

Sterling-LWB Module

APPLICATION GUIDE



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1 Introduction

1.1 Purpose & Scope

The purpose of this document is to provide details regarding the design and integration of certified antennas to the Sterling-LWB module. It covers all four certified off module antenna options, which consist of a ceramic chip, LSR dipole, LSR FlexNotch, and LSR FlexPIFA antenna. It will inform the designer as to the required PCB details required to retain the LSR modular certification for the Sterling-LWB module.

1.2 Applicable Documents

- *Sterling-LWB Datasheet (330-0190)*
- *LSR 2.4 GHz Dipole Antenna Datasheet (330-0016)*
- *LSR U.FL to RPSMA Cable Datasheet (330-0018)*
- *LSR 2.4 GHz FlexPIFA Antenna Datasheet (330-0149)*
- *LSR 2.4 GHz FlexNotch Antenna Datasheet (330-0150)*

2 Sterling-LWB Module and Accessories

The Sterling-LWB Module is a System in Package (SIP) module. The Sterling-LWB module is certified with several off module antennas.


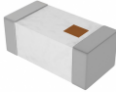




	Part Number	Description
	LSR 450-0159 LSR 450-0159R LSR 450-0159C	Sterling-LWB Module Sterling-LWB Module, Tape & Reel Sterling-LWB Module, Cut Tape
	Johanson 2450AT18D0100	2.4 GHz Ceramic Chip Antenna
	LSR 001-0014	2.4 GHz FlexPIFA Antenna with U.FL Cable
	LSR 001-0015	2.4 GHz FlexNotch Antenna
	LSR 001-0001	2.4 GHz Dipole Antenna with Reverse Polarity SMA Connector
	LSR 080-0001	U.FL to Reverse Polarity SMA Bulkhead Cable 105 mm

Table 1 Sterling-LWB Module and Accessories

The information in this document is subject to change without notice.

3 PCB Layout Requirements

Since this module and its associated set of approved antennas has been certified by the FCC and Industry Canada (IC) as a Modular Radio, the end user is authorized to integrate this module into an end-product, and is solely responsible for the Unintentional Emissions levels produced by the end-product.

In order to preserve the Modular Radio certifications, the integrator of the module must abide by the PCB layout recommendations outlined in the following paragraphs. Any divergence from these recommendations will invalidate the modular radio certifications and require the integrator to re-certify the module and/or end-product.

The module must be used with one of the approved antennas:

1. Johanson Technology 2450AT18D0100 Ceramic Chip Antenna.
2. LSR 001-0014 2.4 GHz FlexPIFA Antenna w/U.FL cable.
3. LSR 001-0015 2.4 GHz FlexNotch Antenna w/U.FL cable.
4. LSR 001-0001 center-fed 2.4 GHz dipole antenna and 080-0001 U.FL to Reverse Polarity SMA connector cable.

When using the module and the reference design that supports the off module U.FL connector(s), you may use a substitute antenna if the antenna gain is less than or equal to +2 dBi. It may be possible to use a substitute chip antenna, however there are restrictions so please contact LSR for guidance prior to making any chip antenna substitutions.

LSR provides a 4-Layer FCC Modular Certified reference design. It is a controlled impedance PCB that uses microstrip trace design to route RF signals from the Sterling-LWB module to the Antennas and coaxial connectors.

Please use the latest CAD files from the LSR web site when incorporating the Sterling-LWB module into a new design. CAD files are provided in native Mentor Graphics PADS PCB and PADS Logic formats, as well as ASCII, Gerber, and PDF formats. CAD files can also be translated to most popular CAD package. Contact LSR Tech support for CAD translation.

Visit the LSR web site <http://www.lsr.com> for current PCB and Schematic CAD files.

4 Reference Designs

In order to use the modular certification for your design, it is critical that the reference design is correctly followed. This section describes the details of using a PCB that is a 4-layer stack up. The full 4-layer Chip Antenna PCB reference design is shown in Figure 1, Schematic Figure 2, and Bill of Materials Table 2. The full 4-layer U.FL (external antenna) PCB reference design is shown in Figure 3 , Schematic Figure 4, and Bill of Materials Table 3.

It is not required to replicate the entire design, but what is required are the circuitry and layout as it pertains to the antenna configuration being used in your design as shown in Chip Antenna

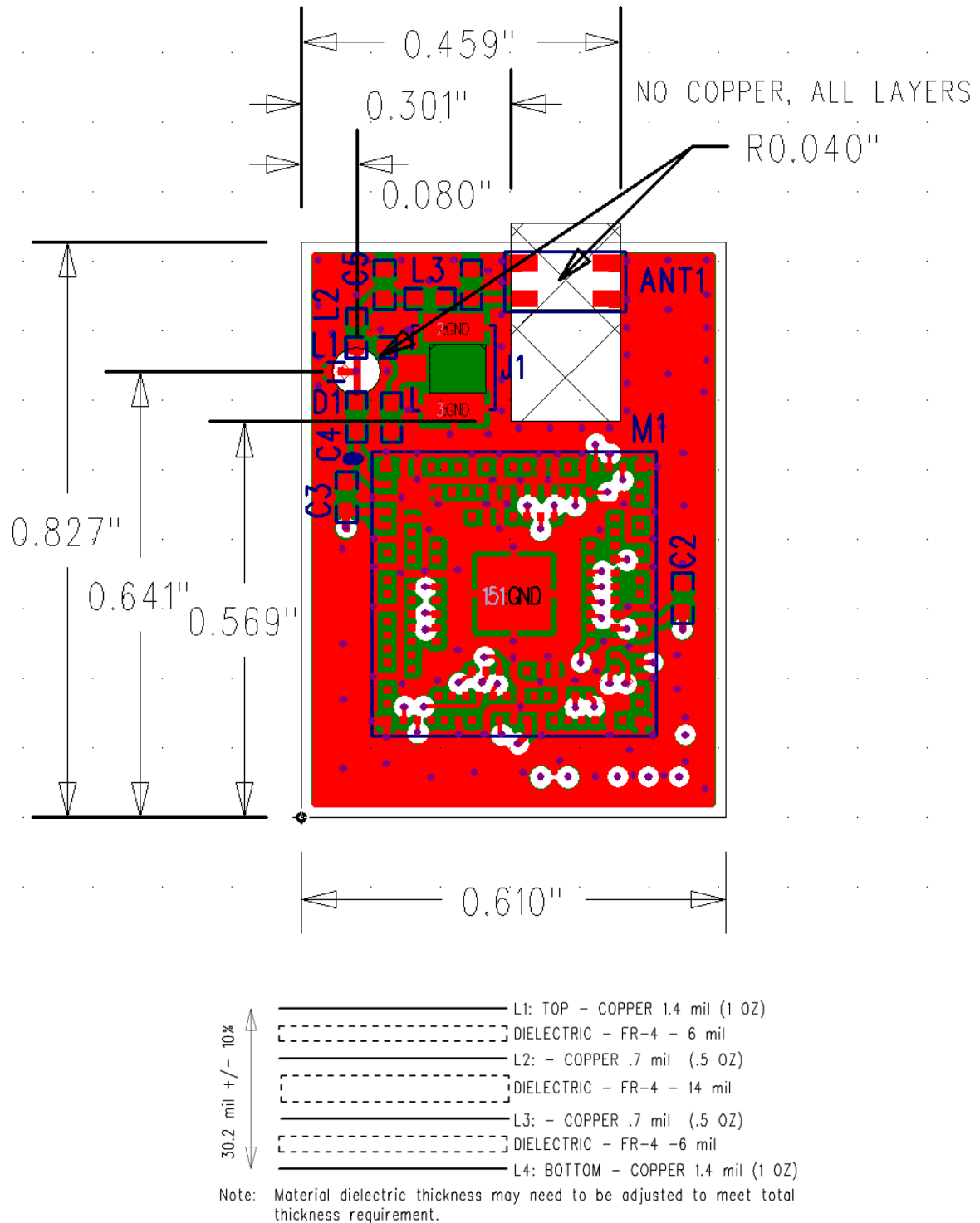


Figure 1 Chip Antenna Reference Design through Figure 4.

