offset[1][4][3][5]	—	-12.7	—	dB
		Interferer is reference signal at -1 MHz offset[1][4][3][5]	—	-12.8	—	dB
N ± 2 Alternate channel selectivity	C/I$_2$	Interferer is reference signal at +2 MHz offset[1][4][3][5]	—	-53.9	—	dB
		Interferer is reference signal at -2 MHz offset[1][4][3][5]	—	-55.8	—	dB
N ± 3 Alternate channel selectivity	C/I$_3$	Interferer is reference signal at +3 MHz offset[1][4][3][5]	—	-54.8	—	dB
		Interferer is reference signal at -3 MHz offset[1][4][3][5]	—	-60.3	—	dB
Selectivity to image frequency	C/I$_{IM}$	Interferer is reference signal at image frequency with 1 MHz precision[1][5]	—	-53	—	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][5]	—	-53.8	—	dB
		Interferer is reference signal at image frequency -1 MHz with 1 MHz precision[1][5]	—	-52.6	—	dB

Note:

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

4.1.14 High-Frequency Crystal

Table 4.14. High-Frequency Crystal

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Crystal frequency	f_{HFXTAL}		—	39	—	MHz
Initial calibrated accuracy	ACC_{HFXTAL}		—	+/-5	—	ppm
Temperature drift	$DRIFT_{HFXTAL}$	Across specified temperature range	-30	—	30	ppm

4.1.15 GPIO Pins

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

Table 4.15. GPIO Pins

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

4.1.16 Microcontroller Peripherals

The MCU peripherals set available in MGM240L modules includes:

- 12-bit 1 Msps ADC
- Analog Comparators
- 16-bit and 32-bit Timers/Counters
- 24-bit Low Energy Timer for waveform generation
- 32-bit Real Time Counter
- USART (UART/SPI/SmartCards/IrDA/I2S)
- I^{2}C peripheral interfaces
- 12 Channel Peripheral Reflex System

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

To learn which GPIO ports provide access to every peripheral, consult Section 6.3 Analog Peripheral Connectivity and Section 6.4 Digital Peripheral Connectivity.

4.2 Typical Performance Curves

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

4.2.1 Antenna Radiation and Efficiency

Typical MGM240L antenna radiation patterns and efficiency under optimal operating conditions are plotted in the figure below. Antenna gain and radiation patterns have a strong dependence on the size and shape of the application PCB the module is mounted on and, also, on the proximity of any mechanical design to the antenna.

Phi0 Gain cut (dBi)
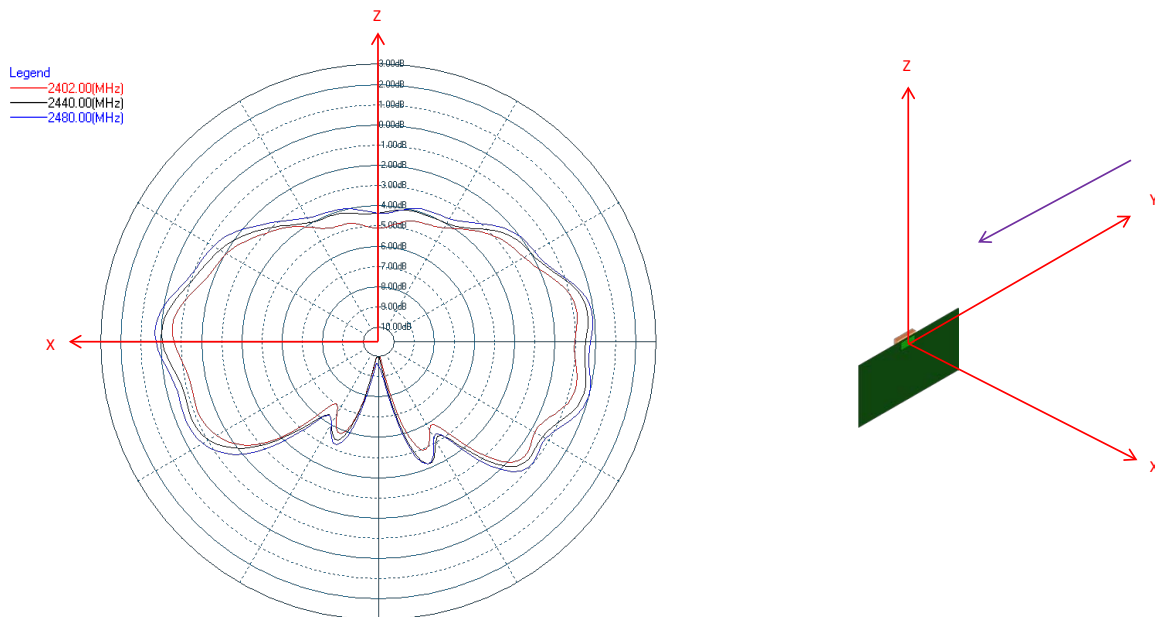
Phi90 Gain cut
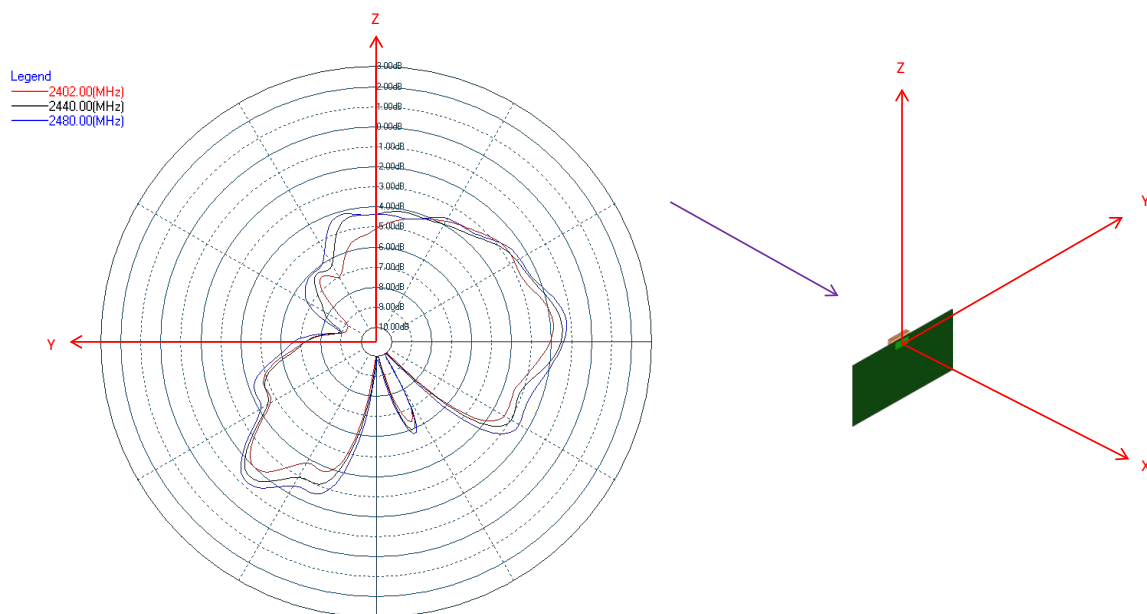
Theta90 Gain cut
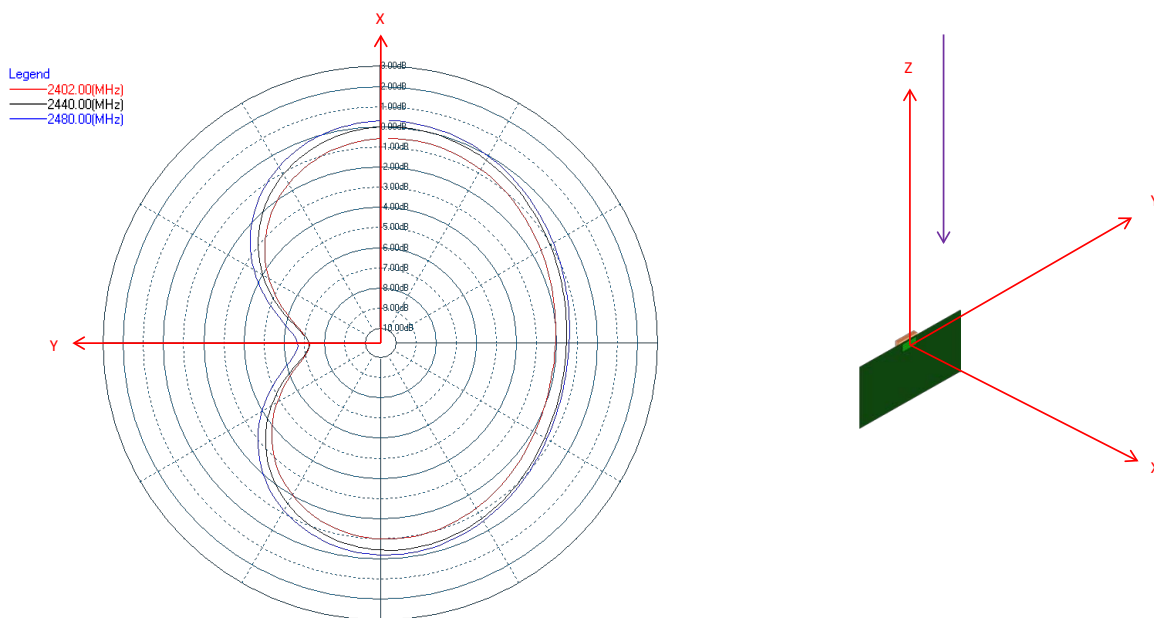
Efficiency (dB), max -2.21dB
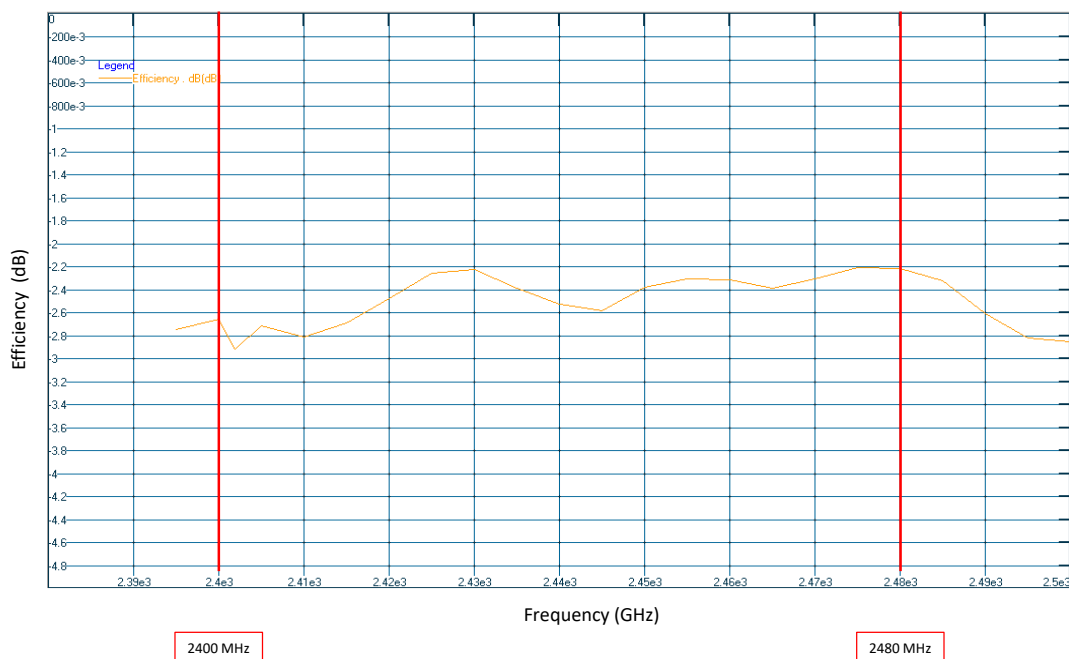
Figure 4.1. Typical 2D Antenna Radiation Patterns and Efficiency

