Appendix L: Manual

Please refer to the following pages for the FHSS and DTS manuals.

Banner RM912HP Transceiver
1 Watt, 900 MHz FHSS Module
User Manual

Overview

The Banner RM912HP device is a frequency hopping spread spectrum transceiver operating in the 902 – 928 MHz band. It is an implementation of a particular ISM band transceiver IC that includes an external LNA in the receive path and external 1 W power amplifier in the transmit path, as well as all necessary RF switches and matching components. Users need only supply power and ground, control signals, and a controlled impedance path to one of our FCC approved antennas to fully implement the device transceiver.

Typical users of this module are projects that are conceived and built by Banner engineering, usually for low power wireless sensor network telemetry. Projects will fundamentally be time division multiple access (TDMA) architecture with frequency hopping spread spectrum (FHSS) employed for distributing RF energy evenly across the ISM band.

Users will have to comply with the hopping schedule, number of channels, dwell times, and other parameters that are covered in FCC part 15, and bounded by the limits set up in the test report. All questions regarding these limits should be directed to the factory.

This certification only covers operation of the transceiver in particular modes of modulation scheme and data rate. Be aware that there are modes of operation on the transceiver IC that are not covered by this certification and must be avoided by the user.

This document will discuss fixed and configurable parameters and their relation to meeting the FCC specifications. Such parameters include the frequency plan, the time sharing architecture, power control, and approved antennas.

Frequency Plan

The radio is licensed to transmitting or receiving on any of 50 equally spaced, non-overlapping channels available in the 902-928 MHz band. (903, 903.5, 904, 927.5 MHz) The hop table should be chosen from this bin of 50 frequencies in a pseudo-random fashion without replacement so as to avoid repeats before the entire table is traversed.

TDMA Plan

The radio is intended for operation in deterministic and ad-hoc networks. The communications channel is shared in these networks using a time domain multiple access protocol. The underlying structure to this protocol is a frame made up of N time slots, each of length T_{slot}. During each time slot, a given radio could spend part of its time transmitting (T_{on}), receiving, or idle to conserve energy. Users must keep the total dwell time on any given transmit channel below 64 ms in any given 100 ms window.

Power Control

Users that wish to utilize the entire 1 W transmit capability of this radio must also ensure that they are using all 50 frequencies. Users that do not wish to use all 50 frequencies must then compensate by keeping the transmit power level below 250 mW, and still must use at least 25 frequencies. Contact the factory for details on adjusting RF power levels.

Operation

Operational details for the radio appear in the PowerPoint document "RM912HP_01_operational_description". This is the document to refer to for connection diagrams, pad layouts, and other implementation details. The other primary reference is the data sheet for the transceiver IC. Please contact Banner Engineering for copies of that reference.

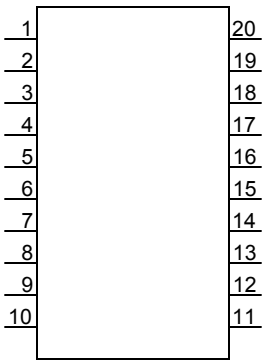
Antenna Choices

The following classes of antennas (**Table 1**) were tested and approved for use with the RM912HP.

Approved antennas	
Antenna style	**Gain**
High gain helical loaded omnidirectional monopole	<= 5 dBi
High gain omnidirectional dipole	<= 8 dBi
High gain Yagi directional	<= 6 dBi)

Table 1

Antennas of like design with less gain than the type tested may also be used. The device must always be professionally installed using unique connectors.



RM912HP Schematic Connection Diagram and Instructions.

Pin #	Pin Name	Pin Function	Connection Instructions
1	G1	RF Ground	Via directly to ground.
2	RF	RF Signal	Route a 50 ohm trace to the antenna.
3	G3	RF Ground	Via directly to ground.
4	SW1	Switch 1 ctrl – active low Tx	Logic low for Tx, high for Rx
5	SW2	Switch 2 ctrl – active low Rx	Logic high for Tx, low for Rx
6	V	Vdd, general purpose supply	Supply 2.7 V, +/- 10%
7	G2	Ground	Signal ground
8	TP2	Power Amp Enable	Power amp enable.
9	Reset	Transceiver ~RST	See Transceiver datasheet.
10	Select	Transceiver ~SEL (for SPI)	See Transceiver datasheet.
11	MISO	Transceiver Data Out	SPI data out of Transceiver
12	MOSI	Transceiver Data In	SPI data in to Transceiver
13	SCLK	Transceiver SPI Clock	SPI Clock, see Transceiver datasheet for usage guidelines.
14	DIG2	Transceiver DIG2	See Transceiver datasheet.
15	G4	Ground	Signal ground
16	V2	Power Amp VCC	Supply 1.5 – 2.7 V during transmit
17	LNA Bias	LNA Enable	Low = ON, HI-Z = OFF
18	LNA Gain	LNA Gain Control	High for high linearity, low for high gain.
19	SLP_TR	Atmel SLP_TR	See Transceiver datasheet; pulse high to initiate Tx
20	IRQ	Atmel IRQ	Various interrupt sources