2.4 GHz Chip Antenna Implementation

When using the certified Chip Antenna (Johanson Part Number 2450AT18D0100), the PCB layout shown in Chip Antenna

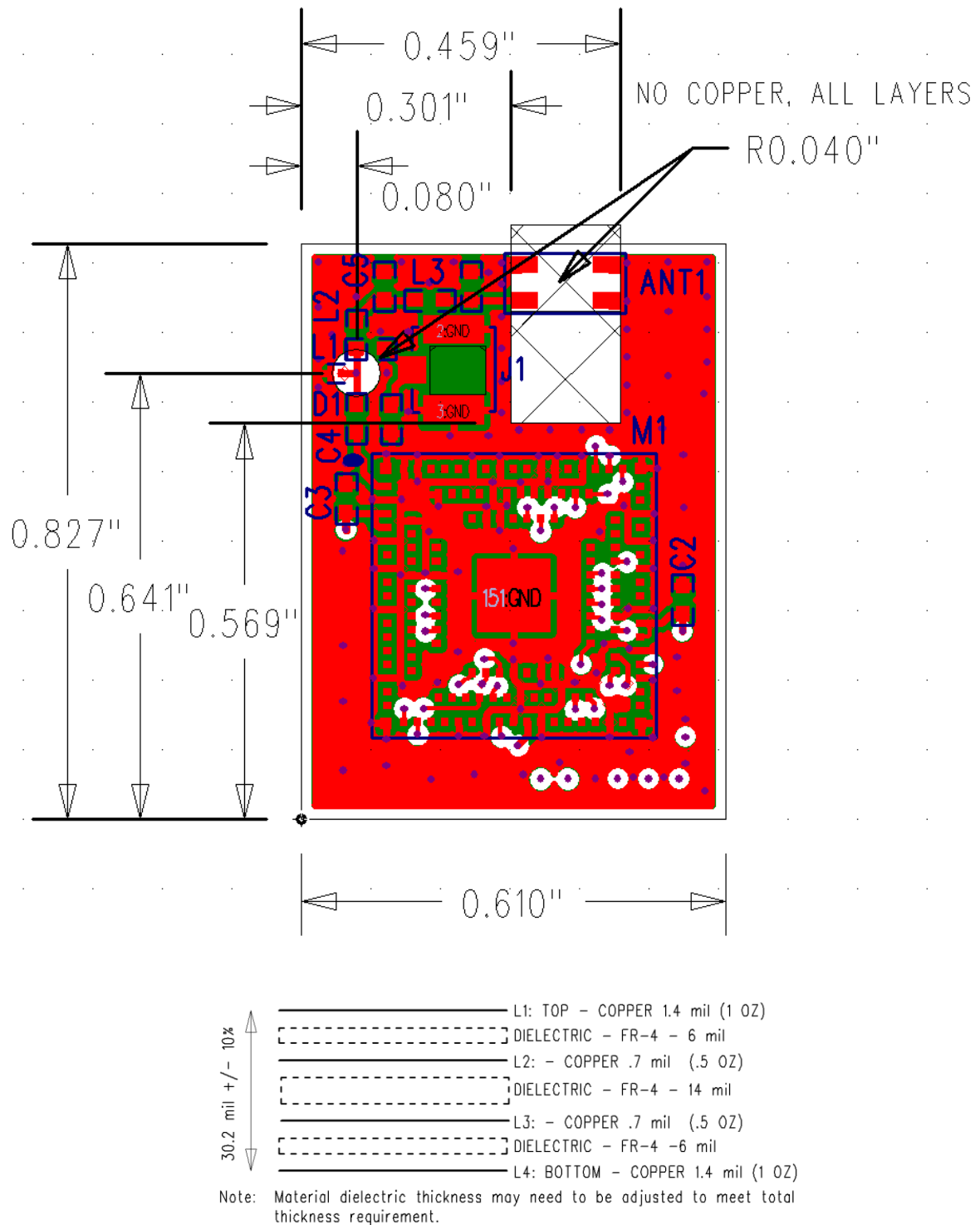


Figure 1 Chip Antenna Reference Design should be followed. It is acceptable to either populate or remove the U.FL circuitry J1 on any of the designs.

* RF components that cannot be substituted are shown in Table 21.

2.4 GHz U.FL Implementation (external antenna)

When using any of the certified antennas, the PCB layout shown in **Error! Reference source not found.** should be followed. Component J1 should be populated as shown in the schematic.

* RF components that cannot be substituted are shown in Table 3.

