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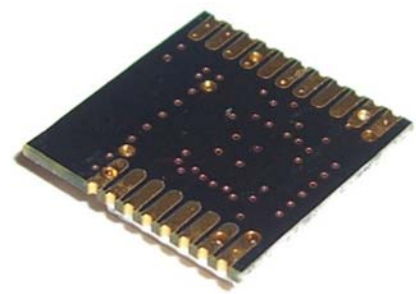
RFDP8
RF Module
RFD21733
RFD21735
RFD21737
RFD21738
RFD21739

Complete 2.4 GHz RF Transceiver Module with Built-In RFDP8 Application Protocol

Part Numbers RFD21733, RFD21735, RFD21737, RFD21738, RFD21739



RFD21733

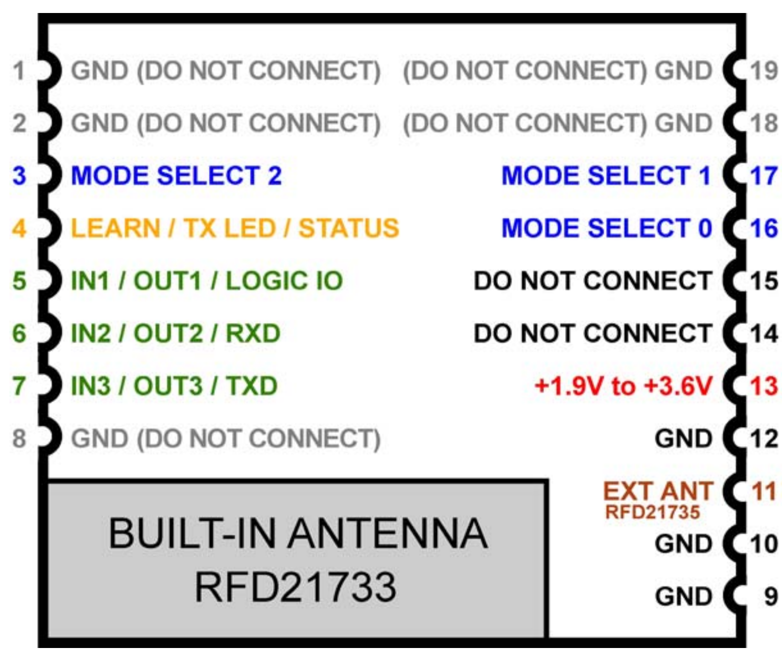
15mm x 15mm (0.600 inch x 0.600 inch)

Optional Configuration

For use with External Antenna

RFD21735

RFD21733 / RFD21735 is a complete, READY-TO-USE wireless solution with it's built-in user application interface (RFDP8). Includes RFID, ESN, Logic Switch Transmitter / Receiver, 9600,N,8,1 Serial UART and many easy-to-use addressable network modes. No development required at all, no RF layout, no code writing, all features are built-in. Be up and running with a full wireless solution in minutes.



Applications

- Active RFID
- Long Range RFID
- Remote Control
- Light Controls
- Home Automation
- Alarm Security
- Keyless Entry
- Perimeter Monitoring
- PC Keyboard Security
- Wireless Keyboard
- Wireless Mouse
- TV Remote
- Home Stereo Remote
- Asset Tracking
- Wireless PTT
- Remote Switches
- Remote Terminals
- Wireless RS232 DB9
- Wireless RS485
- Temperature Control
- HV/AC
- Meter Reading
- Data Acquisition
- Inventory Control
- Keyfob Remotes
- Industrial Controls
- Vending Machines

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RFD21733 / RFD21735 Features

- WiFi interference tolerant.
- Bluetooth interference tolerant.
- Zigbee interference tolerant.
- Very low cost.
- No external parts required.
- No RF layout required.
- Easy and ready-to-use, hand-held, eval and application boards available.
- Ultra small 15mm x 15mm footprint.
- Fully contained, truly a finished, ready to use module.
- FCC, CE, IC (ETSI) Compliance approvals (pending).
- Typical range outdoor; 300 feet (100 meters), indoor 100 feet (33 meters).
- Worldwide 2.4GHz ISM band operation.
- User configurable without need for any programming.
- 2uA Ultra low power modes.
- Only 14mA current consumption at 0dbm RF power output.
- Only 17mA current consumption at -94 dBm receive sensitivity.
- 16 bit CRC data accuracy verification built-in.
- 32 bit unique factory ESN in every module (4 billion combination security).
- Flexible network modes, including broadcast and individual addressing.
- Optional version available for use with external antenna (RFD21735).
- Switch on/off, logic, remote-control without the need for an external controller.
- Switch nodes individually addressable without the need for an external controller.
- Wide supply range +1.9V to +3.6V.
- Built-in, high performance internal antenna (RFD21733).
- Peer to Peer (Ad-Hoc) networks and configurations.
- Point to Multi-Point networks and configurations.
- Multi-Point to Multi-Point networks and configurations.
- Selective addressing of any module by using factory built-in ESN.
- Fast-turn-around, minimal latency (20 millisecond).
- Patent pending RFDP8 interference tolerant protocol.
- Full application protocol runs transparent to the user.
- Easy to use, simple to design in.
- Stores up to 60 ESNs (Electronic Serial Numbers) for network modes.
- Many to one data modes ideal for multi-point data acquisition.
- Unlimited number of module nodes can communicate to each other.

Custom Modules

RF Digital's RFDP8 application firmware loaded into the RFD21733 / RFD21735 modules can be customized to fit application specific user requirements.

RF Digital can design and manufacture fully custom modules to fit specific customer requirements.

If you do not find what you're looking for, feel free to contact RF Digital with your requirements.

Eval Kits

See below for READY-TO-USE Eval boards.

RFDP8 Application Protocol • Mode Selector Chart

RFDP8 8-Mode Chart for RFD21733 / RFD21735
© RF Digital Corp. 01.27.09 8:34 PM

Mode	Description	Mode Select Inputs 2	1	0				Learn / Status	
0	Active RFID Transmitter	0	0	0	IN 3	IN 2	IN 1	TX LED	
1	3 Input Switch Logic Transmitter	0	0	1	IN 3	IN 2	IN 1	TX LED	
2	Serial UART Transceiver, 9600, N, 8, 1	0	1	0	TXD IN	RXD OUT	LOGIC I/O	X	
3	Serial UART Transceiver, 9600, N, 8, 1	0	1	1	TXD IN	RXD OUT	LOGIC I/O	ESN LEARN	Network
4	3 Output Switch Logic Receiver - 500ms	1	0	0	OUT 3	OUT 2	OUT 1	X	
5	3 Output Switch Logic Receiver - 500ms	1	0	1	OUT 3	OUT 2	OUT 1	ESN LEARN	Network
6	3 Output Switch Logic Receiver - 20ms	1	1	0	OUT 3	OUT 2	OUT 1	X	
7	3 Output Switch Logic Receiver - 20ms	1	1	1	OUT 3	OUT 2	OUT 1	ESN LEARN	Network
	RFD21733 / RFD21735 Pin Number:	3	17	16	7	6	5	4	

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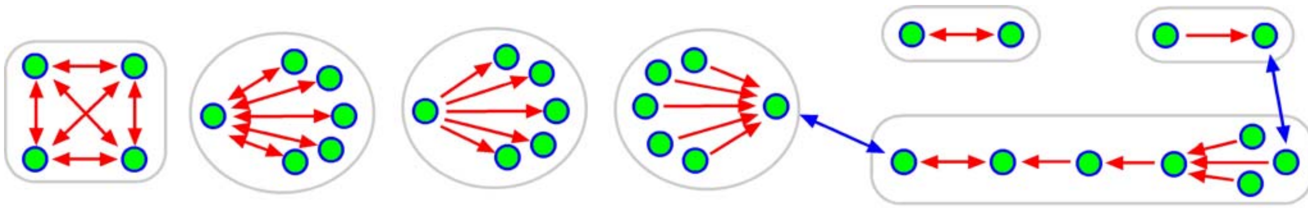
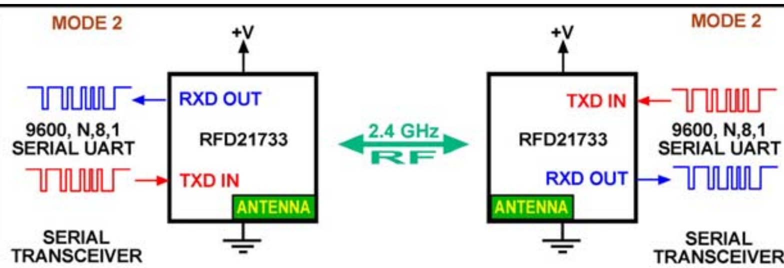
RFD21733 / RFD21735 System Configuration Examples



RFD21733 / RFD21735 Unlimited number of nodes and configurations with and without network mode.

RFD21733 / RFD21735 Application Configuration Examples

Bidirectional serial transceiver normally sits in receive mode, receiving and outputting serial bytes out of the RXD pin, as they come in. When user sends data into TXD pin it automatically switches to transmit.



