

RA1202 User Manual

Narrow Band UHF Radio

Symbol Technologies Inc.

RA1202 User Manual

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1.0 Revision History

REV	DESCRIPTION	DATE	Author
A.0	Initial Release	Sep. 12, 2014	Armia Nazeer
B.0	- Added regulatory comments as per Ultratech's request. - Removed confidential information. Ex. Block diagram	Sep. 18, 2014	Sada, Irfan, Armia

2.0 Introduction

This document is the user manual for the RA1202 Narrow Band Radio module. It describes its function and specifications as well as general architectural details.

All references to Symbol in this document refer to Symbol Technologies Inc.

3.0 General Description

RA1202 is a Narrow Band UHF radio module for data only (no audio) communications. The radio is primarily to be integrated into Symbol's handheld XT15 and vehicle mount VH10 as well as other potential future undetermined hosts.

There are 2 hardware variants of the radio module: 403-435 MHz and 435-470 MHz. The 2 hardware variants are configured during manufacturing into 12 radio types to meet different countries' approved frequency band, channel spacing, power level, baud rate and sub-band restrictions. RA1202 supports the following Symbol's modulations: 2 level 4800, 2 level 9600, 4 level 9600, 4 level 19200 baud FSK modulations at 12.5, 20, 25 KHz channel spacing with factory configured output power of either 1W (+30dBm) or 0.45W (+26.5dBm)(non-FCC).

Communication between the radio and host is through a serial interface. Radio firmware resides on a microcontroller inside the radio modules onboard flash memory. The antenna port of the radio module is of u.Fl type and is meant for connection to an external antenna that is part of the host device

RA1202 is designed to be integrated into a client host device only. It is not suitable for use as a base station radio. RA1202 is backward compatible with the following legacy Symbol radios: RA1001A; RA1001; TRX7370; TRX7345 (4 level modulations only);

4.0 References

4.1 Applicable Documents and Drawings – Symbol Technologies

Doc./Dwg No.	Description
PD001744A01	Radio module manufacturing test procedure
PD001746A01	Radio module manufacturing control plan
PD001745A01	Radio module manufacturing tester specification
PD001747A01	RA1202 product requirements document (export from Cradle tool) Includes: System requirements Hardware requirements Software requirements
PD001748A01	Hardware Block Diagram
PD001749A01	Software architecture

4.2 Abbreviations and Acronyms

API	Application Programmer's Interface
BIST	Built-in Self Test
BER	Bit Error Rate
EMC	Electro Magnetic Compatibility
EMI	Electro Magnetic Interference
ESD	Electro Static Discharge
FCS	First Customer Ship
MCU	Micro-Controller Unit
MER	Message Error Rate
MTBF	Mean Time Between Failure
MTTR	Mean Time To Repair
POST	Power ON Self Test
SAR	Specific Absorption Ratio
SINAD	Signal to Noise and Distortion ration
WLAN	Wireless Local Area Network
UI	User Interface
FSK	Frequency Shift Keying

5.0 Product Level Specifications

The RA1202 provides narrowband data communications using legacy Symbol proprietary narrowband protocol and FM modulation schemes. These include:

- 2 level FSK running at 4800 and 9600 bps
- 4 level FSK running at 9600 and 19,200 bps

The RA1202 is functionally backward compatible for all modulations with currently existing Symbol narrowband radios including RA1001A; RA1001; TRX7370, TRX7355 (4 level modulations only).

The implementation of the RA1202 is modular and is meant for integration in Symbol's XT15 handheld and VH10 vehicle mount terminals as well a future potential host device. For a usable radio system an external antenna system, antenna feed cable and data and power interface board will be necessary for integration with any target host as required, the design of which shall not be covered under this specification.

An interface board is necessary to provide conversion of host power from host voltage to required radio voltage as well as for providing appropriate mechanical connection between the host device and the radio, and for data interconnect.

5.1 Host Support

RA1202 is initially intended to be integrated into the following hosts:

- XT15 handheld terminal with WinCE 6.0 operating system
- VH10 vehicle mount terminal with WinCE 6.0 operating system

The open architecture of RA1202 is designed to allow ease of integration with any potential future host devices by limiting the connection to single power supply and communications bus (RS232 UART serial interface). In addition to electro-mechanical integration a driver will be required for using the radio module in alternate operating systems such as but not limited to Windows CE 7 and Windows 7.