5. Reference Diagrams

A typical application circuit for the MGM240L module is shown below.
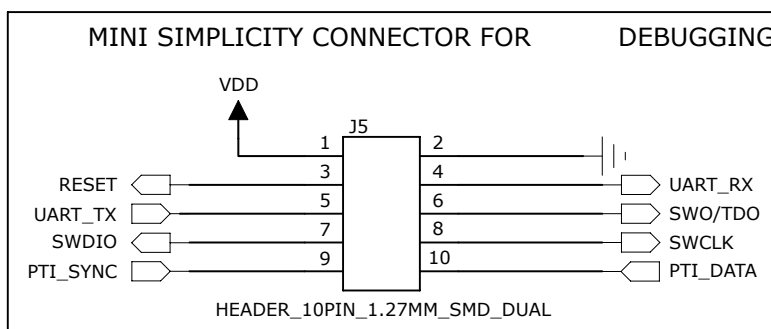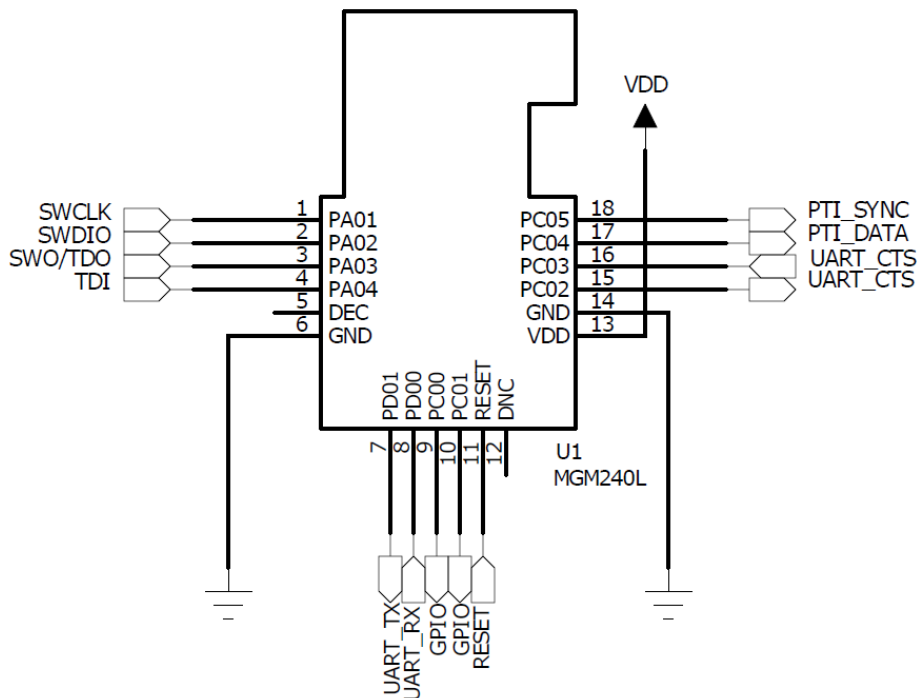
Figure 5.1. MGM240L Application Schematic

Interconnection labels correspond to supported pin functions described in 7.4 Debug, 7.5 Packet Trace Interface (PTI) and 6.4 Digital Peripheral Connectivity.

Placing the module horizontally on the end-application board permits access to all module pins. Placing it vertically restricts access to pins 13 through 18 only. The reference schematic above is applicable for the former case only. Refer to 7. Design Guidelines for more details.