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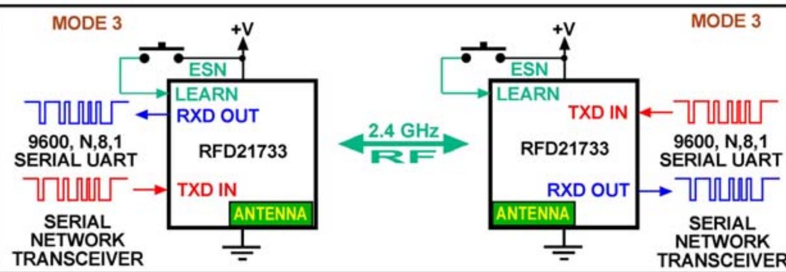
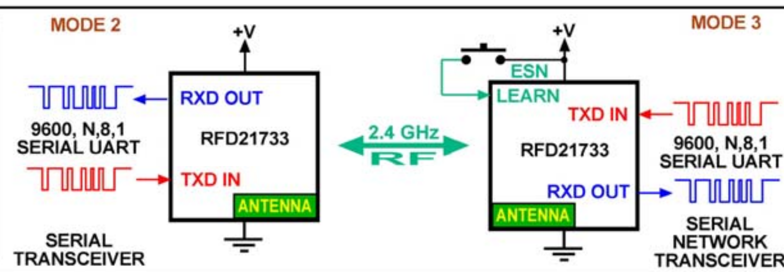
Bidirectional serial transceiver normally sits in receive mode, receiving and outputting serial bytes out of the RXD pin, as they come in. When user sends data into TXD pin it automatically switches to transmit. The receiver will only respond to transmitters if it has learned their ESNs.



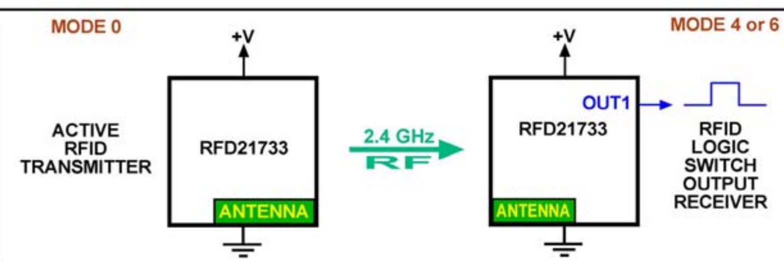
Bidirectional serial transceiver normally sits in receive mode, receiving and outputting serial bytes out of the RXD pin, as they come in. When user sends data into TXD pin it automatically switches to transmit. The receiver will only respond to a transmitters if it has learned their ESNs.

Bi-directional serial transceiver normally sits in receive mode, receiving and outputting serial bytes out of the RXD pin, as they come in. When user sends data into TXD pin it automatically switches to transmit.



Bi-directional serial transceiver normally sits in receive mode, receiving and outputting serial bytes out of the RXD pin, as they come in. When user sends data into TXD pin it automatically switches to transmit. The receiver will only respond to transmitters if it has learned their ESNs.

In this mode, simply apply 1.9 to 3.6 VDC (typically 3V), and the RFD21733 and it will automatically transmit once every 2 seconds as an RFID transmitter. With every transmission it also sends it's unique 32 BIT ESN (Electronic Serial Number).



Once every 2 seconds, depending on the configured mode, OUT1 will output a level high signal for a duration of 20 or 500 milliseconds. The idle state is low.

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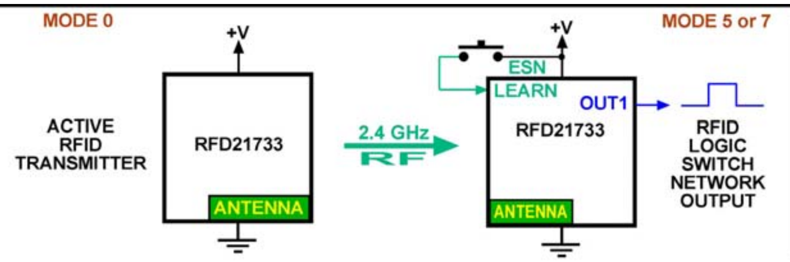
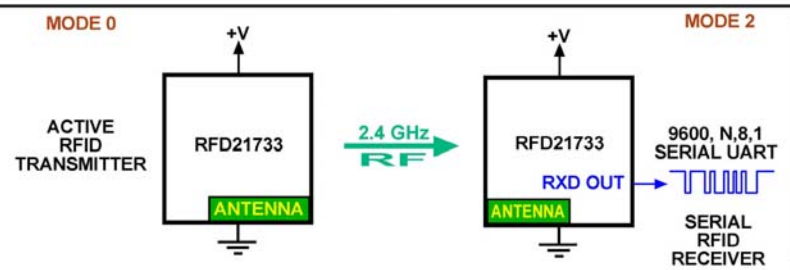


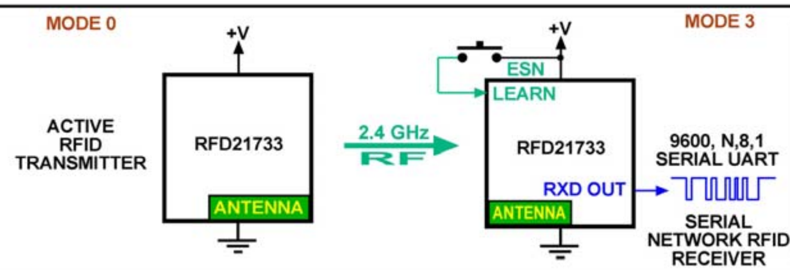
Once every 2 seconds, depending on the configured mode, OUT1 will output a level high signal for a duration of 20 or 500 milliseconds. The idle state is low. The receiver will only respond to transmitters if it has learned their ESNs.

In this mode, simply apply 1.9 to 3.6 VDC (typically 3V), and the RFD21733 and it will automatically transmit once every 2 seconds as an RFID transmitter. With every transmission it also sends it's unique 32 BIT ESN (Electronic Serial Number).



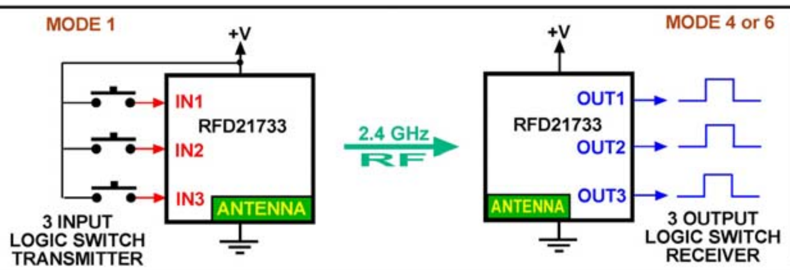
Once every 2 seconds, the RXD pin will output 5 bytes. Byte 1 will have bit 4 and bit 1 set, and bytes 2-5 are the 32 bit ESN of the RFID transmitter.

In this mode, simply apply 1.9 to 3.6 VDC (typically 3V), and the RFD21733 and it will automatically transmit once every 2 seconds as an RFID transmitter. With every transmission it also sends it's unique 32 BIT ESN (Electronic Serial Number).



Once every 2 seconds, the RXD pin will output 5 bytes. Byte 1 will have bit 4 and bit 1 set, and bytes 2-5 are the 32 bit ESN of the RFID transmitter. The receiver will only respond to transmitters if it has learned their ESNs.

The RFD21733 stays in (2 uA) deep sleep, until any combination of the 3 buttons are pressed, then it will transmit the state of all 3 inputs. With every transmission it also sends it's unique 32 BIT ESN (Electronic Serial Number).



OUT1, OUT2 or OUT3 (follow) output any transmission received by the transmitter switch states IN1, IN2 or IN3. Depending on the configured mode there is a 20 or 500 millisecond hang time.

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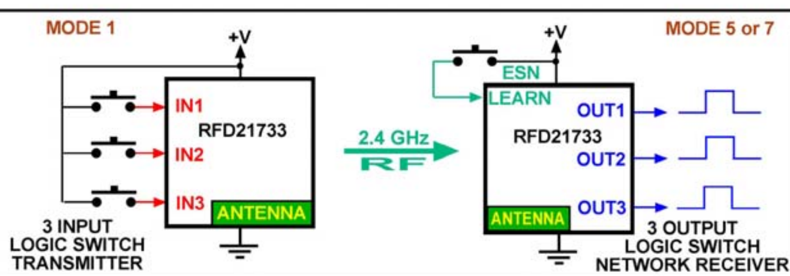

OUT1, OUT2 or OUT3 (follow) output any transmission received by the transmitter switch states IN1, IN2 or IN3. Depending on the configured mode there is a 20 or 500 millisecond hang time. The receiver will only respond to transmitters if it has learned their ESNs.

