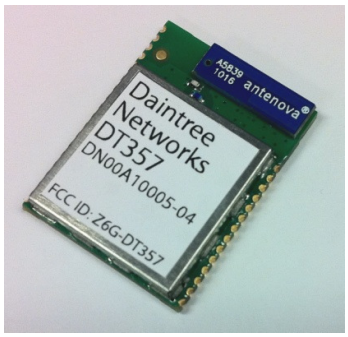
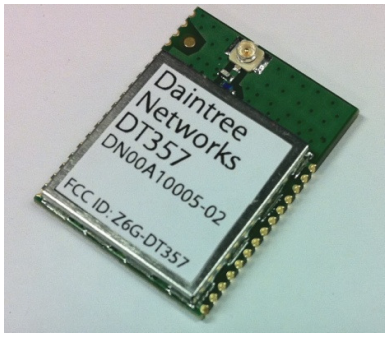
# DT357 Series User Manual




## Description

The DT357 and DT357-U.FL Daintree ZigBee® modules provide a cost-effective RF transceiver solution for 2.4GHz Zigbee and IEEE 802.15.4 data links and wireless networks.
The modules are available either with an on-board chip antenna (DT357) or alternatively with a U.FL connector (DT357-U.FL) for attaching an external antenna.

These modules have been designed to be easily integrated into another device and to provide a fast, simple and low cost wireless mesh networking interface.

The DT357 series module is based on the Ember ZigBee® platform consisting of the EM357 combined with the ZigBee PRO compliant EmberZNet meshing stack. Integration into a wide range of applications is made easy using a simple AT style command interface and advanced hardware design.

## Module Features

• Small physical footprint, SMD module 25mm x 19mm
• Integrated PCB chip antenna
• Optional U.FL connector for use with an external antenna
• -100dBm normal RX sensitivity
• Industry-leading ARM® Cortex™-M3 processor
• 16 RF Channels (Top channel 1A operates at a reduced power level)
• JTAG Programming and real time debugging via the Ember InSight Port
• Very low power consumption: less than 1uA in deep sleep mode.
• +3dBm nominal power output increased to 8dBm in boost mode.
• Wide supply voltage range (2.1 to 3.6V)
• 192kB flash and 12kbytes of RAM
• 24 GPIO lines
• FCC modular compliance.
• RoHS compliant
• Operating temperature range: -40 °C to +85 °C

## Applications

• Wireless lighting controls
• Wireless alarms and security
• Home automation and control
• Building automation and control
• Security and monitoring
• Thermostats
• Traffic management
• General Zigbee wireless networking



