White Paper

Easily Develop RF-compatible Products with Modules: The Differences Between Wireless IC and Module Products

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Abstract

In the era of IoT, where the goal is to connect just about everything to the internet and the exchange of data makes the world go ‘round, Bluetooth® Low Energy is the key to wireless connections. Renesas Electronics answers this call with a lineup of Bluetooth Low Energy microcontrollers that achieve low-power consumption wireless transmissions. Our array of IC products features modules equipped with a crystal resonator and antenna enabling wireless operations. Designers often select an IC product or module solution based on “end product factors” such as mass production, development period, and RF technology. This paper will delve into the differences between wireless IC and module offerings.

Introduction

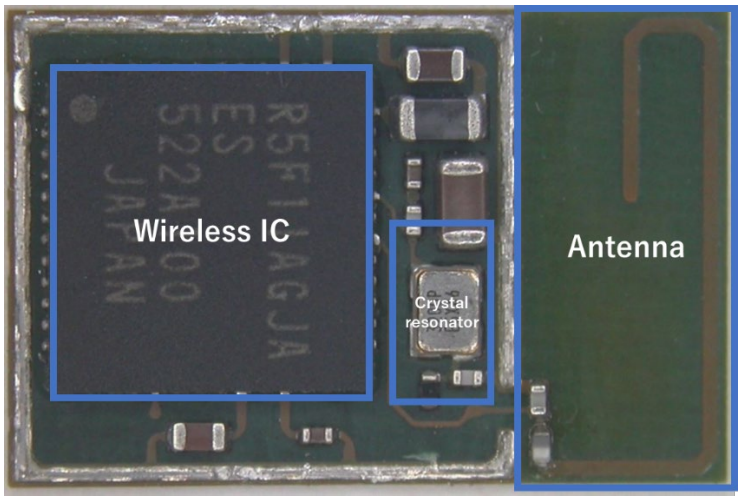
There are basically two ways to commercialize wireless products—final products that mount ICs on the printed board or final products that implement a module solution. Designers often select an IC product or module solution based on end-product factors such as mass production, development period, and RF technology.

There are merits and demerits to both choices. Module solutions are known for significantly reducing the development period, while IC products are less costly. The following explanation of the differences between the IC or module option should help the decision-making process.

Let’s first look at what a Bluetooth module is. A typical example would be a printed board mounted with a wireless IC, a crystal resonator as the clock source for transmitting and receiving radio

waves, as well as an antenna for emitting and receiving radio waves. The configuration also includes passive components for operating the wireless IC.

The crystal resonator serves as the clock oscillation source of radio waves and affects the frequency deviation of radio waves for communication connections. The resonator is adjusted so as not to deviate from the frequency. Also, since the antenna eventually affects the radiation of radio waves, the resonator is adjusted to radiate radio waves efficiently. Spurious emissions or unnecessary radiation can be generated due to the circuit layout around the wireless IC and mounted passive components in wireless products. Bluetooth Low Energy modules are designed to prevent generation of spurious emission or unnecessary radiation.



End products based on IC solutions appear to cost less, but those low prices do not cover design costs, radio law certifications, and the like. Module solutions avoid surprise costs as they are completed packages, with design and certification processes already concluded. A thorough cost comparison is essential before embarking on a new process or development.

Basing product development on an IC solution starts with designing the RF periphery. The layout of crystal resonator, power supply (VDD), ground (GND), and positioning of the bypass capacitors and antenna can be arranged so that noise does not affect the power supply. Board design guidelines provided by the IC manufacturers can aid the engineer at this step. Although influence due to RF noise, a unique characteristic of this circuitry, is an issue, spurious emission and unnecessary radiation can be reduced by faithfully following the guidelines when designing the board. However, without specialized RF knowledge, most engineers will unintentionally overlook key points in board design guidelines, resulting in more time required to redesign the board and ensure specific characteristics. Further complicating the issue is that seemingly minor details, such as the type of capacitor, coil or other passive components, as well as antenna periphery

parts (battery box, etc.), can influence RF characteristics.

