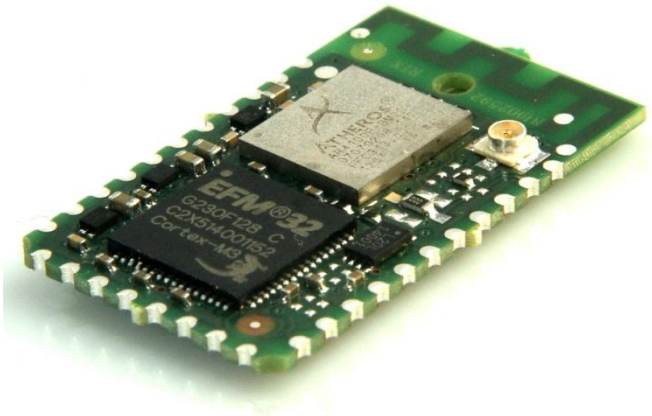
RTX4100

Wi-Fi Module



Datasheet

CONTENT

1 Introduction

1.1 Document History

V1.5	New section: Product Approvals	2012-09-04
V1.4	Updates to section: Blockdiagram	2012-08-31
V1.3	Updates to section: Electrical Characteristics, Assembly information, Block diagram, Pin-out and port overview New section: Application processor alternate pin functionality, Assemply information	2012-08-28
V1.2	Official release	2012-07-05

Disclaimer: This document can be subject to change without prior notice.

1.2 Document References

[AN4]. RTX4100_Application_Note_Regulatory_Approvals_vxxx.docx.
[IS1]. AmelieApi_Vxxxx.pdf.

1.3 General Description

The RTX4100 Wi-Fi Module is a small form-factor, single stream, 802.11b/g/n Wi-Fi module with on-board low power application processor. It is targeted at applications that send infrequent data packets over the network. Typically, these 802.11 applications will place a higher priority on system cost, power consumption, ease of use, and fast wake-up times as compared to high throughput.

The RTX4100 has been optimized for client applications in the home, enterprise, smart grid, home automation and control that have lower data rates and transmit or receive data on an infrequent basis. The RTX4100 Wi-Fi Module also enables rapid application development of ultra low power devices with the complete application SW on-chip (battery or mains powered devices). The module utilizes the combination of the energy friendly Energy Micro Gecko G230 microcontroller and the flexible low power single stream Atheros AR4100 Wi-Fi (b/g/n) SiP. This combination makes the RTX4100 Wi-Fi Module an ideal solution for low power automation and sensor solutions because of its high efficiency and low power consumption. Current consumption with the application processor active with an OS tick of 100ms results in a current consumption of typical 4 μA. In this mode the application processor can monitor peripherals such as eg. sensors. Furthermore, due to the encryption capabilities of the module, it is also suitable for security applications.

The RTX4100 Wi-Fi Module integrates all Wi-Fi functionality into a low-profile, 18 mm x 30 mm SMT module package that can be easily mounted on a low-cost main PCB with application specific circuits.

The RTX4100 Wi-Fi Module supports a development platform that reduces development time through multiple interfaces and power supply options. The reference hardware, showing an application example using the RTX4100 module, is designed to reduce design efforts by supporting a the necessary development interfaces, sensor interfaces etc. Furthermore, developers can also choose from a wide range of different software packages and reference applications with well-documented API's.

The RTX4100 Wi-Fi Module can be used to design applications using 802.11b/g/n communication protocols. The module includes an integrated antenna. Variants for connecting external antenna consist of U.fl and via edge connector. The module offers, via edge connectors, a flexible interface to the carrier board. This interface includes power supply pins, ADC ports, DAC ports, analog comparator, GPIO ports, SPI, I2C and UART ports.

1.4 Device Features

802.11 b/g/n single stream @ 2.4 GHz
Supports WEP, WPA/WPA2 and WPS modes of security (Wi-Fi drivers and WPA supplicant)
On-board application processor with flexible interfaces
Designed for ultra low power operation through use of Energy Micro Gecko G230 MCU and Atheros AR4100 Wi-Fi SiP
Avaliable antenna variants : integrated antenna, U.fl connector and edge connector
Can be powered from an unregulated power supply, and hence, suitable for both battery powered and mains powered devices
Compact surface mount module 18x30mm
Full IPv4 and IPv6 stack
FCC and IC Certified
RoHS and CE compliant
Wide range of connector ports including ADC ports, DAC ports, analog comparators, GPIO ports, SPI, I2C and UART ports.

