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# Datasheet

## RADIO APPARATUS – RAMP Wireless Module

2.4 GHz FHSS Wireless Module

Version 1.2



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#### **REVISION HISTORY**

Version	Date	Notes	Approver
1.1	2020 11 23	Initial Release	J Bond
1.2	2020 12 21	Update RFX information	J Bond



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#### **RAMP Modules**

Vermeer Corporation RAMP (Range Amplified MultiPoint) modules are designed to provide robust wireless communications for any number of applications requiring a wireless transport for serial data. RAMP modules feature a Frequency Hopping Spread Spectrum (FHSS) protocol for excellent interference and multipath immunity. RAMP modules server/client architecture allows for more than 16 million clients to be addressed and communicating within the network. This document contains information about the hardware and software interface between a Vermeer Corporation RADIO APPARATUS transceiver and a host. Information includes the theory of operation, specifications, and interface definitions.

Note:

Unless mentioned specifically by name, the RADIO APPARATUS modules are referred to as *module*, *radio*, or *transceiver*. Individual naming is used to differentiate product specific features. The host (PC/microcontroller/any device to which the RADIO APPARATUS module is connected) is referred to as *OEM host* or *host*.

#### **Key Features**

- Retries and acknowledgements
- Configurable network parameters
- Multiple generic I/O
- 280 kbps or 500 kbps RF data stream
- Idle current draw of 9.5 mA, sleep current of <1 uA (varies depending on sleep mode)</li>
- Software-selectable interface baud ranging from 1200 bps to 230.4 kbps
- Upgradable FW through serial port
- Low cost, low power, and small size ideal for high volume, portable, and battery powered applications
- All modules are qualified for Industrial temperatures (-40°C to 85°C)



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#### Table 1: Specifications table

	General				
Form Factor	SMD-ANT+U.FL, Pluggable-ANT+U.FL, SMD-U.FL, Pluggable-U.FL				
Antenna	External antenna through U.F	L connector			
Serial Interface Data Rate	Baud rates from 1200 to 230- supported.	00. Non-standard baud ra	tes are also		
Channels	10 mW – 42 selectable chanr	els			
Security	Channelization, System ID, Ve	ndor ID, and Extended Sys	stem ID		
Minimum Flash (EEPROM) Memory Endurance	1000 Write/Erase cycles				
Transceiver					
Frequency Band	2400-2483.5 MHz				
RF Data Rate (Raw)	280 kbps or 500 kbps selectable				
Hop Bin	900 kHz over 79 hops				
Spacing	1500 kHz over 43 hops				
RF Technology	Frequency Hopping Spread Spectrum				
Modulation	MSK				
Maximum Output Power Conducted <sup>1</sup>	+10 dBm				
Supply Voltage	2.3-3.6 V ± 50 mV ripple				
Current Draw	Mode				
	Tx Burst	40 mA			
	Rx Active	36 mA			
	Idle Current	9.5 mA			
	PM2/Cyclic Sleep	0.9 µA			
	PM3/Deep Sleep	0.38 µA			
	RF Profile	Receiver Sensitivit PER)	y (dBm) (1%		
Receiver	500 kbps	-88			
Sensitivity (1%	280 kbps	-92			
PER)	FEC 500 kbps	-91 (See No	te 5)		
	FEC 280 kbps	-95 (See No	te 5)		
	*See No	te 6			
Range	Outdo	or (line-	Indoor		
(based on external 2.0 dBi	of-s	ight)	(estimated)		
data rate) <sup>2</sup>	10 mW 1.0 km (	).6 miles)	100 m (328 feet)		



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Environmental	
Temperature (Operational)	-40°C to 85°C
Temperature (Storage)	-50°C to 150°C
Physical	
SMD-U.FL Dimensions	25.4 mm x 32.4 mm x 3.6 mm (1.0" x 1.28" x 0.14")
Pluggable-U.FL Dimensions	26.7 mm x 33 mm x 10.6 mm (1.05" x 1.29" x 0.42")
Certifications	
FCC – Part 15.247	2AXF5-VERMEER1
Industry Canada (IC)	26431-VERMEER1
RoHS	Yes