If a pattern antenna is mounted, the shape and length will need to be adjusted. A chip antenna is preferable; use the guidelines provided by the chip antenna manufacturer when designing it. A chip antenna is relatively easy to adjust by simply changing external parts.

The above mentions RF designs and the design confirmation tests as required equipment listed below. Costs of obtaining such equipment should also be considered when determining whether to use an IC or module for your wireless design. Naturally, selecting a wireless module eliminates the costs for such testing equipment.

- Transmission test: spectrum analyzer
- Reception test: Bluetooth tester (signal generator)
- Antenna adjustment: requires network analyzer
- Antenna radiation characteristics test: equipment such as anechoic chamber, antenna measurement software, network analyzer, measurement antenna, and rotation table.

The end product must comply with various laws and regulations. Wireless products must abide by radio laws. To receive a certification, you must apply to the appropriate certification authority.

Radio laws differ from country to country. Therefore, the country where certification is acquired depends on which country the end product will be initially sold.

Some country's radio laws use the same test methods and will accept reports and applications for certification based on those test results. Because there are cases like this, if it is necessary to acquire the radio law of each country, you may be able to save the examination fee by acquiring the certification of multiple countries collectively. Testing costs can be kept at a minimum by applying for certification from multiple countries at one time whenever possible.

The following patterns are used in various country's radio laws.

- No need to submit test results for end products using a module
- Test results for end products using a module may be used, but must be submitted with the end product
- Test required for the end product

The RL78/G1D module (RY7011) has been certified in the U.S., Canada, Japan, and Europe according to each country's radio laws. Below is a sample of fees incurred when obtaining radio law certification for use of an IC product. Certification fees differ according to the certification agency, regardless of the availability of certification guidance. The chart below shows costs used

as a reference when estimating total certification fees.

Getting certified in the U.S. costs $5,500 for testing and $3,000 for the authentication and conformity check, totaling $8,500. By asking the same certification agency to obtain certification from the U.S. and Canada at the same time, you might be able to use the same test results for both countries. In this case, you will only need to pay the authentication and conformity check fee of $3,500. Japan requires a Construction Type Certification, which costs $5,000.

Radio law certification in Europe (ETSI/CE) costs $10,000. However, in general, Europe requires certifications other than the radio law standards for end products. Additional tests are required specific to the end product. In Europe, authentication standards may be changed. At that time, additional tests may be required. When such changes are made, test items will increase, and certification expenses rise.

The following comparison table highlights the significant cost difference of radio law certification in the U.S., Canada, Japan, and Europe for end products integrating an IC or module solution.

	End Product using Module Solution	**End Product using IC**
US	$0	$8,500
CANADA	$0	$3,500
JAPAN	$0	$5,000
EUROPE	$0	$10,000
TOTAL	$0	$27,000

※ These costs are listed as references only. Fees vary according to certification authority and timing. Please confirm actual certification fees with your corresponding certification authority.

In addition, the Renesas RL78/G1D module (RY7011) has already received Bluetooth SIG qualification, which means the user only needs to declare the end product with Bluetooth SIG. Declaration fees vary according to membership level. An Adopter Member (no registration fee) must pay $8,000 to list a product, and an Associate Member must pay $4,000. The software protocol stack has been certified for IC products as well and can be used as is. However, if you have created a Bluetooth SIG standard profile, you will need to obtain qualification. At the bare minimum, the RF PHY qualification test for hardware will be necessary. RH PHY test fees vary according to the Bluetooth version, but you can expect to pay at least $5,000 for Bluetooth 4.x. The cost will increase when including temperature and voltage conditions or Bluetooth RF PHY

function support, etc. These costs also need to be considered when making the choice between IC and module products. For details on the cost, please contact the Bluetooth Qualification Consultant (BQC) of the Bluetooth Qualification Test Facility (BQTF).

	Module Solution	**IC Product**
RF PHY test cost	$0	$5,000
Total	$0	$5,000

※ These costs are listed as references only. Fees vary according to certifying organization and timing. Please confirm actual certification fees with your corresponding certification authority.

	Module Solution	**IC Product**
Bluetooth listing cost	Adapter $8,000	Adapter $8,000
	Associate $4,000	Associate $4,000

IC and module products feature even more differences – the development period itself differs according to which solution strategy you follow.

