

# Lyra S - Bluetooth Module

Datasheet

v1.0

## 1 INTRODUCTION

The Lyra S is a module designed and built to meet the performance, security, and reliability requirements of battery-powered IoT products running on Bluetooth networks.

Based on the Silicon Labs EFR32BG22 SoC, the Lyra S enables Bluetooth® Low Energy connectivity while delivering best-in-class RF range and performance, future-proof capability for feature and OTA firmware updates, enhanced security features, and low energy consumption.

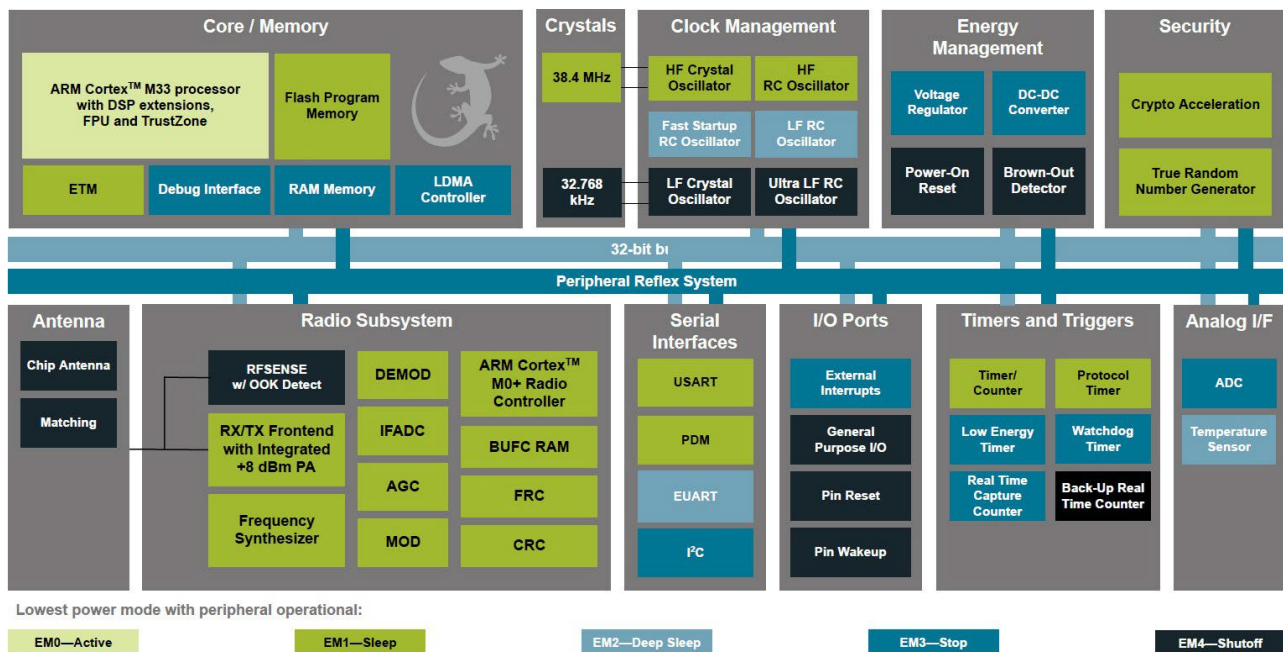
Lyra S modules are a full solution that comes with fully upgradeable, robust software stacks, world-wide regulatory certifications, advanced development and debugging tools, and support that will minimize and simplify the engineering and development of your end-products helping to accelerate their time-to-market.

The Lyra S is intended for a broad range of applications, including:

- Asset Tags and Beacons
- Portable Medical
- Sports, Fitness, and Wellness devices
- Connected Home
- Industrial and Building Automation
- Bluetooth mesh Low Power Nodes

### KEY FEATURES

- Bluetooth 5.2
- Built-in antenna or RF pin
- Up to 6 dBm TX power
- -98.6 dBm BLE RX sensitivity at 1 Mbps
- 32-bit ARM Cortex-M33 core at up to 76.8 MHz
- 512/32 kB of Flash/RAM memory
- Optimal selection of MCU peripherals
- 25 GPIO pins
- 6 mm × 6 mm × 1.1 mm



## 2 FEATURE LIST

### **Supported Protocols**

- Bluetooth Low Energy (Bluetooth 5.2)
  - Direction finding
  - 1M, 2M, and LE Coded PHYs
- Bluetooth Mesh Low Power Node