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RFD21733 / RFD21735 Application Configuration Examples

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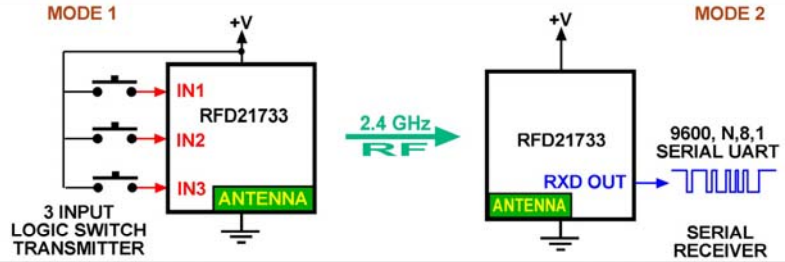
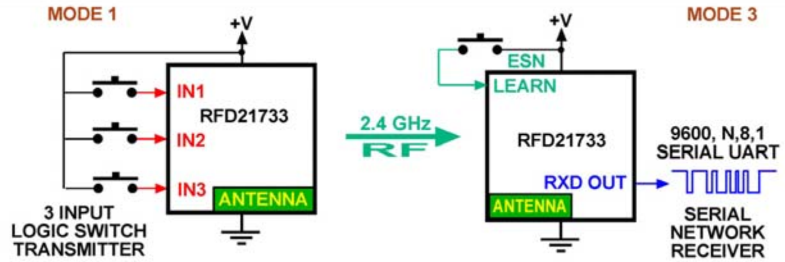


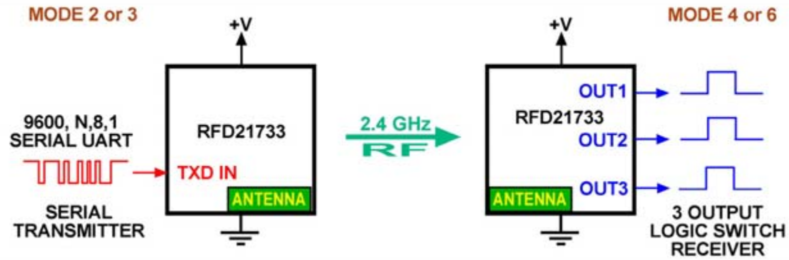
When a transmission is received. The RXD pin outputs 5 bytes. Byte 1 (bit 4,5,6) are the transmitter input states IN1, IN2, IN3. Bytes 2-5 are the 32 bit ESN of the switch transmitter.

The RFD21733 stays in (2 uA) deep sleep, until any combination of the 3 buttons are pressed, then it will transmit the state of all 3 inputs. With every transmission it also sends it's unique 32 BIT ESN (Electronic Serial Number).



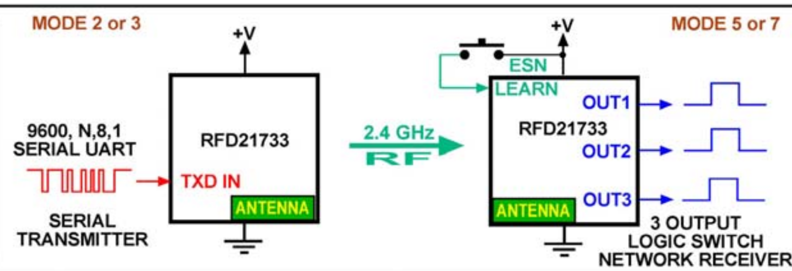
When a transmission is received. The RXD pin outputs 5 bytes. Byte 1 (bit 4,5,6) are the transmitter input states IN1, IN2, IN3. Bytes 2-5 are the 32 bit ESN of the switch transmitter. The receiver will only respond to transmitters if it has learned their ESNs.

Apply a single byte into the TXD pin to control the states of the switch receiver. Bit position 4,5,6 represent OUT1, OUT2, OUT3 on the receiver, all other bits must be zero. The receivers outputs states can not be updated any faster then once every 20 milliseconds.



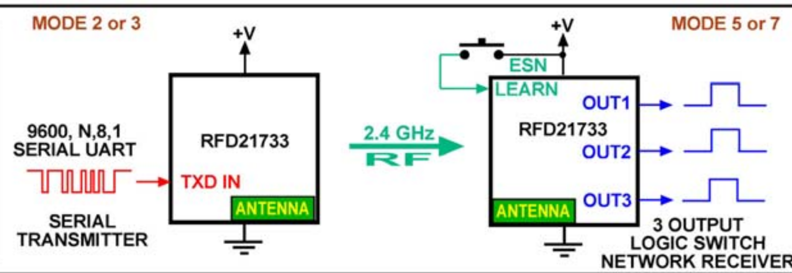
When a byte is received by the serial transmitter, OUT1, OUT2, OUT3, follow the states in bit position 4,5,6. Depending on the configured mode there is a 20 or 500 millisecond hang time.

Apply a single byte into the TXD pin to control the states of the switch receiver. Bit position 4,5,6 represent OUT1, OUT2, OUT3 on the receiver, all other bits must be zero. After sending the single byte, wait at least 20 milliseconds before sending again.



When a byte is received by the serial transmitter, OUT1, OUT2, OUT3, follow the states in bit position 4,5,6. Depending on the configured mode there is a 20 or 500 millisecond hang time. The receiver will only respond to transmitters if it has learned their ESNs.

To address a specific switch receiver, apply 5 bytes into the TXD pin. Byte 1, bit position 4,5,6 represent OUT1, OUT2, OUT3 on the receiver, all other bits must be zero. Byte 2-5 is the specific receiver's ESN. After sending the 5 bytes, wait at least 20 milliseconds before sending again.



When 5 bytes are received in a row from a serial transmitter, OUT1, OUT2, OUT3, follow the states in Byte1, bit position 4,5,6. Depending on the configured mode there is a 20 or 500 millisecond hang time. The receiver will only respond if byte 2-5 contains it's ESN.

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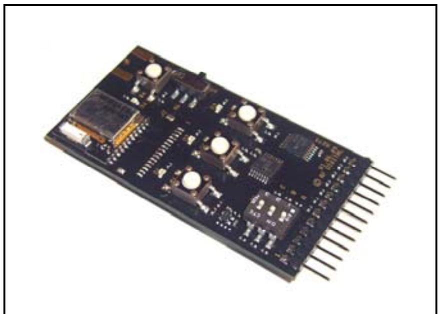
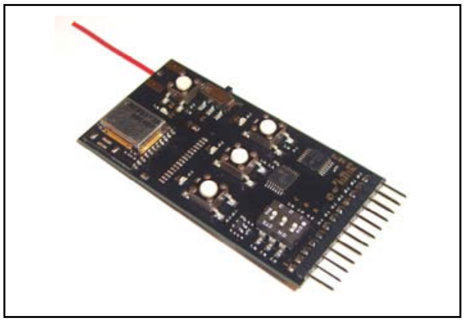
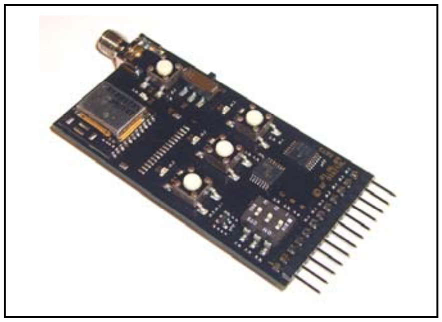
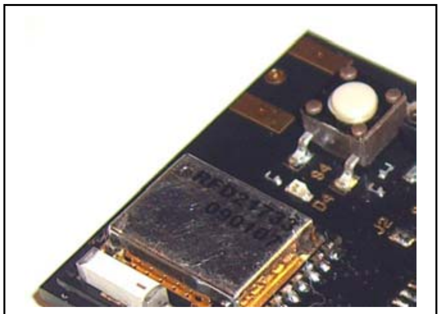
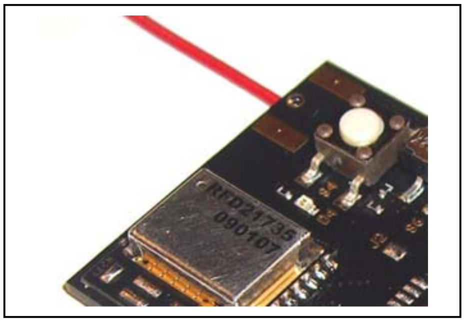
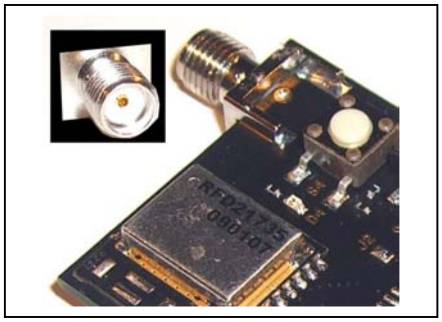
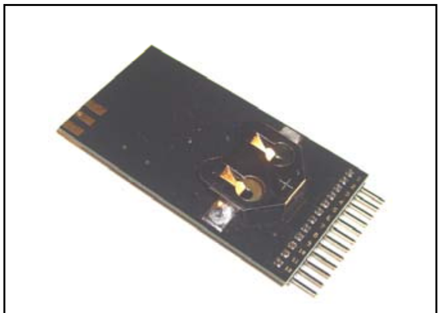
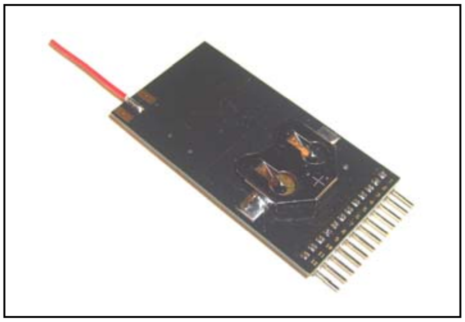
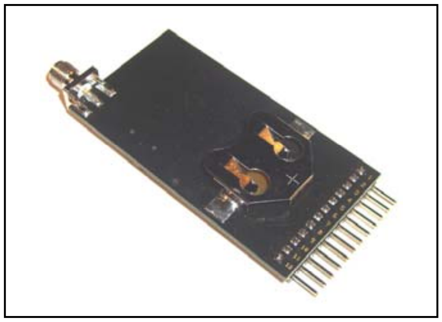
Differences Between Eval Boards

