

# **TIWI TRANSCEIVER MODULE**

## *EMC Compliance Guide*



**LS RESEARCH, LLC**  
WIRELESS PRODUCT DEVELOPMENT

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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 module. 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 module 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

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

### 1.4 Revision History

Date	Change Description	Revision
10-14-2010	Initial release.	1.0
11-4-2010	Updates	1.1
03-08-2011	Updated FCC ID, Added IC ID, updates to end product responsibilities	1.2

**Table 1 Revision History**



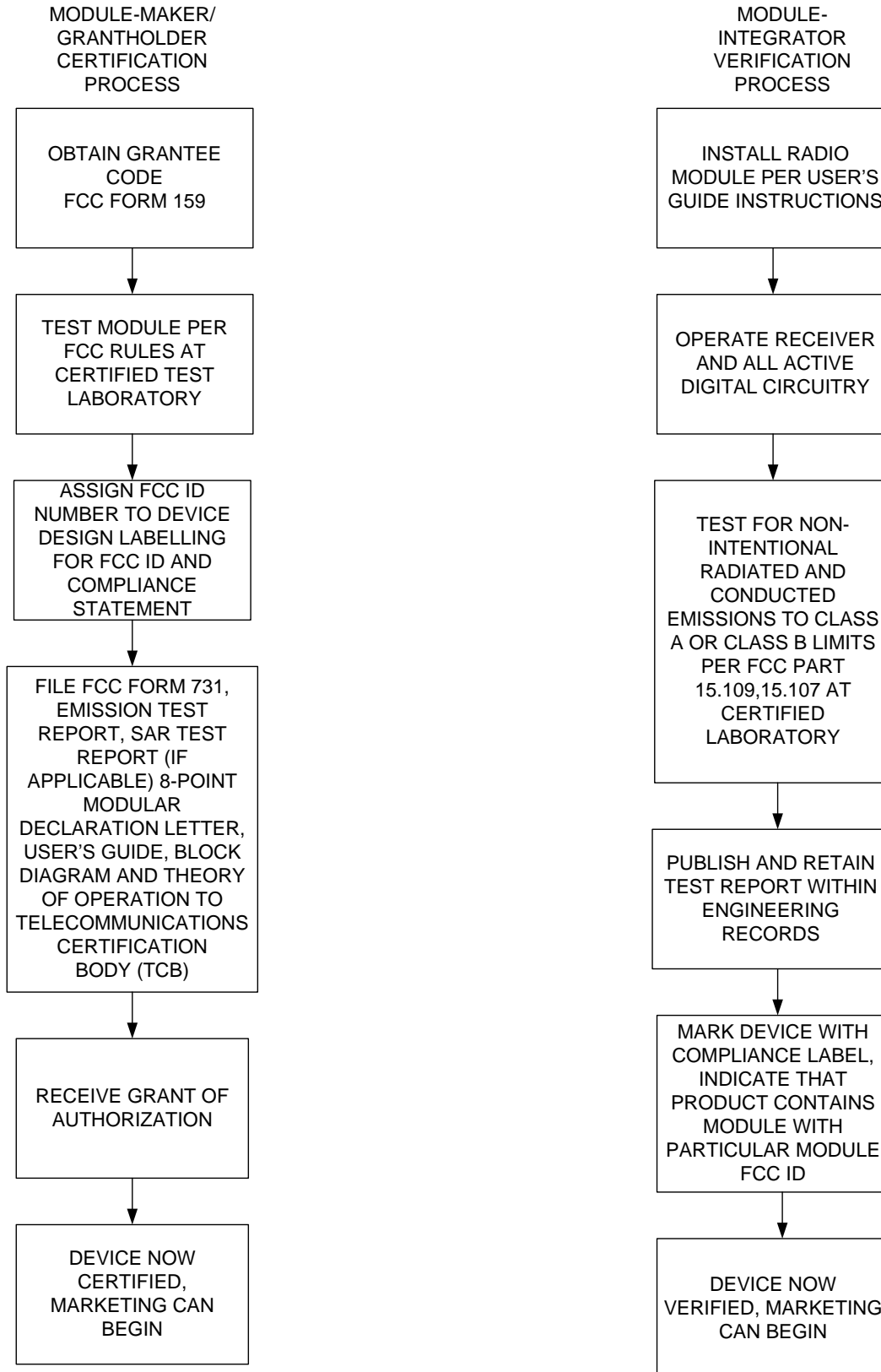
## **2 FCC Compliance – Two Different Paths**

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.