Notes:

- 1. See <u>*Regulatory Information*</u> in this guide.
- 2. While the use of FEC does not affect the actual PER, it does allow correct reception at a lower SNR, thus extending communication range. We've measured this to yield an effective sensitivity increase on the order of 3dBm.
- 3. The RADIO APPARATUS can operate at two different RF baud rates: 250 kbps and 500 kbps. The chip receiver saturation is -11dBm at 250 kbps and -15 dBm at 500 kbps. Inside the module, there is an FEM which has net gain of about 11-13dB. For 500 kbps RF baud rate, the input RF signal must be less than -28 dBm without causing any saturation, and at 250 kbps RF baud rate the signal must be less than -24dbm. In real deployment, some margin to cover the signal variation is required. With all these factors considered, we suggest the received RF signal should not be stronger than -40 dBm.

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#### **Pin Definitions**

#### Table 2: RADIO APPARATUS pins

SMT	Plugga	Ту	Signal	Functions
Pin	ble Pin	ре	Name	Generic Output /
1	7	0	GIO-0	Hop_Frame
2	6	0	GIO_1	Generic Output
3	8		DNC	Do Not Connect
4	17	0	GIO_2	RS485 Driver Enable
5	19	0	GIO_3	PWM Output
6	3	I	RXD	Asynchronous serial data input to transceiver
7	2	0	TXD	Asynchronous serial data output from transceiver
8	10	GND	GND	Signal Ground
9	1	PWR	Vcc	2.3 – 3.6 V ±50 mV ripple (must be connected)
10	-	PWR	Vpa	2.3 - 3.6 V ±50 mV ripple (must be connected on SMT version)
11	-	GND	GND	Signal Ground
12	9	Ι	Force 9600 /Sleep Interrupt	Force 9600 – When pulled logic Low and then applying power or resetting, the transceiver's serial interface is forced to a 9600, 8-N-1 rate. Sleep Interrupt – When taken Low, this pin wakes the radio from any of the three sleep modes. Note: Pulling this pin to GND disables some modes of operation, therefore it should not be permanently pulled Low during normal

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SMT Pin	Plugga ble Pin	Ту ре	Signal Name	Functions
			·	operation.
13	14	I	GIO_4	Generic Input
14	5	I	Error!	Reset – Controlled by the RADIO APPARATUS for power-on reset if left unconnected. After a stable power-on reset, a logic low pulse resets the transceiver.
15	11	I	Error!	When logic Low, the transceiver interprets incoming OEM host data as command data. When logic High, the transceiver interprets OEM host data as transmit data.
16	15	0	Error!	When logic Low, the client is in range and synchronized with a server. This is always Low on a server.
17	16	I	RTS	Request to Send – Floats high if left unconnected. When enabled in EEPROM, the module will not transmit Serial UART data to the OEM Host unless this pin is Low.
18	12	0	CTS	Clear to Send – CTS is used for hardware flow control indication to the OEM Host. CTS toggles high when the Serial UART RX input buffer reaches the CTS On threshold and remains high until the buffer recedes below the CTS Off threshold.
1 9	18		GIO_8	Generic Input

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SMT Pin	Plugga ble Pin	Ту ре	Signal Name	Functions
20	13		GIO_5	Reserved for future use. Do not connect.
21	4		GIO_6	Reserved for future use. Do not connect.
22	20	I	GIO_7	Analog to Digital input

#### Tips:

- All I/O directions are referenced to Vcc.
- All inputs are weakly pulled High via a 20 k Ohm pull-up resistor and may be left floating during normal operation.
- Minimum connections: VCC, VPA, GND, TXD, and RXD.
- Signal direction is with respect to the transceiver.
- Leave unused pins disconnected.