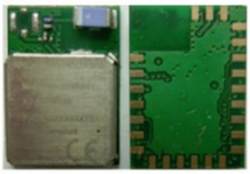
Also, when assembling products using the IC solution, all types of manufacturing processes are required. The RF function cannot be achieved unless the required IC product, crystal resonator, and passive components are available at assembly. It is impossible to start assembling without all parts present. In addition, an RF characteristics test must be carried out in the production. This process is not required when designing in a module-based solution. In other words, use of a module ensures a short turnaround time for the end product.

Renesas' RL78/G1D MCU with Bluetooth Low Energy wireless technology comes in both IC and module formats. Both the IC and module products use the same protocol, stack, and software. This allows the designer to employ a module solution for commercialization of the first end product, then switch to use of the IC product at a later phase. The designer is free to choose between the IC and module solution based on mass production scale, development period, and RF technology knowledge.

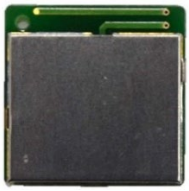
United States:

	 Inventek Systems
Parts number	ISMRL78G1D-L31
RF chip	RL78/G1D Bluetooth v4.2 single mode (Bluetooth Low Energy) Master/Slave
Size	11 x 13 mm
Certification	FCC (US)
Evaluation Board	ISMRL78G1D-EVB
Web Site	http://www.inventeksys.com/products-page/ble/ble/

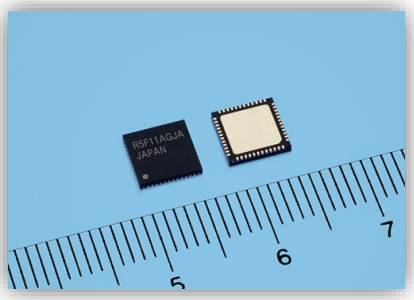
Singapore:

	 RFCOM Technologies Pte Ltd
Parts number	RTBTM01
RF chip	RL78/G1D Bluetooth v4.2 single mode (Bluetooth Low Energy) Master/Slave
Size	10.0mm x 14.0mm x 1.9mm
Certification	RoHS, CE, FCC, RCM
Evaluation Board	RTBTM01 Evaluation Kit
Web Site	https://www.rfcom-tech.com/product/rtbtm01/

Korea:

	 New TC Corp.
Parts number	PM-BLE
RF chip	RL78/G1D Bluetooth v4.2 single mode (Bluetooth Low Energy) Master/Slave
Size	15 x 15 x 2.6
Certification	KC(Korea) MIC (Japan)
Evaluation Board	PM-BLE Evaluation Board
Web Site	http://www.newtc.co.kr/dpshop/shop/item.php?it_id=1523843598

The Renesas Electronics lineup offers both IC and module products, as shown below.



RL78/G1D (R5F11A)

RL78/G1D Module (RY0711)

Please consider the following list of differences when choosing between IC and module products for your next development project.

	RL78/G1D IC	RL78/G1D Module
Application	Consumer/industrial use	Consumer use
Operating ambient temperature	-40 degrees C to 85 degrees C	-25 degrees C to 75 degrees C
Radio Law certification	Must be obtained by customer	MIC (Japan), FCC, IC, and CE already obtained
Bluetooth certification	RF PHY certification and registration required	Already certified

	 Renesas Electronics Corporation.
Parts number	RY7011A0000DZ00#001 MOQ 2.5K RY7011A0000DZ00#002 MOQ 100
RF chip	RL78/G1D Bluetooth v4.2 single mode (Bluetooth Low Energy) Master/Slave
Size	8.95 x 13.35 x 1.7 mm
Certification	FCC (US), IC (Canada), CE (Europe), MIC (Japan)
Evaluation Board	RM-110-RFB-2 (Sold by Naito Densei Machida Mfg.)
Web Site	https://www.renesas.com/products/microcontrollers-microprocessors/rl78/rl78g1x/rl78g1d.html

Find Renesas Electronics' Bluetooth® Low Energy solutions at the following link.
https://www.renesas.com/solutions/bluetooth