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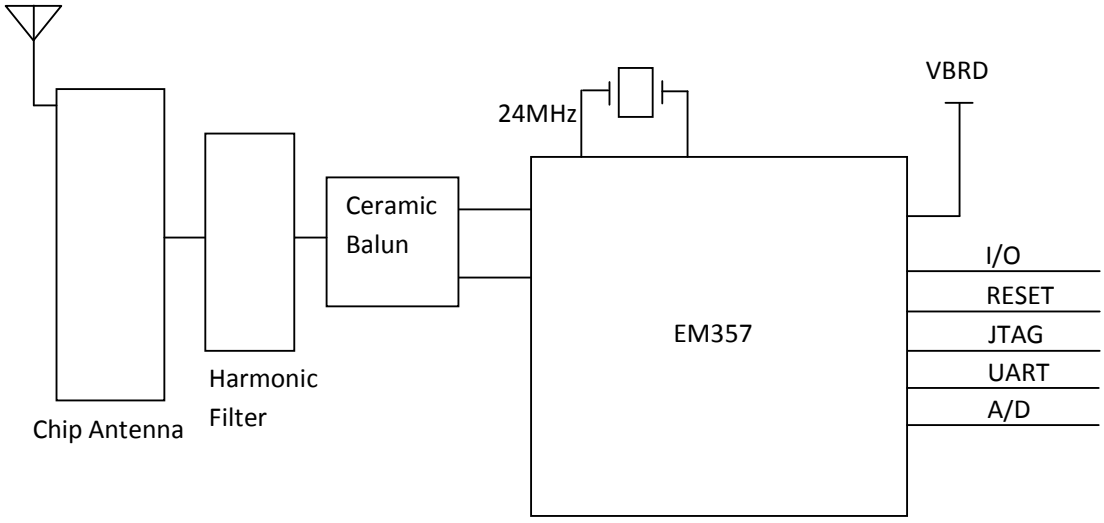
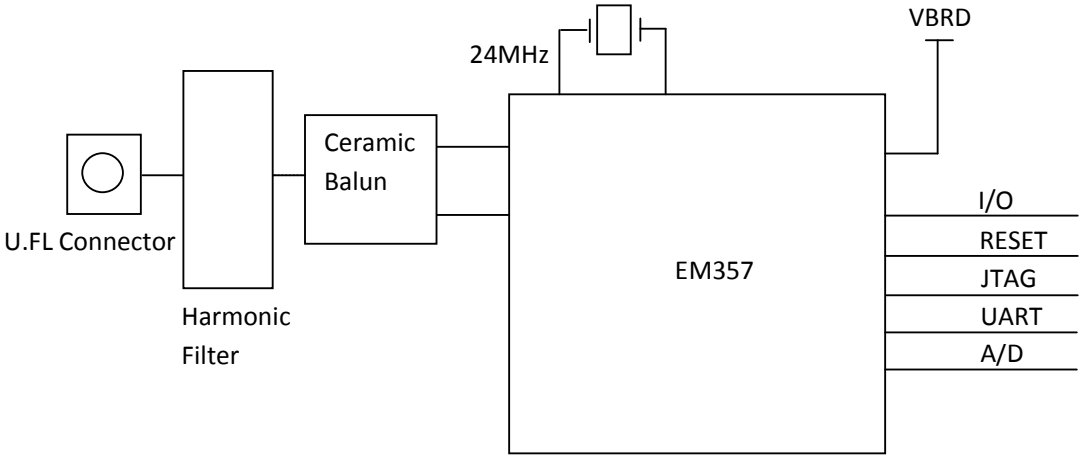
## Table of Contents

# 1. Hardware Description




**BLOCK DIAGRAM OF DT357**




**BLOCK DIAGRAM OF DT357-UFL**

**PROCESSOR**

The DT357 series module utilises an Ember EM357 S.O.C (System on Chip) which has an integrated

32-bit ARM® Cortex™-M3 processor, flash (196kB) and RAM (12kB) memory and peripherals. This is interfaced by standard serial wiring (UART) and includes JTAG programming interface. This allows for powerful software debugging and programming of the ARM Cortex ™-M3 core.

The EM357 has built in 1.8V and 1.25V regulators as well as a power-on-reset circuit which reduces the amount of external circuitry required.

**ANTENNA**

The DT357 module includes an integrated chip antenna (Antenova Rufa) which is compact in size but has a uni-directional radiation pattern allowing a gain of 2.1dBi. Further details of the antenna can be found on the Antenova website.

The DT357-U.FL module includes a U.FL connector instead of a chip antenna that allows for the connection of an external antenna up to a gain of 2.0dBi.

## 2. Absolute Maximum Ratings

| Rating | Value | Unit |
|---|---|---|
| Power Supply Voltage | 3.6 | Vdc |
| Voltage on any Digital I/O | -0.3 to $V_{CC}$ +0.3 | Vdc |
| RF Input level | 15 | dBm |
| Storage Temperature Range | -40 to +105 | ℃ |

**Note**: Exceeding the maximum ratings may cause permanent damage to the module or devices

## 3. Recommended Operating Conditions

| Characteristic | Min | Typ | Max | Unit |
|---|---|---|---|---|
| Power Supply Voltage | 2.1 | | 3.6 | Vdc |
| Input Frequency | 2405 | | 2480 | MHz |
| Operating Temperature | -40 | | 85 | ℃ |
| RF Input Power | | | 0 | dBm |