#### **Input Characteristics**

#### Table 3: Input characteristics

Signal Name	High Min.	High Max.	Low Min.	Low Max.
μP_Reset	0.8 v	Vcc	0 v	0.6 v
RTS	2.31 v	Vcc	0 v	.99 v
AD_In	N/A	Vcc	0 v	N/A
All other inputs	70% Vcc	Vcc	0 v	30% Vcc

#### **Output Characteristics**

#### Table 4: Output characteristics

Signal Name	High Min.	High Max.	Low Min.	Low Max.	Sink Current
GO_0	2.5 v	3.3 v	0 v	0.4 v	20 mA
GO_1	2.5 v	3.3 v	0 v	0.4 v	20 mA
PWM_Output	N/A	3.3 v	0 v	N/A	4 mA
All other outputs	2.5 v	3.3 v	0 v	0.4 v	4 mA

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#### **Block Diagram**





#### **Timing Specifications**

#### Table 5: Timing specifications

Parameter	Server/Client	Min.	Тур.	Max	Notes
Power on to CTS Low		5 ms	10 ms	N/A	The first boot after a FW upgrade requires more than the typical amount of time for CTS to toggle Low.
EEPROM Read		800 µs	1 ms	2 ms	Measured from last byte of command to first byte of response: 870 μs for 1 byte; 1.1 ms for 80 bytes; 1.4 ms for 256 bytes
EEPROM Write		20 ms	30 ms	40 ms	Measured. EEPROM writes cause the radio to resynchronize.
Power on to In Range	Client only	13 ms	600 ms	1700 ms	Maximum time assuming all beacons are heard; RF interference could extend the maximum time indefinitely.
Hop Period In Range			13.19 ms		
Hop Period Out of Range	Client only		38.4 ms		



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Parameter	Server/Client	Min.	Тур.	Max	Notes
Reset Pulse		250 ms			
PWM Output Period			39.3846 µs		
Restore Default EEPROM Command		10 ms	38 ms		Restore command also initiates a soft reset, so monitoring CTS is the best indication of a completed command.
Non- specific AT Command		1 ms	10 ms		Some AT Commands could wait indefinitely for a response.
Write Flash					For FW upgrade.
Read Flash					

#### **RF Hop Frame**

The RADIO APPARATUS hops every 13.19 milliseconds and can be configured for two different RF data rates to provide options for range or throughput. During each hop, the RADIO APPARATUS reserves a certain amount of time for overhead such as the synchronization beacon, internal messaging, and user data transmission. The diagrams below outline the various transmissions that occur during a hop. These transmissions are transparent to the user sending data, but may be useful for applications that require critical timing. User data is only transmitted during the data slots and after the Interface Timeout or RF Packet Size criteria has been met. Data transmission only begins at the beginning of a data slot. When configured for Full Duplex, data slot 1 is reserved for the server and data slot 2 is shared by all clients for transmissions.



Figure 2: RF hop frame diagram

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#### **Hardware Interface**

#### **Pin Descriptions**

RXD and TXD

The RADIO APPARATUS accepts 3.3 VDC TTL level asynchronous serial data from the OEM host via the RXD pin. Data is sent from the transceiver, at 3.3 volt levels, to the OEM host via the TXD pin. Pins should be left floating or high when not in use. Leaving the RXD tied low results in the radio transmitting garbage serial data across the RF.

#### Force 9600 /Sleep Interrupt

When pulled logic Low before applying power or resetting, the transceiver's serial interface is forced to 9600,

8-N-1 (8 data bits, no parity, 1 stop bit) regardless of the actual EEPROM setting. RTS is ignored, the interface timeout is also set to three milliseconds, and the RF packet size is set to the default size for the selected RF data rate. To exit, the transceiver must be reset or power-cycled with the test pin logic High or disconnected. When in Force 9600 mode, the radio's receiver is disabled. When enabled in the EEPROM, the 9600 Boot option causes the 9600 pin to be ignored on cold boot (power-up), command boot (0xCC 0xFF), and brown-out conditions. Therefore, the 9600 pin is only observed on warm boots (reset pin toggled). This can be helpful so that brown-out conditions don't cause the baud rate to change if the 9600 pin happens to be low at the time. When 9600 Boot option is disabled, the 9600 pin is used for all boot conditions. 9600 Boot option is enabled by default.

