Sure-Fi

IOT/M2M Radio Module OEM/Integrators Manual

Revision 1.0

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FCC and Industry Canada Regulatory Statements

FCC

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. Any changes or modifications not expressly approved by manufacturer could void the user's authority to operate the equipment.

IMPORTANT! Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

Industry Canada

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie 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, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, meme si le brouillage est susceptible d'en compromettre le fonctionnement.

IMPORTANT! Tous les changements ou modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actioner cet équipement.

47 CFR 15.105- FCC

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 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.

This Class B digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada

FCC Radiation Exposure Statement
This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator and your body.

Important Note:
Radiation Exposure Statement:
This equipment complies with IC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator and your body.

Note Importante: (Pour l'utilisation de dispositifs mobiles)
Declaration d'exposition aus radiations:
Cet équipement est conforme aux limites d´exposition aux rayonnements IC établies pour un environnement non contrôlé. Cet équipment doit être installé et utilisé avec un mimimum de 20 cm de distance entre la source de rayonnement et votre corps.

OEM Requirements

- This module is limited to OEM Installation only.
- The OEM is responsible for ensuring that the end-user has no manual instructions to remove or install this module.
- The antenna on this module is neither removable, replaceable or modifiable by the OEM or end user.
- This module is limited to installation on mobile or fixed applications.
- If the FCC ID of the module is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label stating:
  - Contains FCC ID: 2ADZ3C001
  - Contains FCC ID: SH6MDBT42Q
  - Contains IC: 12684A-C001
  - Contains IC: 8017A-MDBT42Q
- Separate approval is required for all other operating configurations, including portable configurations with respect to Part 2.1093. Guidance for achieving this compliance can be obtained from Sure-fi Inc. in the Contact Information section at the end of this manual.
- The OEM integrator is responsible for ensuring compliance with Part 15 Subpart B requirements when this module is installed in a host product. Guidance for achieving this compliance can be obtained from Sure-fi Inc. in the Contact Information section at the end of this manual.

Description

The Sure-Fi Wireless Radio Module is the most versatile and highest performance modular solution available for the IOT/M2M industries. Programmable radio settings allow the user to optimize application requirements through trade-offs between range (or obstruction and interference), data rate and latency (from 300 bps to 300 kbps), or power savings. All settings are configurable through a simple serial interface.

Sure-Fi's patented PCB antenna eliminates the need for bulky, expensive external antennas without sacrificing performance. Adjustable power outputs from 1 mWatt to 1 Watt (1.65 Watts radiated when including 2.2 dBi antenna gain)[1].

Specifications

RADIO			Note
Frequency Band	902 – 928 MHz		ISM Band
Channel Quantity	72		@ 350 KHz channel spacing
Modulation Methods	DTS: Chirped Spread Spectrum and QFSK	Frequency Hopping: Chirped Spread Spectrum	Programmable
Bandwidths	32.125 - 500 KHz		MIN, MAX
Data Rates	≈ 46 bps – 300 Kbps		
Antenna	Integrated PCB		No user antenna allowed
Antenna Gain	2.2 dBi		
Transmit Power	0 dBm (1 milliWatt)	30 dBm (1 Watt)	MIN, MAX
Receiver Sensitivity	-129 dBm	-148 dBm	MIN, MAX
Interface			
UART	115,200 Baud		
SPI	2 Mhz		
Data Encryption	AES128, proprietary		

ELECTRICAL	MIN	TYP	MAX
Supply Voltage (VDD)	4.5 VDC	5.0 VDC	5.5 VDC
Voltage on any Pin w/ respect to VSS		VSS - 0.3 VDC	
Voltage on any Pin w/ respect to VDD		VDD +0.3 VDC	
GPIO sink/source current per pin		11 ma	
GPIO sink/source total		50 ma	
Logic input Low Voltage		<= .2 x VDD	
Logic input High Voltage		> = .8 x VDD	
Current Consumption			
Transmit			
1 Watt (30dBm)		750 ma	

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[1] Maximum power not available in all modes. See APPENDIX for details.

