DATA SHEET

RF Engine® 300 Series

Model Number: RF300
Part Number: RF300PD1

Document Revision v1.3

Wireless Technology to Control and
Monitor Anything from Anywhere™

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1.0   RF Engine 300 Series OEM Modules Overview

The RF Engine 300 Series (Model Number RF300) is a low power, highly-reliable solution to embedded wireless control and monitoring network needs that require high data rates. The RF300 embeds Synapse's SNAP OS, the industry's first Internet-enabled, wireless, mesh network operating system into the Silicon Laboratories Si1000 single-chip microcontroller with an integrated transceiver that delivers up to 150kbps. These low-cost modules can have a range of up to 3 miles and power consumption less than 16 µA to enable a new generation of battery-driven systems.

SNAP's on-board Python interpreter provides for rapid application development and over-the-air programming, while Silicon Laboratories' low-power RF single-chip design saves board space and lowers the overall Bill of Materials and power consumption. The RF300 is approved as an FCC Part 15 unlicensed modular transmitter. The modules provide up to 16 channels of operation in the ISM 915MHz frequency band. The on-board Si1000 transceiver contains both a power amplifier for transmission and a low noise amplifier in the receive path for extended range.

This Data Sheet details Part Number RF300PD1, which includes:

- 15 GPIO and up to 12 A/D inputs
- 192K total FLASH with 64K used by SNAP core, 64K free for uploadable SNAPpy scripts, and 64K reserved
- UART port for control or transparent data
- Low power modes: <16µA with internal timer running
- Frequency Hopping (FHSS) technology
- Socket-able or solder-able
- 150Kbps RF Data Rate
- 915 MHz RF Frequency
- 20 dBm Transmit Power for best-in-class range
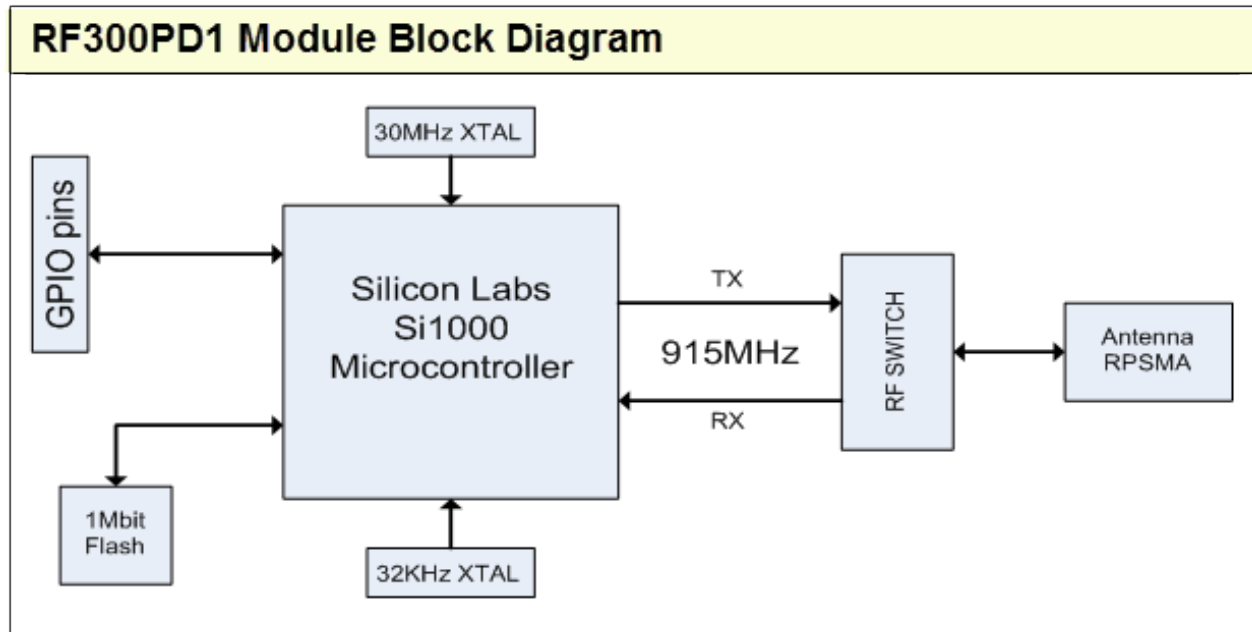- SMA antenna (up to 3 miles LoS)