6. Pin Definitions

6.1 Module Pinout
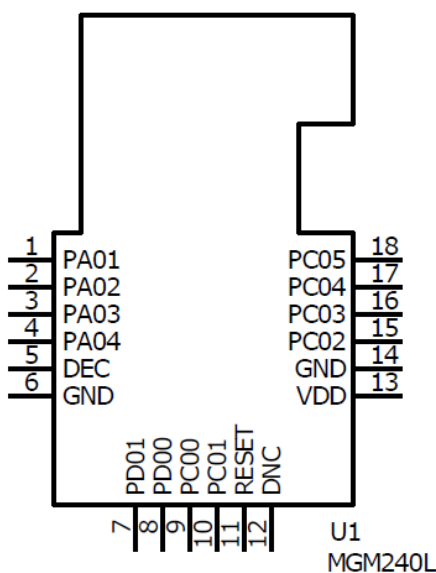
Figure 6.1. MGM240L Lighting Module Pinout

The next table shows the MGM240L pinout and general descriptions for each pin. Refer to 6.2 Alternate Pin Functions, 6.3 Analog Peripheral Connectivity, and 6.4 Digital Peripheral Connectivity for details on functions and peripherals supported by GPIOs.

Table 6.1. MGM240L Lighting Module Pin Definitions

Pin Name	Pin(s)	Description	Pin Name	Pin(s)	Description
PA01	1	GPIO/Debug	PC05	18	GPIO[2]
PA02	2	GPIO/Debug	PC04	17	GPIO[2]
PA03	3	GPIO/Debug	PC03	16	GPIO[2]
PA04	4	GPIO/Debug	PC02	15	GPIO[2]
DEC	5	Decouple[1]	GND	14	Ground
GND	6	Ground	VDD	13	VDD
PD01	7	GPIO	DNC	12	Do Not Connect
PD00	8	GPIO	RST	11	Reset Pin[3]
PC00	9	GPIO	PC01	10	GPIO

Note:
1. Available for powering module through external PMIC. Should be left disconnected typically. Do not use Decouple supply to power external circuitry.
2. Internally terminated with series 56 ohm resistor.
3. Connected to pull-up resistor to VDD internally. External pull-up is not required.

6.2 Alternate Pin Functions

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

Table 6.2. GPIO Alternate Functions Table

GPIO	Alternative Function		
PA01	GPIO.SWCLK		
PA02	GPIO.SWDIO		
PA03	GPIO.SWO	GPIO.TDO	GPIO.TRACEDATA0
PA04	GPIO.TDI	GPIO.TRACECLK	
PC00	GPIO.EM4WU6		
PC01	GPIO.EFP_TX_SDA		
PC02	GPIO.EFP_TX_SCL		
PC05	GPIO.EFP.INT	GPIO.EM4WU7	
PD00	LFXO.LFXTAL_O		
PD01	LFXO.LFXTAL_I	LFXO.LF_EXTCLK	

6.3 Analog Peripheral Connectivity

Many analog resources are routable and can be connected to numerous GPIO's. The table below indicates which peripherals are available 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 available 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		PC		PD	
		EVEN	ODD	EVEN	ODD	EVEN	ODD
ACMP0	ANA_NEG	Yes	Yes	Yes	Yes	Yes	Yes
	ANA_POS	Yes	Yes	Yes	Yes	Yes	Yes
ACMP1	ANA_NEG	Yes	Yes	Yes	Yes	Yes	Yes
	ANA_POS	Yes	Yes	Yes	Yes	Yes	Yes
IADC0	ANA_NEG	Yes	Yes	Yes	Yes	Yes	Yes
	ANA_POS	Yes	Yes	Yes	Yes	Yes	Yes
VDAC0	VDAC_CH0_ABUS_OUTPUT	Yes	Yes	Yes	Yes	Yes	Yes
	VDAC_CH1_ABUS_OUT	Yes	Yes	Yes	Yes	Yes	Yes
VDAC1	VDAC_CH0_ABUS_OUTPUT	Yes	Yes	Yes	Yes	Yes	Yes
	VDAC_CH1_ABUS_OUT	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 avaliable on each GPIO port.

Table 6.4. DBUS Routing Table

Peripheral.Resource	PORT		
	PA	**PC**	**PD**
ACMP0.DIGOUT	Available	Available	Available
ACMP1.DIGOUT	Available	Available	Available
CMU.CLKIN0		Available	Available
CMU.CLKOUT0		Available	Available
CMU.CLKOUT1		Available	Available
CMU.CLKOUT2	Available		
EUSART0.CS	Available		
EUSART0.CTS	Available		
EUSART0.RTS	Available		
EUSART0.RX	Available		
EUSART0.SCLK	Available		
EUSART0.TX	Available		
EUSART1.CS	Available	Available	Available
EUSART1.CTS	Available	Available	Available
EUSART1.RTS	Available	Available	Available
EUSART1.RX	Available	Available	Available
EUSART1.SCLK	Available	Available	Available
EUSART1.TX	Available	Available	Available
FRC.DCLK		Available	Available
FRC.DFRAME		Available	Available
FRC.DOUT		Available	Available
HFXO0.BUFOUT_REQ_IN_ASYNC	Available		
I2C0.SCL	Available	Available	Available
I2C0.SDA	Available	Available	Available
I2C1.SCL		Available	Available
I2C1.SDA		Available	Available
KEYSCAN.COL_OUT_0	Available	Available	Available
KEYSCAN.COL_OUT_1	Available	Available	Available
KEYSCAN.COL_OUT_2	Available	Available	Available
KEYSCAN.COL_OUT_3	Available	Available	Available
KEYSCAN.COL_OUT_4	Available	Available	Available

Peripheral.Resource	PORT		
	PA	PC	PD
KEYSCAN.COL_OUT_5	Available	Available	Available
KEYSCAN.COL_OUT_6	Available	Available	Available
KEYSCAN.COL_OUT_7	Available	Available	Available
KEYSCAN.ROW_SENSE_0	Available		
KEYSCAN.ROW_SENSE_1	Available		
KEYSCAN.ROW_SENSE_2	Available		
KEYSCAN.ROW_SENSE_3	Available		
KEYSCAN.ROW_SENSE_4	Available		
KEYSCAN.ROW_SENSE_5	Available		
LETIMER0.OUT0	Available		
LETIMER0.OUT1	Available		
MODEM.ANT0	Available	Available	Available
MODEM.ANT1	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		
MODEM.DIN	Available		
MODEM.DOUT	Available		
PCNT0.S0IN	Available		
PCNT0.S1IN	Available		
PRS.ASYNCH0	Available		
PRS.ASYNCH1	Available		
PRS.ASYNCH2	Available		
PRS.ASYNCH3	Available		
PRS.ASYNCH4	Available		
PRS.ASYNCH5	Available		
PRS.ASYNCH6		Available	Available

Peripheral.Resource	PORT		
	PA	PC	PD
PRS.ASYNCH7		Available	Available
PRS.ASYNCH8		Available	Available
PRS.ASYNCH9		Available	Available
PRS.ASYNCH10		Available	Available
PRS.ASYNCH11		Available	Available
PRS.ASYNCH12	Available		
PRS.ASYNCH13	Available		
PRS.ASYNCH14	Available		
PRS.ASYNCH15	Available		
PRS.SYNCH0	Available	Available	Available
PRS.SYNCH1	Available	Available	Available
PRS.SYNCH2	Available	Available	Available
PRS.SYNCH3	Available	Available	Available
RAC.LNAEN	Available	Available	Available
RAC.PAEN	Available	Available	Available
TIMER0.CC0	Available	Available	Available
TIMER0.CC1	Available	Available	Available
TIMER0.CC2	Available	Available	Available
TIMER0.CDTI0	Available	Available	Available
TIMER0.CDTI1	Available	Available	Available
TIMER0.CDTI2	Available	Available	Available
TIMER1.CC0	Available	Available	Available
TIMER1.CC1	Available	Available	Available
TIMER1.CC2	Available	Available	Available
TIMER1.CDTI0	Available	Available	Available
TIMER1.CDTI1	Available	Available	Available
TIMER1.CDTI2	Available	Available	Available
TIMER2.CC0	Available		
TIMER2.CC1	Available		
TIMER2.CC2	Available		
TIMER2.CDTI0	Available		
TIMER2.CDTI1	Available		
TIMER2.CDTI2	Available		
TIMER3.CC0		Available	Available
TIMER3.CC1		Available	Available
TIMER3.CC2		Available	Available