## 4. DC Electrical Characteristics@ 25°C, $V_{CC}$ = 3.0V, NORMAL MODE unless otherwise stated

| Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|
| Ambient Temperature Range | -40 | 25 | 85 | °C |
| **Power Consumption** | **Min** | **Typ** | **Max** | **Unit** |
| Transmit Mode at 3dBm Output Power | | 31 | | mA |
| Transmit Mode at 8dBm Boost Output Power | | 42 | | mA |
| Receive Mode | | 26.5 | | mA |
| Standby Mode | | 1 | | uA |

## 5. Digital I/O

| Digital I/O | Min | Typ | Max | Unit |
|---|---|---|---|---|
| Logic Low Schmitt Input Switching Threshold | 0.42 x Vcc | | 0.5 x Vcc | V |
| Logic High Schmitt Input Switching Threshold | 0.62 x Vcc | | 0.8 x Vcc | V |
| Logic Low Output | 0 | | 0.18 x Vcc | V |
| Logic High Output | 0.82 x Vcc | | Vcc | V |
| Output Sink Current (Std Pad) | | | 4 | uA |
| Output Source Current (Std Pad) | | | 4 | uA |
| Output Sink Current (High I Pad) | | | 8 | uA |
| Output Source Current (High I Pad) | | | 8 | uA |
| Input Current For Logic 0 | | | -0.5 | uA |
| Input Current For Logic 1 | | | 0.5 | uA |
| Total Output Current (I/O Pads) | | | 40 | mA |

## 6. RF Electrical Characteristics

| Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|
| RF Frequency Range | 2400 | | 2500 | MHz |
| RF Data Rate | | 250 | | Kbps |
| **Receive Characteristics** | **Min** | **Typ** | **Max** | **Unit** |
| Receiver Sensitivity (1% PER) NORMAL | | -100 | -94 | dBm |
| Receiver Sensitivity (1% PER) BOOST | | -102 | -96 | dBm |
| High-Side Adjacent Channel Rejection | | 35 | | dB |
| Low-Side Adjacent Channel Rejection | | 35 | | dB |
| $2^{nd}$ High-Side Adjacent Channel Rejection | | 46 | | dB |
| $2^{nd}$ Low-Side Adjacent Channel Rejection | | 46 | | dB |
| **Transmit Characteristics** | **Min** | **Typ** | **Max** | **Unit** |
| Transmitter Output Power NORMAL | 1 | 5 | | dBm |
| Transmitter Output Power BOOST | | 8 | | dBm |
| Minimum Output Power | | -55 | | dBm |