½ Watt (27dBm)		450 ma	
¼ Watt (24 dBm)		275 ma	
1/8 Watt (21dBm)		200 ma	
1/16 Watt 18dBm)		160 ma	
1 mWatt (0 dBm)		42 ma	
Receive		33 ma.	
Standby		TBD	
Sleep		TBD	

	LENGTH	WIDTH	HEIGHT
DIMENSIONS	2.15 in (54.61 mm)	1.71 in (43.43 mm)	.346 in (8.79 mm)

ENVIRONMENTAL	MIN	TYP	MAX
Operating Temperature	-40C		+85C
Storage Temperature	-40C		+115C
Humidity	10%		90%
Non condensating			

Pin Diagram
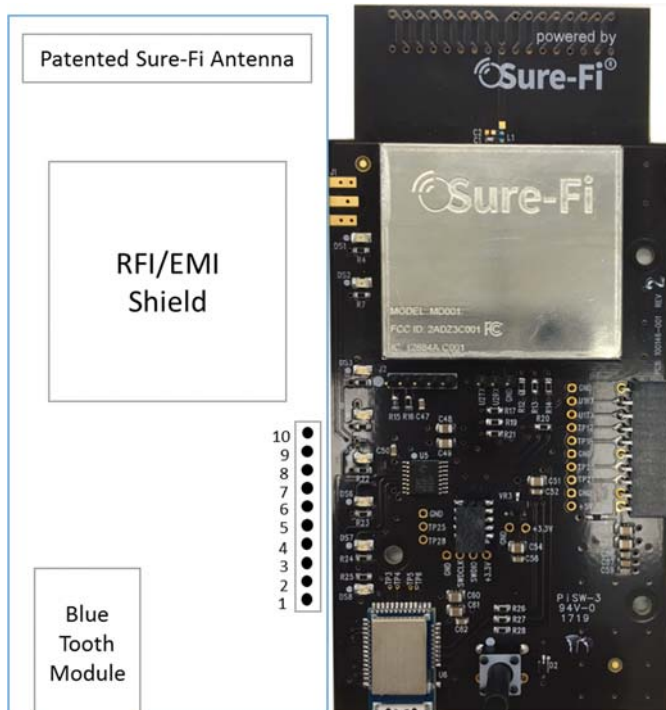
Pin Description

PIN	DESCRIPTION	NOTE
10	GND	
9	UART_RX	Data In
8	UART_TX	Data Out
7	GPIO0	
6	GPIO1	
5	GND	
4	GPIO2	
3	GPIO3	
2	GND	
1	VDD	+5 VDC IN

Minimum Hardware Connection
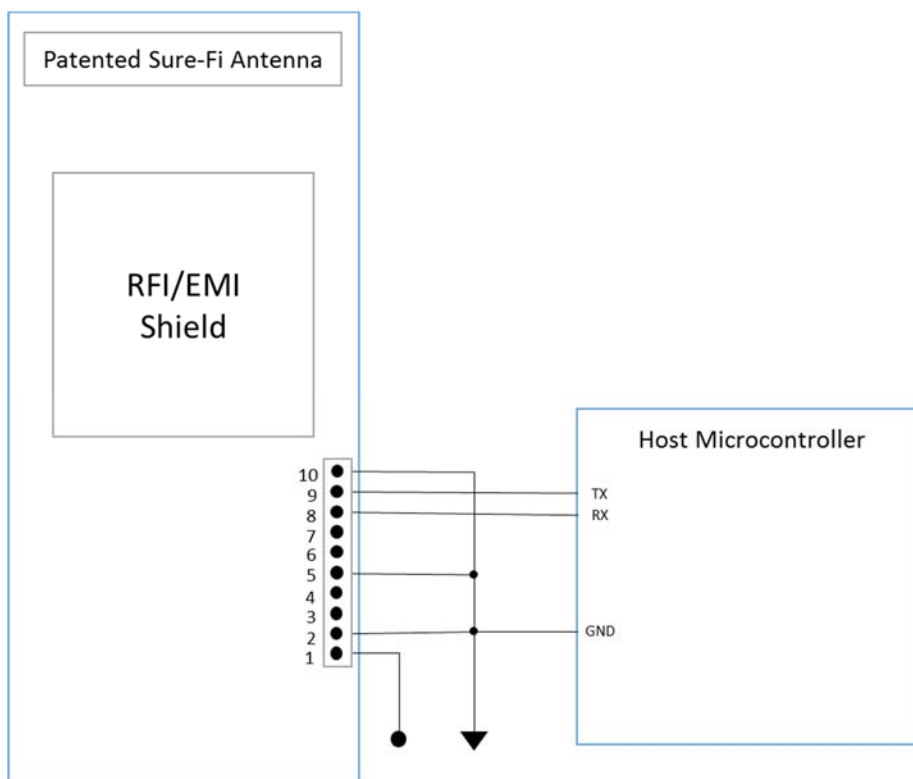
Command Reference

