SRF305 User Manual

17 April 2014
U080.0.2-SRF305

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-SRF305 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-SRF305 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-2.4-uSP	B141	+3.8dBipeak	50 Ohm
RFM Or Equivalent	OMNI242R Or Equivalent	BB3-07	+3dBipeak	50 Ohm
Alfa Or Equivalent	ARSN19TNC 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 SRF305 Introduction

The SRF305 receive/transmit module (RTM) is based on a single-chip radio frequency (RF) transceiver integrated circuit (RFIC), an Atmel AT86RF231. The RT module also contains an external RF transmit power amplifier plus low noise RF receive preamplifier integrated circuit (PA/LNA), an RFaxis RFX2401C. The SRF305 RTM is intended to be integrated into Cervis Inc. products, providing a wireless RF connectivity option.

The SRF305 RTM operates in the 2.45 GHz ISM band, using spread spectrum modulation with a maximum conducted RF transmit power of +19.95dBm 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 orthogonal quadrature phase shift keying (O-QPSK).

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 SR305 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 SRF305 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 SRF305 RTM may be realized in various PCB shapes, some with non-RF circuits applicable to the requirements of particular hot applications. Variations include:

07440305-2H-12R “large mezzanine” (tested, pictured)
07610304-2H “mini-module” (tested, pictured)
07420305-2H-12R “small mezzanine” (not yet tested)
07100366-2H “postage stamp” (not yet tested)

1.1 SRF305 Features

FCC Part 15 certified
IC Certified
CE certified
2405-2480 MHz Operation
5 MHz Selectable Channel
Orthogonal Quadrature Phase Shift Keying (O-QPSK)
Direst Sequence Spread Spectrum (DSSS)
250 kbps Data Rate (tested)
500 kbps Data Rate (capable, not tested)
1000 kbps Data Rate (capable, not tested)
2000 kbps Data Rate (capable, not tested)
Up to +19.95dBm Output Power (tested)
Use with a variety of approved, supplied internal and external antennas
IEEE 802.15.4-2006 messaging
SPI host interface
Simple power requirements
Compliant will all FCC (and equivalent IC) requirements for a modular transmitter:

In accordance with FCC Rule Part 15.212 for the product certified under FCC ID:

LOBSRF305, the following elements confirm that LOBSRF305 complies with the definition of a modular transmitter:

a. The radio elements of the modular transmitter have their own shielding. The physical crystal and tuning capacitors are located internal to the shielded radio elements.

b. The modular transmitter has buffered modulation/data inputs to ensure that the module will comply with part 15 requirements under conditions of excessive data rates or over-modulation.

c. The modular transmitter has its own power supply regulation.

d. The modular transmitter complies with the antenna and transmission system requirements of §§15.203, 15.204(b) and 15.204(c). hen installed in the host application, the antenna is either be permanently attached or employs a “unique” antenna coupler (at all connections between the module and the antenna, including the cable). The “professional installation” provision of §15.203 is not applicable to modules but can apply to limited modular approvals under paragraph (b) of this section.

e. The modular transmitter has been tested in a stand-alone configuration, i.e., the module must not be inside another device during testing for compliance with part 15 requirements. When the transmitter module is not battery powered it complies with the AC line conducted requirements found in §15.207. AC or DC power lines and data input/output lines connected to the module do not contain ferrites, unless they will be marketed with the module (see §15.27(a)). The length of these lines shall be the length typical of actual use or, if that length is unknown, at least 10 centimeters to insure that there is no coupling between the case of the module and supporting equipment. Any accessories, peripherals, or support equipment connected to the module during testing shall be unmodified and commercially available (see §15.31(i)).

f. The modular transmitter is equipped with a permanently affixed label displaying its FCC identification number.

g. The modular transmitter complies with any specific rules or operating requirements that ordinarily apply to a complete transmitter and the manufacturer must provide adequate instructions along with the module to explain any such requirements. A copy of these instructions must be included in the application for equipment authorization.

h. The modular transmitter must comply with any applicable RF exposure requirements in its final configuration.