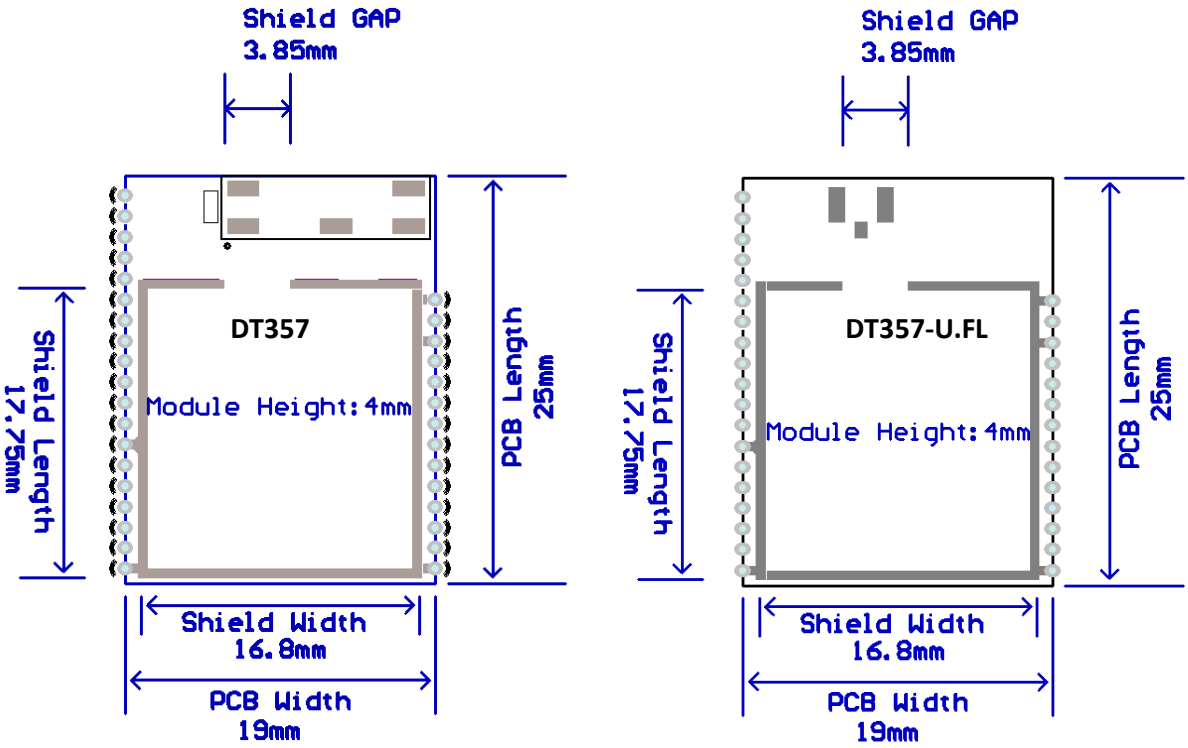
## 7. Environmental Characteristics

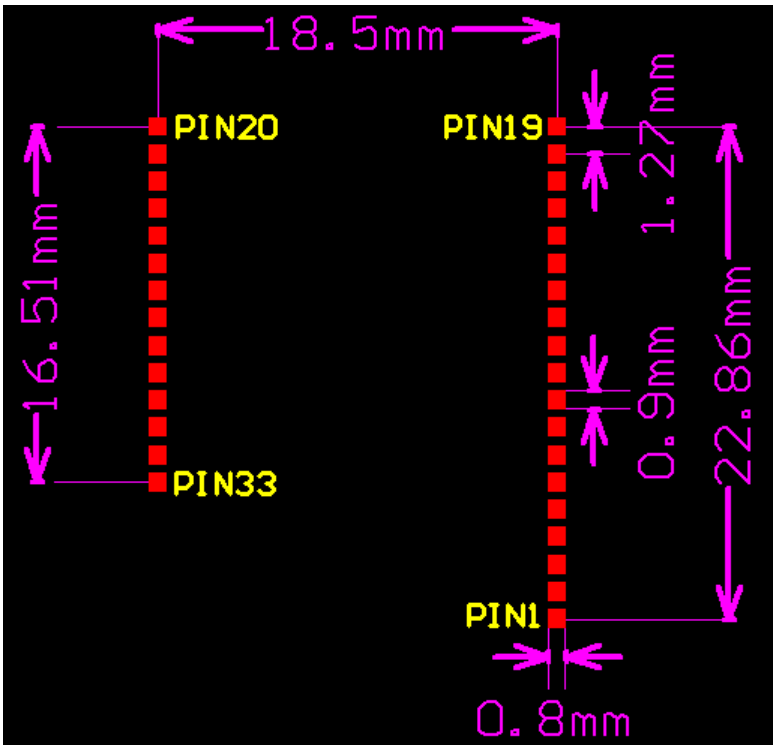
| Environmental Characteristics | Min | Typ | Max | Unit |
|---|---|---|---|---|
| ESD (human body model) | | | ±2 | kV |
| ESD (charged device model) Non-RF pins | | | ±400 | V |
| ESD (charged device model) RF Pins | | | ±225 | V |
| Moisture Sensitivity Level (MSL) | | | MSL3 | |

