ATSAMR21G18-MR210UA

DATASHEET PRELIMINARY

Description

The ATSAMR21G18-MR210UA is a 20mm x 19mm wireless module with a solder mount footprint. It integrates an ATSAMR21G18 IC together with a serial flash and a crypto authentication device.

Features

- ATSAMR21G18 system in package
  - Single-chip ARM® Cortex®-M0+ based 32-bit Microcontroller
  - Low power 2.4GHz transceiver for IEEE 802.15.4 and ZigBee applications
  - 256KB Flash
  - Maximum Operating Frequency: 48 MHz
  - 128-bit AES crypto engine
  - 32-bit MAC symbol counter
  - Temperature sensor
  - Automatic transmission modes
- AT45DB041E 4-Mbit DataFlash
- ATECC508A CryptoAuthentication Device
  - Secure Hardware-based Key Storage
  - Performs High-Speed Public Key Algorithms
  - NIST Standard P256 Elliptic Curve Support
  - SHA-256 Hash Algorithm with HMAC Option
  - Guaranteed Unique 72-bit Serial Number
  - High-quality FIPS Random Number Generator (RNG)
  - Intrusion Latch for External Tamper Switch
- Single 1.8V - 3.6V supply
- Radio module with a link budget of 103dBm
- FCC / ETSI compliant RF front end with harmonic filter
- Three SERCOM units left for external applications
- 32.768kHz crystal oscillator
- High precision 16MHz crystal oscillator
- 12-bit, 350ksps Analog-to-Digital Converter (ADC)

- I^{2}C up to 3.4MHz
- Full-speed (12Mbps) Universal Serial Bus (USB) 2.0 interface
- 17 external GPIO lines
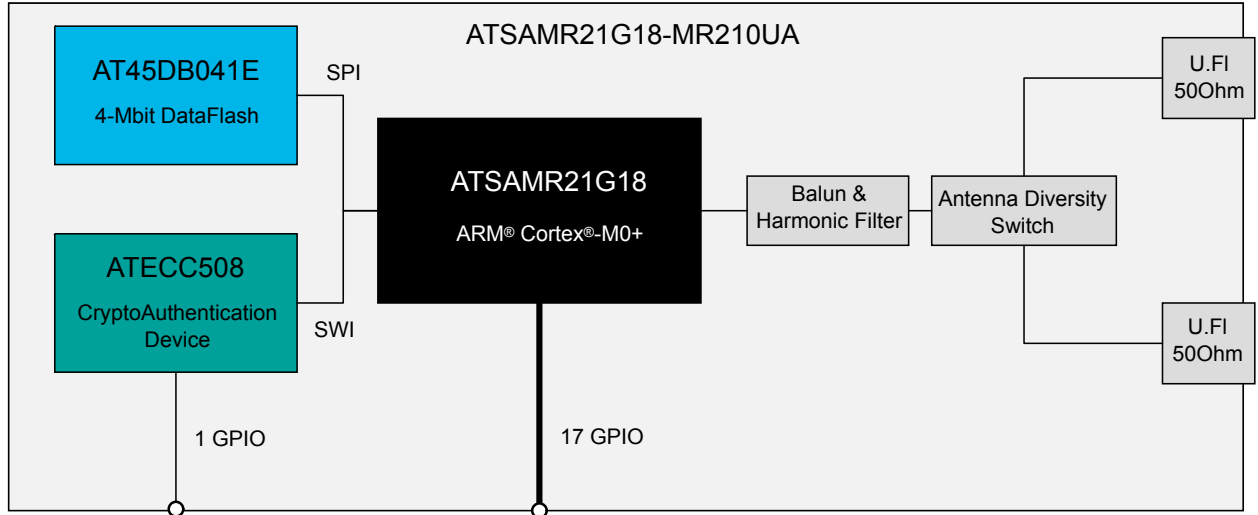- One GPIO for ATECC508A intrusion latch

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1. Integrated Devices and Block Diagram