Figure 1.0 Block diagram showing the major subsystems comprising the RF300PD1

1.1 Specifications

Table 1.0. RF300PD1 Specifications		
Performance	Outdoor LOS Range	Up to 3 miles
	Transmit Power Output	20 dBm
	RF Data Rate	150Kbps
	Receiver Sensitivity	-99 dBm (1% PER)
Power Requirements	Supply Voltage	2.7 - 3.6 V
	Transmit Current (Typ@3.3V)	85mA
	Idle/Receive Current (Typ@3.3V)	18.5mA
	Power-down Current (Typ@3.3V)	<16uA
General	Frequency	ISM 915 MHz
	Spreading Method	FHSS
	Modulation	GFSK
	Dimensions	1.333" x 1.333"
	Operating Temperature	- 40 to 85 deg C.
	Antenna Options	External RPSMA
Networking	Topology	SNAP
	Error Handling	Retries and acknowledgement
	Number of Channels	16
Available I/O	UARTS with HW Flow Control	1 Ports - 4 total I/O
	GPIO	15 total; 12 can be analog in with 10bit ADC
Agency Approvals	FCC Part 15.247	FCC ID: U9O-RF300
	Industry Canada (IC)	IC: 7084A-RF300

1.2 Module Pin Definitions

Pin	Name	Description
	Table 1.1. RF300PD1 Module Pin Assignments	
1	GND	Power Supply
2	GPIO0/ADC17/P2.1	GPIO_0, ADC17, I^2C SDA
3	GPIO1/ADC18/P2.2	GPIO_1, ADC18, I^2C SCL
4	GPIO2/ADC19/P2.3	GPIO_2, ADC19
5	GPIO3/ADC20/P2.4	GPIO_3, ADC20
6	GPIO4/ADC21/P2.5	GPIO_4, ADC21, SPI MOSI
7	GPIO5/ADC22/P2.6	GPIO_5, ADC22, SPI SCLK
8	GPIO6/ADC0/P0.0/V_{REF}	GPIO_6, ADC0, Interrupt, External Voltage Reference, SPI MISO
9	GPIO7/ADC5/P0.5/UART_RX	GPIO_7, ADC5, Interrupt, UART0 Rx Data Input
10	GPIO8/ADC4/P0.4/UART_TX	GPIO_8, ADC4, Interrupt, UART0 Tx Data Output
11	GPIO9/ADC3/P0.3/CTS	GPIO_9, ADC3, UART0 CTS Output
12	GPIO10/ADC2/P0.2/RTS	GPIO_10, ADC2, Interrupt, UART0 RTS Input
13	[GPIO11/ADC16/P2.0]	Not Available, Do Not Connect[1]
14	[GPIO12/ADC15/P1.7]	Not Available, Do Not Connect[1]
15	[GPIO13/ADC13/P1.5]	Not Available, Do Not Connect[1]
16	[GPIO14/ADC14/P1.6]	Not Available, Do Not Connect[1]
17	GPIO15/ADC6/P0.6/CNVSTR	GPIO_15, ADC6, External "Start Conversion" for ADC0
18	GPIO16/P2.7	GPIO_16[2]
19	GPIO17	GPIO_17
20	ANT_A	GPIO_18 (Output Only)
21	VCC	Power Supply
22	C2D	Background Debug Communications
23	RESET	Module Reset, Active Low
24	GND	Power Supply

1 *Pins 13 – 16 are not available for use on the RF300 and should not be tied to any signals. These pins are used for access to the onboard external memory.*
2 *GPIO16 has limited drive strength as it is routed through a 1Kohm resistor. The signal driven from (or to) GPIO16 can also be read, or driven, on pin 22 (CD2), the debug pin.*