1.5 Key Applications

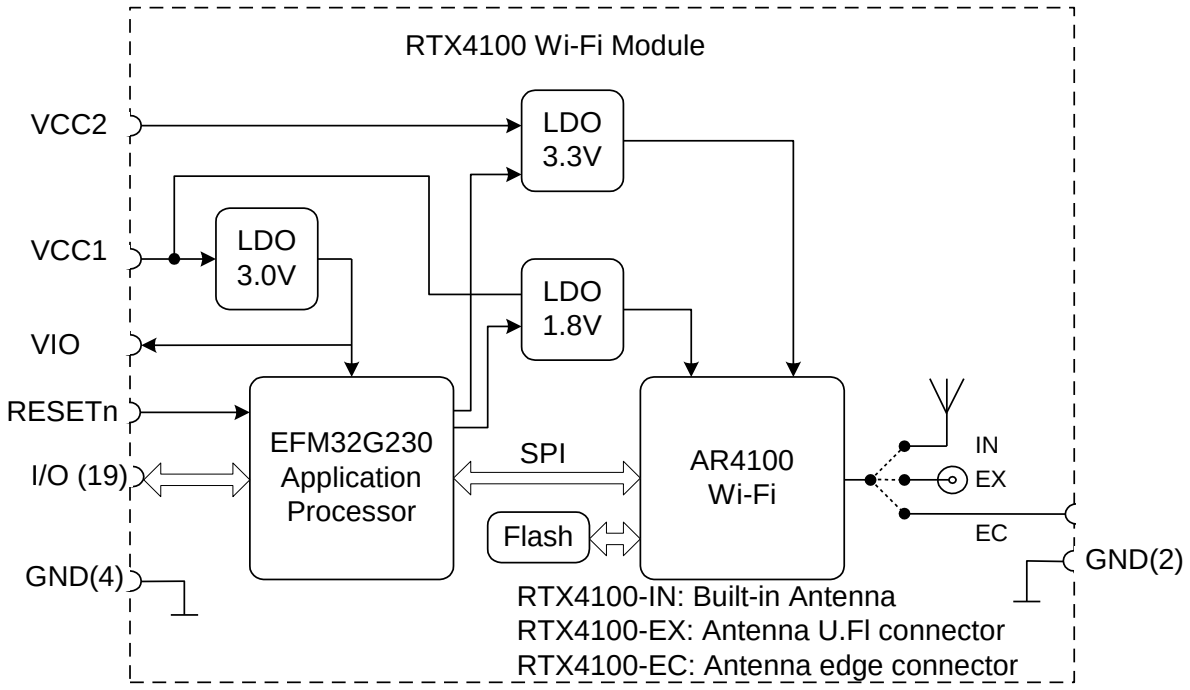
In essence the RTX4100 Wi-Fi Module enables rapid development of sensors for smart energy, security and automation demonstrators through a comprehensive Software Development Kit.
The RTX4100 Wi-Fi Module targets a wide range of application areas including:

Sensors and multi-input sensors (Industrial / Medical)
White Goods and Appliances (IEC-60335 Class B compliant)
Building Automation
Home Automation / Home Security
Larger applications (including MMI)
Actuators
Portable Units

2 Overview

2.1 HW Architecture

2.1.1 Block-diagram



The RTX4100 Wi-Fi Module contains an Atheros AR4100 Wi-Fi SIP chip and an Energy Micro EFM32G230 application processor. The application processor has internal Flash and RAM. The Wi-Fi module boots from a serial Flash. The processor is powered by an LDO with low power consumption to keep the total standby current very low. Furthermore, the application processor controls two additional LDO's to power the Wi-Fi module and the serial Flash. The Wi-Fi AR4100 chip can be turned off to save power when the Wi-Fi functionality is not required.

A number of I/O's are available to allow a wide range of applications. These include timers, serial communication interfaces, analog comparators, Analog-to-Digital Converters, Digital-to-Analog Converters, crystal oscillators and a debug interface.

2.1.2 Pin-out and port overview

Pin no.	Pin name	Type	Proces-sor pin no.	Function
1	GND	GND		
2	PA0	I/O	1	PA0/TIM0_CC0/I2C0_SDA
3	PA1	I/O	2	PA1/TIM0_CC1/I2C0_SCL/CMU_CLK1
4	VCC2	VCC2		VCC2 supply input
5	GND	GND		
6	VCC1	VCC1		VCC1 supply input
7	VIO	O		Application processor I/O supply output
8	PA3/PC1	I/O	4 and 10	PA3/TIM0_CDTI0 PC1/ACMP0_CH1/PCNT0_S1IN/US1_RX
9	PA4/PC0	I/O	5 and 9	PA4/TIM0_CDTI1 PC0/ACMP0_CH0/PCNT0_S0IN/US1_TX
10	PB7	I/O	15	PB7/LFXTAL_P/US1_CLK
11	PB8	I/O	16	PB8/LFXTAL_N/US1_CS
12	GND	GND		
13	RESETn	I-PU	20	RESETn
14	PB12	I/O	22	PB12/DAC0_OUT1/LETIM0_OUT1
15	PB13	I/O	24	PB13/HFXTAL_P/LEU0_TX
16	PB14	I/O	25	PB14/HFXTAL_N/LEU0_RX
17	GND	GND		
18	PD5	I/O	33	PD5/ADC0_CH5/LEU0_RX
19	PC6	I/O	37	PC6/ACMP0_CH6/LEU1_TX/I2C0_SDA
20	PC7	I/O	38	PC7/ACMP0_CH7/LEU1_RX/I2C0_SCL
21	PC5/PB11	I/O	14 and 21	PC5/ACMP0_CH5/LETIM0_OUT1/PCNT1_S1IN/ US2_CS PB11/DAC0_OUT0/LETIM0_OUT0
22	PC4/PD4	I/O	13 and 32	PC4/ACMP0_CH4/LETIM0_OUT0/PCNT1_S0IN/ US2_CLK PD4/ADC0_CH4/LEU0_TX
23	PC2	I/O	11	PC2/ACMP0_CH2/US2_TX
24	PC3	I/O	12	PC3/ACMP0_CH3/US2_RX
25	PF0	I/O	49	PF0/LETIM0_OUT0/DBG_SWCLK
26	PF1	I/O	50	PF1/LETIM0_OUT1/DBG_SWDIO
27	PF2	I/O	51	PF2/ACMP1_O/DBG_SWO
28	GND	GND		
29	ANT	I/O		Only used in RTX4100-EC. This pin should be connected to GND for other variants.
30	GND	GND		