1.1. Module Block Diagram

Figure 1-1 Module Block Diagram

1.2. Integrated Peripherals

1.2.1. Serial Flash Interconnection

Table 1-1 Serial Flash Interconnection

DataFlash Signal	MCU Function	MCU Pin	Port and SERCOM Configuration
SO	MISO	37	PA22 SERCOM5 PAD[2] DIPO=0x2
SI	MOSI	38	PA23 SERCOM5 PAD[3] DOPO=0x2
SCK	SCK	48	PB03 SERCOM5 PAD[1] DOPO=0x2
#CS	GPIO	47	PB02 to be set low in software before SPI access

The signals in this table are not available as module I/O. More information about the FLASH IC can be found in its related datasheet [ADESTO].

1.2.2. UART with Hardware Flow Control (RTS/CTS)

For an Application where the ADC is not in use, SERCOM0 can be multiplexed as shown in the table below.

Table 1-2 UART with Hardware Flow Control (RTS/CTS)

Module Pin	MCU Function	MCU Pin	Port and SERCOM Configuration
14	UART TX	15	SERCOM0; MUX=C; PAD[0] TXPO=0x2
25	UART RX	10	SERCOM0; MUX=D; PAD[1] RXPO=0x1

Module Pin	MCU Function	MCU Pin	Port and SERCOM Configuration
26	UART RTS	11	SERCOM0; MUX=D; PAD[2] TXPO=0x2
13	UART CTS	12	SERCOM0; MUX=D; PAD[3] TXPO=0x2

The signals in this table are not available as module IO. More information about the FLASH IC can be found in its related datasheet. (ADESTO)

1.2.3. 32kHz Crystal

PA00 and PA01 are used for the 32kHz crystal. This pins are not available as module IO.

1.2.4. SAM R21 USB Availability

The USB pins are made available as differential pair routed GPIO's. A base board with the required connection hardware can support an USB interface.

Table 1-3 SAM R21 USB Availability

Module Pin	Function	MCU Pin	Port Configuration or Xplain Function
19	GPIO or USB_D+	33	PA24: For USB MUX=G
20	SPIO or USB_D-	34	PA25: For USB MUX=G

The module power supply can't be operated directly from a 5V USB source. The module base board has to implement the required voltage regulator.

1.3. RF Front End Control

The antenna diversity signals ANT_DIV_P/N are used to control the diversity switch U4. The signal ANT_DIV_P is available at the IO ring pin 18 to indicate the antenna currently in use.

In addition at pin 17, the RX_TX indicator signal is available to indicate if the module is currently in transmit mode.

Table 1-4 RF Front End Control

RF Front End Signal	MCU Function	MCU Pin	Port and SERCOM Configuration
ANT_DIV_P	FECTRL2	21	PA12; MUX=F; F3CFG=DIG1 Available at module pin 18
ANT_DIV_N	FECTRL1	16	PA09; MUX=F; F1CFG=DIG2
FEM_RX_TX	FECTRL3	22	PA13; MUX=F; F0CFG=DIG3 for High active TX indication F0CFG=DIG4 for Low active TX indication Available at module pin 17

2. Mechanical Description

2.1. Mechanical Dimensions

Dimensions are in mm. The module pins are arranged with a 1mm pitch distance. The module is designed in a symmetric way.

