SRF309 User Manual

18 August 2014

U081.0.9 User Manual for SRF309

FCC Statements

15.19 – Two Part Warning

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.

15.21 – Unauthorized Modification

NOTICE: The manufacturer is not responsible for any unauthorized modifications to this equipment made by the user. Such modifications could void the user's authority to operate the equipment.

15.27 – Special Accessories

This device is supplied with special accessories that include an RF adapter cable and antenna. These special accessories must be used with the device. It is the responsibility of the user to use the needed special accessories supplied with the equipment.

15.105(b) – Note:

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. 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. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Industry Canada Statements

RSS-GEN 7.1.2 – Transmitter Antenna / Antenne de L'émetteur

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

This radio transmitter 7955A-SRF309 has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Le présent émetteur radio 7955A-SRF309 a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

Approved Antenna List / Liste Antenne Approuvé

Manufacturer	Part Number	Stock Number	Gain	Impedance
Antenna-Factor/Linx Tech	ANT-916-SP	353	+1.49dBipeak	50 Ohm
Nearson Or Equivalent	S467TR-915S Or Equivalent	BB3-06	+2dBipeak	50 Ohm
Superpass Or Equivalent	SPDAC80 Or equivalent	BB3-08	+9dBipeak	50 Ohm

RSS-GEN 7.1.3 – Notice / Délai

This device complies with Industry Canada licence-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, même si le brouillage est susceptible d'en compromettre le fonctionnement.

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Notes and Observations

Cervis Inc. Safety Precautions

- ✓ ***Read and follow all instructions.***
- ✓ ***Failure to abide by Safety Precautions may result in equipment failure, loss of authority to operate the equipment, and personal injury.***
- ✓ ***Use and maintain proper wiring. Follow equipment manufacturer instructions. Improper, loose, and frayed wiring can cause system failure, equipment damage, and intermittent operation.***
- ✓ ***Changes or modifications made to equipment not expressly approved by the manufacturer will void the warranty.***
- ✓ ***Owner/operators of the equipment must abide by all applicable Federal, State, and Local laws concerning installation and operation of the equipment. Failure to comply could result in penalties and could void user authority to operate the equipment.***
- ✓ ***Make sure that the machinery and surrounding area is clear before operating. Do not activate a remote control system until certain that it is safe to do so.***
- ✓ ***Turn off the module power before attempting any maintenance. This will prevent accidental operation of the controlled machinery.***
- ✓ ***Do not allow liquid to enter the module enclosure. Do not use high pressure equipment to clean the module.***
- ✓ ***Operate and store units only within the specified operation and storage temperatures defined in the Specifications of this document.***

1.0 SRF309 Introduction

The SRF309 receive/transmit module (RTM) is based on a single-chip radio frequency (RF) transceiver integrated circuit (RFIC), an Atmel AT86RF212B. The SRF309 RTM is intended to be integrated into Cervis Inc. products, providing a wireless RF connectivity option.

The SRF309 RTM operates in the 915 MHz ISM band, using spread spectrum modulation with a maximum conducted RF transmit power of +8.60dBm at the antenna port.

The RFIC generates RF signals compliant with the Zigbee standard, IEEE 802.15.4-2006. The spread spectrum technique is direct sequence (DSSS), the modulation method is binary phase shift keying (BPSK).

The RFIC has internal control registers that the host application can access via a serial peripheral (SPI) bus. These registers control all aspects of how the RFIC is used, which must be compliant with all applicable rules and regulations.

The SRF309 RTM is interoperable various other Cervis Inc. RTMs that use the same modulation and message data structure. Interoperability with non-Cervis RTMs, while possible, is not supported.

The SRF309 RTM is most commonly applied in half-duplex master/slave systems: the master transmits a message to a slave, the slave transmits a reply to the master. Other operating modes are possible, provided that applicable rules and regulations are not violated.