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

7. Design Guidelines

7.1 Module Placement

The MGM240L should be placed at the edge of the end-application PCB as seen below. The copper clearance area under the antenna must be void of traces or components to prevent parasitic loading or undesired coupling of signals or noise to the antenna. The width of the GND pour on the end-application PCB should match at least the width of the antenna (e.g. 12.5 mm or greater) to have negligible effect on antenna performance.
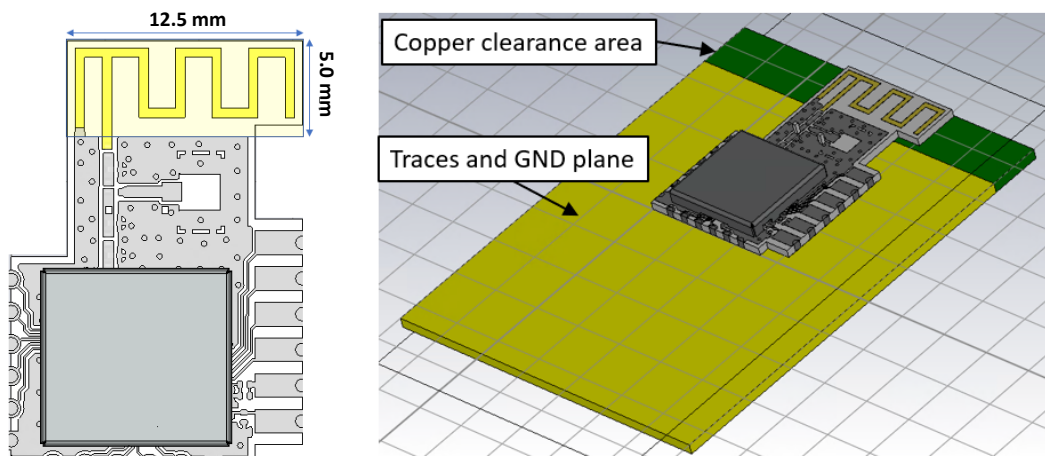
Figure 7.1. Inverted-F Antenna Clearance

MGM240L modules do not support the use of an external, alternative antenna. The U.FL connector land pattern on the top layer of the module should not be used, populated or tampered with.

Figure 7.2 Horizontal Mounting on page 30 illustrates the placement recommended when mounting the module horizontally to an end-application PCB. It also shows examples of layout cases that will result in severe RF performance degradation for the module.
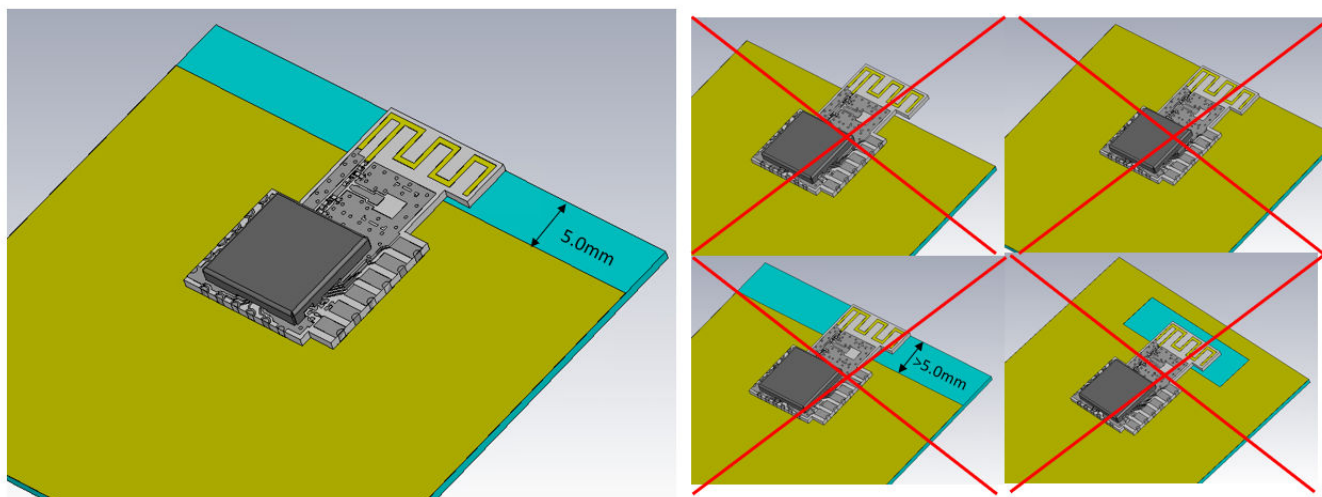
Figure 7.2. Horizontal Mounting

Vertical mounting provides mechanical design flexibility that could be advantageous for certain applications. Figure 7.3 Vertical Mounting on page 31 illustrates the placement recommended when mounting the module vertically to an end-application PCB. It also shows layout examples that will result in severe RF performance degradation for the module.

Notice that vertical mounting limits the number of pins available to interact with the module to six (VDD, GND and four GPIOs) which may be suitable for specific use cases only (e.g. to generate PWM outputs for LED control). The trade offs of vertical mounting should be carefully considered prior to choosing such arrangement.
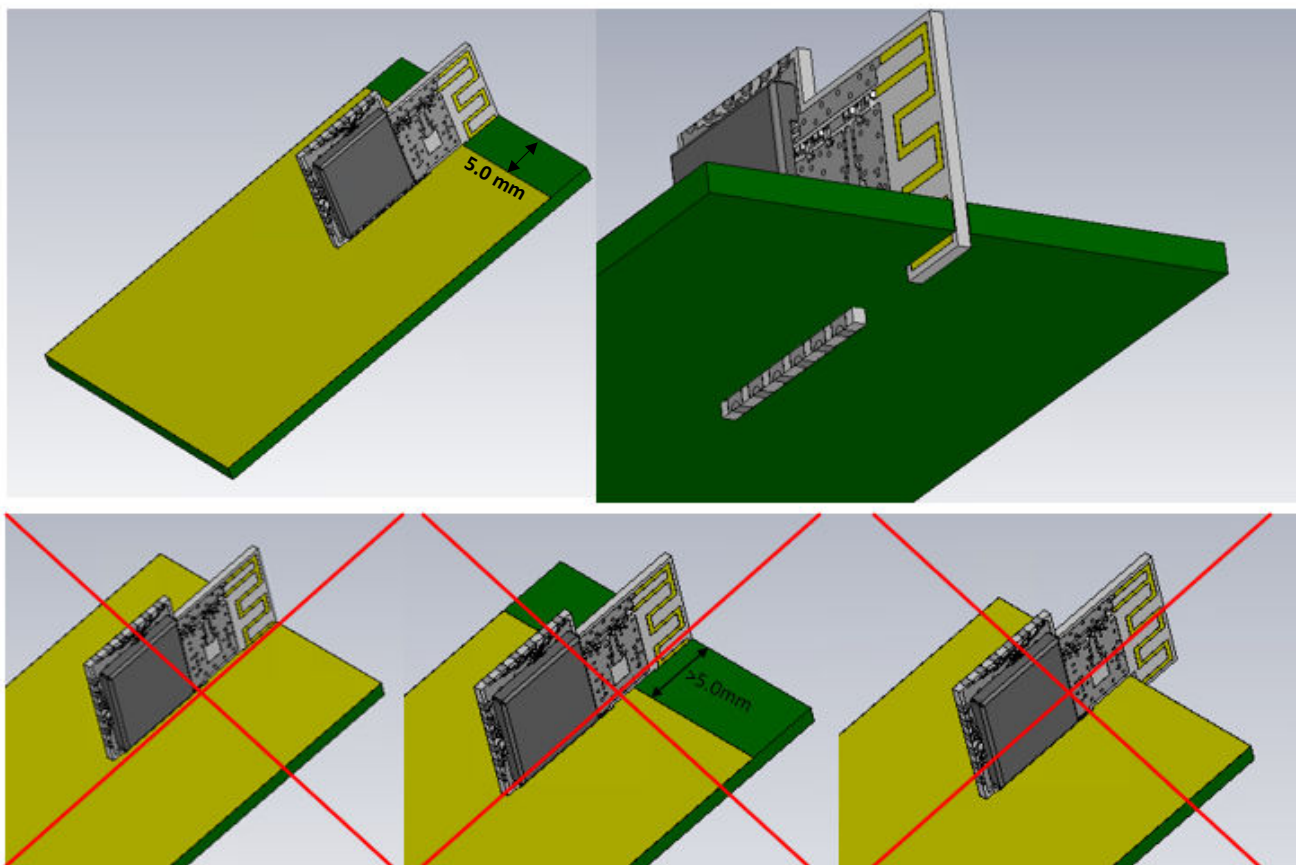
Figure 7.3. Vertical Mounting