Command Enumeration

0x00	Not Used	**0x10**	TransmitData
0x01	Ping	**0x11**	GetPacket
0x02	SetDefault	**0x12**	GetReceiveInfo
0x03	SetReceiveUID	**0x13**	GetTransmitInfo
0x04	SetTranmitUID	**0x14**	SetAckData
0x05	SetPacketSize	**0x15**	SetNumRetries
0x06	Update	**0x16**	SetSpreadingFactor
0x07	GetStatus	**0x17**	SetBandwidth
0x08	Sleep	**0x18**	SetTransmitPower
0x09	GetFirmwareVersion	**0x19**	SetFrequency
0x0A	GetHardwareVersion	**0x1A**	SetFSKmode
0x0B	EnableFrequencyHopping	**0x1B**	
0x0C	DisableFrequencyHopping	**0x1C**	
0x0D	EnableAcknowledgments	**0x1D**	
0x0E	DisableAcknowledgments	**0x1E**	
0x0F	GetTimeOnAir	**0x1F**	

Command Format

Attention	Command	Length	Data
~	0x01-0xFF	0x00 – 0x40	Length as Required

Ping

Description:

Send link test signal to 'TransmitUID' address.

Command:

Attention	Command	Length	Data
~	0x01	EMPTY	EMPTY

Response:

Attention	Response	Length	Data
~	0x01 (OK), or Response Code – see table	EMPTY	EMPTY

Result: Remote device is on/off line, (Quality of Service) QOS value.

SetDefaults

Description:

Set all radio settings to factory defaults.

Command:

Attention	Command	Length	Data
~	0x02	EMPTY	EMPTY

Response:

Attention	Response	Length	Data
~	0x01 (OK), or Response Code – see table	EMPTY	EMPTY

Result:

		Note
Spreading Factor	11	
Bandwidth	250 Khz	
FHSS	ON	
Time On Air	≈ 378 msec.	3 BYTE UID, 12 BYTE payload
Default Transmit Power	1 Watt (30 dBm)	Adjustable by application (1 mWatt – 1 Watt)
Equivalent Bit Rate	≈ 671 bps	bits/second
Link Budget	161.5 dB	Max

SetReceiveUID

Description:

Set Unique Identifier (Address) of this radio module. UID Length is variable and set by "Length". All received packets that are passed to the application must contain this UID. NOTE: The remote module(s) SetTransmitUID must be set to this value to receive packets from it.

Command:

Attention	Command	Length	Data
~	0x03	Variable	"Length" CHAR UID

Response:

Attention	Response	Length	Data
~	0x01 (OK), or Response Code – see table	EMPTY	EMPTY

Result:

Receive UID (address) is set "Data".

SetTransmitUID

Description:

Set Unique Identifier (Address) of the remote radio module. UID Length is variable and set by "Length".
All transmitted packets from this module will be sent to remote module(s) with this UID. NOTE: The
remote module(s) SetReceiveUID must be set to this value to receive packets.

Command:

Attention	Command	Length	Data
~	0x04	Variable	"Length" CHAR UID

Response:

Attention	Response	Length	Data
~	0x01 (OK), or Response Code – see table	EMPTY	EMPTY

Result:

Transmit UID (address) is set to "Data".

SetPacketLength

Description:

Sets the length of a complete transmission and reception. Equals UID length plus the Payload length to
be sent. NOTE: Packet Size must be set the same at the remote and local radio modules. Must be at
least "1".

Command:

Attention	Command	Length	Data
~	0x05	0x01	Packet Length (1 to 255)

Response:

Attention	Response	Length	Data
~	0x01 (OK), or Response Code – see table	EMPTY	EMPTY

Result:

Transmit and Receive packet size is set to "Data".

Update

Description:

TBD

Command:

Attention	Command	Length	Data
~	0x06	TBD	TBD

Response:

Attention	Response	Length	Data
~	0x01 (OK), or Response Code – see table	EMPTY	EMPTY

Result:

TBD

GetStatus

Description:

Get module status.

Command:

Attention	Command	Length	Data
~	0x07	EMPTY	EMPTY

Response:

Attention	Response	Length	Data
~	0x01 (OK), or Response Code – see table	EMPTY	EMPTY

0x00 = Initializing

0x01 = Receive Mode

0x02 = Transmit Mode

0x03 = Awaiting Acknowledge

0x04 = Acknowledging

Result:

Returns module status

GetFirmwareVersion

Description:

Get the current module firmware revision.