Force 9600 is also used to wake the radio from sleep. When the pin is taken low, the radio wakes. The transceiver does not sleep if the pin is low when the sleep command is issued.

**Note:** Because this pin disables some modes of operation, it should not be permanently pulled Low during normal operation.

#### $\mu P_RESET$

µP\_Reset provides a direct connection to the reset pin on the RADIO APPARATUS microprocessor and is used to force a hard reset. For a valid reset, reset must be asserted Low for an absolute minimum of 250 nanoseconds (ns).

#### Command/Data

When logic High, the transceiver interprets incoming serial data as transmit data to be sent to other transceivers. When logic Low, the transceiver interprets incoming serial data as command data. When logic Low, data packets from the radio are not transmitted over the RF interface, however, incoming packets from other radios are still received. Enabling CMD/Data RX Disable in the EEPROM causes incoming RF packets to be queued by the receiving radio while CMD/Data is low. When CMD/Data goes high, the data is sent over the serial interface.



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#### In\_Range

The In\_Range pin is driven low when a client radio's frequency hopping is synchronized with that of a server. In\_Range is always driven low on a server. Following boot, In\_Range transitions low in approximately 12 milliseconds on a server. For a client, the In\_Range takes an average of 500 milliseconds; this time is dependent on the signal strength of the received beacon, the presence and strength of interference, and randomness of the sync function. It can vary from 150 milliseconds to over 1500 milliseconds.

#### GO\_0/Hop\_Frame

The Hop Frame indicator functionality is disabled by default and controlled by the Control 1, Bit-6 EEPROM setting. When enabled, this pin transitions logic Low at the start of a hop and transitions logic High at the completion of a hop. The OEM host is not required to monitor hop frame.

#### RTS and Handshaking

With RTS mode disabled, the transceiver sends any received data to the OEM host as soon as it is received. However, some OEM hosts are not able to accept data from the transceiver at all times. With RTS enabled in EEPROM, the OEM host can prevent the transceiver from sending data by de-asserting RTS (High). Once RTS is re-asserted (Low), the transceiver sends packets to the OEM host as they are received.

Note: Leaving RTS de-asserted for too long can cause data loss once the transceiver's transmit buffer reaches capacity.

#### CTS Handshaking

If the transceiver buffer fills up and more bytes are sent to it before the buffer can be emptied, data loss occurs. The transceiver prevents this loss by de-asserting CTS high as the buffer fills up and asserting CTS low as the buffer is emptied. CTS should be monitored by the host device and data flow to the radio should be stopped when CTS is high.

#### DE/RE

When enabled, RS485 Data Enable uses the DE/RE pin to control the DE pin on external RS-485 circuitry. When the transceiver has data to send to the host, it asserts DE/RE High, sends the data to the host, and then takes DE/RE low.

#### **PWM Output**

PWM output can be configured to output on any of three pins (SMT Pins 5, 6, or 7). The PWM Output can optionally produce a pulse width modulation for RSSI with a period of  $39.3846 \,\mu$ S.



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#### **Reflow Parameters**

Vermeer Corporation's surface mount modules are designed to be easily manufactured, including reflow soldering to a PCB. Ultimately, it is the responsibility of the customer to choose the appropriate solder paste and to ensure oven temperatures during reflow meet the requirements of the solder paste. Vermeer Corporation's surface-mount modules conform to J-STD-020D1 standards for reflow temperatures.

IMPORTANT: During reflow, modules should not be above 260°C and not for more than 30 seconds.



Figure 3: Recommended reflow temperature

Temperatures should not exceed the minimums or maximums presented in Figure 3.