7.2 Antenna Optimization

Due to the nature of PCB trace antennas, the MGM240L is sensitive to the thickness of the application PCB on which it is mounted, as well as to any plastics, metal or dielectric materials in close proximity to the antenna. The layout guide shown in Figure 7.2 Horizontal Mounting on page 30 is optimal for an application board thickness of 0.8 mm. The figure below shows antenna efficiency vs. host board size.
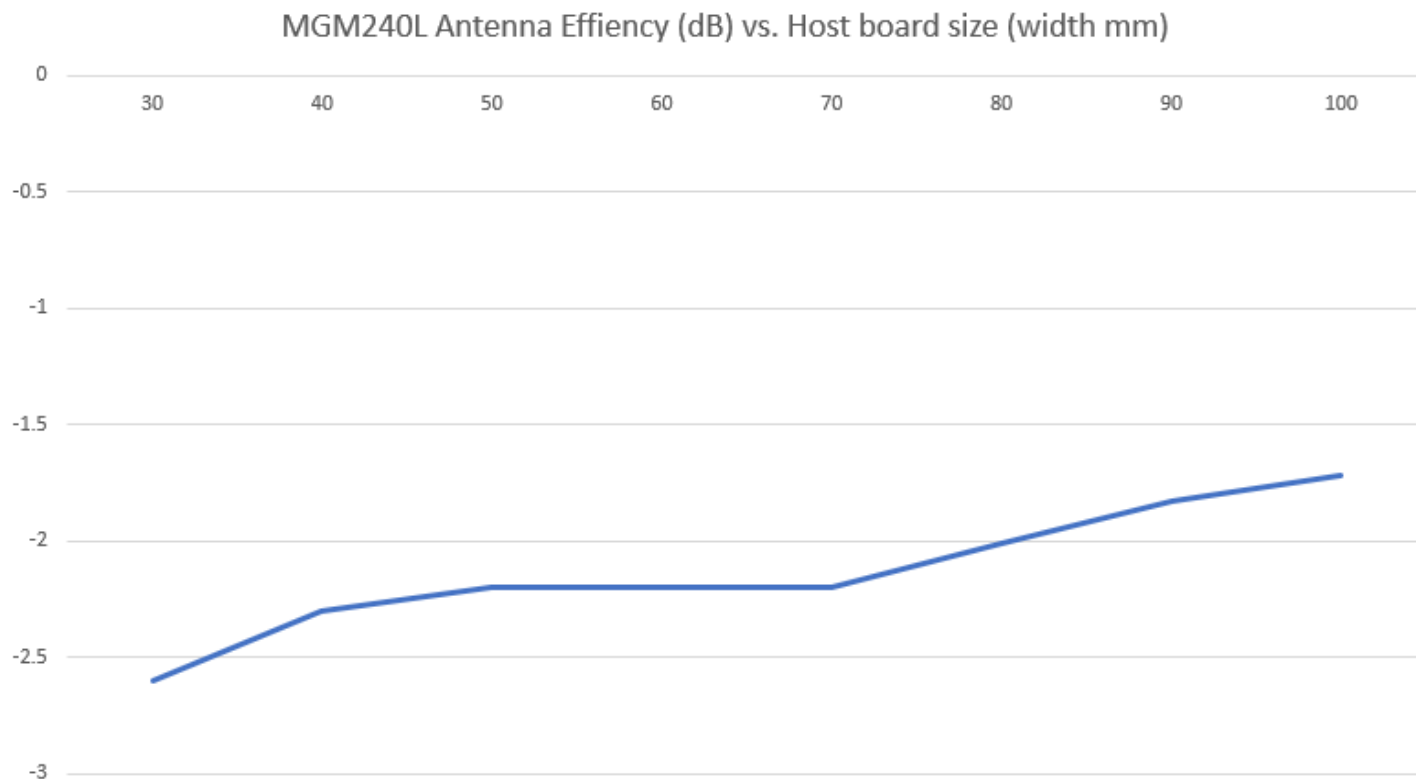
Figure 7.4. Antenna Efficiency vs. Host Board Size

For cases where the application board is of a thickness different than the optimal, the impedance and performance of the antenna may be experimentally adjusted by

1. Cutting out the end-application PCB's FR4 material that is under the antenna, or by
2. Adjusting the separation between the lower side of the antenna and the edge of the application board's GND plane underneath the module

Impedance and performance optimization can be verified by measuring RSSI or radiated output power until either is maximized.

7.3 Reset

The MGM240L can be reset by pulling the RESET line low, by the internal watchdog timer, or by software command. All three methods are applicable when the module is mounted horizontally on a given end-application board and, hence, all module pins are accessible. When mounted vertically, however, only the second and third methods apply.

The reset state does not provide power saving functionality and it is not recommended as a means to conserve power.

7.4 Debug

See *AN958: Debugging and Programming Interfaces for Custom Designs*.

The MGM240L supports hardware debugging via 4-pin JTAG or 2-pin serial-wire debug (SWD) interfaces. It is recommended to expose the debug pins in your own hardware design for firmware update and debug purposes. The table below lists the required pins for JTAG and SWD debug interfacing, which are also presented in 6.2 Alternate Pin Functions.

If JTAG interfacing is enabled, the module must be power cycled to return to a SWD debug configuration if necessary.

Table 7.1. Debug Pins

Pin Name	Pin Number	JTAG Signal	SWD Signal	Comments
PA04	4	TDI	N/A	This pin is disabled after reset. Once enabled the pin has a built-in pull-up.
PA03	3	TDO	N/A	This pin is disabled after reset.
PA02	2	TMS	SWDIO	Pin is enabled after reset and has a built-in pull-up.
PA01	1	TCK	SWCLK	Pin is enabled after reset and has a built-in pull-down.

7.5 Packet Trace Interface (PTI)

The MGM240L integrates a true PHY-level packet trace interface (PTI) peripheral that can capture packets non-intrusively to monitor and log device and network traffic without burdening processing resources in the module's SoC. The PTI generates two output signals that can serve as a powerful debugging tool, especially in conjunction with other hardware and software development tools available from Silicon Labs. The PTI_DATA and PTI_SYNC signals can be accessed through any GPIO on ports C and D (see FRC.DOUT and FRC.DFRAME peripheral resources in Table 6.4 DBUS Routing Table on page 26).