RFD21737	RFD21738	RFD21739
The RFD21733 RF Module with built-in chip antenna is soldered onto the RFD21737 eval board. The antenna is self contained within the module. This eval board is self-contained and does not require an external antenna.	The RFD21735 RF Module is soldered onto the RFD21738 eval board. There is a 1.2 inch wire antenna soldered onto the RFD21738 which connects to the RFD21735 external antenna pin through RF strip-line within the PCB layers. This eval board is self-contained and does not require an external antenna.	The RFD21735 RF Module is soldered onto the RFD21738 eval board. There is a FEMALE SMA connector soldered onto the RFD21738 which allows the user to connect to an external 2.4 GHz antenna of their choice. The RFD21735 external antenna pin is routed to the SMA connector through strip-line within the PCB layers. This eval board requires a user supplied 2.4 GHz antenna with a MALE SMA connector. ANTENNA NOT INCLUDED
		
		
		

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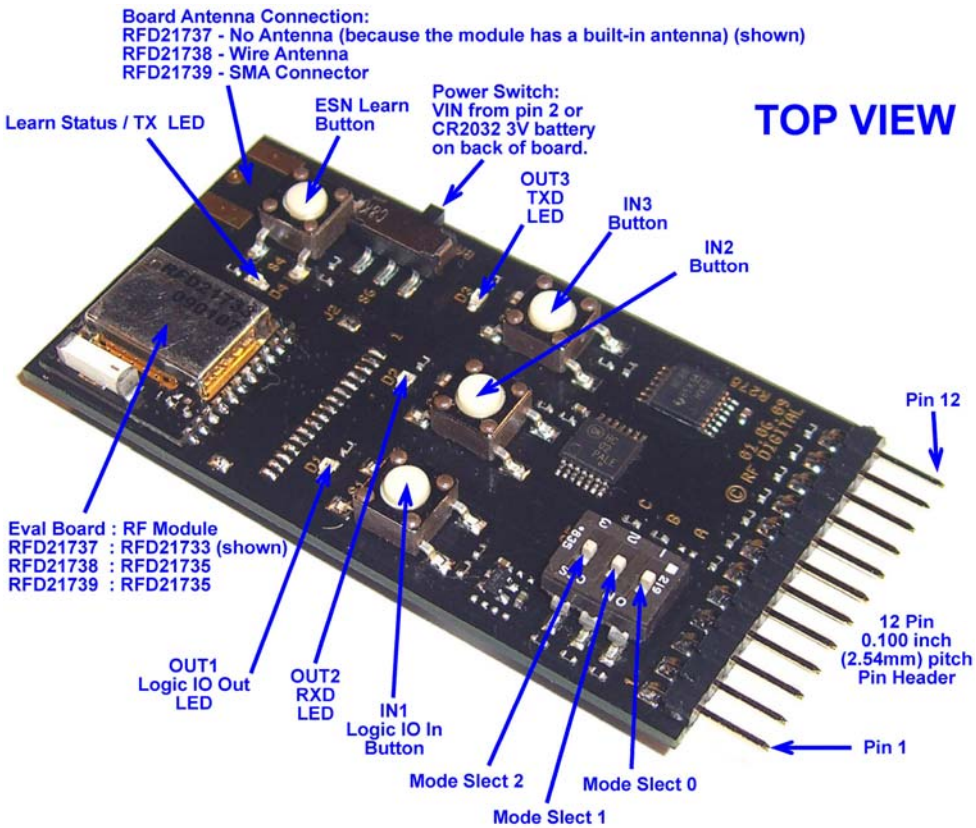
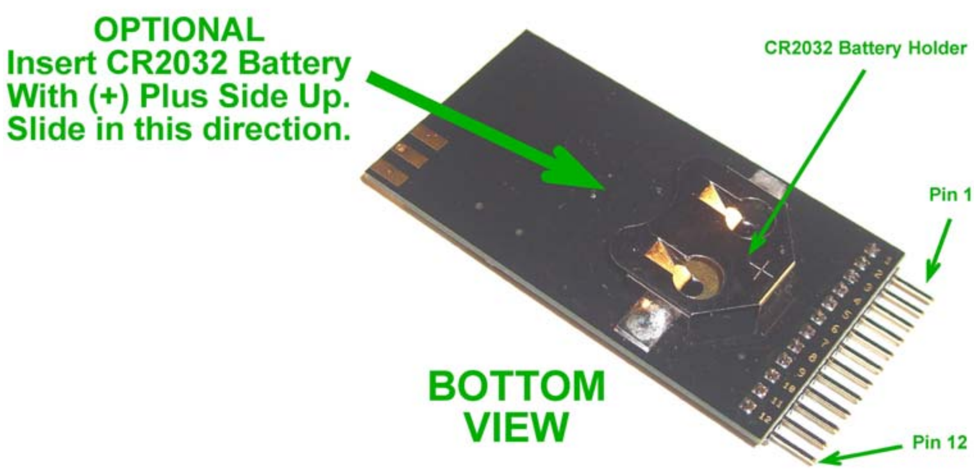
Eval Board Top and Bottom Labeled Views

All three eval boards can be powered from their on-board CR2032 3V battery or through the 12 pin 0.100 inch (2.54mm) pitch header, which can plug into directly into standard solderless breadboards or connect to mating a 0.100 inch (2.54mm) mating socket. The Eval Boards can work as stand-alone or can be wired to your application.





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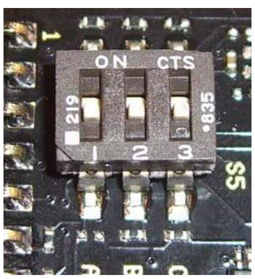
RFDP8 Mode Selector Switch

The 8 different modes of the RFDP8 Application Protocol are selected using the 3-position dip-switch S5 shown in the examples below. The 3 inputs have resistor pull-downs to ground, so when the switch is in its OFF (open) position, there is a low (0) on the input. When the switch is in its ON (closed) position, it connects the input to +V, which produces a high (1).

The proper way to read binary is MSB on the left and LSB on the right. Switch manufacturers label the switches from left to right and furthermore they commonly start with 1 rather then 0. So careful attention needs to be given to identify the switch positions. The binary is read from MSB to LSB, rather then LSB to MSB as shown in the examples below. To remove all doubt, only follow the examples shown below.

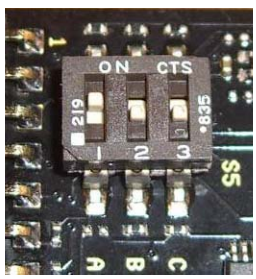
Mode 0
Active RFID Transmitter

OFF	OFF	OFF



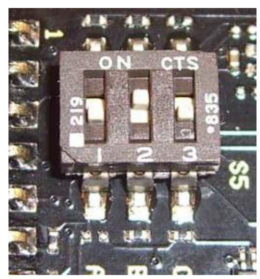
Mode 1
3-Input Switch Logic Transmitter

ON		
	OFF	OFF



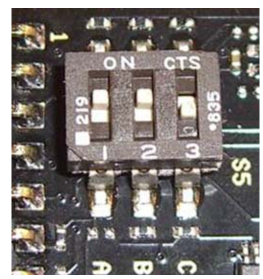
Mode 2
Serial UART Transceiver 9600-8N1

	ON	
OFF		OFF



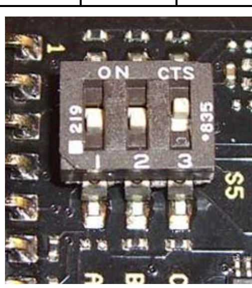
Mode 3
Serial UART Transceiver 9600-8N1 Network

ON	ON	
		OFF



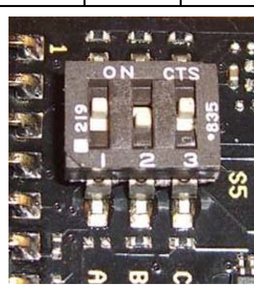
Mode 4
3-Output Switch Logic Receiver 500ms Hang Time

		ON
OFF	OFF	



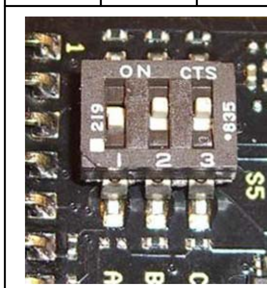
Mode 5
3-Output Switch Logic Receiver 500ms Hang Time Network

