

# TIWI AND TIWI-BLE TRANSCEIVER MODULES

## *EMC Compliance Guide*



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## 1 Introduction

### 1.1 Purpose & Scope

The purpose of this document is to provide details in obtaining FCC compliance for applications of the TiWi and TiWi-BLE modules. The document will detail the responsibilities of the module-maker (LS Research, LLC) and the responsibilities of module integrator (OEM). Further this document will also describe the necessary steps to test an application with an installed TiWi and TiWi-BLE modules for FCC compliance.

### 1.2 Audience

This document is intended to be read by engineers and technical management. A general knowledge of common engineering practices is assumed.

### 1.3 Applicable Documents

- *TiWi Datasheet 330-0041 (LSR)*
- *FCC Test Report # 310117, LS Research, LLC: September 8,2010*
- *Evaluation Board Schematics*
- *Ethertronics Prestta 1000423 Antenna Data Sheet.*
- *Taoglas FXP831.07.0100C Dipole Antenna Data Sheet.*
- *LSR 001-0001 Dipole Antenna Data Sheet.*
- *LSR 080-0001 U.FL to RP-SMA Bulkhead Cable (1.13mm OD 100mm length)*
- *FCC OET Bulletin 62, "UNDERSTANDING THE FCC REGULATIONS FOR COMPUTERS AND OTHER DIGITAL DEVICES", February 1996.*
- *FCC DA 00-1407: PART 15 UNLICENSED MODULAR TRANSMITTER APPROVAL.*
- *FCC 178919 D01 Permissive Change Policy v04r04 [see 1. a) iii]]*
- *TiWi-BLE Datasheet 330-0085 (LSR)*

### 1.4 Revision History

Date	Change Description	Revision
10-14-2010	Initial release.	1.0
11-4-2010	Updates	1.1
3-8-2011	Updated FCC ID, Added IC ID, updates to end product responsibilities	1.2
3-23-2012	Updated for TiWi-BLE	1.3
11-14-2012	Added chip antenna to list of approved antennas	1.4
9-4-2013	Removed Chip Antenna References	1.5
5-16-2014	Added Taoglas Antenna to list of approved antennas	1.6

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**Table 1 Revision History**

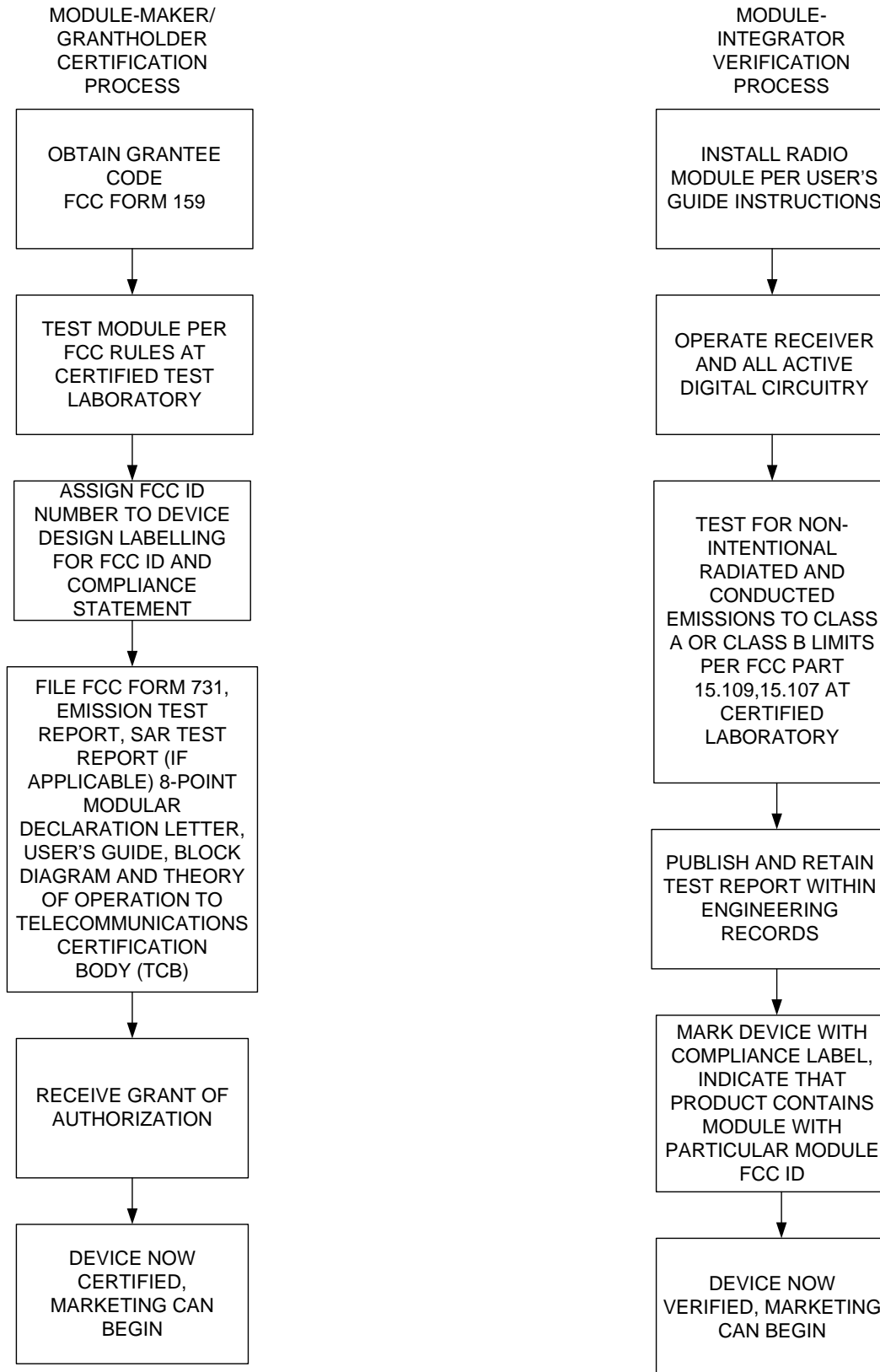
## 2 FCC Compliance – Two Different Paths