4.1 Chip Antenna

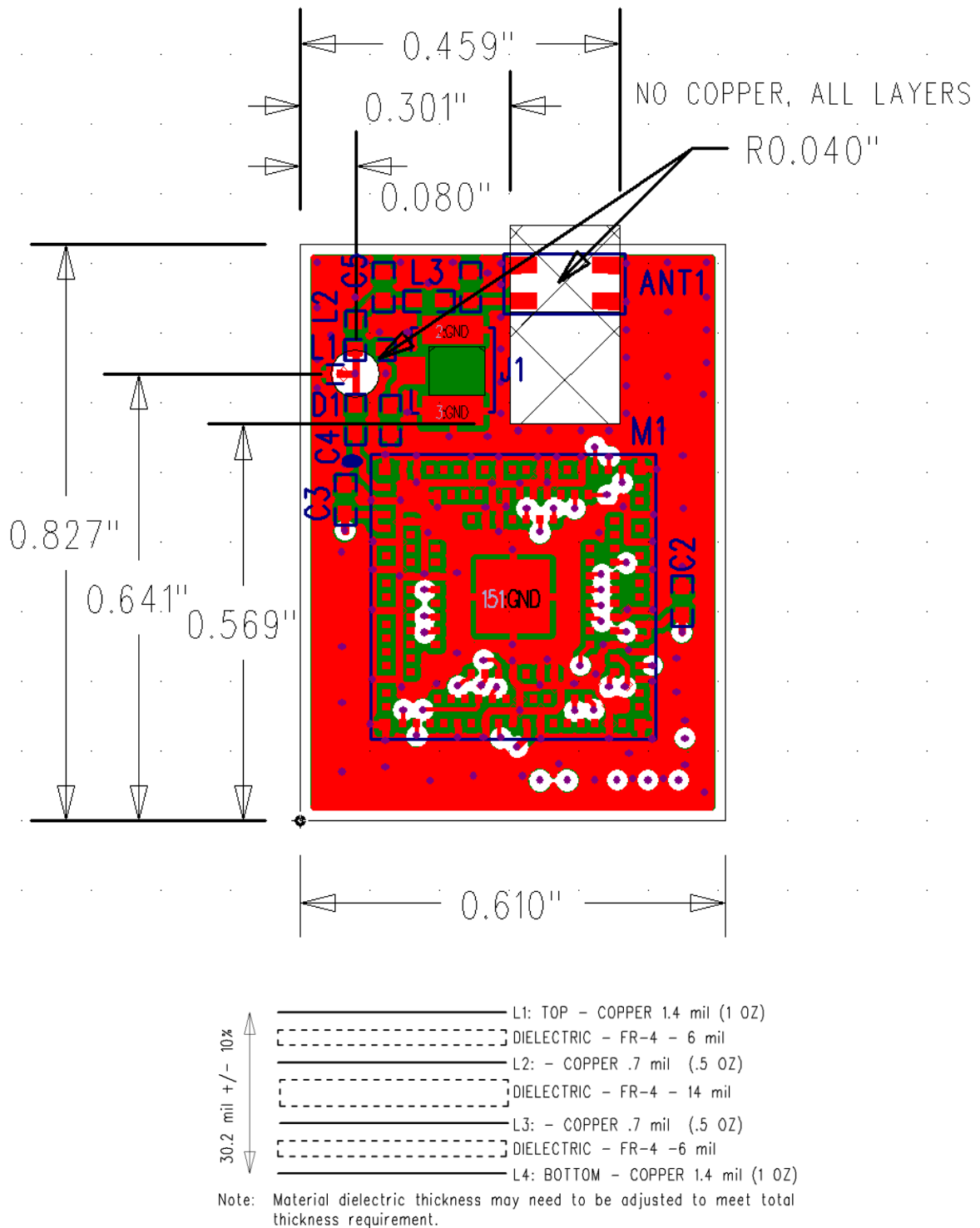


Figure 1 Chip Antenna Reference Design

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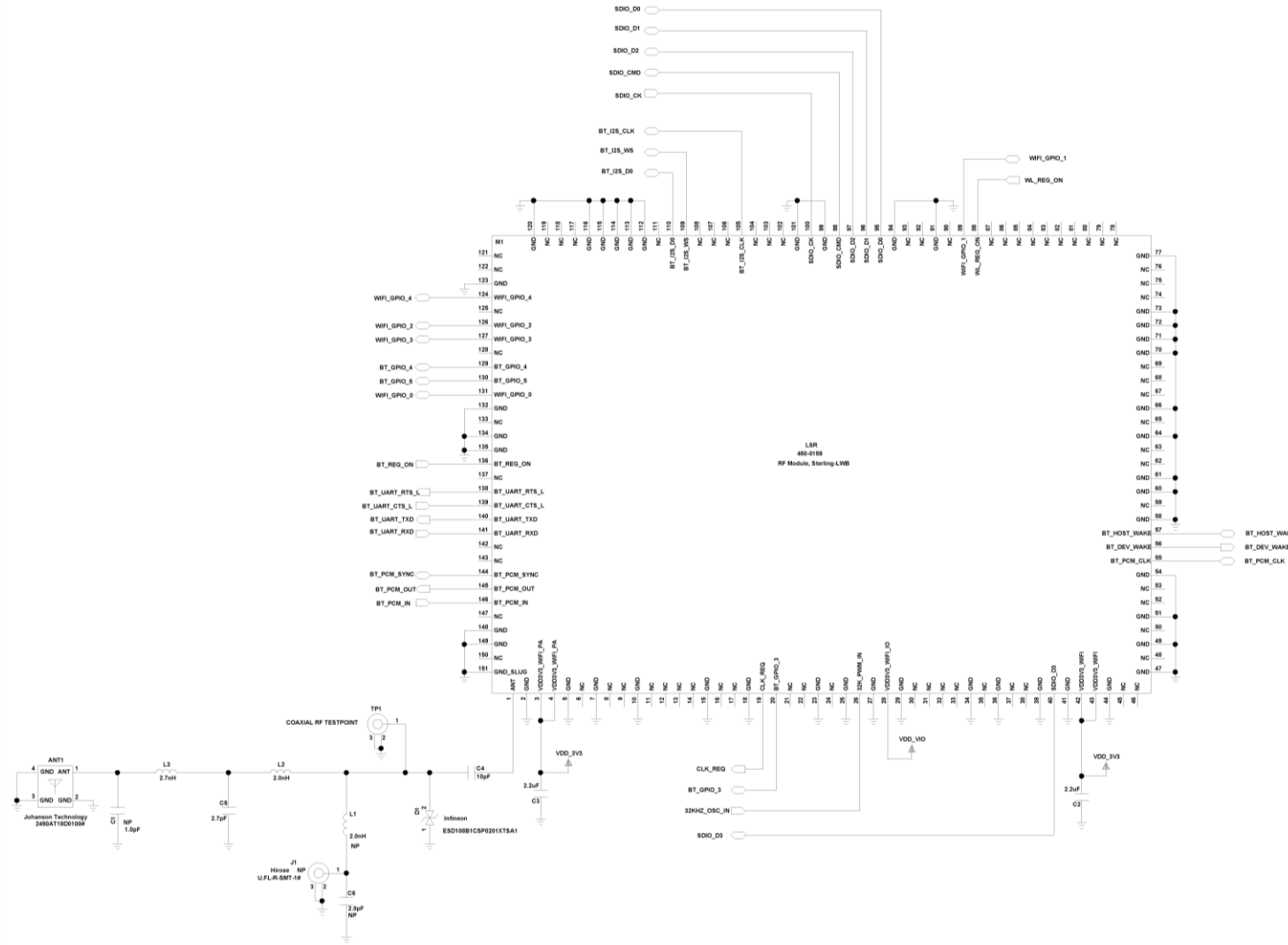


Figure 2 Chip Antenna Reference Design Schematic

The information in this document is subject to change without notice.