Command:

Attention	Command	Length	Data
~	0x09	EMPTY	EMPTY

Response:

Attention	Response	Length	Data
~	0x01 (OK), or Response Code – see table	EMPTY	EMPTY

Result:

Returns two character major and two character minor version separated with ".".

GetHardwareVersion

Description:

Get the current module hardware revision.

Command:

Attention	Command	Length	Data
~	0x0A	EMPTY	EMPTY

Response:

Attention	Response	Length	Data
~	0x01 (OK), or Response Code – see table	EMPTY	EMPTY

Result:

Returns two character major and two character minor version separated with ".".

EnableFrequencyHopping

Description:

Enables frequency hopping. NOTE: The remote module(s) must be set to this value to receive packets.

Command:

Attention	Command	Length	Data
~	0x0B	EMPTY	EMPTY

Response:

Attention	Response	Length	Data
~	0x01 (OK), or Response Code – see table	EMPTY	EMPTY

Result:

Turns frequency hopping mode ON.

DisableFrequencyHopping

Description:

Disables frequency hopping for the chirped spread spectrum mode. Enables narrowband chirped spread spectrum by default at SetFrequency value (below). NOTE: The remote module(s) must be set to this value to receive packets.

Command:

Attention	Command	Length	Data
~	0x0C	EMPTY	EMPTY

Response:

Attention	Response	Length	Data
~	0x01 (OK), or Response Code – see table	EMPTY	EMPTY

Result:

Turns frequency hopping mode OFF. Modulation is set to narrowband (DTS) mode.

EnableAcknowledgements

Description:

Enables acknowledgement sequence from in radio transmission. If no acknowledgement, radio will retry "NumRetries" (set below)

Command:

Attention	Command	Length	Data

~	0x0D	EMPTY	EMPTY

Response:

Attention	Response	Length	Data
~	0x01 (OK), or Response Code – see table	EMPTY	EMPTY

Result:

Enables acknowledgements.

DisableAcknowledgements

Description:

Disables acknowledgement sequence from in radio transmission. No retries will be attempted. Note: disabling acknowledgments does not eliminate the delay time a transmit packet waits for the acknowledgement.

Command:

Attention	Command	Length	Data
~	0x0E	EMPTY	EMPTY

Response:

Attention	Response	Length	Data
~	0x01 (OK), or Response Code – see table	EMPTY	EMPTY

Result:

Disables acknowledgements.

GetTimeOnAir

Description:

Get the current Time On Air per transmission as determined by Spreading Factor, Bandwidth, and Packet Size of current radio settings.

Command:

Attention	Command	Length	Data
~	0x0F	EMPTY	EMPTY

Response:

Attention	Response	Length	Data
~	0x01 (OK), or Response Code – see table	EMPTY	EMPTY

Result:

Returns packet time on air in microseconds (4 bytes as int32).

TransmitData

Description:

Transmit payload (Data) per current radio settings. NOTE: Length must be equal to Packet Length minus UID Length. See SetPacketLength.

Command:

Attention	Command	Length	Data
~	0x10	0 to 255 BYTES	As configured

Response:

Attention	Response	Length	Data
~	0x01 (OK), or Response Code – see table	EMPTY	EMPTY

Result:

Data is sent to remote radio at TransmitUID address.

GetPacket

Description:

Receive payload (Data) from remote module. NOTE: Data length will be equal to Packet Length minus UID Length. See SetPacketLength.

Command:

Attention	Command	Length	Data
~	0x11	0 to 255 BYTES	As configured

Response:

Attention	Command	Length	Data
~	0x11	0 to 255 BYTES	As configured

Result:

"Data" is sent to remote radio at TransmitUID address.

GetReceiveInfo

Description:

Get RSSI and SNR of last packet received.

Command:

Attention	Command	Length	Data
~	0x12	EMPTY	EMPTY

Response:

Attention	Command	Length	Data
~	0x12	0x03	RSSI SNR

Result:

Get RSSI and SNR of last packet received . RSSI as two bytes (signed int16) and SNR as one byte (signed int8)

GetTransmitInfo

Description:

Get retry number and length of data included in acknowledge (if enabled).

Command:

Attention	Command	Length	Data
~	0x13	EMPTY	EMPTY

Response:

Attention	Command	Length	Data
~	0x13	0x02	NUM RETRIES ACK LENGTH

Result:

Get retry number and length of data included in acknowledge (if enabled). Both as uint8.

SetAckData

Description:

Set length and payload to be returned with acknowledgments. NOTE: must be less than or equal to payload length set in SetPacketLength. "Less than" lengths will be padded to payload length set in SetPacketLength.