5.2 UART Interface

A UART interface is required for communication between the host and the radio.

5.3 Radio Protocols and Features

The following protocols are supported by the RA1202:

- Polling protocol and cellular protocol is supported.
- New polling protocol and non-Cellular is not supported.
- TESS and ANSI DATA stream as payload is supported via Open TekTerm application for terminals.

5.4 Support and Test Software

The following software is available for use with the RA102 radio module:

- RTest command line utility which can be used by manufacturing to configure the radio parameters or alternatively to operate radio test only modes. Functions include:
 - Program frequency
 - Select channel spacing
 - Select data Rate
 - Select TX power (Between 1W and 0.45Watt)
 - Select continuous receive mode
 - Select continuous transmit mode (60 seconds time out timer)
 - BER test for real time BER (Bit Error Rate) testing.
- Radio firmware update utility
- NBDebug an application suitable for use for software integration and for product support to test polling protocol and cellular client. The debug is time stamped and has multiple debug levels to allow for efficient debug of any issues during software integration.
- SAR application – Intended for testing SAR for host device. Allows for continuous NB transmit mode at a certain duty cycle simultaneously with any if present host WiFi and Bluetooth radios.
- Site survey software tools for configuration into customer site

5.5 Network Access

The RA1202 is compatible when appropriately configured for network access to the following base stations:

- Symbol's 9150, 9160, 9160 G2 Access Point & Base Station for all modulations.
- 9140 base station when combined with Symbol's 93xx/94xx/95xx Series of Network Controllers for 4 level modulations only.

5.6 RF protocol

The RA1202 supports Symbol's NB Polling Protocol (Cellular mode only) and is compatible with all current 32-bit 4800/9600/19,200 symbol systems. Roaming is transparent via 9140 (4 level modulations only), 9150, 9160 and 9160 G2 Access Point cell base mode

5.7 RF Connectivity

- Frequency range:
 - 403 - 435 MHz, 435 – 470 MHz
- Data rate & mode^{Error! Bookmark not defined.}:
 - 2 level FSK 4800 bps, ¹
 - 2 level FSK 9600 bps
 - 4 level FSK 9600 bps
 - 4 level FSK 19.2 Kbps
- RF Power: Factory set to 0.45 watt (non-US) or 1 watt
- Channel Spacing:
 - 12.5 KHz
 - 20 KHz (non-US & Canada)
 - 25 KHz (not for Part 90)
- Sensitivity²:
 - 0.5uV nominal @ 1% BER [12.5 kHz] or better
 - 0.7uV nominal @ 1% BER [20/25 kHz] or better

5.8 Unsupported Features

The following features are not supported by the RA1202 radio module:

- TelkTalk is not supported.
- Intrinsically Safe is not supported
- Formal MTBF – Formal calculations to MIL-HDBK-217F will not be provided
- Non-cellular protocol is not supported
- Not backward compatible to 9130 and 9140 base stations for 2 level modulations only.

6.0 Applicable Approvals

The RA1202 is pending submission for approval for the following certifications:

- i. FCC Compliance and Approval
 - a. Modular compliance and approval as per CFR47 Part 90, 22, 74, 80 and Part 15.
- ii. Industry Canada Compliance and Approval

¹ Effective peak data rate

² Above are radio module only receiver sensitivity outside of a host. Host receiver sensitivity depends on host EMC characteristics.