The Processor pin no. refers to the pin numbers of the Energy Micro EFM32G230 in the QFN64 package. Moreover, the Functions in the above table refer to the pin names used

in the EFM32G230 data sheet. The pin numbers shown in Figure 1 close to the edges refer to the pin numbers of the SMT pads.

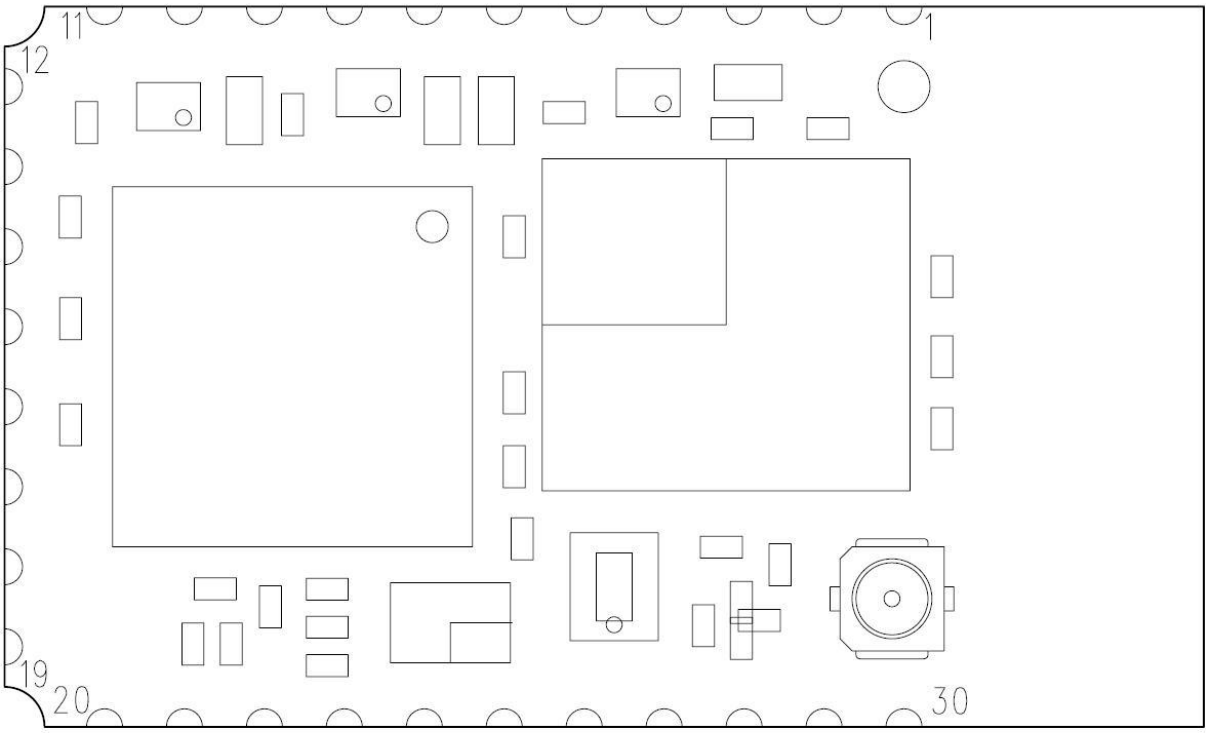


Figure 1: RTX4100 pin numbering

2.1.3 Application processor alternate pin functionality

The Application processor on RTX4100 offers a rich set og IO options. The below table shows an overview of the interfaces available. Please observe that all IO option are not available at the same time as the alternate functions are muxed onto a limited number of module pins, see section 2.1.2. For additional information please see the data sheet for the Energy Micro EFM32G230.