ON		ON
	OFF	



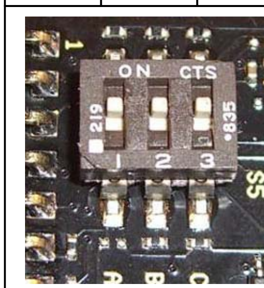
Mode 6
3-Output Switch Logic Receiver 20ms Hang Time

	ON	ON
OFF		



Mode 7
3-Output Switch Logic Receiver 20ms Hang Time Network

ON	ON	ON



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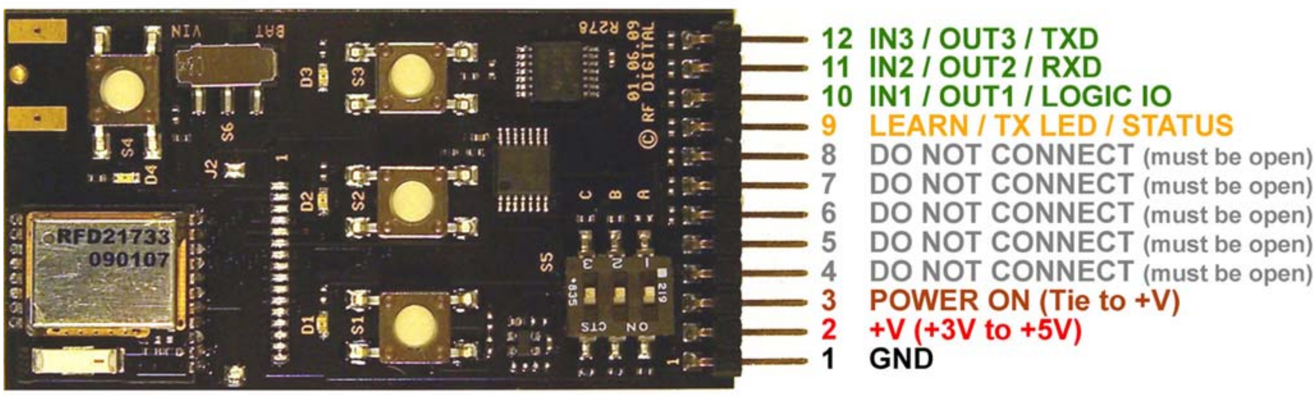
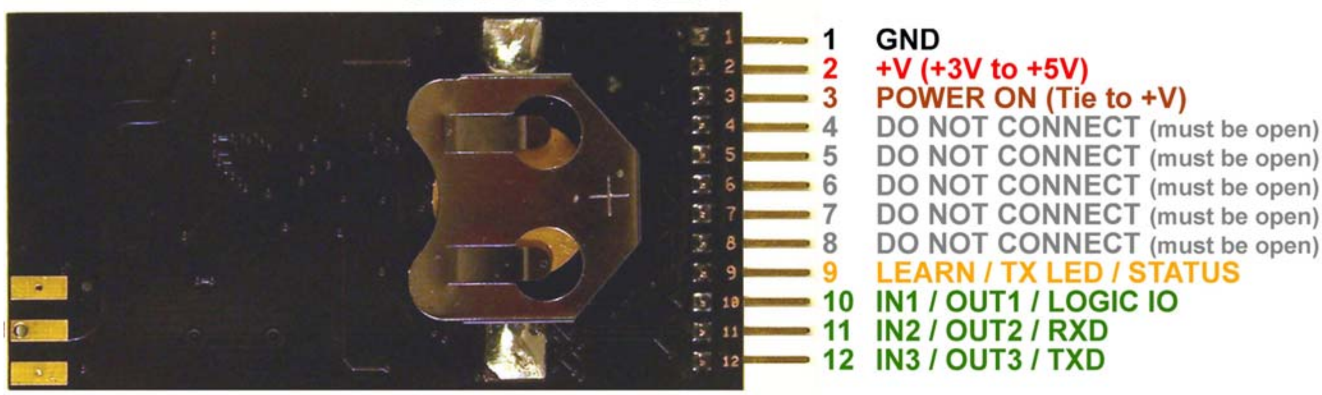
Eval Board Top and Bottom View Pinout

TOP VIEW



BOTTOM VIEW



Eval Board Power Supply and Logic Levels - Important

There is an internal 3.3 Volt (LDO) on the eval boards. At the (pin 2) +V input pin, you can supply 2.1VDC minimum and a maximum of 3.6VDC. When your supplied voltage is between 3.4V and 3.6V the internal regulator is in regulation and the internal supply to all parts will be 3.3V, and all signals on pins 9-12 will be at 3.3V logic. When 2.1V to 3.4V is supplied the internal 3.3V regulator is of regulation and tracks the input voltage (minus 100mv overhead). If you supply 2.5V your logic will be at 2.4V, and if you supply 2.1V your logic will be at 2.0V. The internal 3.3V regulator accept up to a 5V supply input, but at 5V supply, your logic levels on pins 9-12 will be at 3.3V, so use caution. So you will need to use 3.3V to 5V logic level shifters to run properly at 5V or you will cause damage to the module. When using a 5V supply, a very quick 5V level shifter method (not to be used for production) just for testing, which works in some cases would be to use a 22K resistor in series between the eval boards 3.3V logic and your 5V logic. There is a 47k pull down resistor internal to the board on pin 9-12 and this is just enough to switch the logic levels in both directions for a quick and dirty level shifter.

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RFDP8 Firmware

RF Digital offers firmware for the RFD21733 and RFD21735 modules meets many common user requirements. The firmware and a unique identifier are pre-programmed and tested at the factory. The programmed module is therefore immediately ready for use upon delivery.

The RFDP8 firmware use the 3 mode select inputs to select the operating mode. These inputs are sampled when the module powers-on.

Some of the operating modes have additional options which are described in the section for that mode.

The RFDP8 firmware cannot be modified by the user. For applications that require alternative functionality, contact RF Digital for information about custom firmware to fit your specific requirements.

Interference Immunity Algorithm

The RFDP8 firmware employs RF Digital's Proprietary, Patent Pending Interference Immunity Algorithm, which successfully functions in a WiFi environment without performance degradation. In addition, RF Digital's protocol provides a robust communication link in high RF noise environments.

Electronic Serial Number

Every RF Digital Module has its own 32-bit unique identifier (over 4 billion unique values), known as the Electronic Serial Number, or ESN. This value is assigned at the factory and cannot be changed by the user.

The ESN is included in every packet that is transmitted, as part of the protocol overhead and is transparent to the user.

The user does not ordinarily need to know what the ESN is. However, in certain cases it is helpful to know the serial number, and so a mechanism has been provided to read out the ESN. This method is documented in the UART section below.

Network Mode

The UART and the Receiver with logic output can be configured to accept data only from transmitters with which it has been associated, i.e. in its network.

When in network mode, a module must “learn” the ESN of any module which it wishes to “hear." The LEARN signal (listed in the UART and receiver sections below) is usually an input, pulled to GND through an external resistor. When LEARN is driven high for at least 20ms and then allowed to return to GND, the module enters learning mode.

While in learning mode, the LEARN signal is changed to an output and driven high. During this time, the module will learn the ESN of the first module that sends any data; the data will be discarded, the ESN of the transmitting module will be learned by the receiving module. The receiving module indicates that it has learned the ESN by toggling the LEARN output on and off quickly three times.

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After learning the transmitting modules ESN, or after 10 seconds pass, the module will exit learning mode by driving LEARN low and then changing it back to an input.

The LEARN / STATUS pin is bidirectional, it is an input when in the LEARN state and an output when in the STATUS state, so you must drive it using a series resistor, we recommend you not use any value smaller 1k ohm to limit the amount of load current. There is an internal 47k pull down resistor, so if you use a value of 1k series resistor that will easily be enough to drive it high against the internal 47k pull down resistor.

Modules can learn up to 60 unique ESN's. ESN's cannot be deleted individually. The list of learned ESN's can be completely cleared by holding the LEARN signal high for at least 10 seconds and then releasing it. The module will erase its ESN list, and then drive the LEARN signal in a fast alternating high/low pattern for a few seconds to indicate that the ESN list is now empty.

Once a module has learned the ESN of another module, it will accept any and all data from that module only and not any other modules. Up to 60 unique transmitters can be taught to one receiver. If a module is configured to any of the 3 Network modes and it has not learned any transmitters ESN, then it will not receive and output any data, until it learns at least one transmitter.

This network feature can be used for peer-to-peer networks, point to multi-point networks, multi-point to multi-point networks. The association can be between two units for simple functions like opening a garage door or with many units to form complex networks with multiple nodes.

Modes

Mode 0 – Active RFID Transmitter

Pin #	Pin Label	Direction	Function
13	+V	Input	+V Power
10	GND	Input	Ground
16	Mode Select 0	Input	Tie to GND
17	Mode Select 1	Input	Tie to GND
3	Mode Select 2	Input	Tie to GND
4	TX LED	Output	Toggles high during transmission (1 blink every 2 seconds)
5	IN1	Input	Active high switch input #1 (optional) if not used, pull to GND.
6	IN2	Input	Active high switch input #2 (optional) if not used, pull to GND.
7	IN3	Input	Active high switch input #3 (optional) if not used, pull to GND.