Figure 2-1 Module Bottom Dimensions (Seen from a CAD top perspective)
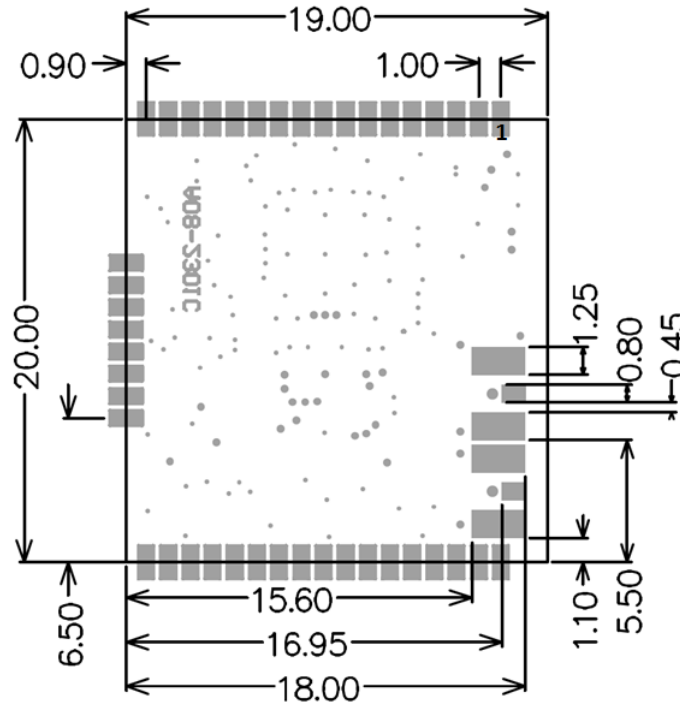
The module can be mounted to a base board with a soldered RF connection. For this case one or both U.FI connectors are left unconnected and the RF pads on the bottom side are used to feed an antenna located on the base board.

2.2. Footprint and Layout Recommendation

Since the module does not contain an antenna, the module does not set any limits for the base board material selection or the board stack-up construction. The module does also not require a certain positioning on the board in relation to the board edge. The module must be placed away from interference sources on the base board like clock oscillators or step converters. The area underneath the module must be filled with a grounded copper plane. The RF-Pad area needs special attention. The following sections provide more information on that.

A typical design is supposed to connect the I/O ring to the base board while the antenna feeds are using the U.FI connectors. Using the antennas in Approved Antennas on page 16, the modular approval for the final product can be used without re-certification.

2.2.1. Design without RF-Pads

For a design without U.FI connected antennas, the base board design has to have no copper fill within the RF-Pad area (*!). All layers with less than 0.5mm distance from top shall not be filled with copper underneath the RF-Pad area.

For all other I/O pads the geometry in below figure should be used.

Figure 2-2 Recommended Base Board Layout
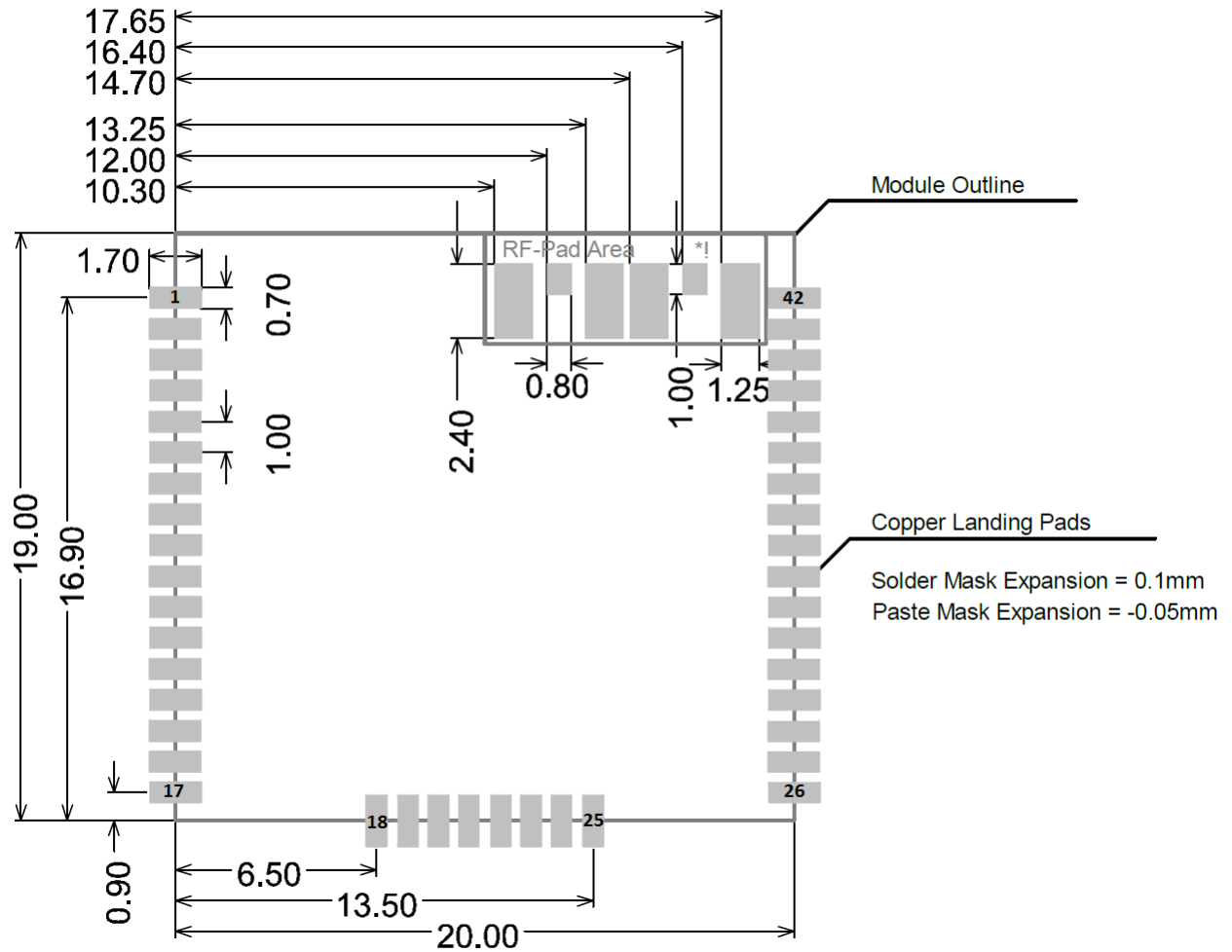
2.2.2. Design without RF-Pads