The manufacturer of radio module, the “module-maker” and the integrator of the module “module-integrator” have two different compliance processes. The module-maker obtains a Grant of Authorization from the FCC for the **certification** of the module. This Grant of Authorization certifies that the module is compliant as an intentional radiator. The module-maker or “grant-holder” is responsible for the stand-alone compliance of the module.

The module-integrator is responsible for installing and operating the module in accordance to the instructions supplied by the module-maker through its user’s guide in order to maintain the compliance of the module. The main benefit that the module-integrator realizes through the application of an approved module is that testing of the final, integrated assembly is exempt from the intentional radiator testing (transmitter function), as long as, the installed module’s FCC ID number is clearly marked on the product as “contains FCC ID”.

The module-integrator is responsible for the non-intentional conducted and radiated emissions and must **verify** that the integrated product is compliant with the rules associated with non-intentional radiators and is only 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.

Shown on the next page in Figure 1 is presentation of the two process paths.



**FIGURE 1:** Module Certification Process and Product Verification Process.

### 3 TIWI and TiWi-BLE MODULE CERTIFICATION

The TiWi and TiWi-BLE modules have been tested and certified to the following requirements. The test results associated with the module can be found in the FCC Test Report.

FCC 15.247, FCC 15.407 FCC.15.209	Band	FCC Test	Test Descriptions	Testing Environment (Chamber, Lab Bench, etc.)	WLAN	BLUETOOTH
15.247 (a) (1)-1	2400-2483.5 MHz	Minimum Channel Separation	max(25 kHz, 20 dB channel BW) or max (25 kHz, 2/3 20 dB channel BW) if Po < 125 mW	All applicable channels	Bench	BLUETOOTH
15.247 (a) (1)-2	2400-2483.5 MHz	Pseudorandom Channels	Channel Hopping Sequence must be pseudorandom	All applicable channels	Bench	BLUETOOTH
15.247 (a) (1)-3	2400-2483.5 MHz	Equal Channel Usage	Each Channel must be used equally on average	All applicable channels	Bench	BLUETOOTH
15.247 (a) (1)-4	2400-2483.5 MHz	Receiver Synchronization	Receiver must be synchronously tuned with Channel Hopping Sequence	By Design	Declared	BLUETOOTH
15.247 (a) (1) (iii)-1	2400-2483.5 MHz	Minimum Number of Channels	Must use at least N=15 Channels	All applicable channels	Bench	BLUETOOTH
15.247 (a) (1) (iii)-2	2400-2483.5 MHz	Channel Occupancy / Dwell Time	Average Channel Occupancy < 0.4 seconds over 0.4 X N	All applicable channels	Bench	BLUETOOTH
15.247 (a) (2)	2400-2483.5 MHz	DTS Minimum Bandwidth, 2.4 GHz	Conducted test for 6 dB BW > 500 kHz	3 channels, 2.4 GHz	Bench	WLAN
15.247 (b) (3)	2400-2483.5 MHz	FH Conducted Output Power	Conducted test for Output Power < + 30 dBm for N=50,	All applicable channels	Bench	BLUETOOTH
15.247 (b) (3)	2400-2483.5 MHz	DTS Conducted Output Power	Conducted test for Output Power < + 30 dBm for N=75, else < +21 dBm	3 channels, 2.4 GHz	Bench	WLAN
15.247 (b) (4)	2400-2483.5 MHz	DTS Radiated EIRP	Radiated test for EIRP < +36 dBm	3 channels, 2.4 GHz	Bench, Antenna Declaration	WLAN
15.247 (d) -1	2400-2483.5 MHz	Spurious Emissions	Conducted test for Relative PSD: Spurious < 20 dB [Ps(100kHz)/Pmax(100 kHz)]	3 channels, 2.4 GHz	3m Semi-Anechoic Chamber	WLAN
15.247 (d) -2	2400-2483.5 MHz	Spurious Emissions	Radiated Test for Emissions in 15.205 restricted bands per 15.209 limits 30-300 MHz	3 channels, 2.4 GHz	3m Semi-Anechoic Chamber	WLAN
15.247 (d) -3	2400-2483.5 MHz	Spurious Emissions	Radiated Test for Emissions in 15.205 restricted bands per 15.209 limits 300-1000 MHz	3 channels, 2.4 GHz	3m Semi-Anechoic Chamber	WLAN