### **Wireless System-on-Chip**

- 2.4 GHz radio
- TX power up to 6 dBm
- High-performance 32-bit ARM Cortex-M33® with DSP instruction and floating-point unit for efficient signal processing
- Up to 512 kB flash program memory
- 32 kB RAM data memory
- Embedded Trace Macrocell (ETM) for advanced debugging

### **High-Receiver Performance**

- -106.4 dBm sensitivity (0.1% BER) at 125 kbps GFSK
- -102.3 dBm sensitivity (0.1% BER) at 500 kbps GFSK
- -98.6 dBm sensitivity (0.1% BER) at 1 Mbps GFSK
- -95.9 dBm sensitivity (0.1% BER) at 2 Mbps GFSK

### **Low-Energy Consumption**

- 4.2 mA RX current at 1 Mbps GFSK
- 4.6 mA TX current at 0 dBm output power
- 26 µA/MHz in Active Mode (EM0)
- 1.40 µA EM2 DeepSleep current (RTCC running from LFXO, Full RAM retention)

### **Regulatory Certifications**

- FCC
- EU
- ISED/ISED
- MIC/TELEC
- KC

### **Wide Operating Range**

- 1.8 to 3.8 V
- -40 to +105 °C and -40 to +85 °C versions available

### **Dimensions**

- 6 mm × 6 mm × 1.1 mm

### **Security Features**

- Secure Boot with Root of Trust and Secure Loader (RTSL)
- Hardware Cryptographic Acceleration for AES128/256, SHA-1, SHA-2 (up to 256-bit), ECC (up to 256-bit), ECDSA, and ECDH
- True Random Number Generator (TRNG) compliant with NIST SP800-90 and AIS-31
- ARM® TrustZone®
- Secure Debug with lock/unlock

### **Wide Selection of MCU Peripherals**

- Analog to Digital Converter (ADC)
  - 12-bit @ 1 Msps
  - 16-bit @ 76.9 ksps
- 25 General Purpose I/O pins with output state retention and asynchronous interrupts
- 8 Channel DMA Controller
- 12 Channel Peripheral Reflex System (PRS)
- 4 × 16-bit Timer/Counter with 3 Compare/Capture/PWM channels
- 1 × 32-bit Timer/Counter with 3 Compare/Capture/PWM channels
- 32-bit Real Time Counter
- 24-bit Low Energy Timer for waveform generation
- 1 × Watchdog Timer
- 2 × Universal Synchronous/Asynchronous Receiver/Transmitter (UART/SPI/SmartCard (ISO 7816)/IrDA/I2S)
- 1 × Enhanced Universal Asynchronous Receiver/Transmitter (EUSART)
- 2 × I2C interface with SMBus support
- Digital microphone interface (PDM)
- RFSense with selective OOK mode

### 3 ORDERING INFORMATION

Table 1: Ordering information

Ordering Code	Protocol Stack	TX Power Rating	Antenna	RF Shield	Flash (kB)	RAM (kB)	LF Clock	GPIO	Temp Range
453-00091R	Bluetooth 5.2	6 dBm	76.8 MHz	Built-in	Yes	512	32	25	-40 to 105 °C

### 4 SYSTEM OVERVIEW

#### 4.1 Introduction

The Lyra S module combines an energy friendly MCU with a highly integrated radio transceiver in a SiP module with a robust, integrated antenna. This section gives a short introduction to the features of the module.

The block diagram for the Lyra S module is shown in Figure 1. The wireless module includes the EFR32BG22 wireless System on a Chip (SoC), required decoupling capacitors and inductors, 38.4 MHz crystal, RF matching circuit, and integrated antenna.