For applications where the antenna is implemented on the base PCB, the RF-Pads can be used to connect the RF signals. The pad layout is available in Figure 2-2 Recommended Base Board Layout on page 8. The base board traces shall be designed with a line impedance of 50Ohm. Depending on the base board stack construction a microstrip or a grounded coplanar design can be implemented. The best choice will be the line type with the best match in between line width and the 0.8mm pad width.

For all other IO pads the geometry in Figure 2-2 Recommended Base Board Layout on page 8 should be used.

3. I/O Pin Assignment

The module pin assignment is shown in below table. The Column "MCU pin" is referring to the ATSAMR21G18 datasheet [SAMR21]. The column "Port Configuration" is intended to help determine the required SAMR21 port configuration..

Table 3-1 RF Front End Control

Module Pin	Function	MCU Pin	Port Configuration
1	GND		
2	GND		
3	VCC		
4	VCC		
5	RSTN	40	
6	SPI_CS	26	SERCOM1; MUX=C; DOPO=0x1; Master PAD1
7	SPI_MOSI	27	SERCOM1; MUX=C; DOPO=0x1 Master PAD2 For slave operation this pin is MISO
8	SPI_MISO	25	SERCOM1; MUX=C; DIPO=0x0 Master PAD0 For slave operation this pin is MOSI
9	SPI_SCLK	28	SERCOM1; MUX=C; DOPO=0x1 Master PAD3
10	GPIO	41	PA28 (Yellow LED; low active)
11	-		Not connected
12	GND		
13	RXD1	12	SERCOM0; MUX=D; PAD[3] RXPO=0x3 Can be used for UART with RTS/CTS
14	TXD1	15	SERCOM0; MUX=C; PAD[0] TXPO=0x0 Can be used for UART with RTS/CTS
15	-		Not connected
16	-		Not connected
17	FEM_RX_TX	22	PA13; MUX=F; FECTRL3 (LED red)
18	ANT_DIV_P	21	PA12; MUX=F; FECTRL2 (LED green)
19	GPIO/USB_DM	33	PA24 for USB MUX=G
20	GPIO/USB_DP	34	PA25 for USB MUX=G
21	-		Not connected
22	RXD0	24	SERCOM2; MUX=C; PAD[3]; RXPO=0x3
23	TXD0	23	SERCOM2; MUX=C; PAD[2]; TXPO=0x1