1.3 Electrical Characteristics

Table 1.2. RF300PD1 DC Characteristics

Symbol	Parameter	Condition		Min	Typ [3]	Max	Units
V_{CC} [4]	Supply Voltage			2.7	3.3	3.6	V
T_{OP}	Operating Temp			-40		85	°C
V_{IH}	Input Hi Voltage	All Digital Inputs		V_{CC} - 0.6			V
V_{IL}	Input Low Voltage	All Digital Inputs				0.6	V
V_{OL}	Output Low Voltage	High Drive Strength	I_{OL} = 8.5ma			0.6	V
			I_{OL} = 10uA			0.1	
			I_{OL} = 25mA		Note [5]	-	
		Low Drive Strength	I_{OL} = 1.4ma			0.6	
			I_{OL} = 10uA			0.1	
			I_{OL} = 4mA		Note [5]	-	
V_{OH}	Output High Voltage	High Drive Strength	I_{OH} = -3ma	V_{CC} - 0.7			V
			I_{OH} = -10uA	V_{CC} - 0.1			
			I_{OH} = -10mA	-	Note [5]		
		Low Drive Strength	I_{OL} = 1.4ma	V_{CC} - 0.7			
			I_{OL} = 10uA	V_{CC} - 0.1			
			I_{OL} = 4mA	-	Note [5]		
IL_{IN}	In Leakage Current	Weak PU On, V_{IN} = 0V, V_{CC} = 3.6V			20	30	uA
$TX\text{-}I_{CC}$	Transmit Current	V_{CC} = 3.3V			85		mA
$RX\text{-}I_{CC}$	Receive Current	V_{CC} = 3.3V			18.5		mA
$SHDN\text{-}I_{CC}$	Sleep Current				8	16	uA

[3] *All typical specifications are measured at 25°C.*
[4] *Absolute maximum stress rated voltage for VCC is -0.3 to 3.6. It is recommended that a bulk decoupling capacitor (47 uF tantalum rated at 6.3volts) be located close to the VCC pin 21 of the RF300PD1 connector on host board.*
[5] *See Si100X datasheet for output current curves.*

Table 1.3. ADC Electrical Characteristics (Operating)

Symbol	Parameter	Condition	Min	Typical	Max	Unit
V_{REF}	Voltage Reference	Internal-Fast		1.65		V
		Internal-Precision		1.68		
		External	0		V_{CC}	
V_{INDC}	Analog input voltage	Absolute Voltage	0		V_{CC}	V
		ADC Input Range	0		V_{REF}	

Table 1.4. ADC Timing/Performance Characteristics

Symbol	Parameter	Condition	Min	Typical	Max	Unit
R_{AS}	Source impedance at input			5		kΩ
RES	Conversion Resolution			10		Bits
INL	Integral non-linearity			0.5	1	LSB
E_{OFF}	Offset Error			<1	2	LSB
E_{FS}	Full Scale Error			1	2.5	LSB