The SRF309 RTM may be realized in various PCB shapes, some with non-RF circuits applicable to the requirements of particular hot applications. Mechanical variations include:

07440305-9H-12R “Type 1” (tested, pictured)
07610304-9H “Type 2” (not yet tested)
07420305-9H-12R “Type 3” (not yet tested)
14001301 “Type 4” (not yet tested)

1.1 SRF309 Features

FCC Part 15 certified
IC Certified
CE certified
905-925 MHz Operation
2 MHz Selectable Channels
Direct Sequence Spread Spectrum (DSSS)
Binary Phase Shift Keying (BPSK) modulation (tested)
40 kbps Data Rate (tested)
Up to +8.60dBm Output Power (tested)
IEEE 802.15.4-2006 messaging
SPI host interface
Simple power requirements: 3.0-3.3V low noise regulated, 20mA

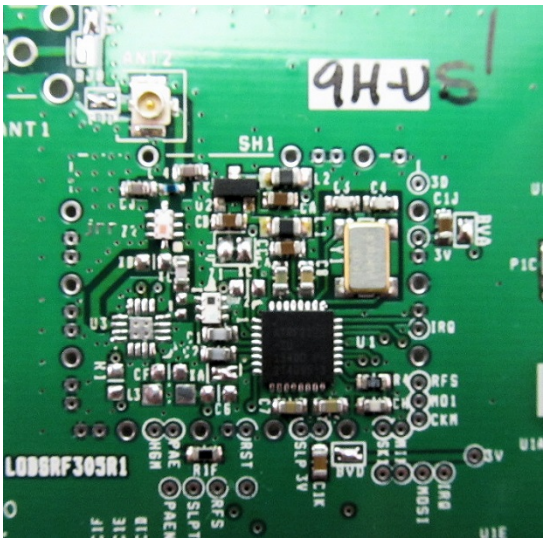

Figure 1. **SRF309 RF section Front**

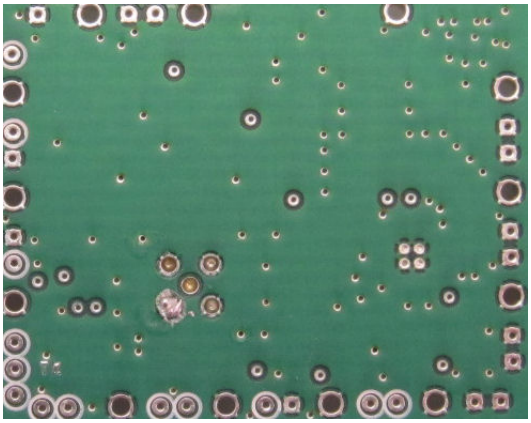

Figure 2. **SRF309 RF section Back**

1.2 SRF309 Pinouts

Table 1-4 show the pinouts and interface signals on several alternative packaging options for the SRF309 RTM:

Table 1. 07440205 PCB (SRF309 Type 1) – connector HDR1

Pin	Name	Signal	Details
1	SPI_CLK	SPI data clock in	Clock from SPI master
2	GND	ground	Low impedance ground
3	MISO	SPI data out	Data from SPI slave
4	MOSI	SPI data in	Data from SPI master
5	RF_SLP_TR	RFIC control	Multipurpose control signal from master
6	/RF_RST	RFIC reset	Low from SPI master

7	/RF_CS	RFIC chip select	Low from SPI master
8	RF_IRQ	RFIC interrupt output	Input to SPI master
9	RF_PAEN	Enable external PA	High from SPI master
10	RF_HGM/BPA	Enable external LNA or Read BPA jumper	Function not used in SRF309 Input to SPI master
11	GND	ground	Low impedance ground
12	GND	ground	Low impedance ground
13	DISPLAYCS	Display chip select	Low from SPI master
14	/RFEE_CS (reserved)	EE chip select	Low from SPI master
15	DISPLAYRS	Display register select	From SPI master
16	DISPLAYBLANK	Display on/off	From SPI master
17	reserved	reserved	reserved
18	reserved	reserved	reserved
19	DISPLAYRST	Display reset	Low from SPI master
20	reserved	reserved	reserved
21	LED_6	Indicator	High from SPI master
22	LED_7	Indicator	High from SPI master
23	LED_4	Indicator	High from SPI master
24	LED_5	Indicator	High from SPI master
25	LED_2	Indicator	High from SPI master
26	LED_3	Indicator	High from SPI master
27	LED_0	Indicator	High from SPI master
28	LED_1	Indicator	High from SPI master
29	GND	ground	Low impedance ground
30	GND	ground	Low impedance ground
31	+24VDC	+3.0-30V	Power indicator LED
32	+5VDC	+3.0-30V	Power indicator LED
33	+3.3VDC	+3.3V	Power indicator LED, RF & logic power. Low noise 50mA max.
34	REVBAT	+3.0-30V	Power indicator LED
	Not required for SRF309		