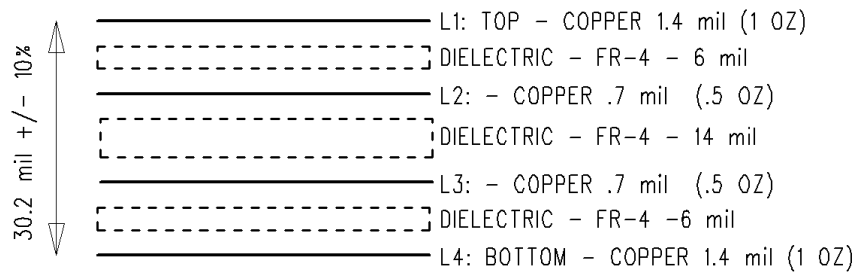
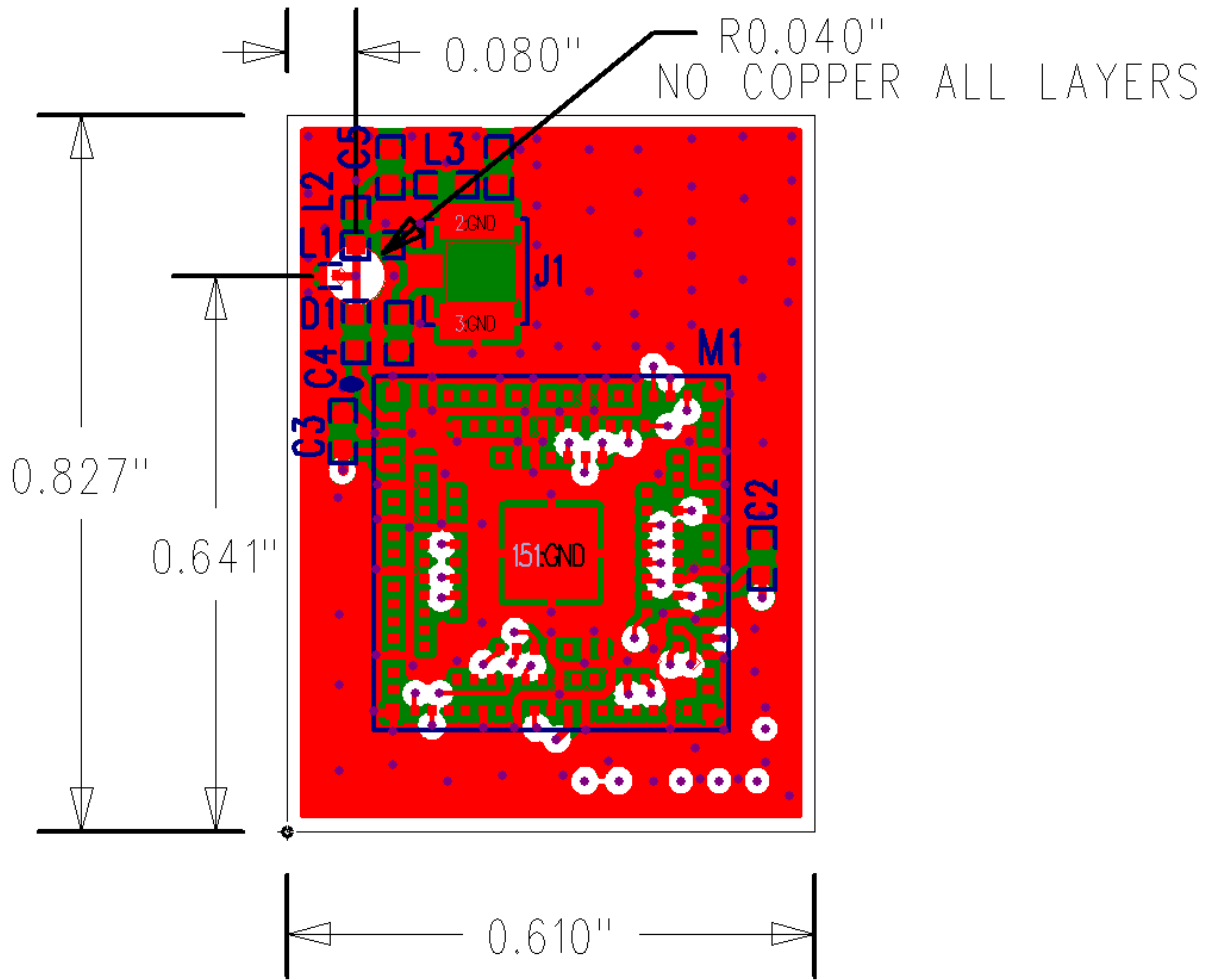
Qty	PCB Ref	POP Optional	Value	Tolerance	Manufacturer	Mfg Part Number
1	ANT1				Johanson	2450AT18D0100
1	C1	NP	1.0pF	+/- 0.25pF	Murata	GRM1555C1H1R0CA01
2	C2 C3		2.2uF	+/- 20%	Kemet	C0402C225M9PAC
1	C4		10pF	+/- 5%	Murata	GRM1555C1H100JA01
1	C5		2.7pF	±0.25pF	Murata	GJM1555C1H2R7CB01
1	C6	NP	2.0pF	+/- 0.25pF	Murata	GJM1555C1H2R0CB01
1	D1				Infineon	ESD108B1CSP0201XTSA1
1	J1	NP			Hirose	U.FL-R-SMT-1#
1	L2		2.0nH	+/- 0.1nH	Murata	LQP15MN2N0B02
1	L1	NP	2.0nH	+/- 0.1nH	Murata	LQP15MN2N0B02
1	L3		2.7nH	+/- 0.1nH	Murata	LQP15MN2N7B02
1	M1				LSR	450-0159

*** RF Critical Components That Cannot be Substituted**

Table 2 Chip Antenna Reference Design BOM

The information in this document is subject to change without notice.

4.2 U.FL (External Antenna)



Note: Material dielectric thickness may need to be adjusted to meet total thickness requirement.

Figure 3 U.FL (External Antenna) Reference Design

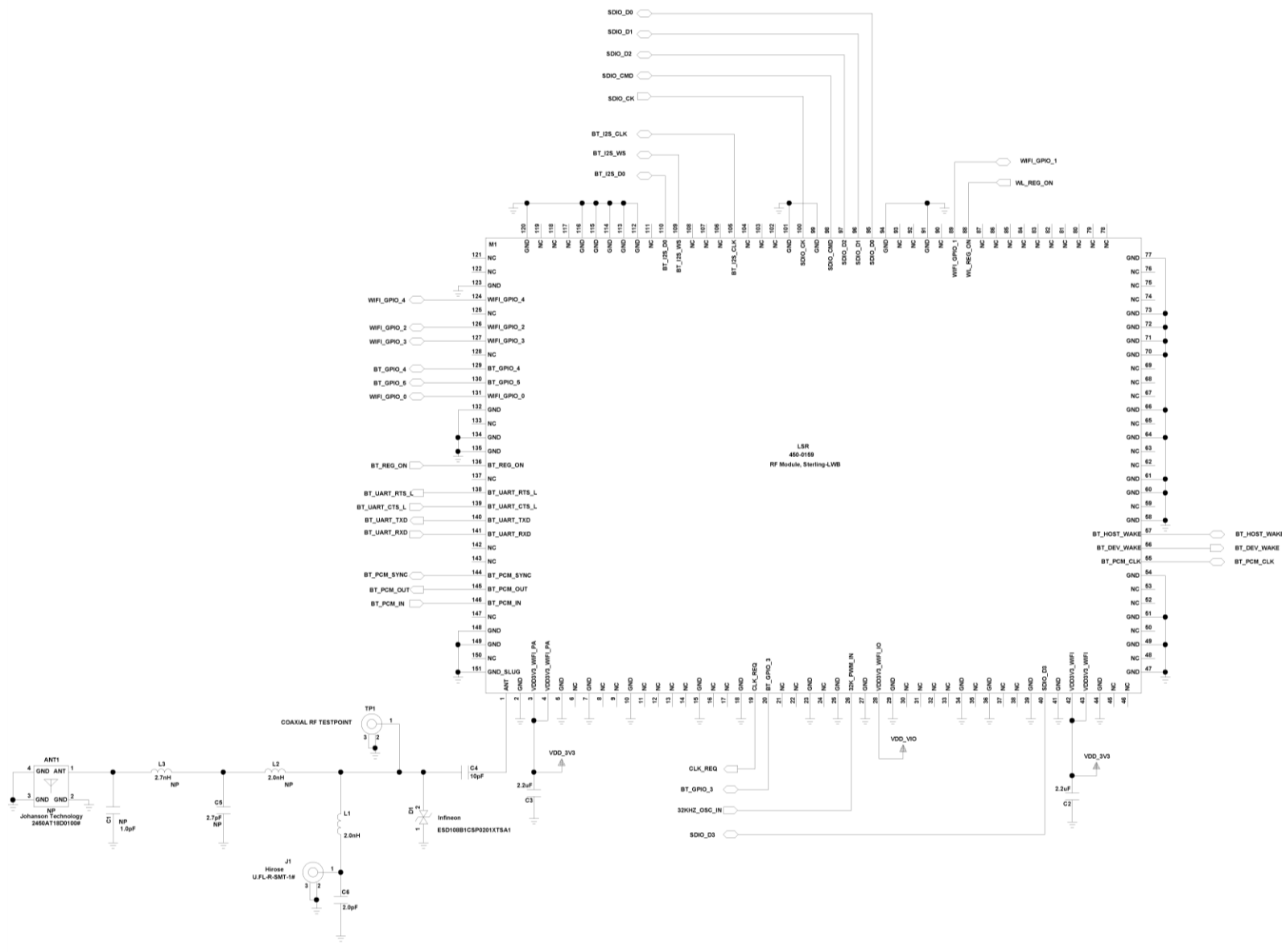


Figure 4 U.FL (External Antenna) Reference Design Schematic

The information in this document is subject to change without notice.