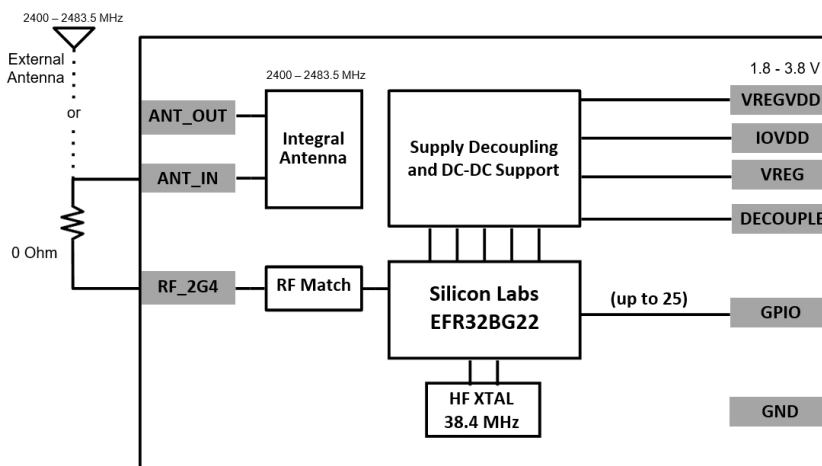


Figure 1: Lyra S block diagram

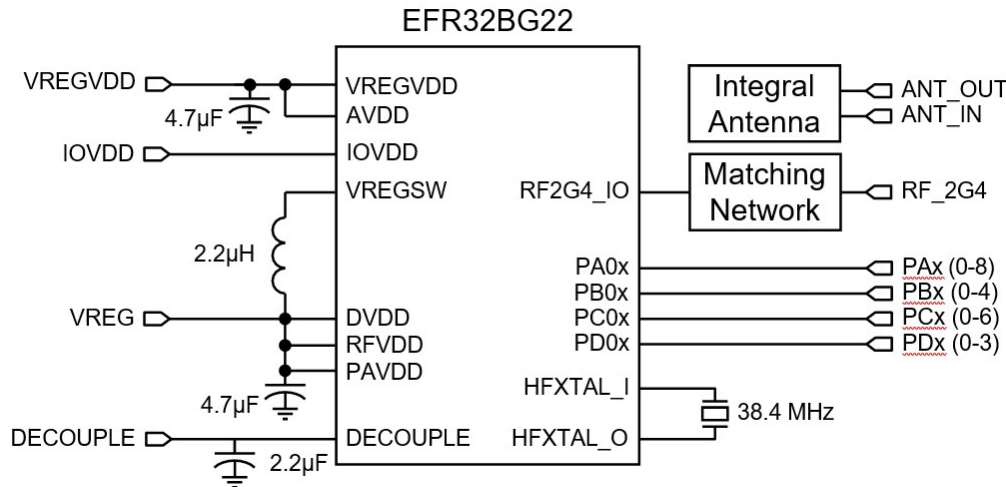


Figure 2: Module schematic

## 4.2 EFR32BG22 SoC

The EFR32BG22 SoC features a 32-bit ARM Cortex M33 core, a 2.4 GHz high-performance radio, 512 kB of flash memory, a rich set of MCU peripherals, and various clock management and serial interfacing options.

## 4.3 Antenna

Lyra S modules include an integral antenna on board with the characteristics detailed in [Table 2](#).

Table 2: Antenna efficiency and peak gain (Lyra S)

Parameter	With Optimal Layout	Note
Efficiency	-1 to -2 dB	Antenna efficiency, gain and radiation pattern are highly dependent on the application PCB layout and mechanical design.
Peak gain	2.3 dBi	

## 4.4 Power Supply

The Lyra S requires a single nominal supply level of 3.0 V to operate. All necessary decoupling and filtering components are included in the module, and the supply is fully regulated internally.

## 5 CERTIFICATIONS

This section details the regulatory certification status of the module in various regions. The address for the module manufacturer and certification applicant is:

Laird Connectivity  
50 South Main Street, Suite 1100  
Akron, Ohio 44308

### 5.1 Qualified Antennas

Lyra S modules have been tested and certified both with the on-board antennas and with external antennas attached to the RF pin (RF\_2G4). Performance characteristics for the integral antennas are presented in Table 2. Details for the external qualified reference antennas are summarized in Table 3.

**Table 3: Qualified antennas**

Antenna Type		Maximum Gain	Impedance	
Connectorized Coaxial Dipole		2.8 dBi	50 Ω	

Manufacturer	Model	Laird Connectivity Part Number	Type	Connector	Peak Gain	
					2400-2500 MHz	2400-2480 MHz
Mag.Layers	EDA-8709-2G4C1-B27-CY	0600-00057	Dipole	IPEX MHF4	2 dBi	-

Any external antenna of the same general type and of equal or less directional gain as listed in the above table and having similar in-band and out-of-band characteristics, can be used in the regulatory areas that have a full modular radio approval, such as USA and Canada, as long as spot-check testing is performed to verify that no performance changes compromising compliance have been introduced. In the particular FCC case, in order to comply with e-CFR Title 47, Part 15, Subpart C, Section 15.203 the module integrator using an external antenna must ensure it has a unique connector or it is undetachable. In countries applying the ETSI standards, like the EU countries, the radiated emissions are always tested with the end-product and the antenna type is not critical, but antennas with higher gain may violate some of the regulatory limits.