The 07440305-9H-12R PCB assembly includes all circuits and features required for properly implementing the SRF309 RTM. The PCB also provides circuits and mounting for various optional non-RF features of use to a host application, including:

12 indicator LEDs (default installation)
LED/LCD display module (future use)

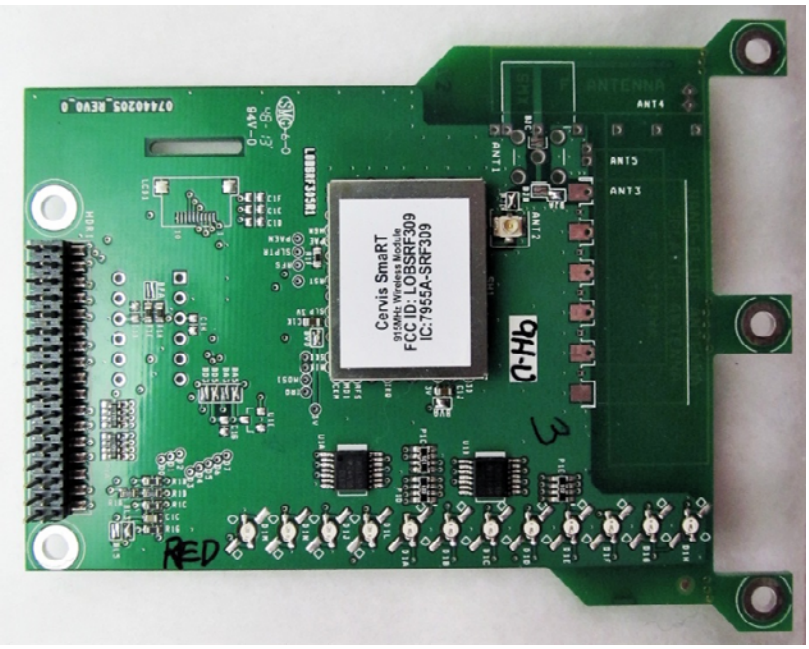

***Figure 3*. 07440305-9H-U-12R, component side, shield, internal label, external antenna connector**

Table 2. 07610204 PCB (SRF309 Type 2) – connector J10

Pin	Name	Signal	Details
1	SPI_CLK	SPI data clock in	Clock from SPI master
2	GND	ground	Low impedance ground
3	MISO	SPI data out	Data from SPI slave
4	MOSI	SPI data in	Data from SPI master
5	RF_SLP_TR	RFIC control	Multipurpose control signal from master
6	/RF_RST	RFIC reset	Low from SPI master
7	/RF_CS	RFIC chip select	Low from SPI master
8	RF_IRQ	RFIC interrupt output	Input to SPI master
9	RF1_3VD	+3.3V	RF & logic power. Low noise 25mA max.
10	GND	ground	Low impedance ground
11	RF1_3VA	+3.3V	RF analog power. Low noise 25mA max.
12	GND	ground	Low impedance ground
13	RF_PAEN	Enable external PA	High from SPI master
14	RF_HGM/BPA	Enable external LNA or Read BPA jumper	Function not used in SRF309 Input to SPI master
15	GND	ground	Low impedance ground
16	GND	ground	Low impedance ground
17	GND	ground	Low impedance ground

The 07610305-9H PCB assembly includes all circuits and features required for properly implementing the SRF309 RTM Type 2.