#### Table 6: Reflow temperatures

Specification	Value	Unit
Temperature increase/decrease rate (maximum)	3	°C/Second
Temperature decrease rate (goal)	2-3	°C/Second
Soak temperature increase rate (goal)	.5-1	°C/Second
Flux soak period (minimum)	60	Seconds
Flux soak period (maximum)	90	Seconds
Flux soak temperature (minimum)	150	°C
Flux soak temperature (maximum)	190	°C



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Specification	Value	Unit
Time above liquidus (maximum)	60	Seconds
Time above liquidus (minimum)	20	Seconds
Time in target reflow range (goal)	30	Seconds
Time at absolute peak (maximum)	30	Seconds
Liquidus temperature (SAC305)	217	°C
Lower target reflow temperature	225	°C
Upper target reflow temperature	250	°C
Absolute peak temperature	260	°C

### **Ordering Information**

#### **Product Part Numbers**

RADIO APPARATUS Part Number	Form Factor	Maximum Tx Power	Antenna	EERPOM Product ID
RADIO APPARATUS- S10-C-30	SMT	10 mW	u.FL Jack	RADIO APPARAT US10C30
RADIO APPARATUS- P10-C-30	Pluggable	10 mW	u.FL Jack	RADIO APPARATU S10C30

### **Regulatory Information**

#### FCC/IC Requirements for Modular Approval

#### Agency Identification Numbers

Product Family	US/FCC	Canada/IC	
RADIO APPARATUS	2AXF5-VERMEER1	26431-VERMEER1	



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#### **RADIO APPARATUS Family**

Part Number *	Form Factor	Tx Output	Antenna
312000283	Surface Mount	10 mW	U.FL
312000284	Pluggable	10 mW	U.FL

#### Antenna Information

The RADIO APPARATUS family is designed to operate with the antennas listed below and a maximum gain of 4.6 dBi. The required antenna impedance is 50 ohms.

Manufacturer	Manufacturer Part Number	Туре	Gain (dBi)
Laird Connectivity	TRA6927M3PBN-001	Dipole	4.6
PCTEL	PCTCN24005	Dipole	4.5
Laird Connectivity	TRAB24003P	Dipole	3.0
PCTEL	BMLPV2400NGP	Dipole	3.0
Nearson	S181FL-5(178)-PX-2450	Dipole	2.0
Laird Connectivity	MAF94045	Dipole	2.0
Molex	1461530150	Dipole	2.4

**Note:** To reduce potential radio interference to other users, the antenna type and gain should be chosen so that the equivalent isotropically radiated power (EIRP) is not more than that permitted for successful communication.

#### Power Exposure Information

#### FCC

In general, there are two agency classifications for RF radiation exposure in wireless applications:

- Mobile A mobile device is defined as a transmitting device designed to be used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structures and the body of the user or nearby persons. The RADIO APPARATUS is fully modular approved for mobile and fixed applications. *Reference FCC Part 2.1091 for further details on mobile devices.*
- Portable Portable is a classification of equipment where the user, in general, is within 20 cm of the transmitting antenna. Further RF evaluation is required by customers who want to use the RADIO APPARATUS in portable applications that do not meet the minimum separation distance required for RF Exposure compliance referenced in the note below.. Contact a qualified test house or a Vermeer Corporation representative for further information on this topic. *Reference FCC Part 2.1093 for further details on portable devices.*

A RF Exposure report has been created to demonstrate compliance with the SAR Test Exclusion Threshold (for the FCC) and with the Exemption Limit for Routine SAR Evaluation (for ISED), provided the minimum separation distances are maintained.

**Note:** To comply with FCC RF Exposure requirements, the following minimum separation distances must be maintained: 7 mm from head and torso, and 5 mm away from extremities.



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**CAUTION:** Any changes or modifications not expressly approved by Vermeer Corporation could void the user's authority to operate the equipment.

**NOTE:** 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 not cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to correct the interference by one or more of the following measures:

- Re-orient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment to an outlet on a circuit that is different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

#### CAUTION:

"THIS DEVICE COMPLIES WITH PART 15 OF THE FCC RULES AND INDUSTRY CANADA LICENSE-EXEMPT RSS STANDARD(S). 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."

Information on test modes and additional testing requirements Additional guidance for testing host products is given in KDB Publication 996369 D04 Module Integration Guide. Test modes should take into consideration different operational conditions for a stand-alone modular transmitter in a host, as well as for multiple simultaneously transmitting modules or other transmitters in a host product.