8. Package Specifications

8.1 Package Outline
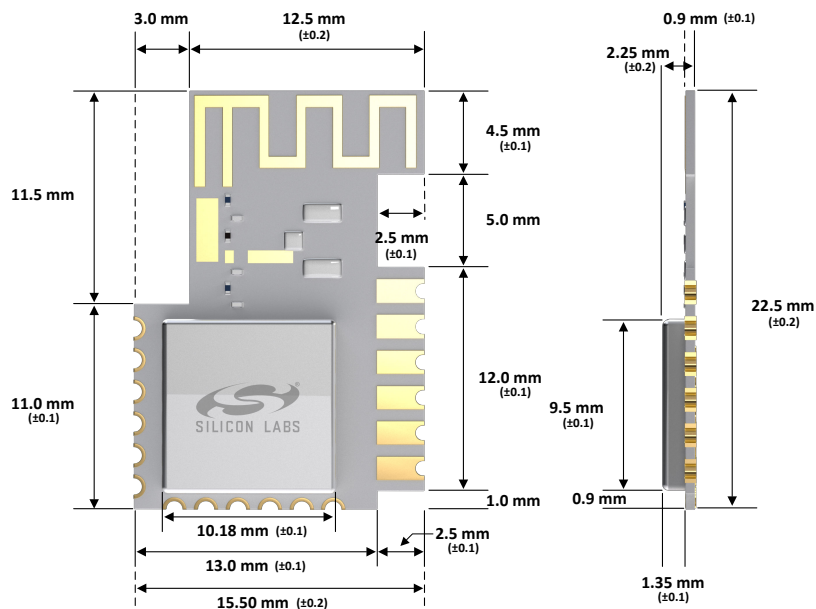
Figure 8.1. Top and Side Views
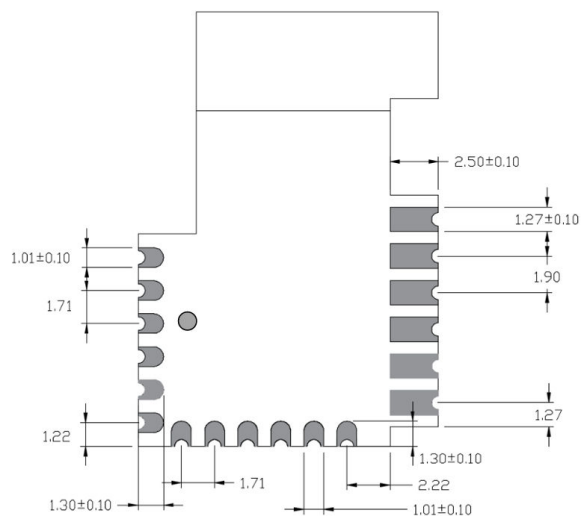
Figure 8.2. Bottom View

NOTE: Solder paste thickness adds 0.1 ± 0.05 mm to overall module height

8.2 PCB Land Pattern
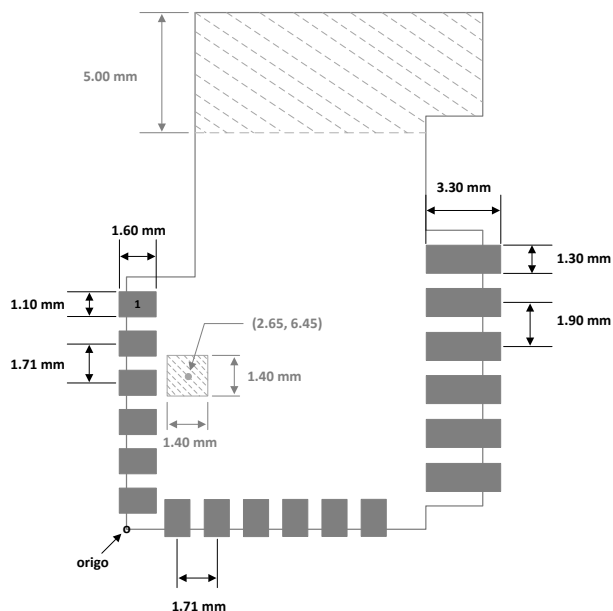
Figure 8.3. Recommended Module PCB Land Pattern

Table 8.1. Pad Sizing and Location

Pad Number	X Coordinate	Y Coordinate	Pad Dimensions
1	0.5	9.78	1.1 x 1.6
6	0.5	1.23	1.1 x 1.6
7	2.23	0.5	1.1 x 1.6
12	10.78	0.5	1.1 x 1.6
13	14.67	2.25	1.3 x 3.3
18	14.67	11.75	1.3 x 3.3

Note:

1. All dimensions in mm unless otherwise stated.

2. X and Y coordinates are specified relative to origo at indicated package corner in the figure above.

3. The module has a test point for VDD on the bottom layer at (X=2.65, Y=6.45). A keep-out area of 1.4 mm x 1.4 mm around this point is recommended to prevent the possibility of a short circuit.

8.3 Marking

The figure below shows the module markings engraved on the RF shield.

Figure 8.4. MGM240L Top Marking

Mark Description

The package marking consists of:
- MGM240Lxxxxxxx - Part number designation
- Model: MGM240L - Model number designation
- QR Code: YYWWMMABCDE
  - YY – Last two digits of the assembly year.
  - WW – Two-digit workweek when the device was assembled.
  - MMABCDE – Silicon Labs unit code
- YYWWTTTTTT
  - YY – Last two digits of the assembly year.
  - WW – Two-digit workweek when the device was assembled.
  - TTTTTT – Manufacturing trace code. The first letter is the device revision.
- Certification-related information (such as the CE Mark, FCC and IC IDs, etc.) is being engraved on the grayed out area, or printed on the back side of the module (silkscreen), according to regulatory body requirements.

9. Soldering Recommendations

It is recommended that final PCB assembly of the MGM240L 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