15.247 (d) -4	2400-2483.5 MHz	Spurious Emissions	Radiated Test for Emissions in 15.205 restricted bands per 15.209 limits 2483.5 MHz Bandedge	3 channels, 2.4 GHz	3m Compact Semi-Anechoic Chamber	WLAN
15.247 (d) -5	2400-2483.5 MHz	Spurious Emissions	Radiated Test for Emissions in 15.205 restricted bands per 15.209 limits 1000-4000 MHz	3 channels, 2.4 GHz	3m Compact Semi-Anechoic Chamber	WLAN
15.247 (d) -6	2400-2483.5 MHz	Spurious Emissions	Radiated Test for Emissions in 15.205 restricted bands per 15.209 limits 4-18 GHz	3 channels, 2.4 GHz	3m Compact Semi-Anechoic Chamber	WLAN
15.247 (d) -7	2400-2483.5 MHz	Spurious Emissions	Radiated Test for Emissions in 15.205 restricted bands per 15.209 limits 18-25 GHz	3 channels, 2.4 GHz	3m Compact Semi-Anechoic Chamber	WLAN
15.247 (e)	2400-2483.5 MHz	DTS Power Spectral Density (PSD)	Conducted test for PSD < +8 dBm/3 kHz	3 channels, 2.4 GHz	Bench	WLAN
15.207	2400-2483.5 MHz	Conducted Spurious Emissions	Power Line Conducted emission conform to 15.207 test limits	3 channels, 2.4 GHz	Bench	WLAN

Table 2

The TiWi and TiWi-BLE modules satisfy the requirements for a radio module per FCC DA 00-1407 as follows:

DA 00-1407 Modular Approval	Description	Requirement	TiWi Compliance Method
DA 00-1407 Item			
(a)	Self-Contained Radio Transmitter	Module must contain complete radio: Local Oscillator, Station Reference Oscillator.	TiWi Contains Local Oscillator, Station Reference Oscillator
(c)	Post-Integration Testing	Additional Tests on final application may be necessary, e.g. 15.109 unintentional radiation.	Final Integrator responsible for compliance of product with exception of transmitter functions
(d)	Applicability	Modular Approval is applicable only to Transmit Functions, Receiver Functions Subject to Verification Testing.	Final Integrator responsible for compliance of product with exception of transmitter functions
(e)	Grantholder Responsibility	The module grant holder is responsible for the compliance of the module in the final application, provided that the final integrator complied with all instructions provided by the Grantee.	LS Research, LLC is grant holder for module and provides all relevant integration instructions to ensure compliance.
1	Shielding Requirement	The radio section of the module must be completely shielded to prevent unintentional coupling onto the application system circuitry and/or wiring.	TiWi completely shields the RF subsystem.
2	Buffered Modulation Requirement	The modulation characteristics of the module cannot be altered by the user.	TiWi controls all modulation formats.
3	Power Supply Regulation Requirement	The module must supply a method of voltage regulation such that the transmitter characteristics do not go out of compliance over the operating voltage range.	TiWi provides on-board voltage regulation.
4	Antenna Requirement	The module must incorporate a fixed antenna or a pre-approved set of external antennas coupled through a unique set of connectors.	TiWi is certified with antennas that are connected by a U.FL connector and where applicable a reverse polarity SMA connector.
5	Stand-Alone Compliance	The module must be tested and be compliant in a stand-alone configuration.	The TiWi Module was tested on the evaluation kit board.
6	Marking Requirement	The module must be clearly marked with its FCC ID number. The application platform must be marked to indicate the device contains the module with its specific FCC ID number.	The TiWi Module is Marked with its FCC ID number.
7	Transmitter Compliance	The transmitter must comply with its specific compliance requirements	The TiWi Module is compliant to FCC Part 15.247
8	RF Exposure Requirements	The module must be compliant to Maximum Permissible Exposure (MPE) limits.	The TiWi Module is compliant to the FCC MPE limits as presented in FCC Part 1.131.compliant.