Qty	PCB Ref	POP Optional	Value	Tolerance	Manufacturer	Mfg Part Number
1	ANT1	NP			Johanson	2450AT18D0100
1	C1	NP	1.0pF	+/- 0.25pF	Murata	GRM1555C1H1R0CA01
2	C2 C3		2.2uF	+/- 20%	Kemet	C0402C225M9PAC
1	C4		10pF	+/- 5%	Murata	GRM1555C1H100JA01
1	C5	NP	2.7pF	±0.25pF	Murata	GJM1555C1H2R7CB01
1	C6		2.0pF	+/- 0.25pF	Murata	GJM1555C1H2R0CB01
1	D1				Infineon	ESD108B1CSP0201XTSA1
1	J1				Hirose	U.FL-R-SMT-1#
1	L2	NP	2.0nH	+/- 0.1nH	Murata	LQP15MN2N0B02
1	L1		2.0nH	+/- 0.1nH	Murata	LQP15MN2N0B02
1	L3	NP	2.7nH	+/- 0.1nH	Murata	LQP15MN2N7B02
1	M1				LSR	450-0159

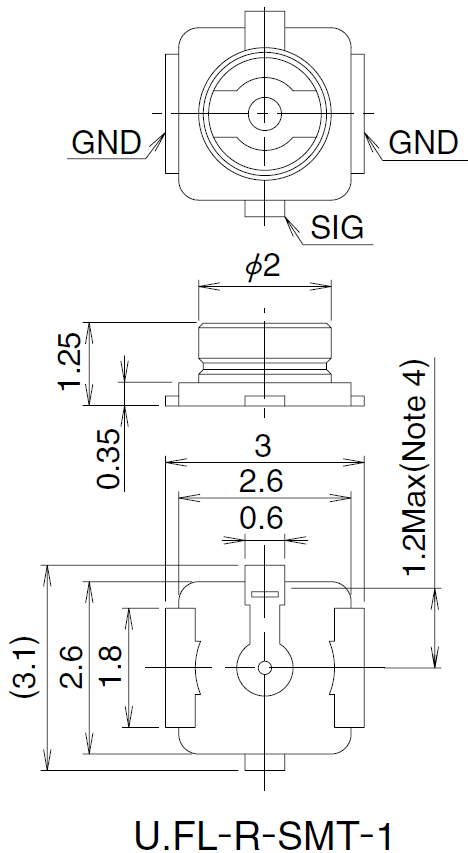
Table 3 U.FL (External Antenna) Reference Design BOM

5 Sterling-LWB Approved Antenna Specifications

5.1 External Antenna Connector

Either the LSR 2.4 GHz Dipole Antenna with Reverse Polarity SMA Connector and U.FL to SMA Cable, the LSR 2.4 GHz FlexPIFA, or the 2.4 GHz FlexNotch Antenna are used in conjunction with the Hirose PCB mounted U.FL connector to provide an externally mounted antenna solution for the Sterling-LWB module.

5.1.1 U.FL Connector Drawing



◆ Recommended PCB Mounting Pattern

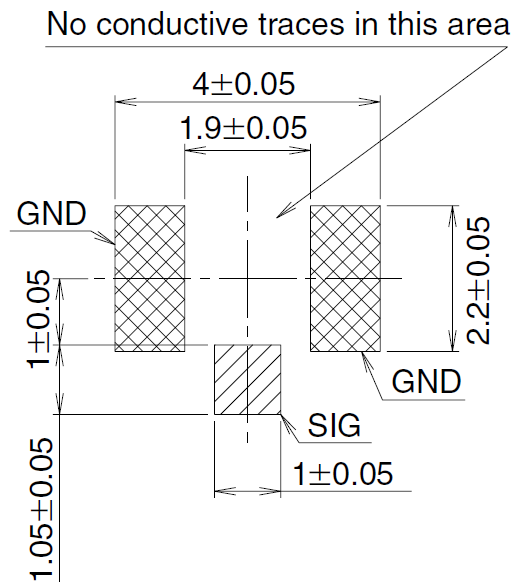


Figure 5 U.FL Connector Drawing

5.2 Chip Antenna Specifications

The Johanson 2450AT18D0100 Ceramic Chip Antenna provides an off-module, PCB mounted, antenna solution for the Sterling-LWB module. The antenna on the Sterling-LWB evaluation platform is positioned on the PCB to allow maximum performance while using a minimum amount of board space.

5.2.1 Mechanical Dimensions

Mechanical Specifications		
	In	mm
L	0.126 ± 0.008	3.20 ± 0.20
W	0.063 ± 0.008	1.60 ± 0.20
T	0.047 ± 0.008	1.20 ± 0.20
a	0.012 ± .004/-0.008	0.30 ± 0.1/-0.2
b	0.020 ± 0.008	0.50 ± 0.20

Figure 6 Chip Antenna Dimensions

5.3 Chip Antenna Typical Radiation Patterns

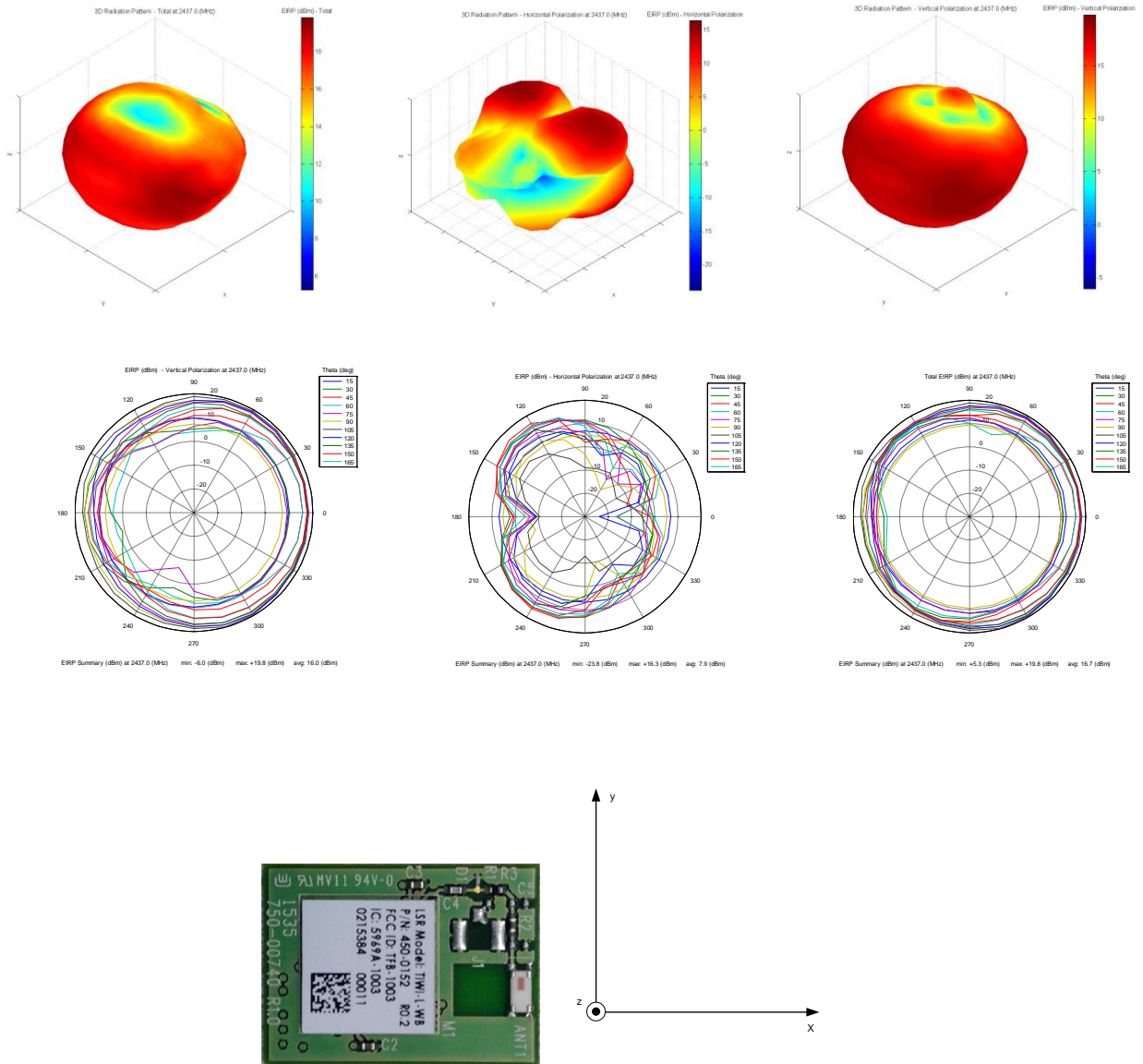


Figure 7 Chip Antenna Typical Radiation Patterns, Orientation Axis shown. 2D-Patterns in standard Spherical Coordinate System (r, θ, ϕ)