When using instead an external antenna of a different type (such as a chip antenna, a PCB trace antenna or a patch) or having non-similar in-band and out-of-band characteristics, but still with a gain less than or equal to the maximum gain listed in the table above, it can be added as a permissive change to the existing grant/certificate. In most of these cases, some radiated emission testing is demanded, but no modular or end-product re-certification is required.

On the other hand, all products with antennas having more gain than the maximum gain listed in the table above are very likely to require a full new end-product certification. Since the exact permissive change procedure is chosen on a case-by-case basis, please consult your test house and/or a certification body for understanding the correct approach based on your unique design. You might also want or need to get in touch with Silicon Labs for any authorization letter that your certification body might ask for.

## 5.2 European Union (EU) – CE

The Lyra P modules are in conformity with the essential requirements and other relevant requirements of the Radio Equipment Directive (RED) (2014/53/EU).

Please note that every application using the Lyra P module must perform the radio EMC tests on the end product, according to EN 301 489-17.

It is ultimately the responsibility of the manufacturer to ensure the compliance of the end-product as a whole. The specific product assembly may have an impact to RF radiated characteristics, and manufacturers should carefully consider RF radiated testing with the end-product assembly.

A formal Declaration of Conformity (DoC) is available at the product web page which is reachable starting from <https://www.lairdconnect.com/>.

## 5.3 USA - FCC

This device complies with FCC's e-CFR Title 47, Part 15, Subpart C, Section 15.247 (and related relevant parts of the ANSI C63.10.2013 standard) when operating with the embedded antenna or with the antenna type(s) listed in Table 43. Operation is subject to the following two conditions:

- This device may not cause harmful interference, and
- 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 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 in- stalled (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, 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. However, such requirement is typically applicable to the final host. Thus, the final host will still need to be re- assessed for compliance to this portion of 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 in the user's manual of the end product which integrates this module.

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

- **OEM/Host Manufacturer Responsibilities**

OEM/host manufacturers are ultimately responsible for the compliance of the host system.

This module must not be incorporated into any other radio device or system without retesting for compliance as multi-radio and combined equipment.

The Lyra S is a shielded design and comes with full modular approval.

## Separation

- To meet the SAR exemption for portable conditions, the minimum separation distance indicated in [Table 4](#) must be maintained between the human body and the radiator (antenna) at all times.
- This transmitter module is tested in a standalone mobile 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 will be required, ultimately leading to a Class II Permissive Change, or more rarely to a new grant.

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**Important Note:** In the event that these conditions cannot be met, then for the FCC authorization to remain valid the final product must undergo additional testing to evaluate the RF exposure, and a permissive change must be applied. The evaluation (SAR) 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 typically acting as the grant holder's agent.

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## End Product Labeling

Lyra S modules are not labeled with their own FCC ID due to their size. Instead, the packaging label contains the FCC ID. In all cases when 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. In that case, the final end product must be labeled in a visible area with the following:

**For Lyra S:**

**Contains Transmitter Module FCC ID: SQG-LYRAS**

or

**Contains FCC ID: SQG-LYRAS**

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**Final note:** As long as all the conditions in this and all the above sections are met, further RF testing of the transmitter with full modular approval is not required. However, OEMs are still supposed to follow the good practice and the FCC 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.

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## Class B Device Notice – Lyra S

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio / TV technician for help.

## 5.4 ISED Canada

### ISED

This radio transmitter (IC: 3147A-LYRAS; HVIN: LYRA-S) has been approved by Innovation, Science and Economic Development Canada (ISED Canada, formerly Industry Canada) to operate with the embedded antenna and with the antenna type(s) listed in [Table 3](#), with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain listed, are strictly prohibited for use with this device.

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

- This device may not cause interference; and
- This device must accept any interference, including interference that may cause undesired operation of the device

### RF Exposure Statement

Exceptions from routine SAR evaluation limits are given in RSS-102 Issue 5.

For the Portable use case, RF exposure or SAR evaluation is not required in all cases, at any distance from the human body, except when the Lyra S is used at full power with the external reference dipole antenna, in which case the separation distance from the human body must be of 13 mm or more for the exemption.

For more details, refer to the values stated in [Table 4](#). If the separation distances from the human body are less than the distances mentioned in the tables, then the OEM integrator is responsible for evaluating the SAR.

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 with the limit(s) exposed in the RF Exposure Analysis.