Table 3

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

## 4 EMC Compliance Application Guide

### 4.1 Summary

The TiWi and TiWi-BLE modules have been tested as Modular Radio in accordance with the FCC. The device has been tested to relevant FCC parts and the results of the testing may be found in the module's test report.

Since this module and its associated set of approved antenna has been certified as a Modular Radio, this allows the end user to integrate this module into an end-product and only be responsible for the Unintentional Emissions levels produced by the product. The manufacturer of the module is the responsible for the compliance of the Intentional Emissions produced by the module, as long as, the recommendations presented in this application guide.

FCC rules only allow the for the modular certification of the TiWi and TiWi-BLE modules for mobile configurations only, which employs a minimum separation distance of 20 cm from the antenna to the human body. For separation distances of 20 cm or less, the module integrator must perform a full product certification including SAR testing.

### 4.2 Module Integration Considerations – Bluetooth Patch Files

The following table shows the BT Patch File combinations for each approved antenna that is required for modular FCC/IC and ETSI compliance. Note the revision for each file name (RX.X) varies per file and is subject to change. The latest revisions are available on the LSR wiki

Radio	Antenna	FCC/IC BT Patch File	ETSI BT Patch File
Bluetooth 2.1 + EDR	LS Research 001-0001 center-fed dipole	TiWi-R2: 480-0015-RX.X.bts TiWi-BLE: 480-0025-RX.X.bts	TiWi-R2: 480-0015-RX.X.bts TiWi-BLE: 480-0025-RX.X.bts
	Ethertronics Prestta 1000423		
	Toaglas FXP831.07.0100C		
Bluetooth 4.0	LS Research 001-0001 center-fed dipole	TiWi-R2: NA TiWi-BLE: 480-0025-RX.X.bts	TiWi-R2: NA TiWi-BLE: 480-0048-RX.X.bts
	Ethertronics Prestta 1000423		
	Toaglas FXP831.07.0100C		

Table 4



### 4.3 Module Integration Considerations – Antenna Systems

This device has been designed to operate with the antenna(s) listed below, and having a maximum gain of 4.3 dBi (LSR Dipole), -0.6dBi (Ethertronics Prestta), and 3.0dBi (Taoglas Flexible Dipole). Antennas not included in this list or having a gain greater than 4.3 dBi, -0.6dBi, and 3.0dBi 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) LS Research 001-0001 center-fed dipole antenna and LS Research 080-0001 U.FL to Reverse Polarity SMA connector cable.
- 2) Ethertronics Prestta 1000423 and Johnson Emerson U.FL to U.FL coaxial cable 415-0088-150.
- 3) Taoglas FXP831.07.0100C flexible dipole antenna with integrated cable and U.FL connector.

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 human body to the antenna.

### 4.4 Module Integration Considerations – Substitute Antenna Systems

The module's certification is only valid for the list of approved antennas presented in section 4.2. However, substitute antennas may be used in place of the approved antenna only if the antennas are of the same type and the peak gain is less than or equal to the peak gain of the similar approved antenna.

### 4.5 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.

### 4.6 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 be not routed anywhere close the module and its associated circuitry on the PCB, doing so could change the emission characteristics of the module.

### 4.7 Testing Requirements for End-Product

Once the module is integrated and the product realized in a mobile configuration, the product must be tested and follow the verification process for Unintentional Conducted and Radiated Emissions in accordance to the FCC guidelines. The module is to be 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. Both the WLAN and BT receivers must be active for the test.