5.4 LSR FlexPIFA Antenna Specifications

Specification	Value
Manufacturer and Part Number	LSR 001-0014
Peak Gain	2.0 dBi
Type	Flexible Planar Inverted F Antenna (FlexPIFA)
Polarization	Linear
Frequency	2400-2480 MHz

Table 4 LSR FlexPIFA Antenna Specifications

5.4.1 LSR 2.4 GHz FlexPIFA Mechanical Dimensions

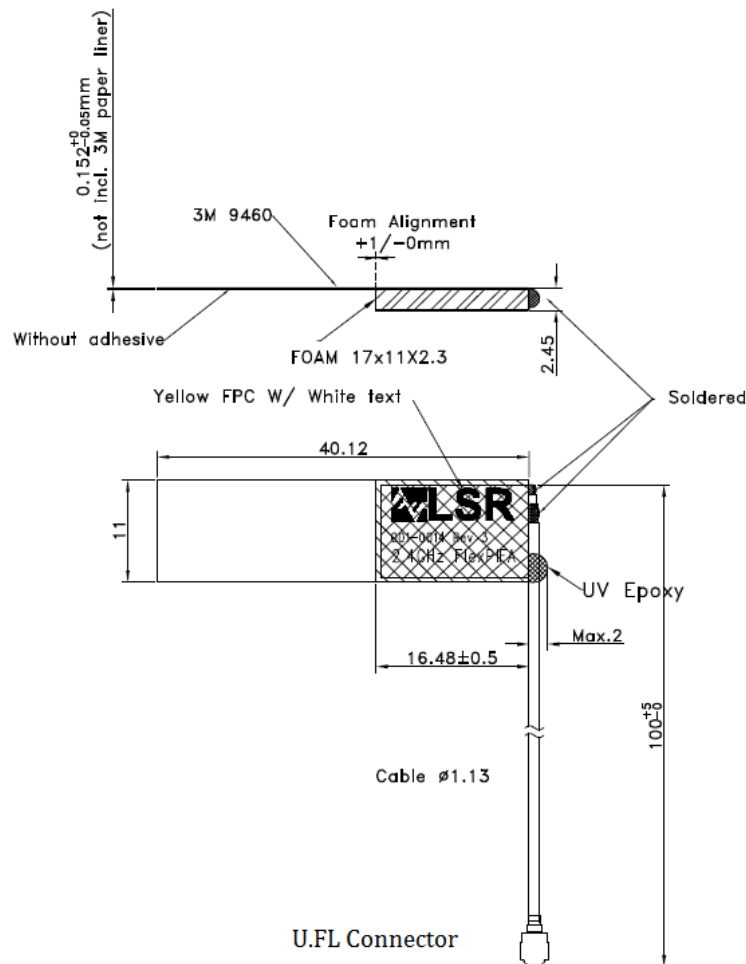


Figure 8 LSR 2.4 GHz FlexPIFA Antenna Dimensions

Visit the LSR web site <http://www.lsr.com> for further information on the LSR FlexPIFA Antenna.

5.5 LSR FlexNotch Antenna Specifications

Specification	Value
Manufacturer and Part Number	LSR 001-0015
Peak Gain	2.0 dBi
Type	Flexible Notch Antenna (FlexNotch)
Polarization	Linear
Frequency	2400-2480 MHz

Table 5 LSR FlexNotch Antenna Specifications

5.5.1 LSR 2.4 GHz FlexNotch Mechanical Dimensions

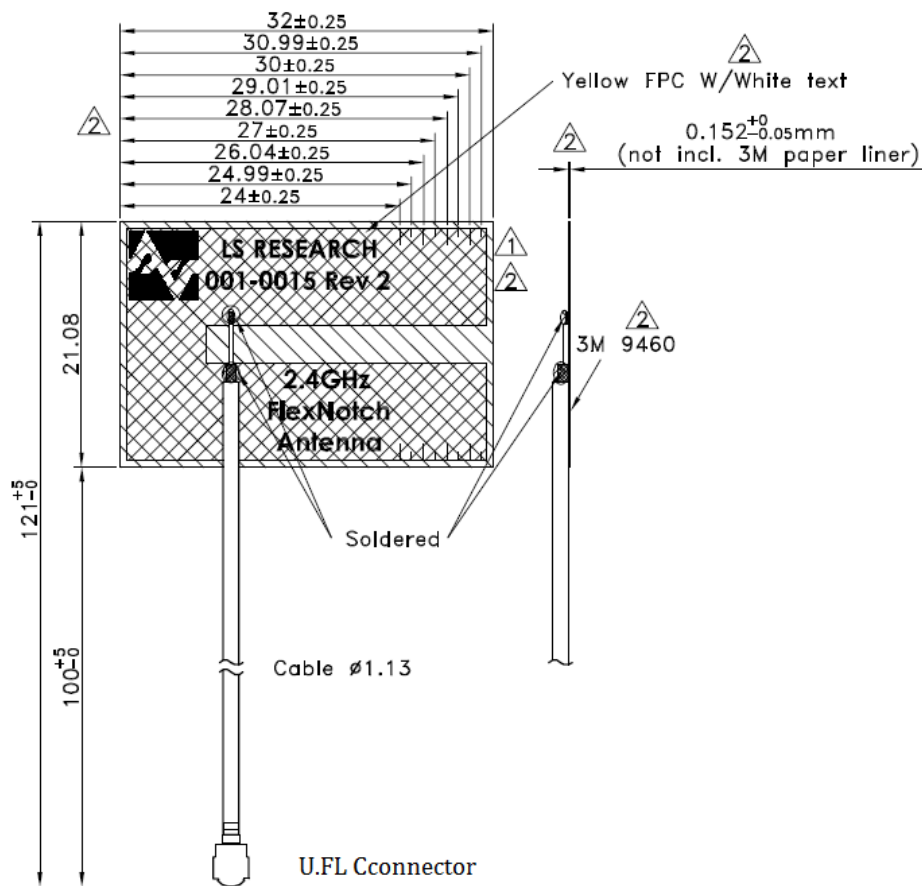


Figure 9 LSR 2.4 GHz FlexNotch Antenna Dimensions

Visit the LSR web site <http://www.lsr.com> for further information on the LSR FlexNotch Antenna.

5.6 LSR Dipole Antenna Specifications

The LSR 2.4 GHz Dipole Antenna is used in conjunction with the LSR U.FL to Reverse Polarity SMA Cable, and the Hirose PCB mounted U.FL connector (Figure 5), to provide an externally mounted antenna solution for the Sterling-LWB module.