The Active RFID Transmitter transmits a packet with its ESN every 2 seconds when the three inputs are all at a low logic level. If any of the three inputs go high, the module transmits the state of all three inputs every 15 ms, until all three inputs are low. The logic inputs should be tied low if they are not used in the end application.

The module is active during transmit for 15ms, but remains in an ultra-low power mode for the rest of the 2 second interval. The average power over time is measured in microamps, such that a CR2032 battery should provide about 60 days of continuous use.

If longer periods of use are required, a larger battery can be used to allow it to run up to years of time without replacing the battery, or contact RF Digital to inquire about a custom time setting which will reduce the transmission interval thus reducing the average power consumption.

Patents
Pending

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Mode 1 – Input Logic Transmitter

Pin #	Pin Label	Direction	Function
13	+V	Input	+V Power
10	GND	Input	Ground
16	Mode Select 0	Input	Tie to +V
17	Mode Select 1	Input	Tie to GND
3	Mode Select 2	Input	Tie to GND
4	TX LED	Output	Toggles high during transmission (1 blink every 15 milliseconds)
5	IN1	Input	Active high switch input #1 (optional) if not used, pull to GND.
6	IN2	Input	Active high switch input #2 (optional) if not used, pull to GND.
7	IN3	Input	Active high switch input #3 (optional) if not used, pull to GND.

When all three switch inputs are low, the module does not transmit, but remains in an ultra-low-power state consuming only 2uA.

When any of the three switch inputs go high, the module transmits the state of all three inputs. As long as any of the three inputs remain high, the module continues to transmit the state of all three inputs every 15ms, while transmitting it will draw about 14mA.

Modes 2 – 9600 baud UART

Pin #	Pin Label	Direction	Function
13	+V	Input	+V Power
10	GND	Input	Ground
16	Mode Select 0	Input	Tie to GND
17	Mode Select 1	Input	Tie to +V
3	Mode Select 2	Input	Tie to GND
4	Not Used	Output	Do not connect, not used.
5	Logic IO	I/O	Bidirectional switch logic I/O, if not used, pull to GND.
6	RXD	Output	RX Data Out, UART output of received data.
7	TXD	Input	TX Data In, UART input of data to transmit.

Modes 3 – 9600 baud UART (Network)

Pin #	Pin Label	Direction	Function
13	+V	Input	+V Power
10	GND	Input	Ground
16	Mode Select 0	Input	Tie to +V
17	Mode Select 1	Input	Tie to +V
3	Mode Select 2	Input	Tie to GND
4	Learn / Status	I/O	Pulse high to enter learn mode and LED Learn Status Output.
5	Logic IO	I/O	Bidirectional switch logic I/O, if not used, pull to GND.
6	RXD	Output	RX Data Out, UART output of received data.
7	TXD	Input	TX Data In, UART input of data to transmit.

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9600 baud half-duplex UART, suitable for connection to a microcontroller, or a level translator (such as a MAX202) to an RS-232 port. RF transmission takes priority over RF reception, so that a module will not receive anything over the air if it is given a full-speed stream of serial data on TX_in.

The UART is configured for 9600 baud, 8 data bits, 1 stop bit, and no parity. Because the module does not perform any parity checking on the data stream, it is possible to use 7 data bits with even or odd parity instead of 8 data bits with no parity.

When in UART mode, the module remains in an active state with the radio enabled in receive mode.

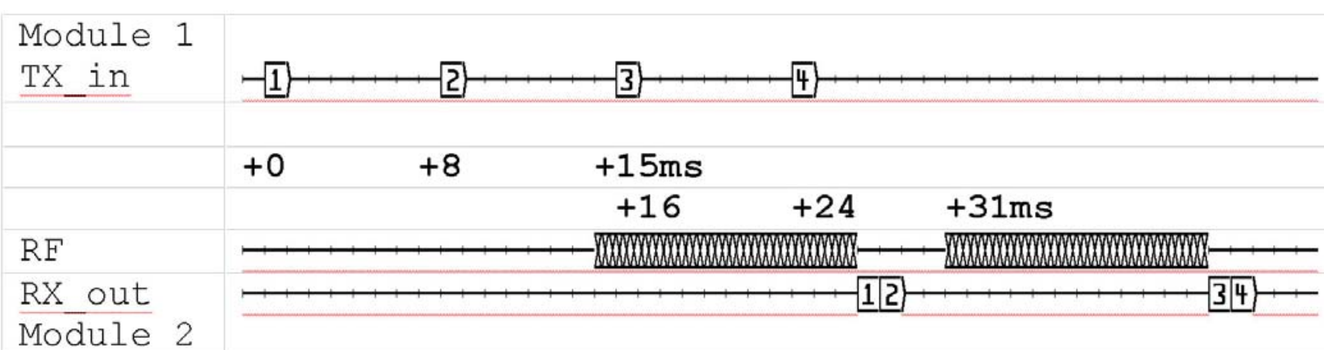
If you are only using the module as a receiver, you must terminate the TXD line with a pull up resistor to +V so you do not leave a floating input which may cause unintentional transmissions by the module detecting anything other then a solid logic level on the TXD pin. The same applies for the general purpose Logic I/O (pin 5).

End-to-End Latency

In order to use the radio efficiently, the RFDP8 firmware buffers data received from the UART into packets which are transmitted over the radio. The firmware transmits a packet when it has buffered 12 bytes of data, or 15ms after receiving a byte of data. On the receiving end, data will be transmitted over the UART at line speed, with no pauses between the bytes (other than the RS-232 start and stop bits). The buffering allows for the RFDP8 to support a full 9600 baud data rate.

The buffering and latency may cause problems with certain microcontrollers that can not tolerate serial data into their UART in a constant stream at 9600-8N1. One possible solution is to add a 16ms delay on the transmitting side which will cause each byte to be sent in its own packet by the module and therefore on the receiving end the bytes will be outputted at a pace of one byte every 16ms which will help your controller of choice handle the fast UART data.

As an example, consider a scenario where one system is sending a byte of data every 8ms. When module 1 receives the 1st byte on its UART, the 15ms timer begins. The 2nd byte arrives before 15ms elapses, and so the first two bytes are sent in a single packet over the air to Module 2. Module 2 will transmit the bytes on its UART with no delay between them. Module 1 receives the third byte on its UART, and re-starts the 15ms timer. As with the 2nd byte, the 4th byte arrives before 15ms elapses, and so the 3rd and 4th bytes are also sent in a single packet over the air, as illustrated in the following timing diagram.



Bi-Directional IO Signal Operation

UART mode includes an additional bi-directional general-purpose IO line. The IO signal is generally an input, and should be pulled to GND with an appropriately sized resistor (for example 10k). If the IO signal is driven high, the

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module will transmit this information, and any UART which receives the data will turn its IO signal into an output and drive it high. This will continue until 20ms pass without receiving any new data, or until the module receives a packet which indicates that the IO signal should be driven low and turned back to an input. The state of the IO signal does not require any extra data in the radio stream, and so is "free" in the packet overhead.

When the module is driving its IO signal high, it will periodically change the pin to an input and check to see if it remains high, before changing it back to an output. This causes a periodic dip in the signal, 1ms every 12-16ms, and so any circuitry which relies on a steady-state output from the IO signal should include conditioning (for example a retriggerable one-shot with a hold time of 2ms) to avoid adverse effects.

ESN Read-back

In certain applications, it is helpful to know the ESN of a module. There is a provision in both UART modes to read back the ESN when the module comes out of reset. ESN read-back is not available in any of the other modes.

Pin 14 on the RFD21733 / RFD21735 is marked as Do Not Connect, this pin normally is not connected for all applications except for reading back the ESN. So that is why it is mentioned here and not anywhere else. The reset signal does not have to be used, instead of using reset you can use power the module off and then back on. The reset is a cleaner way of doing it. If you are using the RFD21737, RFD21738, RFD21739 eval boards, the reset signal is available on pin 5 of the 12 pin connector. Internal to the RFD21733 / RFD21735 there is a 3.3K pull up resistor on the reset signal, so when you are not using it, you can just leave it open.

To activate ESN read-back:

1. Place the module in a reset state by holding the /RESET signal low.
2. Hold the LEARN signal high.
3. Release the /RESET signal.
4. Wait 250ms. If the LEARN signal goes low at any time during this 250ms interval, the module immediately exits ESN read-back mode.
5. Release the LEARN signal.
6. Send the string "READ ESN" (all capitals, one space between the two words) at 9600-8N1 into the module on the TXD Input signal. If this string is not received within 1 second, the module exits ESN read-back mode.

The module will respond with the ESN and a firmware identifier on the RXD Output signal at 9600-8N1, and then exit ESN read-back mode. An example of the output is:

    314CE686:RFDP8 v1.2   11/18/08 08:45:16$

The ESN is 8 characters, representing a 32-bit number in hexadecimal format. A colon separates the ESN from the Firmware ID. The Firmware ID is 32 bytes long. The output is terminated with a carriage return/line feed pair.