## 8. DT357 Pin Description

| Pin No | Name | Direction | Description |
|---|---|---|---|
| 1 | GND | GND | |
| 2 | PC5 | I/O, O | Digital I/O, Logic Control for External Rx/Tx switch |
| 3 | PC6 | I/O, O | Digital I/O, 32.768 kHz OSC, Inverted TX_ACTIVE signal |
| 4 | PC7 | I/O, I | Digital I/O, 32.768 kHz OSC, Digital 32.768 kHz Clock Input source |
| 5 | PA7 | I/O, I, O | Digital I/O, Timer 1 Ch4 Out/In, Ext Regulator Open drain Out |
| 6 | PB3 | I/O, O, I | Digital I/O, Timer 2 Ch3 Out/In, UART CTS1, SPI1 MCLK/SCLK |
| 7 | NRESET | I | Active Low Chip Reset |
| 8 | PB4 | I/O, O, I | Digital I/O, Timer 2 Ch4 Out/In, UART RTS1, SPI Slave Select1 |
| 9 | PA0 | I/O, I, O | SPI2 MOSI, Timer 2 Ch1 Out/In |
| 10 | PA1 | I/O, O, I | SPI2 MISO, Digital I/O, Timer 2 Ch3 Out/In, TWI SDA2 |
| 11 | PA2 | I/O, O, I | SPI2 MCLK/SCLK, Digital I/O, Timer 2 Ch4 Out/In, TWI SCL2 |
| 12 | PA3 | I/O, O, I | SPI2 Slave Sel, Digital I/O, CPU Trace Clk, Timer 2 Ch2 Out/In |
| 13 | GND | GND | |
| 14 | PA4 | I/O, O | Digital I/O, ADC In4, PTI Frame Signal, CPU Trace Data Bit 2 |
| 15 | PA5 | I/O, An, O, I | Digital I/O, ADC In5, PTI Data Signal, Embed Boot Activate, CPU Trace 3 |
| 16 | PA6 | I/O, O, I | Digital I/O, Timer 1 Ch3 Out/In |
| 17 | PB1 | I/O, O, I | UART1 Tx, Digital I/O, SPI1 MISO/MOSI, TWI SDA1, Timer2 Ch1 I/O |
| 18 | PB2 | I/O, I, O | UART1 Rx, Digital I/O, SPI1 MISO/MOSI, TWI SCL1, Timer2 Ch1 I/O |
| 19 | GND | GND | |
| 20 | GND | GND | |
| 21 | JTCK | I, I/O | JTAG CLK In Debug, SW CLK In/Out |
| 22 | PC2 | I/O, O | Digital I/O, JTAG Data Out Debug, SW Out Debug |
| 23 | PC3 | I/O, I | Digital I/O, JTAG Data In Debug |
| 24 | PC4 | I/O, I | Digital I/O, JTAG Mode Sel, SW Data In/Out Debug |
| 25 | PB0 | I/O, An, I, O | Digital I/O, ADC Ref Out/In, Ext IntA, CPU Clk Trace, Timer1 Ext CLK In, Timer2 Clk Mask In |
| 26 | PC1 | I/O, An, O | ADC In3, Digital I/O, SW Out Debug, CPU Trace Data Bit 0 |
| 27 | PC0 | I/O, I, O | Digital I/O, JTAG Reset In Debug, Ext IntD, CPU Trace Data Bit 1 |
| 28 | PB7 | I/O, An, I, O | Digital I/O, ADC In2, Ext IntC, Timer1 Ch2 Out/In |
| 29 | PB6 | I/O, An, I, O | Digital I/O, ADC In1, Ext Int B, Timer1 Ch1 Out/In |
| 30 | PB5 | I/O, An, I | Digital I/O, ADC In0, Timer2 Ext Clk In, Timer1 Ext Clk Mask In |
| 31 | GND | GND | |
| 32 | VBRD | POWER | Analogue Pad Supply (1.8V) |
| 33 | GND | GND | |