Specification	Value
Manufacturer and Part Number	LSR 001-0001
Gain	+2 dBi
Impedance	50 ohms, Nominal
Type	Dipole
Polarization	Linear Vertical
VSWR	≤2.5 : 1, Maximum
Frequency	2400-2500MHz
Weight	13g
Size	105 mm x 10 mm
Antenna Color	Black

Table 6 Dipole Antenna Specifications

5.6.1 Mechanical Dimensions

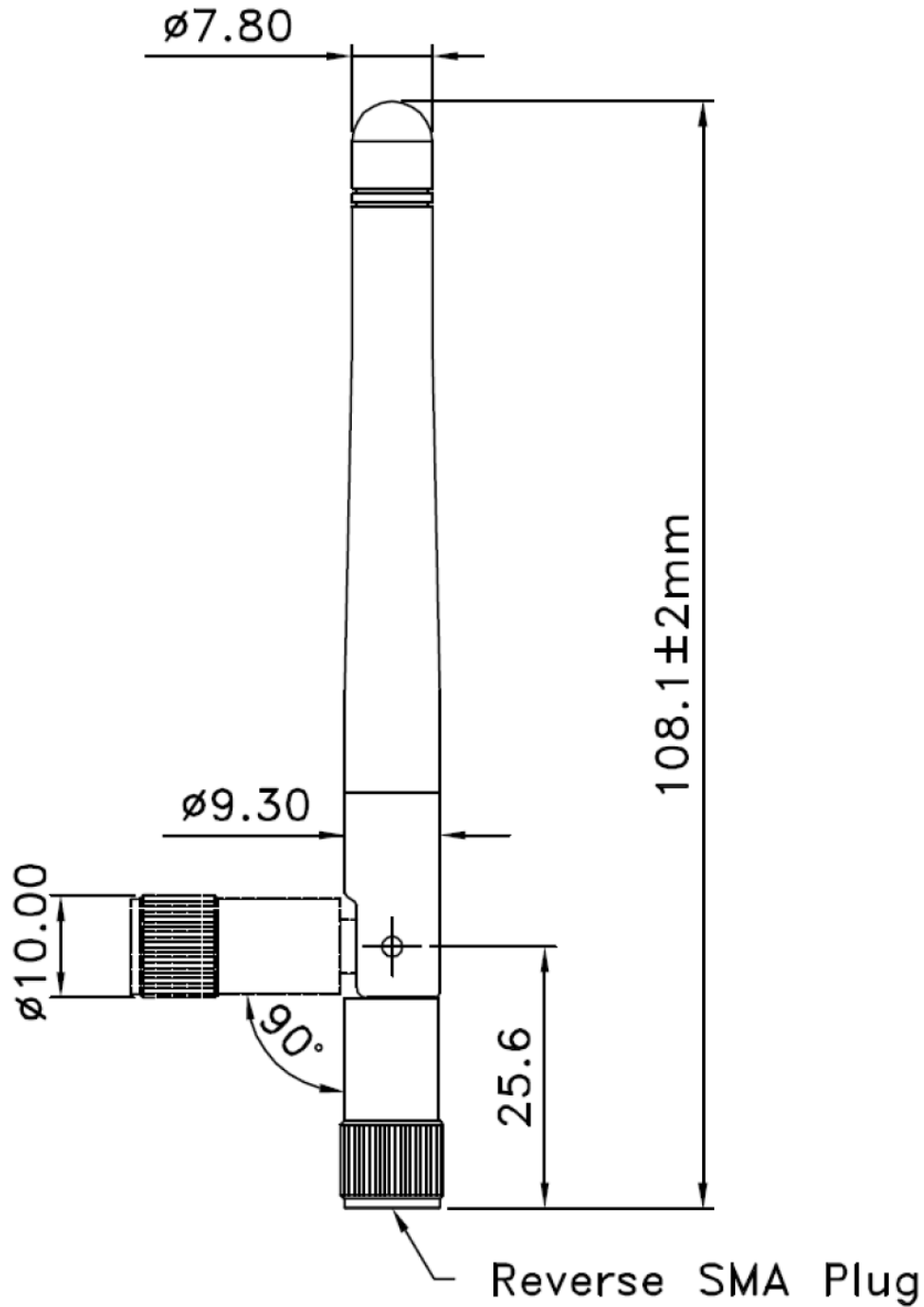


Figure 10 LSR 2.4 GHz Dipole Antenna Dimensions

Visit the LSR web site <http://www.lsr.com> for further information on the LSR Dipole Antenna

6 EMC Compliance

6.1 Summary

The Sterling-LWB module has been tested and approved as a Modular Radio in accordance with the appropriate FCC and IC standards. The supporting test data may be found in the modular test report.

Since this module and its associated set of approved antennas have been certified as a Modular Radio, this allows the end user to integrate this module into an end-product without the requirement of re-certifying the radio module. The module-integrator is responsible for the unintentional conducted and radiated emissions and must **verify** that the integrated product is compliant with the rules associated with unintentional radiators. The module integrator is also required to maintain an engineering record of the verification testing and declare on the product through proper labeling and marking that the device is compliant with these particular rules.

The installed module's FCC ID and IC numbers need to be clearly marked on the product with the following verbiage "Contains FCC ID: TFB-1003" and "Contains IC: 5969A-1003".

6.2 Module Integration Considerations - Antenna Systems

The module must be used with one of the approved antennas:

- 1) LSR 001-0001 2.4 GHz center-fed dipole antenna and LSR 080-0001 U.FL to Reverse Polarity SMA connector cable.
- 2) LSR 001-0014 2.4 GHz FlexPIFA antenna.
- 3) LSR 001-0015 2.4 GHz FlexNotch antenna.
- 4) Johanson 2450AT18D0100 chip antenna.

The antenna should be placed such that it is minimally disturbed by the product's packaging material. The incorporation of the largest practical free-space clearance around the antenna is important for maximizing overall performance. Further, the antenna must be placed such that at least a 20 cm separation distance is maintained from the antenna to all other radio transmitters.

6.3 Module Integration Considerations - Substitute Antenna Systems

The module's certification is only valid for the list of approved antennas presented in section 5. When using the U.FL connector, you may use a substitute antenna if the peak antenna gain is to equal or less than +2 dBi. It may be possible to use a substitute chip antenna however there are restrictions so please contact LSR for guidance prior to making any chip antenna substitutions.

6.4 Module Integration Considerations - Circuit Implementation

It is recommended that all connection PCB (printed circuit board) traces to the power supply and digital control terminal be as short as possible. Though not necessarily required in all cases, it is a best practice to provide an optional shunt capacitor placement at the module pin on all active and routed power supply and digital control lines. Further, a series damping resistor placement should be incorporated between the module pin/shunt capacitor node and the source/sink of the digital control signals. This provides for effective bypassing and decoupling of digital lines from the radio module, in the event that the application circuit has longer power supply and digital routing.

6.5 Module Integration Considerations - Top Assembly

In addition to the recommendations given for the antenna systems and the module placement onto a product PCB, it is recommended that all wiring and interconnect systems within the product not be routed anywhere close the module and its associated circuitry on the PCB, doing so could change the emission characteristics of the module.

6.6 Testing Requirements for End-Product

Once the module is integrated and the end-product is realized, the end-product must be tested and follow the verification process for Unintentional Conducted and Radiated Emissions in accordance to the FCC and IC guidelines. The module needs to be powered and placed in the receive mode for this test. The receiver must be tuned to its lowest frequency channel, mid-frequency channel, and highest frequency channel. The supporting test data does not need to be submitted to the FCC or IC.

The implementation of the module in a specific end-product should also be reviewed to ensure compliance with the FCC and IC requirements for SAR and MPE. Additional information for SAR requirements of this module can be found in this document.