Module Pin	Function	MCU Pin	Port Configuration
24	AREF	9	MUX=B; disable digital
25	ADC0	10	MUX=B; AIN[1]; disable digital Can be used for UART with RTS/CTS
26	ADC1	11	MUX=B; AIN[2], disable digital Can be used for UART with RTS/CTS
27	-		Not connected
28	-		Not connected
29	GND		
30	SWCLK	45	Programming interface
31	SWDIO	46	Programming interface
32	-		Not connected
33	ATECC508 GPIO		Crypto IC GPIO with intrusion detection feature
34	-		Not connected
35	-		Not connected
36	I2C SCL	32	SERCOM3 PAD1 MUX=C
37	I2C SDA	31	SERCOM3 PAD0 MUX=C
38	-		Not connected
39	-		Not connected
40	-		Not connected
41	GND		
42	GND		

4. Electrical Characteristics

This section will outline the main parameters required to build applications. The module characteristics are determined by the implemented parts. See References on page 19 for required datasheet references.

4.1. Absolute Maximum Ratings

Table 4-1 Absolute Maximum Ratings

Symbol	Parameter	Condition		Min.	Typ.	Max.	Unit
T_{STOR}	Storage temperature			-40		+125	°C
V_{PIN}	Pin voltage with respect to GND and V_{DD}			GND-0.3V		V_{DD}+0.3V	V
V_{ESD}	ESD robustness	Modules I/O's routed to SAM R21	Human Body Model	4			kV
			Charged Device Model	550			V
P_{RF}	Input RF level					+10	dBm

4.2. Recommended Operating Ratings

Table 4-2 Recommended Operating Ratings

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
T_{OP}	Operating temperature range		-40		85	°C
V_{DD}	Supply voltage		1.8		3.6	V

4.3. Module Performance Data

If not otherwise stated the measurements are done with VDD=3.3V at 25°C.

Table 4-3 Module Performance Data

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
I_{DD}	Supply current	MCU at TBD MHz[1]		4		mA
		With transceiver in RX_ON state		10		
		With transceiver in TX state		10		
P_{RF}	RF transmit power	U.FI interface	2	3.5		dBm
P_{emit}	Radiated transmit power	Using antenna ANT-24G-S21-P5FL[2]		3.5	8	dBm
		Using antenna M07-FL[3]		8		EIRP

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
P_{SPUR_TX}	Transmitter spurious emissions	U.Fl connector, conducted, >2.5GHz			-50	dBm
P_{SENS}	Receiver sensitivity	U.Fl interface		-98		dBm
d_{od}	Outdoor range	Using antenna ANT-24G-S21-P5FL		TBD		m
		ANT-24G-S21-P5FL in Ch26[2]		TBD		
		Using antenna M07-FL		TBD		
		M07-FL in Ch26[3]		TBD		
f_{Ref_0}	Reference crystal deviation	T = 25°C default XTAL_TRIM setting	-5		+20	ppm
		T = 25°C NV memory XTAL_TRIM setting	-5		+5	
f_{Ref_T}	Reference crystal drift over temperature	-40°C <TOP< +85°C	-15		+15	ppm
f_{32k_0}	Watch crystal deviation	T = 25°C default XTAL_TRIM setting		TBD		ppm
		T = 25°C NV memory XTAL_TRIM setting		TBD		
f_{32lk_T}	Watch crystal drift over temperature	-40°C <TOP< +85°C		TBD		ppm

Note:
1. Transceiver state TRX_OFF, FLASH deselect.
2. For FCC band edge compliance it is required to operate Ch26 with not more than power level 13.
3. For FCC band edge compliance it is required to operate Ch26 with not more than power level 14

5.   Non-Volatile Memory Information

The SAM R21 provides a user readable Non-Volatile Memory (NVM) space referred to as the user row in the data sheet. The base address for the application is 0x804008.