### OEM Responsibilities to Comply with ISED Regulations

The module has 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.

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**Important Note:** In the event that these conditions cannot be met, the final product will have to undergo additional testing to evaluate the RF exposure in order for the ISED authorization to remain valid, and a permissive change will have to be applied with the help of the customer's own Telecommunication Certification Body typically acting as the certificate holder's agent.

In the case of the Lyra S, this variant is a shielded design, and consequently comes with a full modular approval.

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### End Product Labeling

The Lyra S modules are not labeled with their own IC ID due to their size. Instead, the packaging label contains the IC ID. In all cases when the IC 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. In that case, the final end product must be labeled in a visible area with the following:

#### For Lyra S:

**Contains Transmitter Module IC:** 3147A-LYRAS or **Contains IC:** 3147A-LYRAS

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.



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**Final Note:** As long as all the conditions above are met, further transmitter testing is not required. However, 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.).

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## CAN ICES-003 (B) – Lyra S

This Class B digital apparatus complies with Canadian ICES-003.

### ISED (Français)

Le présent émetteur radio (IC: 3147A-LYRAS; HVIN: LYRA-S) a été approuvé par Innovation, Sciences et Développement Économique Canada (ISED Canada, anciennement Industrie Canada) pour fonctionner avec l'antenne intégrée et le ou les types d'antenne énumérés à la section [Table 4](#), avec le gain maximal admissible indiqué. Les types d'antenne non inclus dans cette liste, ayant un gain supérieur au gain maximal indiqué, sont strictement interdits d'utilisation avec cet appareil.

Ce composant est conforme aux normes RSS, exonérées de licence d'ISED. Son mode de fonctionnement est soumis aux deux conditions suivantes:

- Ce composant ne doit pas générer d'interférences.
- Ce composant doit pouvoir être soumis à tout type de perturbation y compris celle pouvant nuire à son bon fonctionnement.

### Déclaration d'exposition RF

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

Pour le cas d'utilisation Portable, l'exposition RF ou l'évaluation SAR n'est pas nécessaire dans tous les cas, à n'importe quelle distance du corps humain, sauf lorsque le Lyra S est utilisé à pleine puissance avec l'antenne dipôle de référence externe, auquel cas la distance de séparation du le corps humain doit être de 13 mm ou plus pour l'exemption.

Pour plus de détails, reportez-vous aux valeurs indiquées dans [Table 5](#) and [Table 6](#): si les distances de séparation du corps humain sont inférieures aux distances mentionnées dans les tableaux, alors l'intégrateur OEM est responsable de l'évaluation du SAR.

Le module répond aux exigences des cas d'utilisation mobile lorsque la distance de séparation minimale du corps humain est de 20 cm ou plus, conformément aux limites exposées dans l'analyse d'exposition RF.

### Responsabilités des OEM pour une mise en conformité avec le Règlement du Circuit Intégré

Le module a été approuvé pour l'intégration dans des produits finaux exclusivement réalisés par des OEM sous les conditions suivantes:

L'antenne doit être installée de sorte qu'une distance de séparation minimale indiquée ci-dessus soit maintenue entre le radiateur (antenne) et toutes les personnes avoisinante, ce à tout moment.

Le module émetteur ne doit pas être localisé ou fonctionner avec une autre antenne ou un autre transmetteur que celle indiquée plus haut.

Tant que les deux conditions ci-dessus sont respectées, il n'est pas nécessaire de tester ce transmetteur de façon plus poussée. Cependant, il incombe à l'intégrateur OEM de s'assurer de la bonne conformité du produit fini avec les autres normes auxquelles il pourrait être soumis de fait de l'utilisation de ce module (par exemple, les émissions des périphériques numériques, les exigences de périphériques PC, etc.).

**Remarque Importante:** Dans le cas où ces conditions ne peuvent être satisfaites (pour certaines configurations ou co-implantation avec un autre émetteur), l'autorisation ISED n'est plus considérée comme valide et le numéro d'identification ID IC ne peut pas être apposé sur le produit final. Dans ces circonstances, l'intégrateur OEM sera responsable de la réévaluation du produit final (y compris le transmetteur) et de l'obtention d'une autorisation ISED distincte.

Dans le cas du Lyra S, cette variante est une conception blindée et est par conséquent livrée avec une approbation modulaire complète.