- a. Modular compliance and approval as per RSS-119 section (IEC-003) unintentional emissions.
- iii. ETSI EN 300-113 Compliance
- iv. ETSI EN 300-220 Compliance
- v. FCC, IC, ETSI – coexistence of Radio Approvals
 - a. When RA1202 radio module is integrated into XT15 and VH10 host devices, coexistence of NB Radio with WLAN and BT as applicable by:
 - i. FCC CFR47 Part 90 (Tx harmonics) and Part 15 subpart B class B
 - ii. Industry Canada RSS-190 (IEC003) Tx harmonics
 - iii. All SAR (FCC bulletin 65, EN 50392, Australian SAR ‘Radiocomms (EMR - Human Exposure) Standard 2003 - amended 2007 & EMR SAR ARPANSA Radiation Protection’)
 - iv. EMC EN 301 489-1-17-5
 - v. EMI EN 55022 class B
 - vi. EU WiFi radio 2.4GHz type EN 300 328 Tx harmonics
 - vii. EU WiFi radio 5GHz type EN 301 893 Tx harmonics
- vi. Australian/New Zealand standard AS/NZS 4768.1:2010.
- vii. Malaysian Communications and Multimedia Commission standard to be used in Land Mobile Services as per SKMM WTS LMR 1.01:2007.
- viii. RA1202 when integrated into XT15 and VH10 hosts
 - a. ETSI EN 301 489-1-17-5. CE Mark Compliance.
- ix. Safety
 - a. EC Low Voltage Directive 73/23/EEC, but no voltage limit applying.
- x. Flammability Rating
 - a. The PCB used for the RA1202 radio module is UL94-V0 (or better) rated.
- xi. Symbol Solutions Inc W18 environmental compliance, which is a superset of RoHs, REACH, China RoHs, Conflict materials and PVC content.

7.0 Approvals and Safety Summary

This equipment complies with Class B 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.

7.1 FCC Information to Users

For Class B Unintentional Radiators:

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 instruction manual, 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 of 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.

7.2 Warning to Users

Changes or modifications not expressly approved by Symbol Technologies Inc, the party responsible for compliance, may void the user's authority to operate the equipment.

7.3 FCC & IC RF Exposure Warning

A separation Distance of at least 22 cm is required to be maintained between the user and the antenna when the antenna with the gain of less than or equal to 2 dBi is used for Mobile Application.

A separation distance of at least 70 cm is required to be maintained between the user and the antenna when the antenna with the gain of less than or equal to 12 dBi is used for Fixed base application.

VH10 collocation evaluation is based on 0 dBi gain antenna requiring a separation distance of at least 20 cm.

7.4 Labeling Requirement for Radio Module

A label is affixed to the radio module with the following information:

Symbol Technologies Inc UHF Radio, Model RA1202

FCC ID: H9PRA1202

IC: 1549L-RA1202”

7.5 Labeling Requirement for Host

After installing the radio module in a host if the label is not visible from outside then a separate label has to be affixed to the outside of the host with following information:

“Contains Symbol Technologies Inc UHF Radio, Model RA1202

FCC ID: H9PRA1202

IC: 1549L-RA1202”

7.6 Testing requirements for portable Host

Testing of portable 7545MBWN has been addressed pending application, for any other portable hosts with radio module RA1202 integrated requires Class II permissive change approval.

7.7 Testing requirements for Mobile Host

RA1202 integrated in a mobile host requires testing for DoC or Certification as a Class B device.

7.8 Collocated Transmitters

Collocation with other transmitters for portable 7545MBWN has been addressed pending application, for any other portable host new certification is required.

Section B – Detailed Specifications

8.0 General

8.1 Description

The radio module consists of 54-pin interface, microcontroller, modem chipset, transmitter, receiver, RF front end for transmit and receive, Tx/Rx switch and antenna port as shown below.

Host sends commands and bidirectional data to the microcontroller (MCU) through the UART interface on the 54-pin interface. MCU sends data and control signals to the modem chipset, which modulates the data in one of 4 of Symbol's 4 modulation types: 2L 4800, 2L 9600, 4L 9600, 4L 19200 baud rate.

Modem outputs IQ data to transmitter, which modulates data to RF carrier, amplifies it and outputs it on antenna port when Tx/Rx switch is set to transmit position.

When Tx/Rx switch is set into Rx positions, received data is filtered, amplified, de-modulated by receiver and then decoded by modem. Modem sends data to MCU, where it is buffered and relayed back to the host device.