1.4   Mechanical Drawings

These drawings in Figure 1.1 show the module with the RPSMA connector for use with an external antenna.
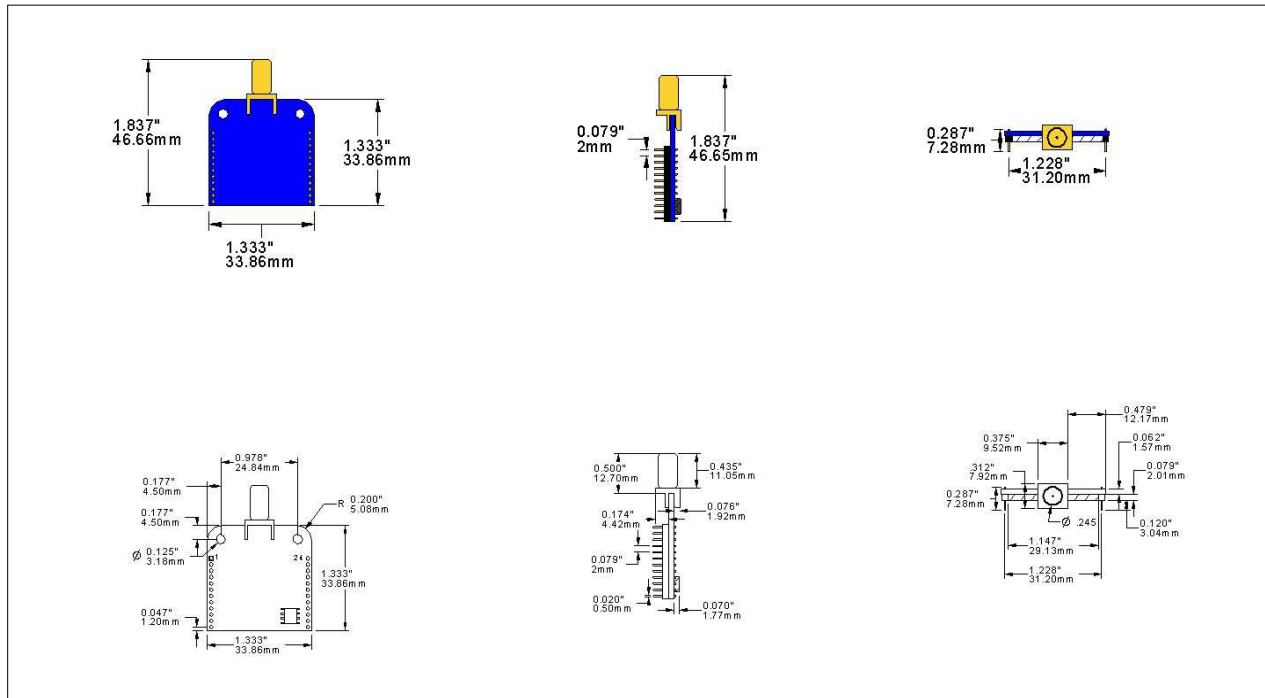

Figure 1.1 Mechanical drawings of the RF300PD1 Module

1.5   Board Mounting Considerations

The RF300PD1 module is designed to mount into a receptacle (socket) on the host board. Picture 1.1 shows an RF300PD1 module plugged in to a host board. The receptacle sockets are on standard 2mm centers. Suggested receptacles to be used on the host are:

(1) Thru-hole receptacle: Samtec   MMS-112-01-L-SV
(2) Surface mount receptacle: Samtec   MMS-112-02-L-SV

It is recommended that the mounting holes provided in the module on either side of the SMA connector be used with supporting mounting hardware to hard mount the module to either the host board or to the enclosure to handle the mechanical stresses that can occur when an external antenna is screwed into the SMA. Picture 1.1 shows the RF300PD1 with SMA connector mounted to the host board.