Table 5-1 NVM (User Row) Data

Offset Address	Field Name	Field Description	Length
+0x00	MIB_REVISION	Data structure revision 0x1501	2 Bytes
+0x02	MAC_IEEE_ADDRESS	Module specific IEEE MAC Address	8 Bytes
+0x0A	BOARD_SERIAL	Module specific serial number	10 Bytes
+0x14	ATMEL_PART_NO	Product specific part number	8 Bytes
+0x1C	PCBA_REV	Product PCB/assembly revision	1 Byte
+0x1D	XTAL_TRIM	Reference crystal calibration value	1 Byte
+0x1E	CRC16	Checksum for this data structure	2 Bytes

The end user application software has to copy two data fields to radio transceiver registers. The data in MAC_IEEE_ADDRESS have to be copied to the registers IEEE_ADDR_0 to _7. The MAC_IEEE_ADDRESS is stored little endian with the first byte stored at the lowest address.

The XTAL_TRIM value has been determined during production test and needs to be copied to the transceiver XTAL_TRIM section inside the XOSC_CTRL register. This will reduce the absolute deviation for the 16MHz reference crystal. See Module Performance Data on page 11 for parameter details.

6. Radio Certification

The module ATSAMR21G18-MR210UA in combination with the approved antennas listed in Approved Antennas on page 16 have received regulatory approvals for modular devices in the United States and European countries.

6.1. United States (FCC)

The module ATSAMR21G18-MR210UA complies with the requirements of FCC part 15.

To fulfill FCC Certification requirements, an OEM manufacturer must comply with the following regulations:

- The modular transmitter must be labeled with its own FCC ID number, and, if the FCC ID is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module.
- This exterior label can use wording such as the following. Any similar wording that expresses the same meaning may be used.

Sample Label for integration of ATSAMR21G18-MR210UA:

> **Contains FCC-ID: VNR-ATSAMR210UA-0**
>
> *This device complies with Part 15 of the FCC Rules. 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 undesired operation.*

This equipment complies with Part 15 of the FCC Rules. 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 undesired operation (FCC 15.19). The antenna(s) used for this mobile transmitter must provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

Installers must be provided with antenna installation instructions and transmitter operating conditions for satisfying RF exposure compliance. This device is approved as a mobile device with respect to RF exposure compliance, and may only be marketed to OEM installers. Use in portable exposure conditions (FCC 2.1093) requires separate equipment authorization.

Modifications not expressly approved by this company could void the user's authority to operate this equipment (FCC section 15.21).

To be compliant with FCC part 15 the transmit power setting (register 0x05, PHY_TX_PWR) for channel 26 must not exceed the values in Table 6-1 Approved Antennas on page 16. The module application software must ensure this settings for operation within the FCC territory.

6.2. Europe (ETSI)

The module ATSAMR21G18-MR210UA is conform for use in European Union countries.

If the ATSAMR21G18-MR210UA module is incorporated into a product, the manufacturer must ensure the compliance of the final product to the European harmonized EMC and low-voltage/safety standards. A Declaration of Conformity must be issued for each of these standards and kept on file as described in Annex II of the R&TTE Directive.

The manufacturer must maintain a copy of the ATSAMR21G18-MR210UA module documentation and ensure the final product does not exceed the specified power ratings, antenna specifications, and/or installation requirements as specified in the user manual. If any of these specifications are exceeded in the final product, a submission must be made to a notified body for compliance testing to all required standards.

The CE marking must be affixed to a visible location on the OEM product. The CE mark shall consist of the initials "CE" taking the following form:

- If the CE marking is reduced or enlarged, the proportions must be respected.
- The CE marking must have a height of at least 5 mm except where this is not possible on account of the nature of the apparatus.
- The CE marking must be affixed visibly, legibly, and indelibly.

More detailed information about CE marking requirements can be found at "DIRECTIVE 1999/5/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL" on 9 March 1999 at section 12.