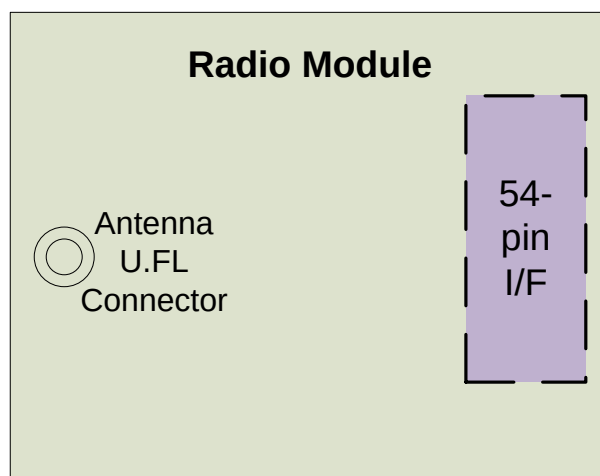
Radio module also includes mechanical structures for support and shielding: top shield, radio frame and bottom shield.

8.2 Block Diagram – Radio Module

Refer to confidential block diagram.

9.0 Interfaces

The figure below describes the connection and interface scheme for RA1202



9.1 Interface and Connection Scheme

The RA1202 module power and data bus connector is as follows:

- Radio module connector: Samtec ASP-176298-02 (8.7mm custom pin lengths of Samtec FTE-125-xx-G-DV-A-P-TR series)
- Mating host connector: Samtec CLE-127-01-G-DV-A-K
- Pin 1 of the radio board (part of the RA1202 radio module) has a square solder pad and silkscreen.

Below pin-out is from the radio module's reference point.

Pin Number	Signal Name	Description	Voltage (V)	Direction (wrt Radio Module) I - Input O - Output A - Analog	Pull Up or Pull Down
1	RX_I_CAL_P	Receiver differential I signal from receiver to modem		A	<i>Test Signal – not connected</i>
3	RX_I_CAL_N			A	
5	GND	Ground			
7	TX_Q_CAL_P	Transmitter differential Q signal from modem to transmitter.	1V p-p	A	<i>Test Signal – 100Kohms</i>
9	TX_Q_CAL_N			A	
11	GND	Ground			
13	TX_I_CAL_P	Transmitter differential I signal from modem to transmitter.		A	<i>Test Signal – 100Kohms</i>
15	TX_I_CAL_N			A	
17	GND	Ground			
19	ABOUT_TO_TX	Indicator when about to transmit	3.0	O	None
21	BACKUP_ACTIVE	Set when radio should go into emergency suspend mode (ex. Battery removal on handheld host).	3.3	I	PD (1M on Radio Bd) <i>Requires 10kohm series resistor on host.</i>

23	WAN_PWR_EN	Power enable for the radio module from the host	3.3	I	PD (100K on Radio Bd)
25	MCU_PWR_EN	Indicator when MCU power is enabled	3.0	O	PD (10K on Radio Board)
27	GND	Ground			
29	MCU_UART2_RX	MCU serial port 2 (RS232 channel to the host)	3.0	I	None
31	MCU_UART2_CTS		3.0	I	None
33	MCU_UART2_TX		3.0	O	None
35	MCU_UART2_RTS		3.0	O	None
37	JTAG_TRST_N/SPARE-2				None
39	GND	Ground			
41	GND	Ground			
43	GND	Ground			
45	GND	Ground			
47	VSYS	Radio Module Power Supply	3.2 to 4.2	Power	<i>Tx current: 1.5A @ 3.7V nominal</i>
49	VSYS				
51	VSYS				
53	VSYS				