Host Board
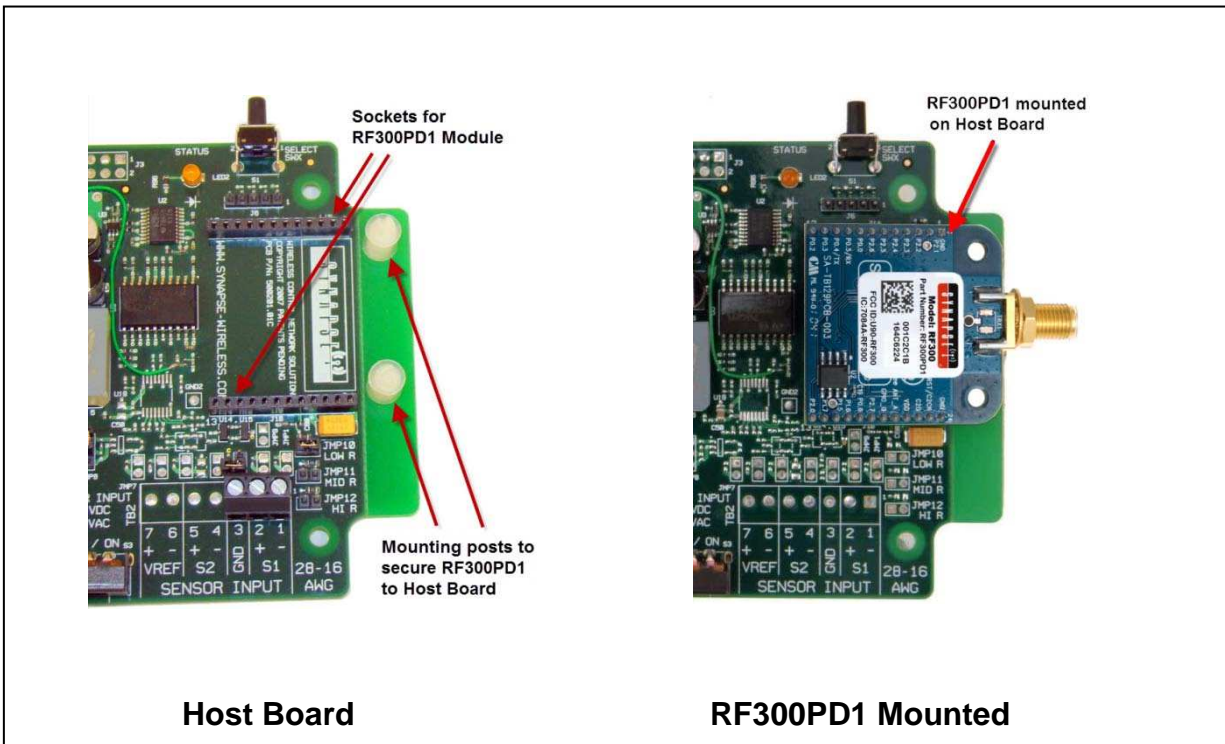
RF300PD1 Mounted

Picture 1.1 RF300PD1 Mounted To Host Board

2.0 Agency Certifications

2.1 United States (FCC)

The Model RF300 modules comply with Part 15 of the FCC rules and regulations. Compliance with the labeling requirements, FCC notices and antenna usage guidelines is required. In order to comply with FCC Certification requirements, the Original Equipment Manufacturer (OEM) must fulfill the following requirements.

1. The system integrator must place an exterior label on the outside of the final product housing the RF300 Modules. Figure 2.1 below shows the contents that must be included in this label.
2. RF300 Modules may only be used with the antenna that has been tested and approved for use with the module. Please refer to the antenna table provided in this section.

2.1.1 OEM Labeling Requirements

NOTICE: The OEM must make sure that FCC labeling requirements are met. This includes a clearly visible exterior label on the outside of the final product housing that displays the contents shown in Figure 2.1 below.

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+--------------------------------------------------------------------+
| MANUFACTURERS NAME                        Figure 2.1 FCC Label      |
| BRAND NAME or TRADE NAME                                            |
|                                                                    |
| Contains RF300 FCC ID:  U9O-RF300                                  |
|                                                                    |
| 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 interferences, and (2) this device must accept any   |
| interference received, including interference that may cause       |
| undesired operation.                                               |
+--------------------------------------------------------------------+
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2.1.2 FCC Notices

WARNING: The RF300 modules have been tested by the FCC for use with other products without further certification (as per FCC Section 2.1091). Changes or modifications to this device not expressly approved by Synapse Wireless Inc. could void the user's authority to operate the equipment.

NOTICE: OEM's must certify final end product to comply with unintentional radiators (FCC Section 15.107 and 15.109) before declaring compliance of their final product to Part 15 of the FCC Rules.

NOTICE: The RF300 modules have been certified for remote and base radio applications. If the module will be used for portable applications, the device must undergo SAR testing.

