Radio Modem Integrator's Manual
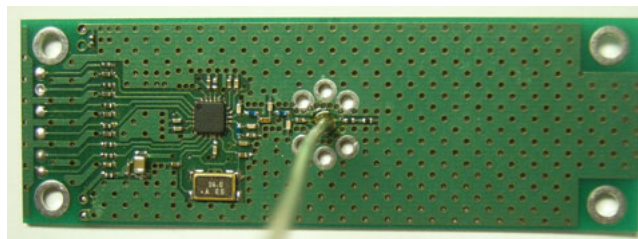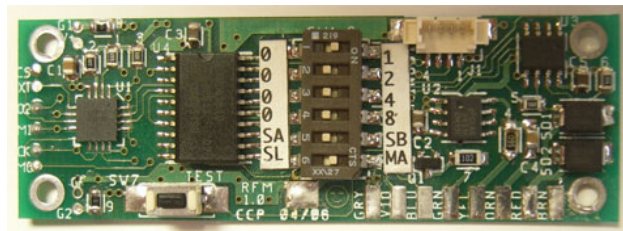# for model RFM 1.0

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Introduction

This product is a Radio Modem Module, where a system of these modules consist of one "Master" and up to 15 "Slaves". Each modem is connected to a host computer or micro-controller through an RS-485 serial port. The host connected to the Master modem is prompted by the Master modem for data to be sent to each of the Slaves. The Slave modems receiving this data then deliver that data to their connected host, which in turn send response data back to the Slave modem to be transmitted back to the Master modem. The Master modem then delivers the Slave's responses to the Master host.

These pre-certified modules are intended to be integrated into your product to add radio communications functionality. If used according to the instructions presented in this manual no FCC Part 15 certification is required.

These modems are primarily intended to serve in applications requiring control and status information to be passed to and from a central location to multiple points in a network. As such, high data throughput is not a primary requirement, but high reliability is. These modems provide the user with a very high success rate in passing messages from one central point in the system to and from another.

FCC Notices

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

2. This product has been tested and complies with the specifications 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 according to 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 is found 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 or devices
- Connect the equipment to an outlet other than the receiver's

- Consult a dealer or an experienced radio/TV technician for assistance

3. The antenna used for this device must be installed to provide a separation distance of at least 20cm (8 inches) from all persons, and must not be co-located or operating in conjunction with any other antenna or transmitter other than those contained within this device.

NOTICE: This equipment complies with the FCC RF Exposure Limits. A minimum of 20 centimeters (8 inches) separation between the device and the user and all other persons should be maintained.

4. The following text must be placed in the manual of the end product that hosts this module:
Contains FCC ID: L5E-RFM10

Hardware Requirements

Mounting the Module

The module can be mounted anywhere inside or outside your equipment, provided enough room is made available for the antenna. If mounted outside the equipment then a separate enclosure should be supplied to house the module and its antenna. If possible, mount the modems as high above ground as possible and away from large metallic objects.

According to FCC rules, under no circumstances may this module be located within 200cm (about 8") from a human body during normal operation. Furthermore, the antenna supplied on the module must not be altered in any way. It is up to you, the integrator, to insure that these precautions are met or the FCC certification for this module will become null and void.

When deciding on a location for the module take care to provide an environment where the antenna is protected from accidental collisions with other objects, since it's attachment point is relatively fragile.

There are 8 electrical connections to the module as shown in the following table. Solder pads are provided on the module for these connections, and if desired you may make connections from these pads to a connector for easy module attachment and removal.

Pad Legend	Function
BRN	Ground
RED	TxRx-
ORN	TxRx+
YEL	Supply Voltage, +4 to +14Vdc @40ma (see text)
GRN	LED cathode
BLU	Piezo +
VIO	Ext Switch Input
GRY	3.3v Vcc Out

BRN - Ground

Module ground.

RED - TxRx-

RS485 "B" or "Z" connection. In a mark condition this line is at or near ground. In a space condition this line is at or near 3.3 volts. It is an input when the module is receiving data and an output when sending data. Data is sent and received at 115.2 kbaud.

ORN - TxRx+

RS485 "A" or "Y" connection. In a mark condition this line is at or near 3.3 volts. In a space condition this line is at or near ground. It is an input when the module is receiving data and an output when sending data. Data is sent and received at 115.2 kbaud.

YEL - Supply Voltage, +4 to +14Vdc @ 40ma

Supply voltage for the module. If supply voltages are from 9 to 14 volts then this must be specified when ordering. (R4 is 56 ohms for 9 to 14v and zero ohms for 4 to 8.9v, and its purpose is to reduce the power dissipation in the voltage regulator I.C.) If

unspecified the module is shipped for a supply voltage of 4 to 8.9v.