When the module exits ESN read-back mode, or if the LEARN signal is not high when the module exists reset, the module will enter regular operation in Mode 2 or 3, according to the mode select signals.

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Modes 4 – Receiver with Logic Output (500ms hang-time)

Pin #	Pin Label	Direction	Function
13	+V	Input	+V Power
10	GND	Input	Ground
16	Mode Select 0	Input	Tie to GND
17	Mode Select 1	Input	Tie to GND
3	Mode Select 2	Input	Tie to +V
4	Not Used	Output	Leave open, not used.
5	OUT1	Output	Active high switch output #1, 500 millisecond hang-time.
6	OUT2	Output	Active high switch output #2, 500 millisecond hang-time.
7	OUT3	Output	Active high switch output #3, 500 millisecond hang-time.

Modes 5 – Receiver with Logic Output (Network) (500ms hang-time)

Pin #	Pin Label	Direction	Function
13	+V	Input	+V Power
10	GND	Input	Ground
16	Mode Select 0	Input	Tie to +V
17	Mode Select 1	Input	Tie to GND
3	Mode Select 2	Input	Tie to +V
4	Learn / Status	I/O	Pulse high to enter learn mode and LED Learn Status Output.
5	OUT1	Output	Active high switch output #1, 500 millisecond hang-time.
6	OUT2	Output	Active high switch output #2, 500 millisecond hang-time.
7	OUT3	Output	Active high switch output #3, 500 millisecond hang-time.

Modes 6 – Receiver with Logic Output (20ms hang-time)

Pin #	Pin Label	Direction	Function
13	+V	Input	+V Power
10	GND	Input	Ground
16	Mode Select 0	Input	Tie to GND
17	Mode Select 1	Input	Tie to +V
3	Mode Select 2	Input	Tie to +V
4	Not Used	Output	Leave open, not used.
5	OUT1	Output	Active high switch output #1, 20 millisecond hang-time.

6	OUT2	Output	Active high switch output #2, 20 millisecond hang-time.
7	OUT3	Output	Active high switch output #3, 20 millisecond hang-time.

Modes 7 – Receiver with Logic Output (Network) (20ms hang-time)

Pin #	Pin Label	Direction	Function
13	+V	Input	+V Power
10	GND	Input	Ground
16	Mode Select 0	Input	Tie to +V
17	Mode Select 1	Input	Tie to +V
3	Mode Select 2	Input	Tie to +V
4	Learn / Status	I/O	Pulse high to enter learn mode and LED Learn Status Output.
5	OUT1	Output	Active high switch output #1, 20 millisecond hang-time.
6	OUT2	Output	Active high switch output #2, 20 millisecond hang-time.
7	OUT3	Output	Active high switch output #3, 20 millisecond hang-time.

In modes 4 through 7, the module is always in receiving mode.

The receiver drives its outputs to match the values received in a packet from a transmitter. This allows up to 8 possible (2^3) combinations on the receiver's outputs.

Since a transmitter does not send any data when all of its inputs are low, there must be a mechanism for turning off the receiver's outputs in the absence of data. When Mode Select 1 is pulled to GND, the receiver will maintain its output state for 500ms or until it receives new data, whichever comes first. The 500ms is referred to as the "hang time," or the time that the outputs will "hang" in the absence of new data. If Mode Select 1 is pulled to +V, the hang time is 20ms.

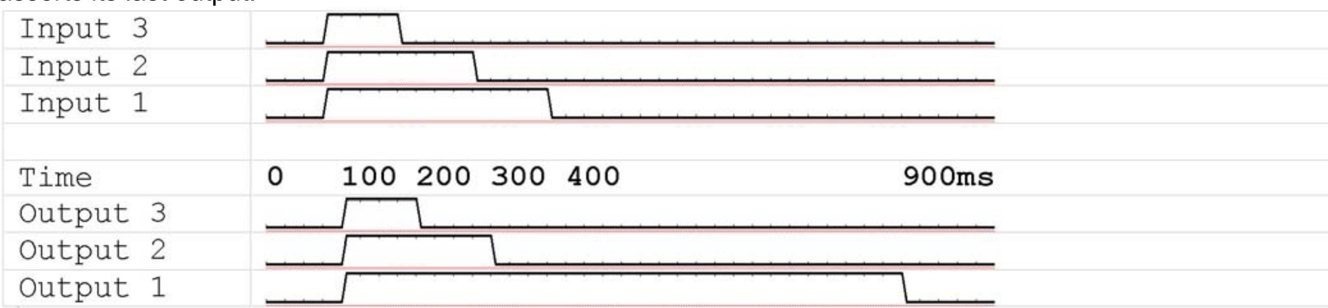
Hang time is a trade-off between latency and resiliency to packet loss. With all RF systems sometimes a packet will be lost, especially as the distance between the transmitter and the receiver grows. If an output is connected to a relay driver, packet loss will result in chattering on the relay, which will not have good results. The 500ms hang time is perfect for applications like a keyless entry system or a garage door opener.

For faster switching to the "all off" state, the 20ms hang time is preferred. Since a transmitter sends new data every 15ms, the time delay to turn off all outputs is only 5ms more than to update the outputs to a different state where at least one of them is still driven high.

The following timing diagrams show the operation of a logic transmitter and a logic receiver with the different hang time options.

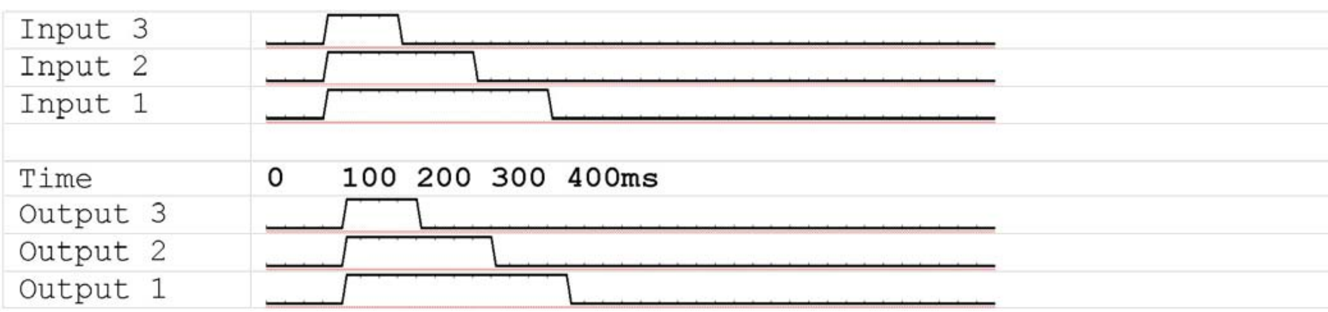
In the first diagram, the logic transmitter's inputs are all asserted, and then sequentially de-asserted. There is a small delay between the transmitter input going high and the corresponding output on the receiver going high, due to the time required to transmit over the air.

Note that when the last input on the transmitter is de-asserted, there is a 500ms delay before the receiver de-asserts its last output.



The second diagram shows the same operation at the transmitter, but with the receiver configured with a 20ms hang time.

Note that shortly after the last input is de-asserted, the receiver updates its output state to turn off all outputs.



Communication between UART and Switch Logic Receiver/Transmitter

The Logic Receiver and Transmitter modes are able to communicate with a module operating in one of the UART modes, which opens up a wide range of possible applications involving PC's or embedded systems with serial communications capability.

Logic Transmitter to UART

A Logic Transmitter (whether RFID or not) sends the state of its inputs as a single byte of data, followed by its ESN as four bytes. A UART can receive this packet and output it as a binary stream to a PC serial port or an embedded microcontroller. The format of the data is:

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1		Input 3	Input 2	Input 1/ RFID				RFID
2	ESN Byte 1							
3	ESN Byte 2							
4	ESN Byte 3							
5	ESN Byte 4							

In the first byte, bits 6 through 4 carry the state of the logic inputs, with a ‘1’ indicating the logic input on the transmitter is high, and a ‘0’ indicating it is low. An RFID Transmitter will set both bits 0 and 4 to indicate that it is a periodic transmission from an RFID Transmitter, and is set to ‘1’ if this is the case.

For example, if an RFID Transmitter with ESN 314CE686 sent a packet on its 2-second interval, a UART would receive the bytes 11 31 4C E6 86 in binary format.

If input #1 on that same RFID transmitter were pulled high, the UART would receive the bytes 10 31 4C E6 86 in binary format; since bit 0 is clear, the receiver can tell that this was not a periodic transmission.

Most ESN’s will contain at least one unprintable character, and so this data will not be suitable for displaying directly in a terminal package (such as HyperTerminal), but a PC-based program or an embedded system (such as the BASIC Stamp) can collect the data and display it in a more friendly fashion.

The ESN which the UART receives is the same one that is in the packet header. If the UART is in Network Mode, and has not learned the ESN, it will never receive the packet, and there will be no output on the serial port.

UART to Logic Receiver

A UART can also send data to a logic receiver, which will decode the data and assert its outputs as though it received a packet from a logic transmitter. The data format is very similar to the one described in the previous section. The differences matter only when the receiver is in Network Mode.