For the operation in Europe, there is no power setting limit.

6.3. Industry Canada (IC) Compliance Statements

This device complies with Industry Canada license-exempt RSS standard(s). 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.

Le présent appareil est conforme aux CNR d'Industrie 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, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

This equipment complies with radio frequency exposure limits set forth by Industry Canada for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20 cm between the device and the user or bystanders.

Cet équipement est conforme aux limites d'exposition aux radiofréquences définies par Industrie Canada pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec un minimum de 20 cm de distance entre le dispositif et l'utilisateur ou des tiers.

CAUTION: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. The OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.). This Module is labeled with its own IC ID. If the IC ID Certification Number is not visible while installed inside another device, then the device should display the label on it referring the enclosed module. In that case, the final end product must be labelled in a visible area with the following:

"Contains Transmitter Module IC: 20266-ATSAMR210UA0"

OR

"Contains IC: 20266-ATSAMR210UA0"

Ce module est étiqueté avec son propre ID IC. Si le numéro de certification IC ID n'est pas visible lorsqu'il est installé à l'intérieur d'un autre appareil, l'appareil doit afficher l'étiquette sur le module de référence ci-joint. Dans ce cas, le produit final doit être étiqueté dans un endroit visible par le texte suivant:

"Contains Transmitter Module IC: 20266-ATSAMR210UA0"

OR

"Contains IC: 20266-ATSAMR210UA0"

6.4. Approved Antennas

The device has been tested and approved for use with the antenna type listed below. The device may be integrated with other custom design antennas which OEM installer must authorize with respective regulatory agencies. The used antenna is to be connected to the Radio PCB via U.FI connection.

Table 6-1 Approved Antennas

Manufacturer	Part Number	Description	Gain	FCC Max. Ch26 Power Register Settings
RF Solutions	ANT-24G-S21-P5FL	21mm quarter wave monopole with U.FI pigtail	0dBi	13..15
TekfunCo.,LTD	M07-FL	170mm quarter wave monopole with U.FI pigtail	5dBi	14..15

The above table shows the allowed power settings for Channel 26 if the equipment is operated under FCC conditions.

According to KDB 178919 [Policy] it is allowed to substitute approved antennas through equivalent antennas of the same type with equal or less antenna gain:

'Equivalent antennas must be of the same type (e.g., yagi, dish, etc.), must be of equal or less gain than an antenna previously authorized under the same FCC ID, and must have similar in band and out-of-band characteristics (consult specification sheet for cutoff frequencies).'

7. Boot Loader

The module will be delivered with a pre flashed boot loader. Refer to the boot loader manual for detailed information. It is online available under the Application Note code AVR2054.

8. Ordering Information

Module Type	Packaging[1]	Ordering Code	Package	Operational Range
ATSAMR21G18-MR210UA	Tape & Reel	ATSAMR21G18-MR210UA-T	19mm x 20mm SMT	Industrial (-40°C to 85°C)

Note:
1. MOQ is a reel with 200 modules.

9. References

1. ADESTO. (n.d.). *Adesto Technologies.* Retrieved from AT45DB041E Datasheet: http://www.adestotech.com

2. ATECC508. (n.d.). *www.atmel.com.* Retrieved from ECC-based Devices: http://www.atmel.com/products/security-ics/cryptoauthentication/ecc-256.aspx

3. Policy, P. C. (n.d.). *178919 D01 Permissive Change Policy.* Retrieved from FCC OET: https://apps.fcc.gov/oetcf/kdb/forms/FTSSearchResultPage.cfm?id=33013&switch=P

4. SAM R21. (n.d.). *www.atmel.com.* Retrieved from http://www.atmel.com/Images/Atmel-42223-SAM-R21_Datasheet.pdf

10. Revision History

Doc Rev.	Date	Description
42475B	09/2015	• Updated United States (FCC) on page 14. • Added Industry Canada (IC) Compliance Statements on page 15
42475A	07/2015	Initial document release.

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