RF Exposure Statement:

This equipment has a power density well below that allowed at 23 cm; therefore, this equipment shall be installed and operated with an antenna with gain not more than 8 dBi and installed with a minimum of 23 cm of separation distance between the antenna and all persons during normal operation.

FCC Regulations Statement

FCC ID: UE3RM912HP This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

FCC Notices

IMPORTANT: The radio modules have been certified by the FCC for use with other products without any further certification (as per FCC section 2.1091). Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.

IMPORTANT: The radio modules have been certified for fixed base station and mobile applications. If modules will be used for portable applications, the device must undergo SAR testing.

IMPORTANT: If integrated into another product, the FCC ID label must be visible through a window on the final device or it must be visible when an access panel, door, or cover is easily removed. If not, a second label must be placed on the outside of the final device that contains the following text: **Contains FCC ID: UE3RM912HP**.

Banner RM912HP Radio Module Specification	
Frequency Band	902- 928 MHz
Modulation method	BPSK, O-QPSK
Spectrum widening	Frequency Hopping Spread Spectrum (FHSS), or DTS for 1000 kb/s rates
Number of channels	Typically 50 or less
Individual channel bandwidth	Variable depending on data rate
Channel separation	Variable depending on data rate
Radiated power	+30 dBm (1 W) max for FHSS modes, +26 dBm for DTS modes
Power supply	3.0 Vdc
Supply current	1000 mA @ 3V
Digital Interface	SPI
Interface data rate	4000 kbits/sec
Sensitivity	-104 dBm

RF Data rate	Selectable, see datasheet
Mechanical dimensions	20 x 28 mm

Banner RM912HP Transceiver
1 Watt, 900 MHz DTS
User Manual

Overview

The Banner RM912HP device is a direct sequence spread spectrum transceiver (DSSS) operating in the 902 – 928 MHz band. It is an implementation of a particular ISM band transceiver IC that includes an external LNA in the receive path and external power amplifier in the transmit path, as well as all necessary RF switches and matching components. Users need only supply power and ground, control signals, and a controlled impedance path to one of our FCC approved antennas to fully implement the device transceiver.

Typical users of this module are projects that are conceived and built by Banner engineering, usually for low power wireless sensor network telemetry. Projects will fundamentally be time division multiple access (TDMA) architecture with DSSS employed for distributing RF energy evenly across the ISM band.

Users will have to comply with the modulation schemes, number of channels, dwell times, and other parameters that are covered in FCC part 15, and bounded by the limits set up in the test report. All questions regarding these limits should be directed to the factory.

This certification only covers operation of the transceiver in particular modes of modulation scheme and data rate. In particular, the device is licensed for to operate within the parameters of the IEEE 802.15.4 standard, which deals with 40 kb/s or 250 kb/sec data. It is also licensed for a proprietary 1000 kb/s mode that has nearly the same spectrum as an 802.15.4 mode. Be aware that there are modes of operation on the transceiver IC that are not covered by this certification and must be avoided by the user.

This document will discuss fixed and configurable parameters and their relation to meeting the FCC specifications. Such parameters include the frequency plan, the time sharing architecture, power control, and approved antennas.

Frequency Plan

The radio is licensed to transmitting or receiving on any of 10 equally spaced, non-overlapping channels available in the 902-928 MHz band (906, 908 …924 MHz) when it is operating in the standard 802.15.4 compliant modes. In the proprietary 1000 kb/s mode, there are 17 equally spaced frequencies available (903, 904.5 …927 MHz) Because it is operating under DTS rules, changing frequencies isn't specifically required, but it is still a good practice.