Insert image of 07610304-9H when available

***Figure 4*. 07610304-9H, component side**

Table 32. 07420205 PCB (SRF309 Type 3) – connector HDR1

Pin	Name	Signal	Details
1	/RFEE_CS (reserved)	EE chip select	Low from SPI master
2	RF_SLP_TR	RFIC control	Multipurpose control signal from master
3	/RF_RST	RFIC reset	Low from SPI master
4	RF_IRQ	RFIC interrupt output	Input to SPI master
5	/RF_CS	RFIC chip select	Low from SPI master
6	RF_PAEN	Enable external PA	High from SPI master
7	RF_HGM/BPA	Enable external LNA or Read BPA jumper	Function not used in SRF309 Input to SPI master
8	SPI_CLK	SPI data clock in	Clock from SPI master
9	MOSI	SPI data in	Data from SPI master
10	MISO	SPI data out	Data from SPI slave
11	GND	ground	Low impedance ground
12	GND	ground	Low impedance ground
13	LED_7	Indicator	High from SPI master
14	LED_6	Indicator	High from SPI master
15	LED_5	Indicator	High from SPI master
16	LED_4	Indicator	High from SPI master
17	LED_3	Indicator	High from SPI master
18	LED_2	Indicator	High from SPI master
19	LED_1	Indicator	High from SPI master
20	LED_0	Indicator	High from SPI master
21	GND	ground	Low impedance ground
22	GND	ground	Low impedance ground
23	REVBAT	+3.0-30V	Power indicator LED
24	+5VDC	+3.0-30V	Power indicator LED
25	+3.3VDC	+3.3V	Power indicator LED, RF & logic power. Low noise 30mA max.
26	+24VDC	+3.0-30V	Power indicator LED
	Not required for SRF309		

The 07420305-9H-12R PCB assembly includes all circuits and features required for properly implementing the SRF309 RTM Type 3. The PCB also provides circuits and mounting for various optional non-RF features of use to a host application, including:

12 indicator LEDs (default installation)

insert picture when available

***Figure 5*. 07420305-9H-12R, component side**

Table 3. 14001200 PCB (SRF309 Type 4) – connections

Pin	Name	Signal	Details
1	SPI_CLK	SPI data clock in	Clock from SPI master
2	GND	ground	Low impedance ground
3	MISO	SPI data out	Data from SPI slave
4	MOSI	SPI data in	Data from SPI master
5	RF_SLP_TR	RFIC control	Multipurpose control signal from master
6	/RF_RST	RFIC reset	Low from SPI master
7	/RF_CS	RFIC chip select	Low from SPI master
8	RF_IRQ	RFIC interrupt output	Input to SPI master
9	RF1_3VD	+3.0-3.3V	RF & logic power. Low noise 25mA max.
10	GND	ground	Low impedance ground
11	RF1_3VA	+3.0-3.3V	RF analog power. Low noise 25mA max.
12	GND	ground	Low impedance ground
13	RF_PAEN	Enable external PA	Active high from SPI master
14	RF_HGM/BPA	Enable external LNA or Read BPA jumper	Function not used in SRF309 Input to SPI master
15	GND	ground	Low impedance ground
16	GND	ground	Low impedance ground
17	GND	ground	Low impedance ground
18	GND	ground	Low impedance ground
19	GND	ground	Low impedance ground
20	RF Port	Antenna connection	50 Ohm RF In/Out port
21	GND	ground	Low impedance ground

The 14001301 PCB assembly includes all circuits and features required for properly implementing the SRF309 RTM Type 4.

Insert image of 14001301 when available

***Figure 4*. 14001301, component side**

2.0 SRF309 Installation

When integrating an SRF309 RTM into a host application, the user must provide all text in the “FCC Statements” and “Industry Canada Statements” in the host application’s user manual (see Forward Material). The text must not be modified in any way and presented in a conspicuous manner that the end user can be reasonably expected to access.

When integrating the SRF309 RTM into host application hardware, the user must properly connect all the circuits identified in Table 1 to suitable host application signals. The host application firmware must properly control the RTM to ensure that emitted RF signals comply with all applicable regulatory approvals.

The SRF309 RTM is always provided with an approved type of antenna, either internal fixed or external replaceable. If a fixed internal antenna is provided as part of the RTM, the on-board coaxial cable connectors are not populated. If the module is assembled for use with an external antenna, one of the on-board coaxial cable connector positions will be populated. The choice of the particular type of coaxial connector that is installed will be decided by the designer of the host application. The on-board connector is not accessible to users, so it does not need to be unique.