## 9. DT357 Dimensions




**Recommended PCB Footprint**



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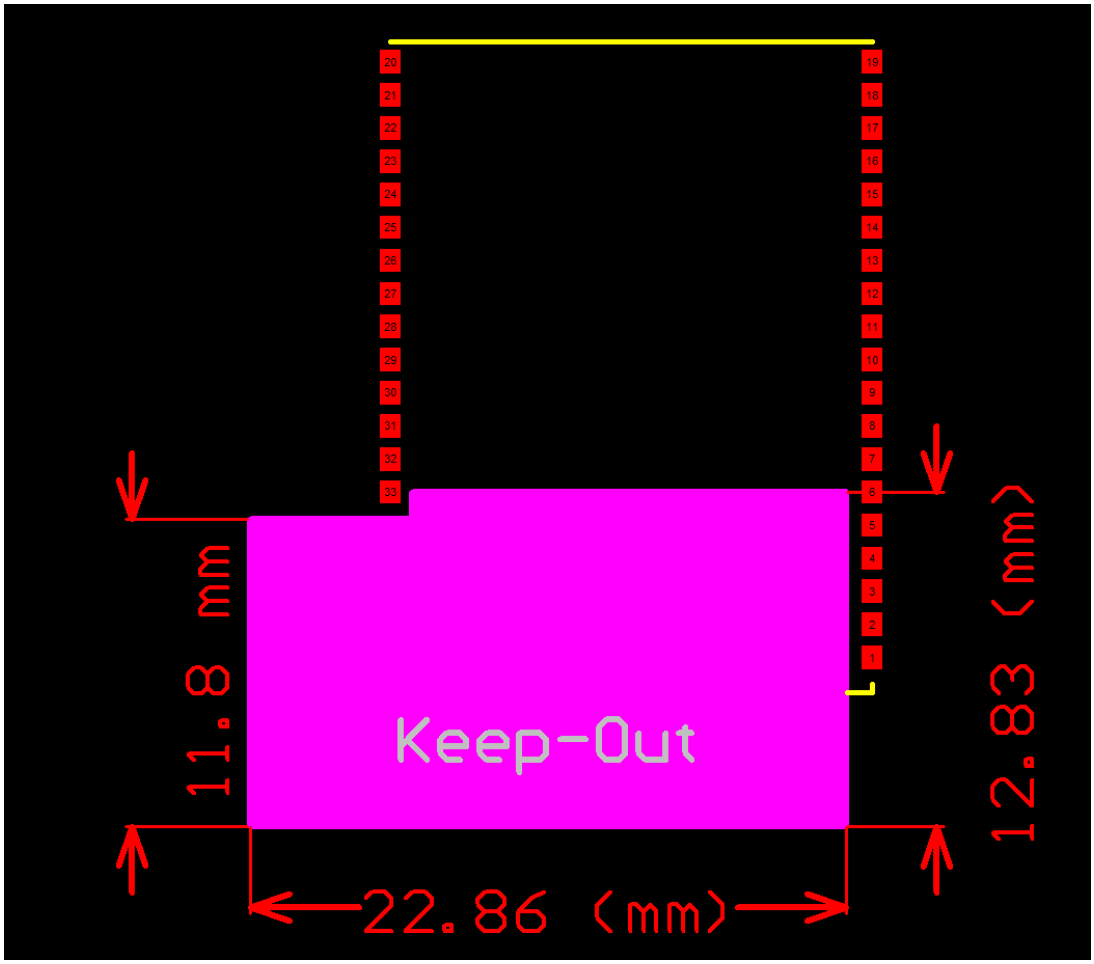
## 10. PCB Keep-Out Areas

For optimum RF performance when using the DT357 module (Chip Antenna version) the module should be placed so that the antenna is located on the edge of the mating PCB. No tracks or planes or components should be located in the keep-out area. When using the DT357-UFL module (external antenna version) the keep-out area does not need to be adhered to.




**Keep Out Area for Chip Antenna (DT357 only)**



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# 11. Product Approvals

The DT357 and DT357-U.FL have been designed for modular compliance into USA (FCC), Canada (IC), Australia (C-Tick) and Europe (CE). Full FCC, IC and C-Tick compliance have been obtained and European compliance (CE) has been part completed with full compliance to follow in the future.

## 11.1 FCC Part 15.247 Certification

The DT357 and DT357-U.FL modules including the antennas listed in Table 1 below have been tested and have been found to comply with FCC CFR Part 15 (USA). The DT357-U.FL has compliance for an external antenna with a maximum gain of 2.0dBi.