#### 4.8 SAR Testing Requirements for End-Product

For portable configurations (antenna-to-body separations of less than 20 cm), the product requires a full product certification, including an SAR evaluation.

## 5 AGENCY STATEMENTS

### 5.1 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.***

## 5.2 Industry Canada Statements

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 4.3 dBi (LSR Dipole), -0.6dBi (Ethertronics Prestta), and 3.0dBi (Taoglas Flexible Dipole). Antennas not included in this list or having a gain greater than 4.3 dBi, -0.6dBi, and 3.0dBi 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) LS Research 001-0001 center-fed dipole antenna and LS Research 080-0001 U.FL to Reverse Polarity SMA connector cable.
- 2) Ethertronics Prestta 1000423 and Johnson Emerson U.FL to U.FL coaxial cable 415-0088-150.
- 3) Taoglas FXP831.07.0100C flexible dipole antenna with integrated cable and U.FL connector.

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 4,3 dBi (LSR Dipôle), -0.6dBi (Ethertronics Prestta), et 3.0dBi (Taoglas Flexibles Dipôle). Antennes pas inclus dans cette liste ou ayant un gain supérieur à 4,3 dBi, 0.6dBi, et 3.0dBi 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) LS Research 001-0001 alimenté par le centre antenne dipôle et LS Research 080-0001 U.FL d'inversion de polarité du câble connecteur SMA.
- 2) Ethertronics Prestta 1000423 et Johnson Emerson U.FL d'un câble coaxial U.FL 415-0088-150.
- 3) Taoglas FXP831.07.0100C antenne dipôle flexible avec câble intégré et un connecteur U.FL.

## 6 OEM Responsibilities to comply with FCC and Industry Canada Regulations

The TiWi and TiWi-BLE Modules have been certified for integration into products only by OEM integrators under the following conditions:

These devices are granted for use in Mobile only configurations in which the antennas used for this transmitter must be installed to provide a separation distance of at least 20cm from all person, as well as, not be co-located with any other transmitters except in accordance with FCC and Industry Canada 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 TiWi et TiWi-BLE modules ont été certifiés pour une intégration dans les produits que parles intégrateurs OEM dans les conditions suivantes:

Ces dispositifs sont accordées pour l'utilisation de Mobile seules configurations dans lesquellesles antennes utilisées pour cet émetteur doit être installé pour fournir une distance de séparationd'au moins 20cm de toute personne et ne pas être co-localisés avec les autres émetteurs, saufen conformité avec FCC et Industrie Canada, multi-émetteur procédures produit.

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.***

## 7 OEM Labeling Requirements for End-Product.

The TiWi or TiWi-BLE 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-TIWI1-01”**

**“Contains Transmitter Module IC: 5969A-TIWI101”**

or

**“Contains FCC ID: TFB- TIWI1-01”**

**“Contains IC: 5969A-TIWI101”**

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

Le module de TiWi ou TiWi-BLE 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-TIWI1-01”**

**“Contient Module émetteur IC: 5969A-TIWI101”**

ou

**“Contient FCC ID: TFB-TIWI1-01”**

**“Contient IC: 5969A-TIWI101”**

Les OEM du module ou de TiWi TiWi-BLE ne devez utiliser l'antenne approuvée (s) ci-dessus, qui ont été certifiés avec ce module.

## 8 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:**

This device is granted for use in Mobile only configurations in which the antennas used for this transmitter must be installed to provide a separation distance of at least 20cm from all person and not be co-located with any other transmitters except in accordance with FCC and Industry Canada 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:**

Ce dispositif est accordé pour une utilisation dans des configurations mobiles seule dans laquelle les antennes utilisées pour cet émetteur doit être installé pour fournir une distance de séparation d'au moins 20cm de toute personne et ne pas être co-localisés avec les autres émetteurs, sauf en conformité avec FCC et Industrie Canada, multi-émetteur procédures produit.

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

## 9 Contacting LS Research

<b>Headquarters</b>	LS Research, LLC W66 N220 Commerce Court Cedarburg, WI 53012-2636 USA Tel: 1(262) 375-4400 Fax: 1(262) 375-4248
<b>Website</b>	<a href="http://www.lsr.com">www.lsr.com</a>
<b>Wiki</b>	<a href="http://www.lsr.com/products-wiki">www.lsr.com/products-wiki</a>
<b>Technical Support</b>	<a href="http://www.lsr.com/products-forum">www.lsr.com/products-forum</a>
<b>Sales Contact</b>	<a href="mailto:sales@lsr.com">sales@lsr.com</a>

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