TDMA Plan

The radio is intended for operation in deterministic and ad-hoc networks. The communications channel is shared in these networks using a time domain multiple access protocol. The underlying structure to this protocol is a frame made up of N time slots,

each of length T_{slot}. During each time slot, a given radio could spend part of its time transmitting (T_{on}), receiving, or idle to conserve energy. To be in compliance with the rules for dwell time as tested, the radio transmitter must be on less than 50 % of the time.

Power Control

Users must ensure that they are maintain a conducted output power of 26 dBm or less. Contact the factory for details on adjusting RF power levels.

Operation

Operational details for the radio appear in the PowerPoint document "RM912HP_06_user_manual". Refer to that document for connection diagrams, pad layouts, and other implementation details. The other primary reference is the data sheet for the transceiver IC. Please contact Banner Engineering for copies of that reference.

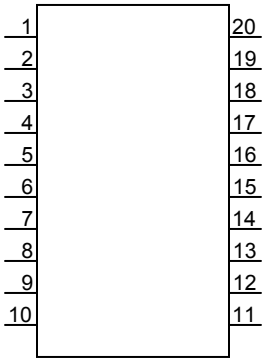
Antenna Choices

The following classes of antennas (**Table 1**) were tested and approved for use with the RM912HP.

Approved antennas	
Antenna style	**Gain**
High gain helical loaded omnidirectional monopole	<= 5 dBi
High gain omnidirectional dipole	<= 8 dBi
High gain Yagi directional	<= 6 dBi)

Table 1

Antennas of like design with less gain than the type tested may also be used. The device is always professionally installed and uses unique connectors.



RM912HP Schematic Connection Diagram and Instructions.

Pin #	Pin Name	Pin Function	Connection Instructions
1	G1	RF Ground	Via directly to ground.
2	RF	RF Signal	Route a 50 ohm trace to the antenna.
3	G3	RF Ground	Via directly to ground.
4	SW1	Switch 1 ctrl – active low Tx	Logic low for Tx, high for Rx
5	SW2	Switch 2 ctrl – active low Rx	Logic high for Tx, low for Rx
6	V	Vdd, general purpose supply	Supply 2.7 V, +/- 10%
7	G2	Ground	Signal ground
8	TP2	Power Amp Enable	Power amp enable.
9	Reset	Transceiver ~RST	See Transceiver datasheet.
10	Select	Transceiver ~SEL (for SPI)	See Transceiver datasheet.
11	MISO	Transceiver Data Out	SPI data out of Transceiver
12	MOSI	Transceiver Data In	SPI data in to Transceiver
13	SCLK	Transceiver SPI Clock	SPI Clock, see Transceiver datasheet for usage guidelines.
14	DIG2	Transceiver DIG2	See Transceiver datasheet.
15	G4	Ground	Signal ground
16	V2	Power Amp VCC	Supply 1.5 – 2.7 V during transmit
17	LNA Bias	LNA Enable	Low = ON, HI-Z = OFF
18	LNA Gain	LNA Gain Control	High for high linearity, low for high gain.
19	SLP_TR	Atmel SLP_TR	See Transceiver datasheet; pulse high to initiate Tx
20	IRQ	Atmel IRQ	Various interrupt sources

RF Exposure Statement:

This equipment has a power density well below that allowed at 20 cm; therefore, this equipment shall be installed and operated with an antenna with gain not more than 8 dBi and installed with a minimum of 20 cm of separation distance between the antenna and all persons during normal operation.

FCC Regulations Statement

FCC ID: UE3RM912HP This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

FCC Notices
IMPORTANT: The radio modules have been certified by the FCC for use with other products without any further certification (as per FCC section 2.1091). Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.
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Frequency Band	902- 928 MHz
Modulation method	BPSK, O-QPSK
Spectrum widening	Frequency Hopping Spread Spectrum (FHSS), or DTS for 1000 kb/s rates
Number of channels	Typically 50 or less
Individual channel bandwidth	Variable depending on data rate
Channel separation	Variable depending on data rate
Radiated power	+30 dBm (1 W) max for FHSS modes, +26 dBm for DTS modes
Power supply	3.0 Vdc
Supply current	1000 mA @ 3V
Digital Interface	SPI
Interface data rate	4000 kbits/sec
Sensitivity	-104 dBm

RF Data rate	Selectable, see datasheet
Mechanical dimensions	20 x 28 mm