When provided, external replaceable antennas always have a unique connector such as: RP-N, U.FL/IPEX, RP-SMA, RP-BNC or RP-TNC. A suitable coaxial cable jumper with appropriate connectors must be used to connect the SRF309 RTM external antenna port to the external antenna. The details of a particular host application will affect the design of the jumper coax, but the external connector must always be of an acceptable unique type.

The coaxial cable used to make the jumper between the RTM and the external antenna mounting position must be suitable for use at 915 MHz and have 50 Ohm impedance. Low loss cable such as RG-316 is suggested, although signal loss will be small if the jumper length is short.

External coaxial cables may be used to help mount the replaceable external antenna in a more useful location. Such cable must have appropriate unique connectors and must be made from low loss 50 Ohm coaxial cable. Cables equivalent to LMR-195 are suitable for lengths up to 30 feet. Longer cables must have suitably lower signal loss, typically using larger cable such as LMR240, LMR-300, or larger (or equivalent). At some point, a practical limit is reached where losses in extension cables negate any gains from relocating the antenna.

3.0 SRF309 Tune-up Procedure

There is no tune-up procedure. The module contains no adjustable components.

Proper RF operation of the module is verified during the manufacturing process using suitable equipment and methods.

4.0 SRF309 Electrical Characteristics

4.1 Supply Voltage and Current

The SRF309 RTM (the components under the RF shield) requires the host application to provide a low noise (linear regulator as opposed to a switching regulator) regulated 3.0-3.3 VDC source that can provide 20mA without losing regulation. The RTM does not provide under-voltage, over-voltage, or reverse polarity protection so use caution when applying power. The RTM contains a low noise linear 2.5V regulator (Fig 1.”U2”, top-center) that buffers the analog power to the RFIC RF section. The RFIC has another internal low noise 1.8V regulator (see the data sheet for Atmel AT86RF212B).

All external connection pints designate as signal “GND” should be connected to the host application “GND” circuit so as to maintain as low a resistive and reactive impedance as practical. The PCB hosting the RTM should be fabricated with low impedance copper floods that connect to “GND”.

The SRF309 RTM can safely operate with a supply voltage over the range of 3.0-3.3V with minimal changes in RF performance. Testing was performed at 3.3V, the preferred supply voltage.

Some implementations of the SRF309 module may have additional non-RF functions. The additional circuits may draw current in addition to what the SRF309 RF circuits use.

4.2 Operating Current

The SRF309 RTM has four primary operating conditions that draw differing amounts of current from to 3.0-3.3V power source:

Off	RFIC is powered down, minimal load
PLL_ON	RFIC is ready to transmit or receive, ~5mA
RX	RFIC is receiving a message, ~12mA
TX	RFIC is transmitting, ~15-20mA, depending on TX output power

In TX mode the operating current may be less than the maximum if the drive to the external PA is reduced because the full +8.60dBm RF output power is not required.

4.3 SPI Interface

The SPI interface between the RFIC (slave) and the host application (master) microcontroller requires four signals:

SCLK – The serial data clock from the SPI master. Must be less than 8 MHz.
MOSI – Serial data from the SPI master.
MISO – Serial data from the SPI slave.
RF_CS – Chip select from the SPI master.

The SPI controller setting must be established by the host application microcontroller to be compatible with the SPI interface timing specified by the RFIC data sheet.

5.0 SRF309 RF Characteristics

5.1 General RF Information

The RFIC used in the SRF309 RTM implements RF modulation modes and timings in compliance with IEEE 802.15.4-2006. The RFIC implements additional proprietary RF modulation modes. Details may be found in the AT86RF212B RFIC data sheet.

The SRF309 general spread spectrum scheme is DSSS. The modulation type is BPSK. The data rate is 40kbps.

5.2 RF Exposure Considerations

The antennas used with the SRF309 RT module should be positioned to minimize possible RF exposure hazards. Handheld applications of the SRF309 RT module must maintain an antenna separation distance >15mm when used in a normal operating pose. Mobile applications of the

SFR309 RT module must maintain an antenna separation distance >20cm away from areas that are likely to be occupied by human body parts.

These separation requirements must be included in end-user manuals for host applications that include an SRF309 RT module.

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