Functionality	Amount	EFM32 alternate pin descriptions
Digital to Analog Converter output channel	2	DAC0_OUT1, DAC0_OUT0
Analog to digital converter input channel	1	ADC0_CH5
Analog comparator input	8	ACMP0_CH0, ACMP0_CH1, ACMP0_CH2, ACMP0_CH3, ACMP0_CH4, ACMP0_CH5, ACMP0_CH6, ACMP0_CH7
Analog comparator digital output	1	ACMP1_O
Timer Capture Compare input / output channel	2	TIM0_CC0, TIM0_CC1
Timer Complimentary Deat Time Insertion channel	2	TIM0_CDTI0, TIM0_CDTI1
Low Energy Timer output channel	2	LETIM0_OUT1, LETIM0_OUT0
Pulse Counter input	3	PCNT0_S1IN, PCNT0_S0IN, PCNT1_S1IN
I2C0 Serial Data interface	1	I2C0_SDA, I2C0_SCL
Universal Synchronous Asynchronous serial Receiver and Transmitter (USART). Supporting UART communication, RS-485, SPI, MicroWire and 3-wire, ISO7816 and IrDA	2	US1_RX, US1_TX, US1_CLK, US1_CS US2_RX, US2_TX, US2_CLK, US2_CS
Low Energy Universal Asynchronous Receiver and Transmitter (LEUART)	2	LEU0_TX, LEU0_RX LEU1_TX, LEU1_RX
Low Frequency Crystal	1	LFXTAL_P, LFXTAL_N
High Frequency Crystal	1	HFXTAL_P, HFXTAL_N
Clock Management Unit clock output	1	CMU_CLK1
Debug-interface	1	DBG_SWCLK, DBG_SWDIO, DBG_SWO

2.2 SW Architecture

The RTX4100 contains two major components; the Wi-fi module and the Application Micro Controller Unit (MCU). The Application MCU contains all the necessary software components to implement a complete Wi-Fi device, including the application.

Figure 2 conceptually illustrates the software architecture of the application MCU.

The complete module firmware is split in the following two parts:

The user application – Also known as a Co-Located Application (CoLA).
The RTX Platform Firmware.

The RTX4100 module comes pre-loaded with the Platform Firmware which has support for Co-Located Applications. The application developer can then build his/her own Co-Located Application using the API's defined by the Platform and the CoLA framework. The Application can be download into the module for execution without having to modify the rest of the Platform Firmware.

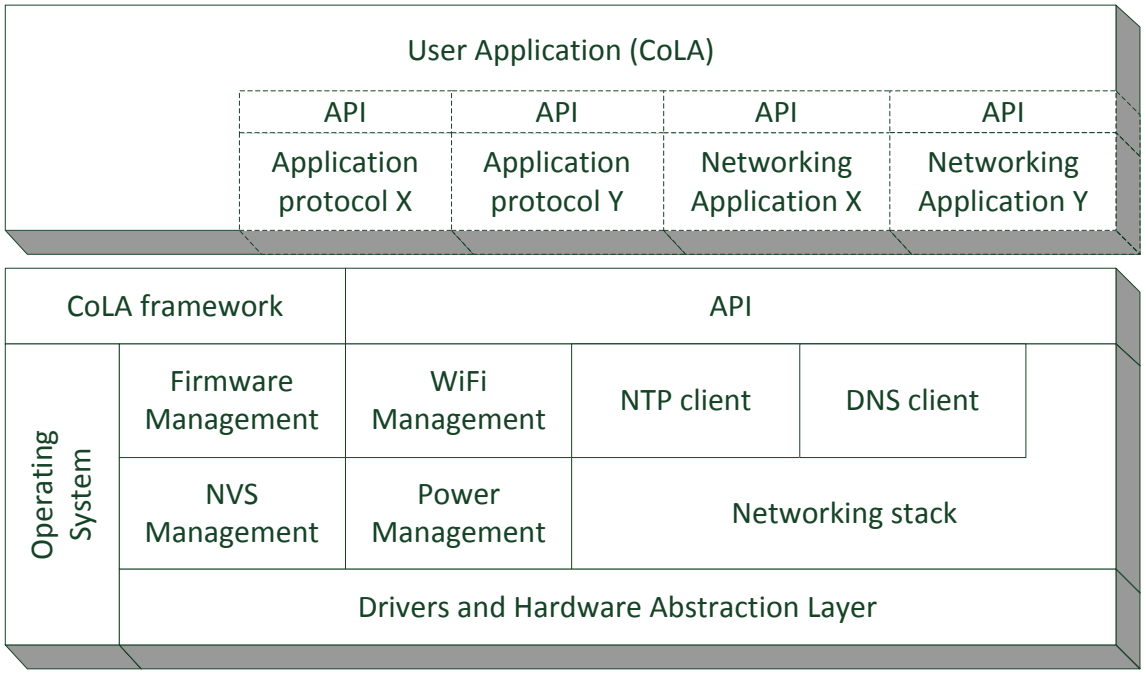


Figure 2 Overview of the SW Architecture on the Application MCU

2.2.1 Co-Located Application SW Blocks

The different parts of the Co-Located Application are briefly described below.