Command:

Attention	Command	Length	Data
~	0x14	As Configured	As Configure

Response:

Attention	Response	Length	Data
~	0x01 (OK), or Response Code – see table	EMPTY	EMPTY

Result:

"Data" will be sent with acknowledgments.

SetNumRetries

Description:

Set the number of retries to try after unacknowledged transmissions

Command:

Attention	Command	Length	Data
~	0x15	0x01	1 to 255

Response:

Attention	Response	Length	Data
~	0x01 (OK), or Response Code – see table	EMPTY	EMPTY

Result:

Retries will occur "Data" number of times.

SetSpreadingFactor

Description:

Set the transmission and reception spreading factor for the chirped spread spectrum mode. NOTE: The remote module(s) must be set to this value to receive packets.

Command:

Attention	Command	Length	Data
~	0x16	0x01	0x1 to 0x7

0x1 = SF6

0x2 = SF7

0x3 = SF8

0x4 = SF9

0x5 = SF10

0x6 = SF11, default

0x7 = SF12

Response:

Attention	Response	Length	Data
~	0x01 (OK), or Response Code – see table	EMPTY	EMPTY

Result:

Radio is set to "Data" spreading factor.

SetBandwidth

Description:

Set the transmission and reception bandwidth for the chirped spread spectrum mode. NOTE: The remote module(s) must be set to this value to receive packets.

Command:

Attention	Command	Length	Data
~	0x17	0x01	0x1 to 0x5

0x1 = 31.25 KHz

0x2 = 62.5 KHz

0x3 = 125 KHz

0x4 = 250 KHz

0x5 = 500 KHz

Response:

Attention	Response	Length	Data
~	0x01 (OK), or Response Code – see table	EMPTY	EMPTY

Result:

Radio is set to "Data" bandwidth.

SetTransmitPower

Description:

Set the transmission power output. Not all output power settings are available in all modulation modes. See Modulation vs. Output Power Settings below.

Command:

Attention	Command	Length	Data
~	0x18	0x01	0x1 to 0x0B

0x1 = 30 dBm (1 WATT)

0x2 = 27 dBm (1/2 WATT)

0x3 = 24 dBm (1/4 WATT)

0x4 = 21 dBm (1/8 WATT)

0x5 = 18 dBm (1/16 WATT)

0x6 = 15 dBm (1/32 WATT)

0x7 = 12 dBm (1/64 WATT)

0x8 = 9 dBm (1/128 WATT)

0x9 = 6 dBm (1/256 WATT)

0x0A = 3 dBm (1/512 WATT)

0x0B = 0dBM (1/1024 WATT)

Response:

Attention	Response	Length	Data
~	0x01 (OK), or Response Code – see table	EMPTY	EMPTY

Result:

Radio is set to "Data" output power.

SetFrequency

Description:

Set the transmission and reception narrow band frequency. NOTE: The remote module(s) must be set to this value to receive packets.

Command:

Attention	Command	Length	Data
~	0x19	0x01	0x1 to 0x47

Frequency Table (MHz)

0x00	*902.5	0x12	908.8	0x24	915.1	0x36	921.4
0x01	902.85	0x13	909.15	0x25	915.45	0x37	921.75
0x02	903.2	0x14	909.5	0x26	915.8	0x38	922.1
0x03	903.55	0x15	909.85	0x27	916.15	0x39	922.45
0x04	903.9	0x16	910.2	0x28	916.5	0x3A	922.8
0x05	904.25	0x17	910.55	0x29	916.85	0x3B	923.15
0x06	904.6	0x18	910.9	0x2A	917.2	0x3C	923.5
0x07	904.95	0x19	911.25	0x2B	917.55	0x3D	923.85
0x08	905.3	0x1A	911.6	0x2C	917.9	0x3E	924.2
0x09	905.65	0x1B	911.95	0x2D	918.25	0x3F	924.55
0x0A	906	0x1C	912.3	0x2E	918.6	0x40	924.9
0x0B	906.35	0x1D	912.65	0x2F	918.95	0x41	925.25
0x0C	906.7	0x1E	913	0x30	919.3	0x42	925.6
0x0D	907.05	0x1F	913.35	0x31	919.65	0x43	925.95
0x0E	907.4	0x20	913.7	0x32	920	0x44	926.3
0x0F	907.75	0x21	914.05	0x33	920.35	0x45	926.65
0x10	908.1	0x22	914.4	0x34	920.7	0x46	927
0x11	908.45	0x23	914.75	0x34	921.05	0x47	927.35

*default narrow band frequency

Response:

Attention	Response	Length	Data
~	0x01 (OK), or Response Code – see table	EMPTY	EMPTY

Result:

Radio is set to "Data" frequency.