Pin Number	Signal Name	Description	Voltage (V)	Direction (wrt Radio Module) I - Input O - Output A – Analog	Pull Up or Pull Down
2	RX_Q_CAL_N	Receiver differential Q signal from receiver to modem		A	<i>Test Signal – not connected</i>
4	RX_Q_CAL_P			O	
6	GND	Ground			
8	UPS_MODE	Indicator from Host to MCU - radio to go into lower power mode.	3.0	I	PD (100k on Radio Board) <i>Future feature to be implemented</i>
10	NOT USED				
12	NOT USED				
14	GND	Ground			
16	TX_ON (RF_PA_GATE_EN)	TX trigger signal from modem for test equipment.		O	
18	GND	Ground			
20	SYMBOL_CLK	Symbol clock from modem chipset	3.0	O	<i>Test Signal – not connected</i>
22	GND	Ground			
24	MCU_UART3_TX	MCU serial port 3 (MCU program and debug)	3.0	O	
26	MCU_UART3_RX		3.0	I	
28	GND	Ground			
30	MCU_BOOT1 **	MCU boot configuration	3.0	I	PD (100K on Radio Board)
32	MCU_BOOT0 **				
34	MCU_RST_N	MCU reset control signal			PD (100K on Radio Board)
36	GND				
38	DO NOT USE				
40	JTAG_TCK	JTAG clock to the MCU.	3.0	I	PD (INT)
42	JTAG_TDI/SPI3_NCC	JTAG shared as SPI CS	3.0	O	None
44	JTAG_TDO/MCU_HRTBEAT	JTAG shared as debug signal	3.0	O	None
46	DO NOT USED				
48	GND	Ground			
50	JTAG_TMS/SPARE-1	JTAG shared as Spare GPIO	3.0	Undefined	None
52	MCU_SPARE_3	Spare GPIO	3.0	Undefined	None

** MCU_BOOT[1:0] = x0 MCU boot from MCU flash memory
 MCU_BOOT[1:0] = 01 MCU boot from system memory
 MCU_BOOT[1:0] = 11 MCU boot from Embedded SRAM

9.2 Antenna Connection

Connector: Hirose U.FL-R-SMT(10)

Antenna: 50 Ohm nominal impedance; external only, via interconnecting RF cable. *Recommend having a ferrite choke on RF antenna cable.*

10.0 Electrical Characteristics

10.1 Power Supply Requirements

Input Voltage Range	3.2 to 4.2 Vdc
Nominal Input Voltage	3.7Vdc
Current consumption at nominal input voltage	
OFF	TBD mA
Idle	TBD mA
Receive	<200mA
Transmit	1.5A nominal at 1Watt output

10.2 Modes of Operation

RA1202 radio module shall support the following modes of operation:

- OFF (Radio powered down, Power can remain present on Radio module interface)
- Idle (Radio module MCU powered, but modem, transmitter, receiver and RF front end off)
- Receive
- Transmit

11.0 Software Features and Functions

11.1 Radio Module Firmware

Radio module firmware running on the Radio module microcontroller (MCU) communicates with the host, controls all aspects of the radio chipsets, RF front end and Tx/Rx switch.

11.2 Radio module serial number storage

During manufacturing, radio module serial number and part number are stored into the radio module MCU write-once non-volatile flash memory. This allows host to query radio module part number and serial number and therefore allow correlation of each radio module with the factory test report.

11.3 Radio Type storage and security

RA1202 radio module has 2 hardware types. These 2 hardware types are configured during manufacturing into 12 different radio types to meet country region approval requirements. Radio type is factory set and stored in the radio MCU non-volatile memory.

Radio type is locked outside of manufacturing of the radio module. There are 3 levels of security to ensure end users cannot modify the radio type outside of factory or authorized service depots:

- Locked and signed software does not allow access to commands to modify radio type. *Control panel in windows can only read the radio type.*
- Password protection. This is added security beyond the locked and signed software.
- Specialized commands to change radio types, which are only available in manufacturing and authorized service depots.

11.4 Radio Protocol

Drivers are available supporting the following features:

- Compatible with Symbol's NarrowBand Polling Protocol Cellular only. Non-cellular modes not be supported.
- Transparent roaming and power saving modes (terminals only). 9130/9140 2L modulation base stations not be supported
- RMAN API interface supported by the TekTerm application (terminals only)
- Radio protocol diagnostic information (viewable via TekTerm for terminals)

11.5 Radio Calibration data

All calibration parameters are calibrated and tested during manufacturing then locked out from end customers.

12.0 Host Software

12.1 Radio Tests

RTest command line utility allow developers and approval testers to perform the following radio tests:

- Channel (frequency) selection
- Transmit long
- Transmit test
- Receive Test (BER)

12.2 Configuration and Tuning

RTest allows developer, manufacturing and approval tester to configure all necessary radio settings such as data rate, modulation type and operating frequency.

End user shall not be able to modify any approval related parameters of the radio module. This is done by 3 layers of protection described in section 11.3 of this document.