User Application: This is the component implementing the application functionality of the Wi-Fi device. It is normally written by the application programmer / developer using the API availiable.

Application Protocols: These are optional product specific functional layers implementing protocols for a specific functionality like e.g. CoAP or SEP2.0. The application protocol offloads the application developer by implementing a number of translation protocols like XML coding / decoding for message payloads, parsing of incoming messages and construction of outgoing messages. Application protocols may be part of the RTX SW delivery as either source code or a binary library.

Networking Applications: These are optional product specific functional components implementing a variety of networking application, FTP, TFTP, HTTP, Web server etc. Networking Applications may be part of the RTX SW delivery as either source code or a binary library.

2.2.2 Module Firmware SW Blocks

The different parts of the Module Firmware are briefly described below.
Co-Located Application (CoLA) Framework: This component implements a programming model where the application is dynamically linked with the services provided by the lower layers. The application is compiled and linked as a separate program that at runtime is loaded and run as a task under the Operating System.

API: This is the interface exposed by the Platform Firmware. It exposes all functionality needed by the application to implement a Wi-Fi device, like a sensor or actuator device. A detailed description of all the API's available can be found in ([IS1]). All the API's are mail based.

Operating System: RTX low power operating system implementing the necessary functionality to host internal tasks as well as the Co-Located Application

Networking Stack: This is a functional layer implementing the UDP, TCP/IP networking stack for IPv4 and IPv6 networking

NTP Client: The NTP client is used to request the current time from a NTP server.

DNS Client: The DNS client is used to translate domain names to IP address by querying a DNS server.

WiFi Management: This component handles all aspects of Wi-Fi connection to an WiFi acces point including security and key handling to secure the wireless connection, Wi-Fi power management etc.

Power Management: This component handles the MCU internal clock trees as well as module power management. It ensures that any MCU internal part or external peripheral is only running for the appropriate amount of time to preserve power.

Firmware Management: This component implements functionality to perform remote firmware update of the Co-Located Application.

NVS Management: This component implements a None Volatile Storage (NVS) in a part of the internal FLASH in the MCU.

Drivers: This is a functional layer implementing a number of hardware drivers for MCU peripherals as well as the physical interface to the Wi-Fi sub-component.

2.2.3 Application Reserve

The flash / RAM space left for the application depends on the configuration of the protocol and stack.

2.3 RTX4100 development kits

2.3.1 Evalualtion kit (EVK)

The RTX4100 EVK (Evaluation Kit) allows a connection from a PC to a Wireless Sensor Application Board (WSAB) to control the WSAB Wi-Fi operation. The terminal application included in the RTX4100 module provides means to connect to another client or server on the network through a Wi-Fi Access Point and send data power efficiently over the network. If two EVKs are available, connection to another RTX4100 on the same network is possible. The EVK includes a WSAB (Wireless Sensor Application Board) containing a RTX4100-IN module and carrier board, a dedicated USB interface cable, and batteries.

2.3.2 Development kit (DVK)

The RTX4100 DVK (Development Kit) includes a comprehensive Application Programming Interface (API), a rich set of demonstration applications supplied as source code, and an embedded firmware development suite with download tools. The DVK enables a developer to run a collocated application (CoLA) directly on a RTX4100 Wi-Fi module. No external MCU is required. The DVK includes the EVK (Evaluation Kit) plus toolchain and CoLA software, USB cable, and a docking station.

2.3.3 Upgrade kit (E2D - EVK to DVK)

The RTX4100 upgrade kit allows someone with an Evaluation Kit (EVK) to upgrade to a full Development Kit (DVK) in order to develop, embed and run an application on the RTX4100 module itself (rather than on an external host MCU).