SetFSKmode

Description:

Set the radio to GFSK mode at SetFrequency value (above). NOTE: The remote module(s) must be set to this value to receive packets.

Command:

Attention	Command	Length	Data
~	0x1A	0x01	1 to 255

Response:

Attention	Response	Length	Data
~	0x01 (OK), or Response Code – see table	EMPTY	EMPTY

Result:

Set radio to GFSK mode.

Bluetooth Module

The Bluetooth Module is an OEM device provided by Raytac, Inc. part number MDBT42Q that utilizes a Nordic Semiconductor NRF52 radio transceiver SOC.

Bluetooth commands are sent via a simple UART communication connection.

Specifications

RADIO			Note
Frequency Band	2360 – 2500 MHz		ISM Band
Data Rates	≈ 1 Mbps – 2 Mbps		
Antenna	Integrated PCB Chip		No user antenna allowed
Transmit Power	-20 dBm	4 dBm (2.5 milliWatt)	MIN, MAX
Receiver Sensitivity	-93 dBm	-96 dBm	MIN, MAX
Interface: UART	115,200 Baud		
Data Encryption	AES128		

Commands

The Bluetooth Module is primarily used for firmware updating of the Sure-Fi Radio Module. For instructions and source code to implement firmware updating, contact Sure-Fi.

For information to use the Bluetooth module in other modes, consult Raytac, Inc. and/or Nordic Semiconductor.

APPENDIX

Modulation vs. Output Power Settings

Not all power settings are available for all modulations. Below are maximum power outputs.

Modulation	Bandwidth	Output Power (MAX)[2]
CSS/FHSS	500 KHz	.5 WATT (Avg)
CSS/FHSS	250 KHz	1 WATT (Peak)
CSS/FHSS	125 KHz	1 WATT (Peak)
CSS/FHSS	62.5 KHz	1 WATT (Peak)
CSS/FHSS	31.25 KHz	1 WATT (Peak)
CSS/DTS	500 KHz	.5 WATT (Avg)
CSS/DTS	250 KHz	.207WATT (Avg)
CSS/DTS	125 KHz	.102 WATT (Avg)
CSS/DTS	62.5 KHz	.053 WATT (Avg)
CSS/DTS	31.25 KHz	.036 WATT (Avg)
GFSK	500 KHz	.035 WATT (Avg)

CSS = Chirped Spread Spectrum

FHSS = Frequency Hopping Spread Spectrum

DTS = Narrow Band - Digital Transmission System (FCC definition)

GFSK = Gaussian Frequency Shift Keying

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[2] Does not reflect 2.2 dBi antenna gain

Frequency Table (MHz)

0x00	[3]902.5	0x12	908.8	0x24	915.1	0x36	921.4
0x01	902.85	0x13	909.15	0x25	915.45	0x37	921.75
0x02	903.2	0x14	909.5	0x26	915.8	0x38	922.1
0x03	903.55	0x15	909.85	0x27	916.15	0x39	922.45
0x04	903.9	0x16	910.2	0x28	916.5	0x3A	922.8
0x05	904.25	0x17	910.55	0x29	916.85	0x3B	923.15
0x06	904.6	0x18	910.9	0x2A	917.2	0x3C	923.5
0x07	904.95	0x19	911.25	0x2B	917.55	0x3D	923.85
0x08	905.3	0x1A	911.6	0x2C	917.9	0x3E	924.2
0x09	905.65	0x1B	911.95	0x2D	918.25	0x3F	924.55
0x0A	906	0x1C	912.3	0x2E	918.6	0x40	924.9
0x0B	906.35	0x1D	912.65	0x2F	918.95	0x41	925.25
0x0C	906.7	0x1E	913	0x30	919.3	0x42	925.6
0x0D	907.05	0x1F	913.35	0x31	919.65	0x43	925.95
0x0E	907.4	0x20	913.7	0x32	920	0x44	926.3
0x0F	907.75	0x21	914.05	0x33	920.35	0x45	926.65
0x10	908.1	0x22	914.4	0x34	920.7	0x46	927
0x11	908.45	0x23	914.75	0x34	921.05	0x47	927.35

Contact Information

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Sure-Fi.com

Liability

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[3] default narrow band frequency