6.7 Agency Certifications

FCC ID: TFB-1003, 15.247

IC ID: 5969A-1003, RSS 247

CE: Compliant to standards EN 60950-1, EN 300 328, and EN 301 489

6.8 Agency Statements

Federal Communication Commission Interference Statement

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 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.

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.

FCC CAUTION: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

Industry Canada 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.

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that permitted for successful communication.

This device has been designed to operate with the antenna(s) listed below, and having a maximum gain of 2.0 dBi (LSR Dipole), 2.0 dBi (LSR FlexPIFA), 2.0 dBi (LSR FlexNotch), and 1.5dBi (Johanson Chip). Antennas not included in this list or having a gain greater than 2.0 dBi, 2.0 dBi, 2.0 dBi, and 1.5dBi are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.

List of all Antennas Acceptable for use with the Transmitter

- 1) LSR 001-0001 2.4 GHz center-fed dipole antenna and LSR 080-0001 U.FL to Reverse Polarity SMA connector cable.
- 2) LSR 001-0014 2.4 GHz FlexPIFA antenna.
- 3) LSR 001-0015 2.4 GHz FlexNotch antenna.
- 4) Johanson 2450AT18D0100 chip antenna.

Cet appareil est conforme avec Industrie Canada , exempts de licence standard RSS (s). L'opération est soumise aux deux conditions suivantes: (1) cet appareil ne peut pas provoquer d'interférences et (2) cet appareil doit accepter toute interférence, y compris les interférences qui peuvent causer un mauvais fonctionnement de l'appareil.

Pour réduire le risque d'interférence aux autres utilisateurs, le type d'antenne et son gain doivent être choisis de manière que la puissance isotrope rayonnée équivalente (PIRE) ne dépasse pas celle permise pour une communication réussie.

Cet appareil a été conçu pour fonctionner avec l'antenne (s) ci-dessous, et ayant un gain maximum de 2,0 dBi (LSR Dipole), 2,0 dBi (LSR FlexPIFA), 2,0 dBi (LSR FlexNotch), et 1,5dBi (Johanson Chip). Antennes pas inclus dans cette liste ou présentant un gain supérieure à 2,0 dBi, 2,0 dBi, 2,0 dBi, et 1,5dBi sont strictement interdits pour une utilisation avec cet appareil. L'impédance d'antenne requise est de 50 ohms.

Liste de toutes les antennes acceptables pour une utilisation avec l'émetteur

- 1) Antenne LSR 001-0001 2.4 GHz de centre-dipôle alimenté et LSR 080-0001 U.FL inverser câble connecteur SMA à polarité.
- 2) LSR 001-0014 antenne FlexPIFA 2,4 GHz w/U.FL câble.
- 3) LSR 001-0015 antenne FlexNotch 2,4 GHz w/U.FL cable.
- 4) Antenne de puce Johanson 2450AT18A100.

6.9 OEM Responsibilities To Comply With FCC and Industry Canada Regulations

The Sterling-LWB Module has been certified for integration into products only by OEM integrators under the following conditions:

To comply with FCC and Industry Canada RF exposure limits for general population / uncontrolled exposure, the antenna(s) used for this transmitter must be installed to provide a separation distance of at least 29mm from all persons and operating in conjunction with any other antenna or transmitter, except in accordance with FCC multi-transmitter product procedures.

As long as the two conditions above are met, further transmitter testing will not be 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.).

IMPORTANT NOTE: In the event that these conditions cannot be met (for certain configurations or co-location with another transmitter), then the FCC and Industry Canada authorizations are no longer considered valid and the FCC ID and IC Certification Number cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC and Industry Canada authorization.

Le module de Sterling-LWB a été certifié pour l'intégration dans des produits uniquement par des intégrateurs OEM dans les conditions suivantes:

Pour se conformer aux limites d'exposition aux RF de la FCC et d'Industrie Canada pour la population générale / exposition non contrôlée, l'antenne(s) utilisée pour ce transmetteur doit être installée pour fournir une distance de séparation d'au moins 29mm de toutes les personnes et fonctionnant conjointement avec une autre antenne ou émetteur, sauf en conformité avec les procédures de produits multi-émetteur FCC.

Tant que les deux conditions précitées sont réunies, les tests de transmetteurs supplémentaires ne seront pas tenus. Toutefois, l'intégrateur OEM est toujours responsable de tester leur produit final pour toutes les exigences de conformité supplémentaires requis avec ce module installé (par exemple, les émissions appareil numérique, les exigences de périphériques PC, etc.)

NOTE IMPORTANTE: Dans le cas où ces conditions ne peuvent être satisfaites (pour certaines configurations ou de co-implantation avec un autre émetteur), puis la FCC et Industrie autorisations Canada ne sont plus considérés comme valides et l'ID de la FCC et IC numéro de certification ne peut pas être utilisé sur la produit final. Dans ces circonstances, l'intégrateur OEM sera chargé de réévaluer le produit final (y compris l'émetteur) et l'obtention d'un distincte de la FCC et Industrie Canada l'autorisation.

6.10 OEM Labeling Requirements For End-Product

The Sterling-LWB module is labeled with its own FCC ID and IC Certification Number. The FCC ID and IC certification numbers are not visible when the module is installed inside another device, as such the end device into which the module is installed must display a label referring to the enclosed module. The final end product must be labeled in a visible area with the following:

“Contains Transmitter Module FCC ID: TFB-1003”

“Contains Transmitter Module IC: 5969A-1003”

or

“Contains FCC ID: TFB-1003”

“Contains IC: 5969A-1003”

The OEM of the Sterling-LWB Module must only use the approved antenna(s) listed above, which have been certified with this module.

Le module de Sterling-LWB est étiqueté avec son propre ID de la FCC et IC numéro de certification. L'ID de la FCC et IC numéros de certification ne sont pas visibles lorsque le module est installé à l'intérieur d'un autre appareil, comme par exemple le terminal dans lequel le module est installé doit afficher une étiquette faisant référence au module ci-joint. Le produit final doit être étiqueté dans un endroit visible par le suivant:

“Contient Module émetteur FCC ID: TFB-1003”

“Contient Module émetteur IC: 5969A-1003”

ou

“Contient FCC ID: TFB-1003”

“Contient IC: 5969A-1003”

Les OEM du module Sterling-LWB ne doit utiliser l'antenne approuvée (s) ci-dessus, qui ont été certifiés avec ce module.

6.11 OEM End-Product User Manual Statements

The OEM integrator should not 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.

The user manual for the end product must include the following information in a prominent location:

To comply with FCC and Industry Canada RF exposure limits for general population / uncontrolled exposure, the antenna(s) used for this transmitter must be installed to provide a separation distance of at least 29mm from all persons and operating in conjunction with any other antenna or transmitter, except in accordance with FCC multi-transmitter product procedures.

Other user manual statements may apply.

L'intégrateur OEM ne devraient pas fournir des informations à l'utilisateur final sur la façon d'installer ou de supprimer ce module RF ou modifier les paramètres liés RF dans le manuel utilisateur du produit final.

Le manuel d'utilisation pour le produit final doit comporter les informations suivantes dans un endroit bien en vue:

Pour se conformer aux limites d'exposition aux RF de la FCC et d'Industrie Canada pour la population générale / exposition non contrôlée, l'antenne(s) utilisée pour ce transmetteur doit être installé pour fournir une distance de séparation d'au moins 29mm de toutes les personnes et fonctionnant conjointement avec une autre antenne ou émetteur, sauf en conformité avec les procédures de produits multi-émetteur FCC.

Autres déclarations manuel de l'utilisateur peuvent s'appliquer.

7 Contacting LSR

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