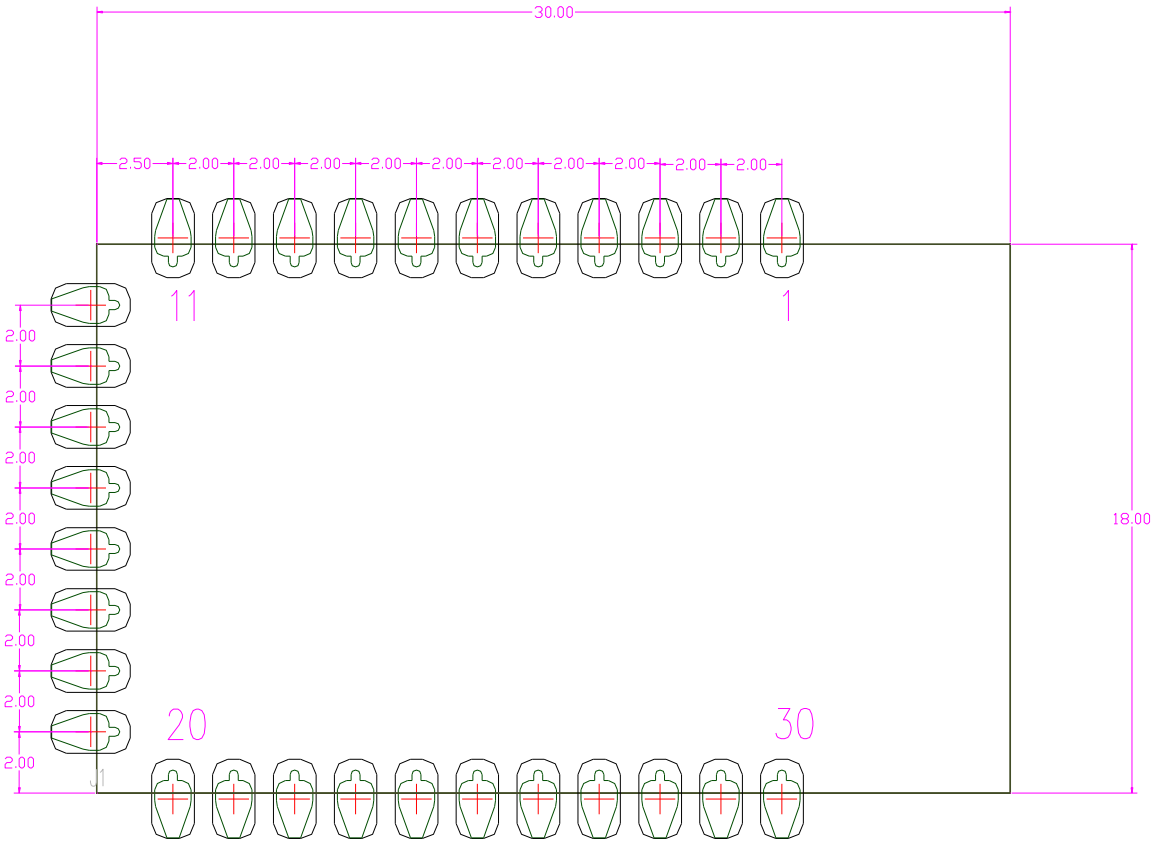
2.3.4 In- circuit Debugger (RTX2040 Unity-II)

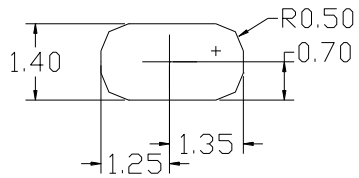
The RTX In-Circuit Debugger provides a generic target interface for RISC MCU architectures. It facilitates debugging of software running on RISC cores that includes Serial Debug Interface Plus (SDI+) logic. The RTX-2040 Unity-II comes with a interface cables and is useful for the full range of RTX modules.

3 Design and Operation Guide

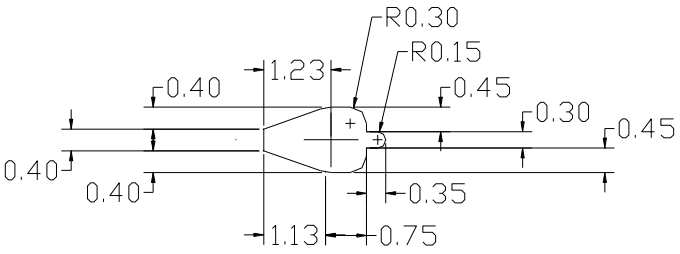
3.1 Central Design Considerations

Recommended pad layout. All dimensions are in mm.





Footprint and Pastemask



Soldermask

There should be a good ground plane on the main PCB to provide a reference for the antenna. This is particularly important when using the on-board antenna.

The antenna area should be kept free of metal parts, other PCB base material, plastic etc. to ensure optimum conditions for the on-board antenna to work.

4 Specifications and Characteristics

4.1 Specifications

4.1.1 Standards supported

Compliance
IEEE802.11b/g/n
IEEE802.11i (WPA/WPA2)

Connectivity
Single stream Wi-Fi @ 2.4 GHz with support for WEP security mode as well as WPA/WPA2
WPS support
FTP and HTTP transport modes

4.1.2 SW features

RTX Software Development Kit
Wi-Fi drivers and WPA supplicant
Low power RTOS and drivers
Full IPv4 and IPv6 stack

4.1.3 HW components

Components
Atheros AR4100SIP Wi-Fi SIP
Energy Micro Gecko G230 MCU

RAM & Flash
128 kByte flash, 16 kByte RAM (total values)

Antenna options
Integrated antenna
U.fl connector
edge connector

4.1.4 Physical dimensions

30 x 18 x 2.4 mm (Length x Width x Height)

4.2 Electrical Characteristics (preliminary)

4.2.1 Absolute Maximum Ratings

Parameter	Conditions	Min.	Typ.	Max.	Unit
Storage temperature range		-40		125	°C
Supply voltage VCC1 and VCC2		0		6	V
Internal supply voltage VIO		0		3.8	V
Voltage on any I/O pin		-0.3		VIO+ 0.3	V