All dimensions are given in mm unless otherwise indicated.
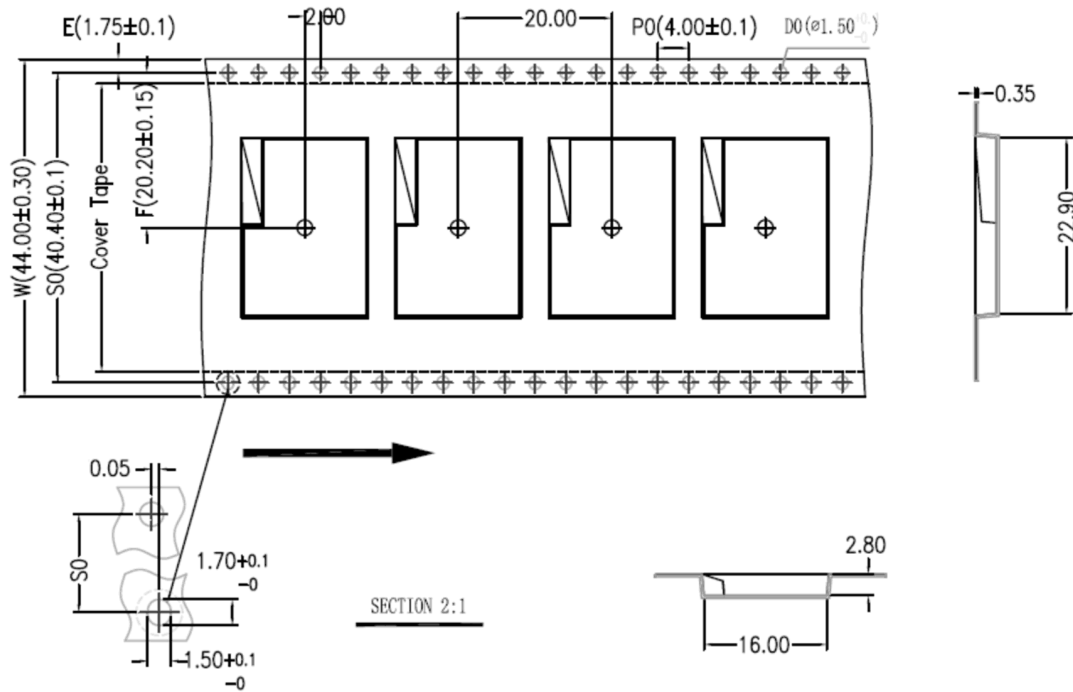
Figure 10.1. Carrier Tape Dimensions
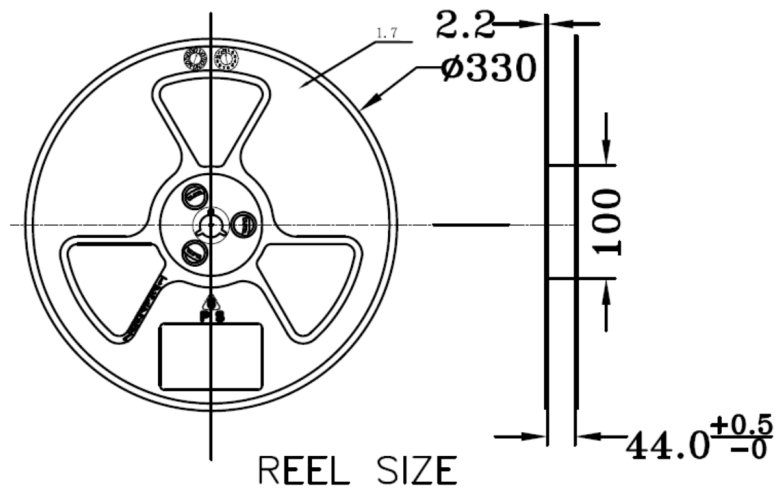
Figure 10.2. Reel Dimensions

11. Certifications

This section details the certification status of the module with regards to regional regulatory radio approvals. Where applicable, the status with the industrial qualifications against the specifications of the supported wireless standards is given too.

The address of the module manufacturer (technology owner) and certification applicant is:

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

The MGM240L modules have brand name of "Silicon Labs".

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

11.1 CE and UKCA - EU and UK

The MGM240L modules have been tested against the relevant harmonized/designated standards 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).

Please notice that every end-product integrating a MGM240L module will need to perform the radio EMC tests on the whole assembly, according to the ETSI 301 489-x relevant standards.

Furthermore, it is ultimately the responsibility of the manufacturers to ensure the compliance of their end-products as a whole. The specific product assembly is likely to have an impact to RF radiated characteristics, when compared to the bare module. Hence, manufacturers should carefully consider RF radiated testing with the final product assembly and the possible deviations in the PSD, EIRP and spurious emissions measurements, as defined in the ETSI EN 300 328 standard.

The modules are entitled to carry the CE and UKCA Marks, and a formal Declaration of Conformity (DoC) is available at the product web page which is reachable starting from https://www.silabs.com/.

11.2 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.

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 13.5 mm in the case of 802.15.4, and 12.5 mm in the case of Bluetooth Low Energy. These distances are reported for convenience also in Table 11.1 Minimum Separation Distances for SAR Evaluation Exemption 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, even with a module having a full modular approval, in accordance with 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 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 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 final product which integrates this module.

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

- **Host Manufacturer Responsibilities**

  Host manufacturers are ultimately responsible for the full compliance of their host system. 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.

Separation

- To meet the SAR exemption for portable conditions, the minimum separation distance indicated in Table 11.1 Minimum Separation Distances for SAR Evaluation Exemption on page 43 must be maintained between the human body and the radiator (antenna) at all times. In particular, in the use case of 802.15.4 the minimum distance must be 13.5 mm, whereas in the use case of Bluetooth Low Energy the minimum distances must be 12.5 mm.
- 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 in order 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 MGM240L modules are labeled with their own FCC ID. In all those cases when the FCC ID is not visible after 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 product must be labeled in a visible area with the following:

"Contains Transmitter Module FCC ID: QOQ-MGM240L"

or

"Contains FCC ID: QOQ-MGM240L"

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.

11.3 ISED - Canada

This radio transmitter (IC: 5123A-MGM240L) has been approved by *Innovation, Science and Economic Development Canada (ISED Canada, formerly Industry Canada*) to operate with the built-in integral antenna.

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; 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.

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 15.0 mm in the case of 802.15.4, and 15.0 mm in the case of Bluetooth Low Energy.

If the separation distance from the human body is less than the values stated above, which are also reported in Table 11.1 Minimum Separation Distances for SAR Evaluation Exemption on page 43 for convenience, 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 original module's certificate holder.

OEM Responsibilities to comply with IC Regulations

The MGM240L modules have 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 the above 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 grant holder.

End Product Labeling

The MGM240L modules are labeled with their own IC ID. In all those cases when the IC ID is not visible after a 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 product must be labeled in a visible area with the following:

"**Contains Transmitter Module IC: 5123A-MGM240L**"

or

"**Contains IC: 5123A-MGM240L"**

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.

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

ISED (Français)

Le présent émetteur radio (IC: 5123A-MGM240L) a été approuvé par Innovation, Sciences et Développement Économique Canada (IS-ED Canada, anciennement Industrie Canada) pour fonctionner avec l'antenne intégrée.

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 susceptibled'en compromettre le fonctionnement.

Déclaration d'exposition RF

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

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'exposition aux fréquences radio ou l'évaluation du SAR n'est pas nécessaire lorsque les distances de séparation du corps humain sont égales ou supérieures à 15.0 mm pour le dans le cas de 802.15.4, et à 15.0 mm dans le cas de Bluetooth Low Energy.

Si la distance de séparation du corps humain est inférieure aux valeurs indiquées ci-dessus, également indiquées dans le tableau 11.2 pour des raisons de commodité, 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 permissive serait également nécessaire, sous la responsabilité du fabricant de l'hôte, suite à une autorisation de cotation 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:

• L'antenne doit être installée de manière à maintenir une distance de séparation minimale, comme indiqué ci-dessus, entre le radiateur (antenne) et toutes les personnes.
• 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 conditions 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 permissive 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 changement permissif qui peut être effectué avec l'aide de l'organisme de certification des télécommunications du client, après autorisation de cotation multiple par le titulaire de la certification du module.

Étiquetage des produits finis

Les modules MGM240L est étiqueté avec son propre ID de certification.Si l'ID de certification n'est pas visible lorsque le module est installé dans un autre appareil, 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-MGM240L**"

ou

"**Contient IC: 5123A-MGM240L"**

L'intégrateur OEM doit être conscient de ne pas fournir à l'utilisateur final 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.

Tant que toutes les conditions ci-dessus sont remplies, aucun test supplémentaire de l'émetteur ne sera nécessaire. Toutefois, l'intégrateur OEM reste responsable de l'essai de son produit final pour déterminer les exigences de conformité supplémentaires requises avec ce module installé (par exemple, émissions d'appareils numériques, exigences relatives aux périphériques PC, etc.)

11.4 Human Body Proximity

When using the MGM240L 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/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 and 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 MGM240L modules allow for the minimum separation distances detailed below in Table 11.1 Minimum Separation Distances for SAR Evaluation Exemption on page 43 for the 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 11.1. Minimum Separation Distances for SAR Evaluation Exemption

Certification	802.15.4	Bluetooth LE
FCC	13.5 mm	12.5 mm
ISED	15.0 mm	15.0 mm
CE	The RF exposure should always be evaluated with the end-product when transmitting with power levels higher than 20 mW (13 dBm).	