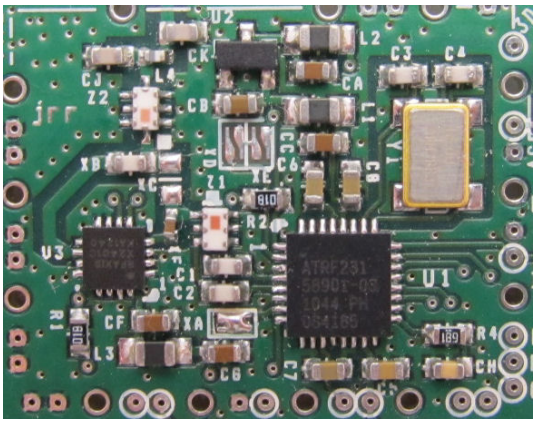

Figure 1. **SRF305 RF section Front**

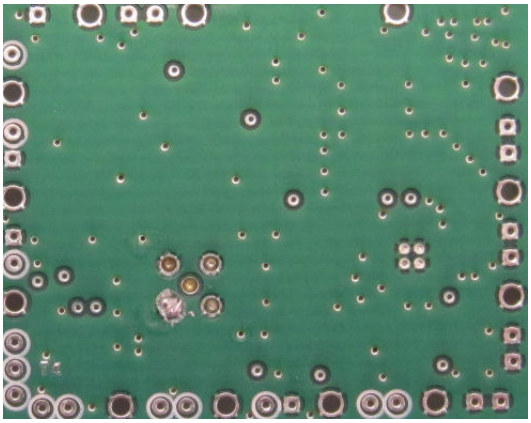

Figure 2. **SRF305 RF section Back**

1.2 SRF305 Pinouts

Table 1-4 show the pinouts and interface signals on several alternative packaging options for the SRF305 RTM:

Table 1. 07440205 PCB – plug-in 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 SRF305 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 150mA max.
34*	REVBAT	+3.0-30V	Power indicator LED
	*Not required for SRF305		

The 07440305-2H-12R PCB assembly includes all circuits and features required for properly implementing the SRF305 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)

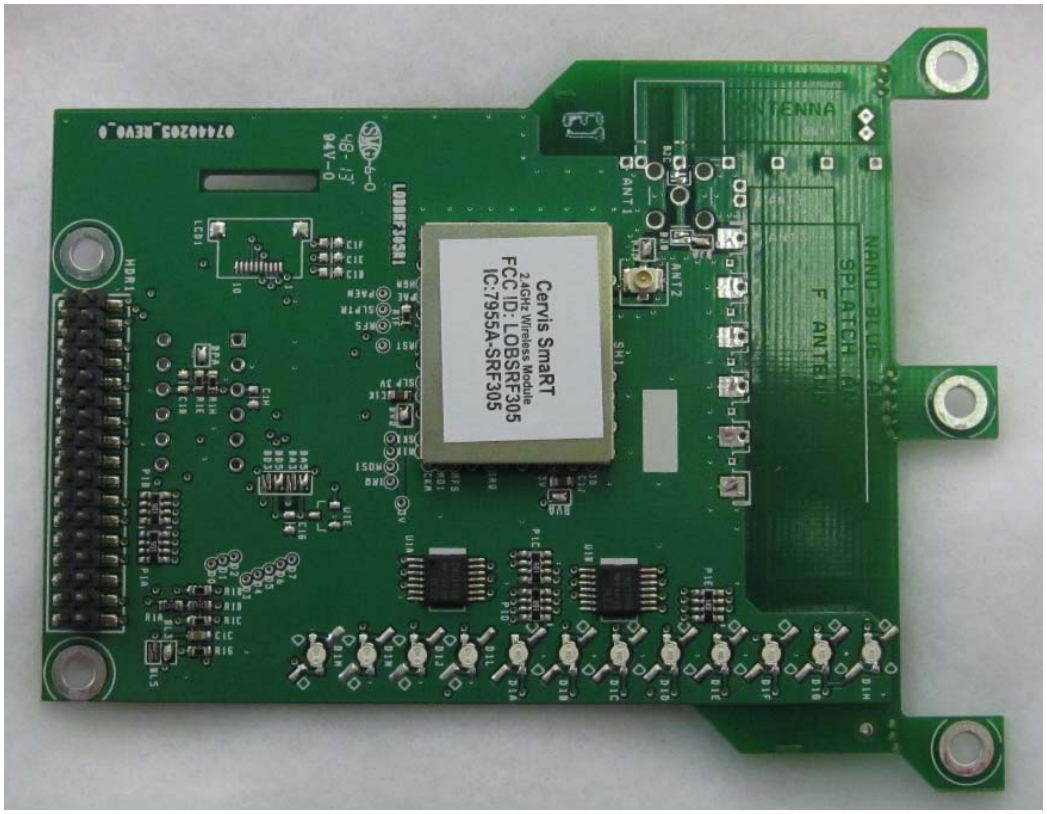

***Figure 3*. 07440305-2H-U-12R, component side, shield, internal label, external antenna connector**

Table 2. 07420205 PCB – plug-in 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 SRF305 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 150mA max.
26*	+24VDC	+3.0-30V	Power indicator LED
	*Not required for SRF305		

The 07420305-2H-x-12R PCB assembly is similar to the approved 07440305-2H-x-12R PCB assembly, except for a change in the shape and connector to accommodate use in host applications that utilize the form-factor of the 07420305-2H-x-12R. Except for some minor differences outside the shielded RF section, the operation of 07420305-2H-x-12R is compliant with the SRF305 modular approval, as demonstrated by testing.