4.2.2 Recommended Operating Conditions

Parameter	Conditions	Min.	Typ.	Max.	Unit
VCC1, Operating Supply input voltage		2.2(1)	3.5	5.25	V
VCC2, Operating Supply input voltage		3.4(1)	3.5	5.25	V
VIO, Application processor supply output voltage	VCC1 = 3.5V		3.0		V
Operating temperature range low datarate	WiFi Transmitter duty cycle up to 60%, VCC2 < 5.25V	-30		85	°C
Operating temperature range high datarate	WiFi Transmitter duty cycle up to 100%, VCC2 < 4.5 V	-30		85	°C

(1) Minimum voltage based on unregulated power supply

4.2.3 Current Consumption

Conditions: VCC1=VCC2=3.5V, Below current figures represent the sum on supply currents (VCC1+VCC2).

Parameter	Conditions	Min.	Typ.	Max.	Unit
Supply current, standby	Application processor dynamic OS tick		2.7		uA
Supply current, WiFi active and associated, IEEE PS	Listening interval 1000ms		0.76		mA
	Listening interval 100ms		2.6		mA
TX Supply current, peak	peak current during TX		300		mA
RX Supply current, peak	peak current during RX		100		mA

4.2.4 DC Electrical Characteristics Module IO

Please refer to EFM32 datasheet for details.

Parameter	Conditions	Min.	Typ.	Max.	Unit
Output high voltage	Sourcing 6mA	0.95*VIO			V
Output low voltage	Sinking 6mA			0.05*VIO	V
Input high voltage		0.7*VIO			V
Input low voltage				0.3*VIO	V
Input leakage current				+/- 25	nA
I/O pull up resistor			40		kohm
I/O pull down resistor			40		kohm

4.2.5 Oscillators

Parameter	Conditions	Min.	Typ.	Max.	Unit
LFRCO frequency(*)	T = 25°C		32.768		kHz
HFRCO frequency	T = 25°C		28		MHz

(*) The LFRCO drives the timersystem in the software operatingsystem. The LFRCO is calibrated against HFRCO. Calibration intervals can be initiated by the application software to suit the application needs. Please refer to the EFM32 datasheet for LFRCO and HFRCO specifications.

4.2.6 Radio Received Characteristics

Parameter	Conditions	Min.	Typ.	Max.	Unit
Received Input Frequency range		2412.0		2483.5	MHz
Sensitivity					
802.11b, CCK, 1 Mbps		-	-96	-	dBm
802.11b, CCK, 11 Mpbs		-	-87	-	
802.11g OFDM, 6 Mbps		-	-92	-	
802.11g OFDM, 54 Mpbs		-	-75	-	
802.11n, HT20, MSC0		-	-91	-	
802.11n, HT20, MSC7		-	-72	-	
Adjacent Channel Rejection					
802.11b, CCK, 1 Mbps		-	48	-	dB
802.11b, CCK, 11 Mpbs		-	39	-	
802.11g, OFDM, 6 Mbps		-	39	-	
802.11g, OFDM, 54 Mpbs		-	24	-	
802.11n, HT20, MSC0		-	36	-	
802.11n, HT20, MSC7		-	21	-	

Conditions: Measurements done conducted using the RTX4100-EX U.fl connector, VCC1=VCC2=3.5V, T=25°C.

4.2.7 Radio Transmitter Characteristics

Parameter	Conditions	Min.	Typ.	Max.	Unit
Transmitter Output Frequency range		2412.0		2483.5	MHz
Output Power FCC/IC region					
802.11b		-	17	-	dBm
802.11g 6-36 Mbps		-	17	-	
802.11g 48-54 Mbps		-	15	-	
802.11n MCS0-3		-	17	-	
802.11n MCS4-6		-	15	-	
802.11n MCS7		-	8	-	
Output Power EU region					
802.11b		-	14	-	dBm
802.11g 6-36 Mbps		-	14	-	
802.11g 48-54 Mbps		-	14	-	
802.11n MCS0-3		-	14	-	
802.11n MCS4-6		-	14	-	
802.11n MCS7		-	8	-	
Accuracy of Power Leveling Loop		-	±1.5	-	dB

Conditions: Measurements done conducted using the RTX4100-EX U.fl connector, VCC1=VCC2=3.5V, T=25°C.