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### 3 TIWI MODULE CERTIFICATION

The TiWi module has been tested and certified to the following requirements. The test results associated with the module can be found in the FCC Test Report [2].

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

The TiWi module satisfies the requirements for a radio module per FCC DA 00-1407 [8] 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)	Grant holder 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 two 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.

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## **4 EMC Compliance Application Guide**

### **4.1 Summary**

The TiWi module has 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 [2].

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 module 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 – Antenna Systems**

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

1. LS Research 001-0001 center-fed dipole antenna [5] and LS Research 080-0001 u.fl to Reverse Polarity SMA connector cable [6].
2. Ethertronics Presetta 1000423 and Johnson Emerson u.fl. to u.fl coaxial cable 415-0088-150 [4].

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.

### **4.3 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 [9].



#### **4.4 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.

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

#### **4.6 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 [7]. 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.

#### **4.7 SAR Testing Requirements for End-Product**

SAR testing for mobile configurations was done on the TiWi Module, and this report can be obtained by contacting LS Research.

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



## **5 OEM Responsibilities to comply with FCC and Industry Canada Regulations**

The TiWi-R2 Module has been certified for integration into products only by OEM integrators under the following conditions:

- 1) The antenna(s) must be installed such that a minimum separation distance of 20cm is maintained between the radiator (antenna) and all persons at all times.
- 2) The transmitter module must not be co-located or operating in conjunction with any other antenna or transmitter.

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.***



## **6 OEM Labeling Requirements for End-Product.**

The end product must be marked or labelled with the following statement when the device is operating in a country that recognizes FCC rules:

“Contains FCC ID: TFB-TIWI1-01”

The product must be marked or labelled with the following statement when the device is operating in a country that recognizes Industry Canada rules:

“Contains IC: 5969A-TIWI101”

## **7 OEM End Product User Manual Statements.**

### **7.1.1 FCC Statements**

#### **Compliance Statement (Part 15.19)**

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.
- 2) This device must accept any interference received, including interference that may cause undesired operation.

#### **Warning (Part 15.21)**

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

#### **FCC Interference Statement (Part 15.105 (b))**

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:

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

### **7.1.2 If the OEM End Product is Portable and does NOT require SAR Testing**

This portable transmitter with its antenna complies with FCC/IC RF exposure limits for general population / uncontrolled exposure.



### 7.1.3 If the OEM End Product is Portable and does require SAR Testing

This portable transmitter with its antenna has shown compliance with FCC's SAR limits for general population / uncontrolled exposure. The maximum listed SAR level is:

**X.X W/kg (head) and X.X W/kg (body).**

The antenna used for this device must not be co-located or operating in conjunction with any other antenna or transmitter.

### 7.1.4 Industry Canada

PLEASE NOTE ALL STATEMENTS MUST BE IN **BOTH** ENGLISH AND FRENCH

#### Section 7.1.2 of RSS-GEN

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. 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 necessary for successful communication.

User manuals for transmitters equipped with detachable antennas shall also contain the following notice in a conspicuous location:

This radio transmitter (identify the device by certification number, or model number if Category II) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

This device has been designed to operate with the antenna(s) listed below, and having a maximum gain of 4.3 dBi (LSR Dipole) and -0.6dBi (Ethertronics Presetta). Antennas not included in this list or having a gain greater than 4.3 dBi and -0.6dBi dBi 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 [5] and LS Research 080-0001 u.fl to Reverse Polarity SMA connector cable [6].
- 2) Ethertronics Presetta 1000423 and Johnson Emerson u.fl. to u.fl coaxial cable 415-0088-150 [4].



**Section 7.1.3 of RSS-GEN**

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.

## 8 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
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