### *Étiquetage des produits finis*

Les modules Lyra S ne sont pas étiquetés avec leur propre ID IC en raison de leur taille. Au lieu de cela, l'étiquette d'emballage contient l'ID IC. Dans tous les cas, lorsque l'ID IC n'est pas visible lorsque le module est intégré au sein d'un autre produit, cet autre produit dans lequel le module est installé devra porter une étiquette faisant apparaître les référence du module intégré. Dans un tel cas, sur le produit final doit se trouver une étiquette aisément lisible sur laquelle figurent les informations suivantes:

**Contient le module transmetteur:** 3147A-LYRAS or **Contient le circuit:** 3147A-LYRAS

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**Note finale:** L'intégrateur OEM doit être conscient qu'il ne doit pas fournir, dans le manuel d'utilisation, d'informations relatives à la façon d'installer ou de d'enlever ce module RF ainsi que sur la procédure à suivre pour modifier les paramètres liés à la radio.

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### **CAN ICES-003 (B) - Lyra S**

Cet appareil numérique de classe B est conforme à la norme canadienne ICES-003

## 5.5 Proximity to Human Body

When using the Lyra S modules in an application where the radio is located close to the human body, the human RF exposure must be considered. FCC, ISED, and EU 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 and human body varies accordingly. The properties of the Lyra S modules allow for the minimum separation distances detailed in the tables below for 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 4: Minimum separation distances for SAR evaluation exemption (Lyra S)**

Certification	Lyra S
FCC	0 mm
ISED	13 mm with the reference external antenna 12 mm for integral antenna
EU	The RF exposure must always be evaluated using the end-product when transmitting with powerlevels higher than 20 mW (13 dBm).

For FCC and ISED, using the module in end-products where the separation distance from the human body is smaller than that listed above is allowed but requires evaluation of the RF exposure in the final assembly and applying for a *Class 2 Permissive Change* or *Change of ID* to be applied to the existing FCC/ISED approvals of the module. For CE, RF exposure must be evaluated using the end- product in all cases when transmitting at more than the power level indicated in the table.

**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.

## 5.6 Japan – MC

The Lyra S are certified in Japan with certification number 209-J00457

The Lyra S modules are not labeled with their own ID due to their size. Instead, the packaging label contains the ID. In all cases when the 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. In that case, the final end product must be labeled in a visible area.

It is the end-product manufacturer's responsibility to ensure that the module is configured to meet the limits documented in the formal certification test report available at <https://www.lairdconnect.com/>. If needed, refer to the API reference manual(s) to learn how to configure the maximum RF TX power for the normal operations.

Since September 1, 2014 it is allowed (and highly recommended) that a manufacturer who integrates a radio module in their host equipment places the certification mark and certification number on the outside of the host equipment. This combination of mark and number, and their relative placement, is depicted in [Figure 5](#), and depending on the size of the module it might also appear on the topshield markings of the radio module. The certification mark and certification number must be placed close to the text in the Japanese language which is provided below. This change 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 device which is approved for use in Japan.

It is recommended that the host device bears a label showing the Japanese “GITEKI” mark and the certification number accompanied by the following statement:

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: *This equipment contains specified radio equipment that has been certified to the Technical Regulation Conformity Certification under the Radio Law.*



**Figure 3: GITEKI mark and number**

## 5.7 South Korea – KC

The Lyra S modules have a RF certification for import and use in South-Korea.

Certification number is: R-C-L7C-LYRAS

When integrating the RF-certified module, an end-product is exempted from doing the RF emission testing, as long as the recommended design guidance is followed, and the approved antennas are used.

EMC testing, and any other relevant test, might still be required for full compliance.

## 5.8 Bluetooth Qualification

The Lyra S modules come at launch with a pre-qualified Bluetooth Low Energy RF-PHY Tested Component having Declaration ID of XXXXX and QDID of XXXX and having a listing date of CXXXXXX

Because the validity set by the SIG for Tested Components is currently of 3 years, during the product lifetime Laird Connectivity will renew this Component as it expires, whenever applicable. Renewed Tested Components will come with new DIDs and QDIDs, and these will be then referred to in end-product listings. Such new DIDs and QDIDs can be discovered starting from the original ones.

This module's RF-PHY Tested Component should be combined with the latest Wireless Gecko Link Layer and Host pre-qualified components by Silicon Labs, when in the process of qualifying an end-product embedding the Lyra S via the SIG's Launch Studio.

## 6 REVISION HISTORY

Version	Date	Notes	Contributor(s)	Approver
1.0	TBD	Initial Release		Jonathan Kaye