4.3 Assembly information

4.3.1 Recommended soldering data for ROHS using SAC alloy

Parameter	Conditions	Min.	Typ.	Max.	Unit
Peak temperature		235		245	°C
TAL (Time above liquidus)		45		60	s
SOAK time (150°C+185°C)		40		90	s
Rising slope				3	°C/s
Falling slope				5	°C/s

4.3.2 Recommended soldering profile

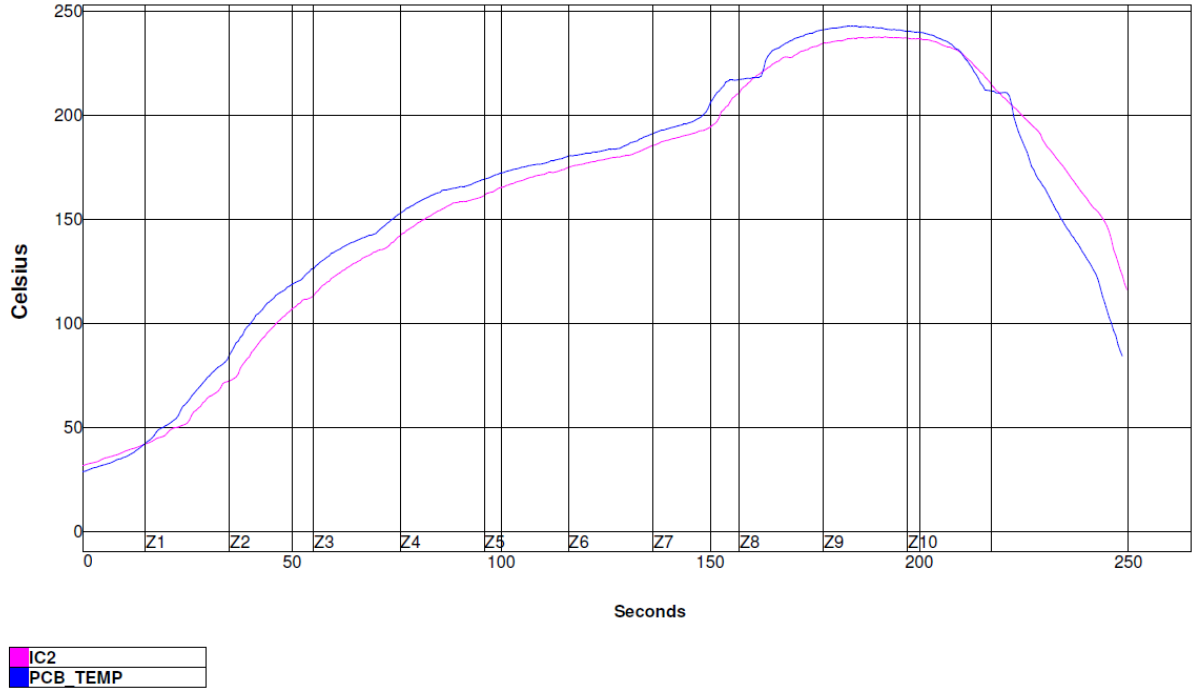


Figure 3 Recommended solder profile (based on Solder Paste: Alpha CVP-390)

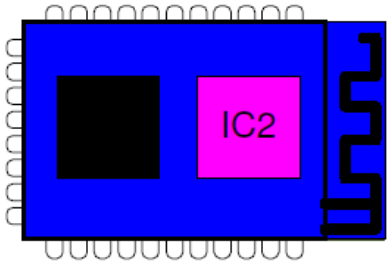


Figure 4 Module temperature measurement positions

Below the characteristics of the recommended soldering profile is tabulated.

Measurement position	Max. Rising Slope [°C/s]	Max. Falling Slope [°C/s]	Soak Time 150-185°C [s]	Reflow time /221°C [s]	Peak temp. [s]
IC2	2.25	-3.62	53.88	52.19	237.90
PCB_TEMP	2.55	-4.27	55.28	50.54	243.05

5 Product Approvals

The RTX4100 has been designed to meet most national regulations for worldwide use. Please refer to ([AN4]) for a list of the national certifications and the requirements that must be meet when integrating the RTX4100 into a product.

6 Ordering Information

6.1 Variants

The basic configuration of the module includes 128 kByte Flash and 16 kByte RAM. For other memory configurations, please contact RTX below.

Ordernumber	Description
RTX4100-IN	Integrated antenna
RTX4100-EX	Antenna signal routed to U.fl connector
RTX4100-EC	Antenna signal routed to edge connector

6.2 Sales offices

Europe and Asia:

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For more information about RTX Telecom modules, applications, services, and for a current sales office listing, please visit our web site http://www.rtx.dk

For more information about purchasing RTX4100 Modules, Evaluation and Development kits, please visit http://www.rtx.dk/LPW/RTX4100

7 Abbreviations

The following abbreviations are used in this document:

AC	Alternating Current
ADC	Analog-to-Digital Converter
API	Application Programming Interface
BSP	Board Support Package
CoAP	Constrained Application Protocol
CoLA	Co-Located Application
DAC	Digital-to-Analog Converter
GPIO	General Purpose Input/Output
IEEE	Institute of Electrical and Electronics Engineers
MCU	Micro Controller Unit
PCB	Printed Circuit Board
RTOS	Real-Time Operating System
SIP	System-in-Package
UART	Universal Asynchronous Receiver/Transmitter
WEP	Wired Equivalent Privacy
Wi-Fi	Wireless Fidelity
WPA	Wi-Fi Protected Access
WPS	Wi-Fi Protected Setup

8 Liability Disclaimer

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