To meet the section 12.209 emission requirements in the restricted bands of section 15.205, the transceiver transmitter power for the DT357 and DT357-U.FL modules needs to be reduced from 8dBm to 7dBm on the top channel 1A (2480 MHz).

**The software Daintree will release with the DT357 and DT357-U.FL modules will limit the end user to a maximum of 7dBm on the top channel 1A (2480 MHz) to ensure compliance.**

These devices meet the requirements for modular transmitter approval as detailed in the FCC public notice DA00.1407.transmitter. These additional requirements can allow the DT357/DT357-U.FL modules to be installed in a new device without subsequent new equipment authorisation to be obtained.

***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.***

| Item | Part No | Manufacturer | Type | Gain |
|---|---|---|---|---|
| 1 | S131CL2-L-XXX-2450 | Nearson | 1/2 Wave | 2.0dBi |

The Daintree DT357 and DT357-U.FL modules have been tested and found to comply with the limits for a 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. The Daintree modules generate, use 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 the Daintree module does cause harmful interference to radio or television reception, which can be determined by turning the Daintree module off and on, the user is encouraged to try and correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the Daintree module and receiver.
- Connect the Daintree module 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.

The DT357 and DT357-U.FL modules with their antennas comply with FCC/IC RF exposure limits for general population/uncontrolled exposure.

While the applicant for a device into which the DT357 and DT357-U.FL with an approved antenna in Table 1 is to be installed is not required to obtain a new authorization for the module, this does not ensure that some other form of testing may be required for the end product.

Any changes or modifications made to this device that are not expressly approved by Daintree may void the user's authority to operate the equipment.

When using the DT357-U.FL with approved antennae, it is required to prevent end-users from replacing them with non-approved ones.

***To comply with FCC and Industry Canada RF radiation exposure limits for general population the antennas used for the DT357 and DT357-U.FL must be installed such that a minimum separation distance of 20cm is maintained between the antenna and all persons at all times and must not be co-located or operating in conjunction with any other antenna or transmitter.***

## 11.2 FCC Labelling Requirements

When integrating the DT357 and DT357-U.FL into a product it is necessary that the FCC labelling requirements are met. This includes a clearly visible label on the outside of the finished product specifying the Daintree FCC identifier (**FCC ID: Z6G-DT357**) as well as the statement above. This label can use wording such as **"Contains Transmitter Module FCC ID: Z6G-DT357"** or **"Contains FCC ID: Z6G-DT357"** or similar words which convey the same information.

**FCC ID: Z6G-DT357**

## 11.3 Canada IC Certification

The DT357 and DT357-U.FL comply with Industry Canada License-exempt RSS standards.

- Operation is subject to the following two conditions: 1) this device may not cause interference, and 2) this device must accept any 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 is necessary for successful communication.
- This radio transmitter DT357-U.FL has been approved by Industry Canada to operate with the antennas listed in Table 1 with a maximum permissible gain of up to 2.0dBi. Antenna types having a gain greater than the maximum gain indicated for that type are strictly prohibited for use with this device. The antenna impedance required is 50 ohms.

The labelling requirements are similar to those of FCC. A visible label displaying the IC number must be shown. The end user is responsible for the final product to comply with IC ICES-003 (Unintentional radiators).

## 11.4 European Certification

The DT357 and DT357-U.FL have been certified to the following standards:

- Radio: EN 300 328 v1.7.1 (10/2006)
- EMC: EN 301 489-17 v2.1.1 (09/2008). EN 301 489 compliance to be completed in the future.

The DT357 will be tested with its integrated chip antenna with a gain of 2.1dBi. The DT357-U.FL will be tested with an antenna listed in Table 1 with a maximum gain of 2.0dBi.

The 'CE' marking must be applied to a visible location on the user's product and must be legible. For more information please refer to http://ec.europa.eu/enterprise/faq/ce-mark.htm. Customers assume full responsibility for meeting the required guidelines for each country for their product distribution market.