The exemption distances above, calculated for reference in the full output power use case, are based on the rules in force at the time of writing this datasheet. Even though changing rarely, always ensure to apply the rules in force at the time of placing a product in the market.

In the cases of FCC and ISED, it is allowed to use the module at its max RF TX power in end-products 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. In order to proceed with the permissive change, module manufacturer should be asked for an authorization to proceed first with a Change in ID and/or Multiple Listing, so that the new portable condition will be added to the new parallel grant owned by the end-product manufacturer.

For the CE/UKCA compliance, RF Exposure must be considered and evaluated for the end-product in all cases, if any, when transmitting at more than the power level indicated 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.

11.5 MIC - Japan

The MGM240L modules are certified in Japan with certification number 203-JN1272.

Manufacturers integrating a certified radio module into their host equipment are supposed to make the compliance mark and the certification number visible on the outside of their radio-equipped device, typically in the device's label. This combination of mark and number, and their relative placement, is depicted in the example Figure 11.1, and depending on the overall size it might also appear among the top shield markings of the radio module. The compliance mark and certification number must be placed close to the text in the Japanese language which is provided below. This requirement 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-equipped 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" Mark shown in the following figures must be affixed to an easily noticeable section of the specified radio-enabled host equipment. Note 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
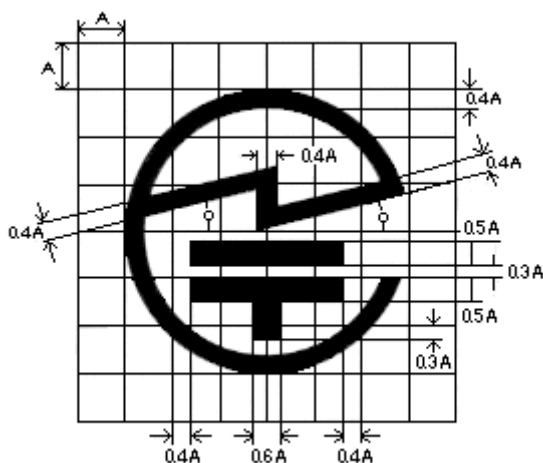
Figure 11.2. Detail of GITEKI Compliance Mark

11.6 China (SRRC)

Note: This certification is pending.

The MGM240L module has a full modular radio type approval for re-use by the OEM integrators:

Certificate number: TBD

CMIIT ID: TBD

Note for modules with a full modular approval: every end-product integrating the module must be labeled with the following statement, or alternatively the statement will have to go to the end-product's user manual:

本设备包含一个无线电发射器模块，型号核准代码为: CMIIT ID: TBD

(Translation: This equipment contains a radio transmitter module with type approval code: CMIIT ID: TBD

·中国· **– SRRC**

MGM240L 模塊具有完整的模塊化認證，可供 OEM 集成商重複使用:

认证编号: TBD

CMIIT ID: TBD

具有完全模塊化批准的模塊注意事項：以下聲明必須出現在嵌入模塊的最終產品的標籤和/或用戶手冊中：

本设备包含一个无线电发射器模块，型号核准代码为: CMIIT ID: TBD

11.7 South Korea (KC)

The MGM240L modules have an RF registration for import and use in South-Korea.

Registration number is KC ID: R-R-BGT-MGM240L

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.

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.

11.8 Taiwan (NCC)

The MGM240L is certified in Taiwan with NCC certification number of CCAO23Y10010T1.

MGM240L 模塊在台灣通過了 NCC 認證編號 CCAO23Y10010T1 的認證。

Manufacturers are required to mark their end-products with the following sentence: "This product contains a radio frequency module with certification number CCAO23Y10010T1."

"系統製造商應在平台上放置如下聲明："本產品包含認證號為CCAO23Y10010T1的射頻模塊。"

Note: The outer packaging of the final product must also be marked with the NCC conformity mark by the manufacturer

注意：最終產品的外包裝也必須由製造商打上NCC合格標誌

Additionally, the final product will have to be listed in the NCC database of approved radio-equipped devices. Consequently, the end manufacturer is also supposed to contact the certification house that originally released the full modular approval and apply for the registration of their device under the above certification number (fees might apply.)

此外，該平台必須列在 NCC 批准的無線電設備數據庫中。因此，平台製造商還應聯繫最初頒發全模塊化批准的認證機構，併申請在上述認證編號下註冊其設備（可能需要付費）。

NCC Statement
For low-power radio frequency equipment that has been certified, companies, firms, or users are not allowed to change the frequency, increase the power, or change the characteristics and functions of the original design without further NCC approval. The use of low-power radio frequency equipment shall not affect flight safety and interfere with legal communications. If interference is found, it shall be immediately stopped, and the equipment can be brought back into use only after it has been improved, so that interference is found no more. The aforementioned legal communication refers to radio communications operating in accordance with the provisions of the Telecommunications Management Act. Low-power radio frequency equipment must withstand interference from legitimate communications or radiating electrical equipment for industrial, scientific, and medical applications.

NCC 警語
取得審驗證明之低功率射頻器材，非經核准，公司、商號或使用者均不得擅自變更頻率、加大功率或變更原設計之特性及功能。 低功率射頻器材之使用不得影響飛航安全及干擾合法通信。 經發現有干擾現象時，應立即停用，並改善至無干擾時方得繼續使用。 前述合法通信，指依電信管理法規定作業之無線電通信。 低功率射頻器材須忍受合法通信或工業、科學及醫療用電波輻射性電機設備之干擾。

11.9 Global Market Access (GMA)

The MGM240L modules have radio type approvals in the countries listed below:

- Australia (ACMA)
- Dominican Republic (INDOTEL)
- Hong Kong (OFCA)
- Serbia (RATEL)
- Israel (MOC)
- Jordan (TRC)
- Kuwait (CITRA)
- Morocco (ANRT)
- Qatar (CRA)
- Singapore (IMDA)
- Bahrain (BTRA)
- Egypt (NTRA)
- Thailand (NBTC)
- Oman (OTRA)
- Saudi Arabia (CITC)

The formal certificates are available at www.silabs.com or upon request.

11.10 Bluetooth Qualification

The MGM240L modules are launched with a pre-qualified Bluetooth Low Energy RF-PHY Tested Component based on Core Specification 5.3 having Declaration ID of D059594 and QDID of 184327.

The RF-PHY Tested Component should be imported and combined together with the latest Wireless Gecko Link Layer and Host pre-qualified Components by Silicon Labs, when in the process of qualifying an end-product which embeds the MGM240L via the SIG's Launch Studio. Please find out more in chapter 2.2 of the quick start guides QSG139 and GSG169.

Notice that the validity set by the SIG for Tested Components is currently of 3 years: during the product lifetime, Silicon Labs will reassess or re-qualify the RF-PHY Component as it expires, whenever applicable. In case of a re-qualification, a Tested Component will come with a new DID and a new QDID, and the latter will be then referred to in new end-product listings. Newer DIDs and QDIDs can be discovered by using the search engine in the SIG's Launch Studio, or by asking Silicon Labs via the technical support platform.

12. Revision History

Revision 1.0

June, 2023
- Updated Section 2. Ordering Information
- Updated Section 1. Features
- Updated Section 4. Electrical Specifications
- Updated Section 6. Pin Definitions
- Updated Section 11. Certifications
- Updated Top Marking

Revision 0.6

April, 2023

Updated RAM size
- Updated Section 2. Ordering Information
- Updated Section 1. Features
- Updated Section 4. Electrical Specifications
- Updated Section 6. Pin Definitions
- Updated Section 11. Certifications
- Updated Top Marking

Revision 0.5

May, 2022
- Updated Section 2. Ordering Information
- Updated Section 1. Features
- Updated Section 4. Electrical Specifications
- Updated Section 6. Pin Definitions
- Updated Section 11. Certifications

Revision 0.1

May, 2022
- Initial Release.

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