The UART must follow a packet with at least 15ms of no data so that all bytes as described below are sent as a single packet.

Note that a UART can send a single zero byte – all bits clear – to force a receiver to turn off its outputs immediately, regardless of hang time.

Format 1:

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1		Output 3	Output 2	Output 1				

When the receiver is not in Network Mode, the receiver will accept any packet it receives, and so this is the preferred format.

A receiver in Network Mode will use the UART’s ESN from the packet header to determine if it should accept the packet. This allows one UART to send the same data to multiple receivers, provided that each receiver has learned the UART’s ESN.

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Format 2:

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1		Output 3	Output 2	Output 1				
2	ESN Byte 1							
3	ESN Byte 2							
4	ESN Byte 3							
5	ESN Byte 4							

To allow individual addressing of receivers in Network Mode, the UART can send a particular receiver's ESN after the byte for the logic state. In this case, the receiver will only accept the packet if the ESN in the data portion matches the receiver's own ESN.

If the receiver is actively learning ESN's, it will learn only the ESN from the packet header; the ESN in the data portion will not be learned.

Electrical Characteristics

Operating Conditions

Symbol	Parameter	Minimum	Typical	Maximum
VDD	Supply voltage	1.9V	3.0V	3.6V
	Operating Temperature	-40°C		+85°C

Power Consumption

Conditions: VDD = 3.0V, T_A = +25°C

Logic Transmitter or Active RFID Transmitter

Parameter	Minimum	Typical	Maximum
Ultra-low power mode - Switch Logic Transmitter / RFID		2uA	

UART or Switch Logic Transmitter / Receiver

Parameter	Minimum	Typical	Maximum
Listening - Receiving		17mA	
Transmitting		14mA	

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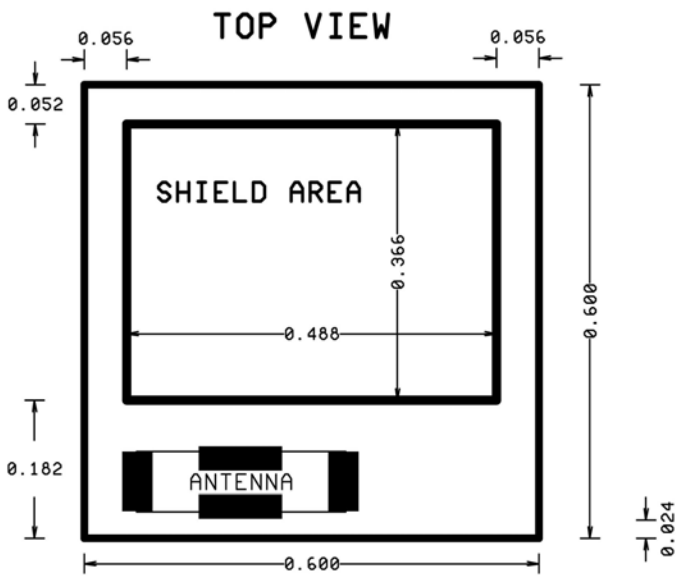
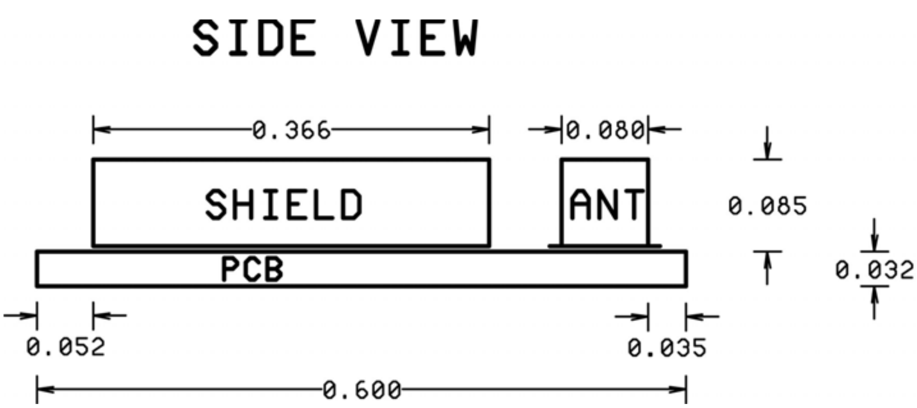
Overall Dimensions • Top View



Overall Dimensions • Side View



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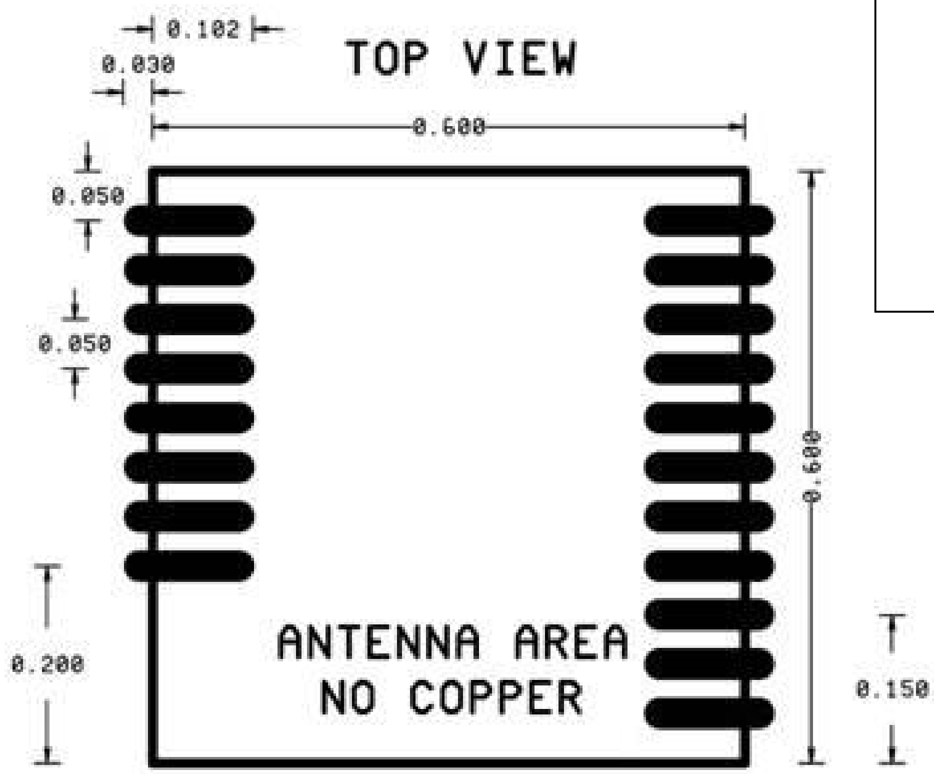
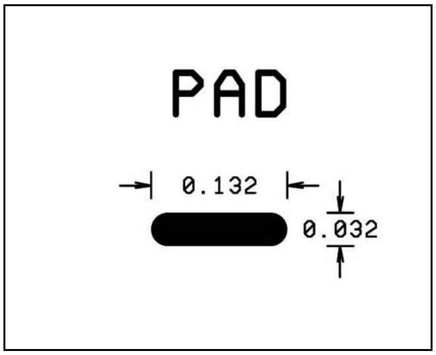
PCB Layout





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FCC NOTICE

Relating to Model Number R24 (RFD Stock Code: RFD21733)

LABELING REQUIREMENT FOR USA
FCC CERTIFICATION

This device has a modular approval from the FCC. When this module is used inside another product where the FCC ID number located on the module itself is not in an obvious place to be viewed by the user. Then you must place the following label outside, on your product in an obvious location.

Permanently attached label in a conspicuous location with the following statement:

This device contains an FCC ID: UYI24 RF module that 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.

NOTES:

1. The FCC does not specify the size of the label or the lettering thereon. The only requirement is that the text be legible.

2. If the entire label can not be placed on the unit due to space constraint (e.g. Pacemaker), only “contains an FCC ID: UYI24” may be displayed on the unit. In such cases, the compliance statement will have to be included in the "instruction to the user."

******* It is the users responsibility to determine if their device requires additional approvals *******

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SAMPLE FCC STATEMENT TO BE INCLUDED IN USER'S MANUAL

INSTRUCTION TO THE USER (if device DOES NOT contain a digital device)

The user is cautioned that changes or modifications not expressly approved by the party responsible for compliance could void the user’s authority to operate this equipment.

INSTRUCTION TO THE USER (if device contains a digital device)

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.

In order to maintain compliance with FCC regulations, shielded cables must be used with this equipment. Operation with non-approved equipment or unshielded cables is likely to result in interference to radio and TV reception. The user is cautioned that changes and modifications made to the equipment without the approval of manufacturer could void the user's authority to operate this equipment.

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Important Notice

RF Digital reserves the right to make corrections, modifications, and/or improvements to the product and/or its specifications at any time without notice.

RF Digital assumes no liability for the user's product and/or applications.

RF Digital products are not authorized for use in safety-critical applications, including but not limited to life-support applications.

RF Digital assumes no liability for parts or their application beyond replacement or refunding the original purchase price.

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