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.
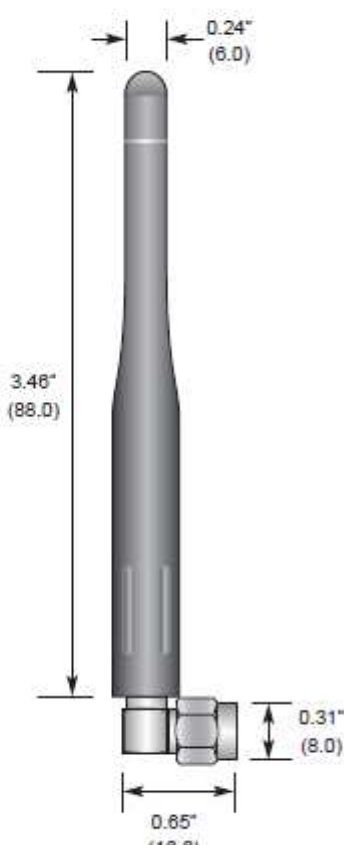
2.1.3 FCC Approved Antennas

The RF300 modules are FCC-approved for fixed base station and mobile applications. The FCC requirement for mobile applications states that the antenna must be mounted at least 20 cm (8 in) from nearby persons.

Notice: To reduce potential radio interference to other users, the antenna type and its gain should be chosen so that the equivalent isotropically radiated power (e.i.r.p.) is not more than that permitted for successful communication. This module has been designed to operate with the antennas listed below in Table 2.1. The required antenna impedance is 50 ohms.

Table 2.1. Approved Antennas				
Part Number	Type	Gain	Application	Min. Separation
Linx ANT-916-CW-RCL	Dipole (quarter-wave RPSMA)	0.47 dBi	Fixed/Mobile	20 cm.

Recommended Antenna:

RF Exposure WARNING: This equipment complies with FCC radiation exposure limits for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator and your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

NOTICE: The preceding statement must be included as a CAUTION statement in OEM product manuals in order to alert users of FCC RF Exposure compliance.

2.2   Canada (IC)

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.

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.

> *Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.*
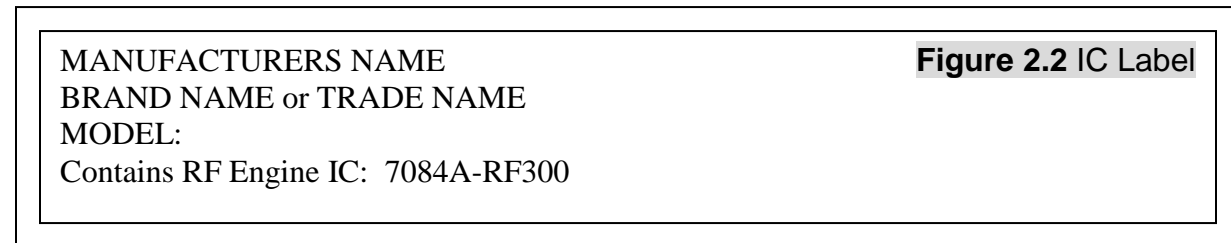
This radio transmitter Model: RF300, IC: 7084A-RF300 has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

> *Le présent émetteur radio (identifier le dispositif par son numéro de certification ou son numéro de modèle s'il fait partie du matériel de catégorie I) a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.*

Table 2.2. Approved Antennas

Part Number	Type	Gain	Application	Min. Separation
Linx ANT-916-CW-RCL	Dipole (quarter-wave RPSMA)	-	Fixed/Mobile	20 cm.

2.2.1 OEM Labeling Requirements

Labeling requirements for Industry Canada are similar to those of the FCC. A clearly visible label on the outside of the final product housing must display the contents shown in Figure 2.2 below.

MANUFACTURERS NAME   **Figure 2.2** IC Label
BRAND NAME or TRADE NAME
MODEL:
Contains RF Engine IC: 7084A-RF300

NOTE: The OEM can choose to implement a single label combined for both FCC and IC labeling requirements. If a combined single label is chosen, there must be a clearly visible label on the outside of the final product housing displaying the contents shown in Figure 2.3 below.

MANUFACTURERS NAME   **Figure 2.3** Combined FCC and IC Label
BRAND NAME or TRADE NAME

Contains RF Engine FCC ID: U9O-RF300
Contains RF Engine IC: 7084A-RF300

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 interferences, and (2) this device must accept any interference received, including interference that may cause undesired operation.