#### Additional testing – Part 15 Subpart B disclaimer

The module is only FCC authorized for the specific rule parts listed on the grant, and that the host product must be compliant to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. The final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.



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#### Industry Canada Statement

This device contains license-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's license-exempt RSS(s). Operation is subject to the following two conditions:

- (1) This device may not cause interference
- (2) This device must accept any interference, including interference that may cause undesired operation of the device

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

- (1) L'appareil ne doit pas produire de brouillage;
- (2) L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

#### **Radio Identification Statements:**

The host devices shall be labeled with the following statements: This device contains FCC ID: 2AXF5-VERMEER1 and IC ID: 26431-VERMEER1

#### **Radiation Exposure Statement:**

This equipment complies with Canada radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 15 mm between the radiator & your body and 10 mm between the radiator & body extremities.

#### Déclaration d'exposition aux radiations:

Cet équipement est conforme Canada limites d'exposition aux radiations dans un environnement non contrôlé. Cet équipement doit être installé et utilisé à distance minimum de 15 mm entre le radiateur et votre corps.

This device is intended only for OEM integrators under the following conditions: 1) The transmitter module may not be co-located with any other transmitter or antenna.

As long as 1 condition above are met, further transmitter test 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.

Cet appareil est conçu uniquement pour les intégrateurs OEM dans les conditions suivantes:

1) Le module émetteur peut ne pas être coïmplanté avec un autre émetteur ou antenne.

Tant que les 1 condition ci-dessus sont remplies, des essais supplémentaires sur l'émetteur ne seront pas nécessaires. Toutefois, l'intégrateur OEM est toujours responsable des essais sur son produit final pour toutes exigences de conformité supplémentaires requis pour ce module installé.

#### **IMPORTANT NOTE:**

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the Canada



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authorization is no longer considered valid and the IC ID can not 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 Canada authorization.

#### NOTE IMPORTANTE:

Dans le cas où ces conditions ne peuvent être satisfaites (par exemple pour certaines configurations d'ordinateur portable ou de certaines co-localisation avec un autre émetteur), l'autorisation du Canada n'est plus considéré comme valide et l'ID IC ne peut pas être utilisé sur le produit final. Dans ces circonstances, l'intégrateur OEM sera chargé de réévaluer le produit final (y compris l'émetteur) et l'obtention d'une autorisation distincte au Canada.

#### **End Product Labeling**

The final end product must be labeled in a visible area with the following: "Contains IC: 26431-VERMEER1".

#### Plaque signalétique du produit final

Le produit final doit être étiqueté dans un endroit visible avec l'inscription suivante: "Contient des IC: 26431-VERMEER1.

#### Manual Information to the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual, beginning at the bottom of page 15 (where the Regulatory Information section begins), to the end of this document.

#### Manuel d'information à l'utilisateur final

L'intégrateur OEM doit être conscient de ne pas fournir des informations à l'utilisateur final quant à la façon d'installer ou de supprimer ce module RF dans le manuel de l'utilisateur du produit final qui intègre ce module. Le manuel de l'utilisateur final doit inclure toutes les informations réglementaires requises et avertissements comme indiqué dans ce manuel.

This radio transmitter [IC: 26431-VERMEER1] has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Le présent émetteur radio [IC: 26431-VERMEER1] a été approuvé par Innovation, Sciences et Développement économique Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal. Les types d'antenne non inclus dans cette liste, et dont le gain est supérieur au gain maximal indiqué pour tout type figurant sur la liste, sont strictement interdits pour l'exploitation de l'émetteur.



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Manufacturer	Manufacturer Part Number	Туре	Gain (dBi)
Laird Connectivity	TRA6927M3PBN-001	Dipole	4.6
PCTEL	PCTCN24005	Dipole	4.5
Laird Connectivity	TRAB24003P	Dipole	3.0
PCTEL	BMLPV2400NGP	Dipole	3.0
Nearson	S181FL-5(178)-PX-2450	Dipole	2.0
Laird Connectivity	MAF94045	Dipole	2.0
Molex	1461530150	Dipole	2.4