12.3 Site Survey (terminals only)

A site survey application shall be developed for RA1202 that will perform in a similar manner to the site survey application available on 7530 G2 and 8525/8530 G2 terminals. This is used by system installers to determine the best location of base stations for new NarrowBand sites. It also indicates the coverage level.

12.4 Software Update feature

Software is available to upgrade RA1202 firmware through UART host connection, for in-system upgrade and depot upgrade.

As a backup in case of flash corruption and serial interface no longer operational it is possible to update firmware through JTAG programming interface.

Only firmware which Regulatory Agency approved can be loaded on the radio module.

13.0 Mechanical & Ergonomic Specifications

13.1 General

Interface to Host:	54-pin Samtec ASP-176298-02 (8.7mm custom pin lengths of Samtec FTE-125-xx-G-DV-A-P-TR series)
Antenna Cable Interface:	Hirose U.FL-R-SMT(10)
Weight:	37.1g
Dimensions:	64 (W) x 52.5 (L) x 17.1 (H) mm

13.2 Drop Rating

This is highly dependent upon host mounting system. For RA1202 Radio module integrated into MSI XT15 handheld terminal the following drop specifications are met:

- 26 drops from 1.7m at room temperature to polished concrete
- 6 drops from 2.0 m at room temperature to polished concrete
- 6 drops from 1.7 m at -20C to polished concrete
- 6 drops from 1.7m at +50C to polished concrete

13.3 Environmental Conditions

Storage temperature:	-35C to +85C
Operating temperature:	-30C to +80C
Humidity*:	5% to 95% (non-condensing)
Temperature shock*:	-30C to +50C (85% R.H.) as per MIL-STD-810G; Method 503.5 Procedure I-C (Multi-cycle shocks)

** There will be NO environmental protection on the RA1202 radio module, as it is designed to be fully enclosed within a host unit.*

13.4 Labeling Requirements

3 different labels must be in the following 3 locations:

- External to RA1202 radio module
- External to host unit
- External to host unit shipping box

They must include all applicable notices as per regulatory requirements of section 5.0 adhering to the minimum text and label sizes defined therein.

Identify Symbol Technologies Inc RA1202 radio module and part number specific to the radio configuration.

14.0 Appendices

Radio Performance Specifications

14.1 General

Frequency Range:	435-470 MHz [high band – FCC, IC, EU, & other] 403-435 MHz [low band – non-FCC, non-IC]
Frequency Control:	Synthesized
Channel Spacing:	12.5 kHz [FCC & others] 20 kHz [non-FCC] 25 kHz non Part 90
Mode of Operation:	Simplex or Half Duplex
Regulated Supply Voltage:	3.7VDC +/- 15%
Operating Temperature Range:	-30C to +80C
Maximum Dimensions:	64 (W) x 52.5 (L) x 17.1 (H) mm
Weight:	37.1g
FCC Compliance:	Yes [high band only – 435-470 MHz] No [low band]

14.2 Receiver

Bandwidth:	35 MHz [high band] 32 MHz [low band]
Frequency Stability:	+/- 1ppm [-30C to + 80C]
Digital Sensitivity	0.4uV at 1% BER [at 12.5 kHz channel spacing] as per ETSI EN300 113-1 v 1.7.1
RF Input Impedance	50 ohms
Selectivity	-61 dB [12.5 kHz channel spacing]
Spurious Rejection	88 dB
Intermodulation	-70dB
Conducted Spurious	85 dB
Receive Current Drain	200 mA
Receive Attach Time	< 3.5 msec

14.3 Transmitter

Bandwidth:	35 MHz [high band] 32 MHz [low band]
Frequency Stability:	+/- 1ppm [-30C to + 80C]
TCXO coupling	AC
RF Output Power	1W nominal 0.5W [available for non-FCC variant]
RF Output Impedance	50 ohms
Modulation Distortion	< 3%
Maximum Duty Cycle	30%, 60 seconds maximum continuous transmit time
Transmitter Attack Time	< 3.5 msec
Spurious & Harmonic FM	-79 dB
Transmit Current Drain	1.5A at 3.7 VDC nominal

14.4 Host Interface

Data Input Impedance	100 Kohms
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