GRN - LED cathode

This output is used to drive a user-supplied LED. It is driven to ground when the LED is on and open otherwise. If used, the LED anode can be connected to the Supply Voltage or to any other user voltage from 3 to 15 volts. A current limiting resistor of 1 Kohms is in series with this output. The LED is ON or blinking during acquisition mode or during the 40ms time slot immediately after a transmit time slot (see Status Indicators section).

BLU - Piezo +

This output is intended to drive a user-supplied self-excited piezoelectric beeper. It is driven to 3 volts when ON and to ground when OFF. If used, the negative terminal of the piezo should be connected to ground. The piezo is ON for 40ms following the reception of a valid packet (see Status Indicators section).

VIO - Ext Switch Input

This normally open input is connected to ground via your circuitry to provide remote sensing of a simple contact closure. It is only valid for this purpose for modems with ID numbers of 14, 15 or 0(see Special Modems section). For all other modems this input will have no effect. It is a parallel connection to the "TEST" pushbutton switch on the module circuit board. The module provides a 17.5 to 52.5 Kohm pullup resistor to Vcc for this input.

GRY - 3.3v Vcc Out

This is the output of the module's 3.3v Vcc voltage regulator. Your circuitry may draw up to 10ma from this source.

Configuring the Module

Each module must be configured prior to use. Configuration involves establishing one modem as the Master and the remaining modems as Slaves, assigning modem ID numbers to each, and selecting one of two "channel sets" of operation. These settings are performed by a series of DIP switches on the module circuit board as shown in Figure 1.

There is an optional second level of configuration which is done via a command issued from a connected host to the modem. This second level provides a SYSTEM ID code to the modem so that it responds only to messages from other modems with the same SYSTEM ID code. Using the SYSTEM ID code together with the two available channel sets will provide a fair degree of isolation among multiple systems operating within the same radio environment.

The host computer connected to the Master modem is allowed to send a short message to any of the Slaves in the system and to receive a reply from the host connected to that Slave modem. The Master can communicate with any Slave but Slaves cannot communicate directly between themselves. It is obvious then, that only the modem connected to the central controller in your system be configured as a Master and all others configured as Slaves, with no two units having the same modem ID number. Typically the Master would be configured with a modem ID of 1 and all Slaves be numbered from 2 onward, with higher modem numbers farther away from the Master than lower numbers (this will be explained in greater detail later).
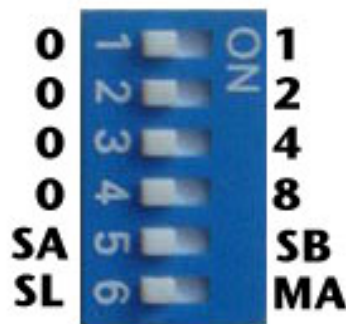

Figure 1 - Configuration DIP Switch

Modem ID Number

The modem ID number is set via the first 4 DIP switches. Set the switches to the left or right so that the digits next to the switch positions add up to the desired modem ID number.

Channel Set A or Channel Set B

Set switch #5 (labeled "SA" on the left and "SB" on the right) to the position corresponding to the desired channel set, A or B. All modems that are part of the same communications network should be set the same. To use 2 networks within the same radio environment, set all modems in one system to A and all in the other system to B.

Master or Slave

Set switch #6 (labeled "SL" on the left and "MA" on the right) to the SL position if the modem is to be a Slave, or to the MA position if it is to be a Master.

Specifications:

Length ....2.825"
Width ....0.950"
Mounting Hole Distance, Length......................2.525"
Mounting Hole Distance, Width........................0.700"
Antenna Height..3.25" (1/4 wave wire)

Supply Voltage ....4-14v (see text)
Current (Transmit) ....25.5ma (typ)
Current (Receive) ....20.5ma (typ)

Transmit Power ....10mw (typ)
Receive Sensitivity ....-98 dbm minimum
Transmit Data Rate 38.4kbaud
Modulation...FSK
Deviation 19KHz
Method ....FHSS
Number of Channels.......................................56
Base Frequency, Channel Set A.......................904.00 MHz
Base Frequency, Channel Set B.......................904.20 MHz
Channel Separation ....400 KHz

Message Payload Size ....31 bytes
Time Slot 40.39216ms
Message Roundtrip Time[1] (16 units/system) ....31 time slots (1.25 S)
Message Roundtrip Time[1] (12 units/system) ....23 time slots (0.93 S)
Message Roundtrip Time[1] (8 units/system) ......15 time slots (0.61 S)
Message Roundtrip Time[1] (4 units/system) ......7 time slots (0.28 S)
Message Roundtrip Time[1] (2 units/system) ......3 time slots (0.12 S)

Range .... 0.8 miles (open field)

Obviously the range depends upon many factors. In open field testing between two devices mounted 12 feet above ground, most locations yielded a range of 0.8 miles or more with a message success rate above 50%.

[1] Message Roundtrip Time is the time for a message from the Master to be received by a Slave and for the Slave's response to arrive back at the Master.