The 07420305-2H-x-12R PCB assembly includes all circuits and features required for properly implementing the SRF305 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)

Insert image of 074200305-2H-12R when available

***Figure 4*. 07420305-2H-U-12R, component side, shield, internal label, external antenna connector**

Table 3. 07610204 PCB – plug-in connector J1

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 125mA 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	High from SPI master
14	RF_HGM/BPA	Enable external LNA or Read BPA jumper	Function not used in SRF305 Input to SPI master
15	GND	ground	Low impedance ground

The 07610304-2H-x PCB assembly is similar to the approved 07440305-2H-x-12R PCB assembly, except for elimination of non-RF circuits and a change in the shape and connector to accommodate use in host applications that utilize the form-factor of the 07610304-2H-x. Except for some minor differences outside the shielded RF section, the operation of 07610304-2H-x is compliant with the SRF305 modular approval, as demonstrated by testing.

The RF connection of 076100304-2H-x is always via a coaxial cable and unique connector.

The 07610304-2H-x PCB assembly includes all circuits and features required for properly implementing the SRF305 RTM

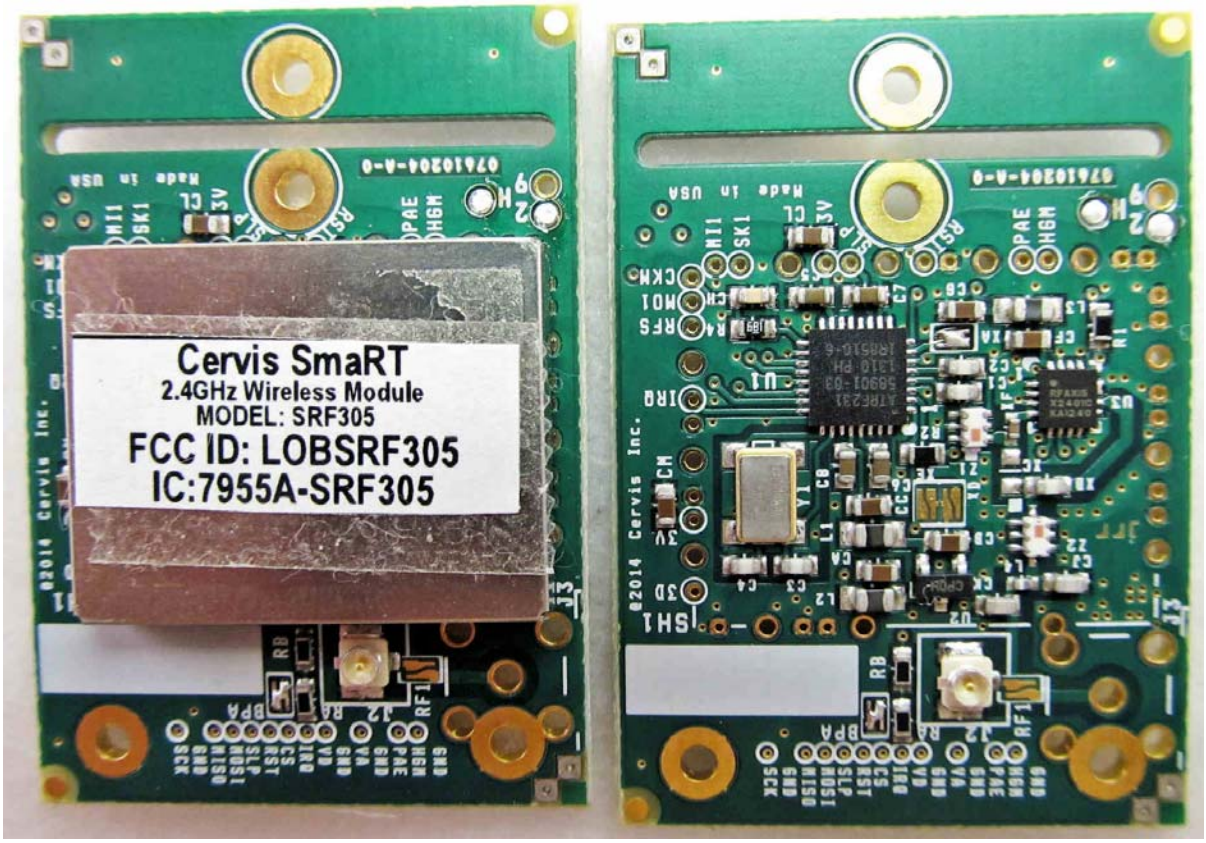

***Figure 5*. 07610304-2H-U, component side, shield, internal label, external antenna connector**

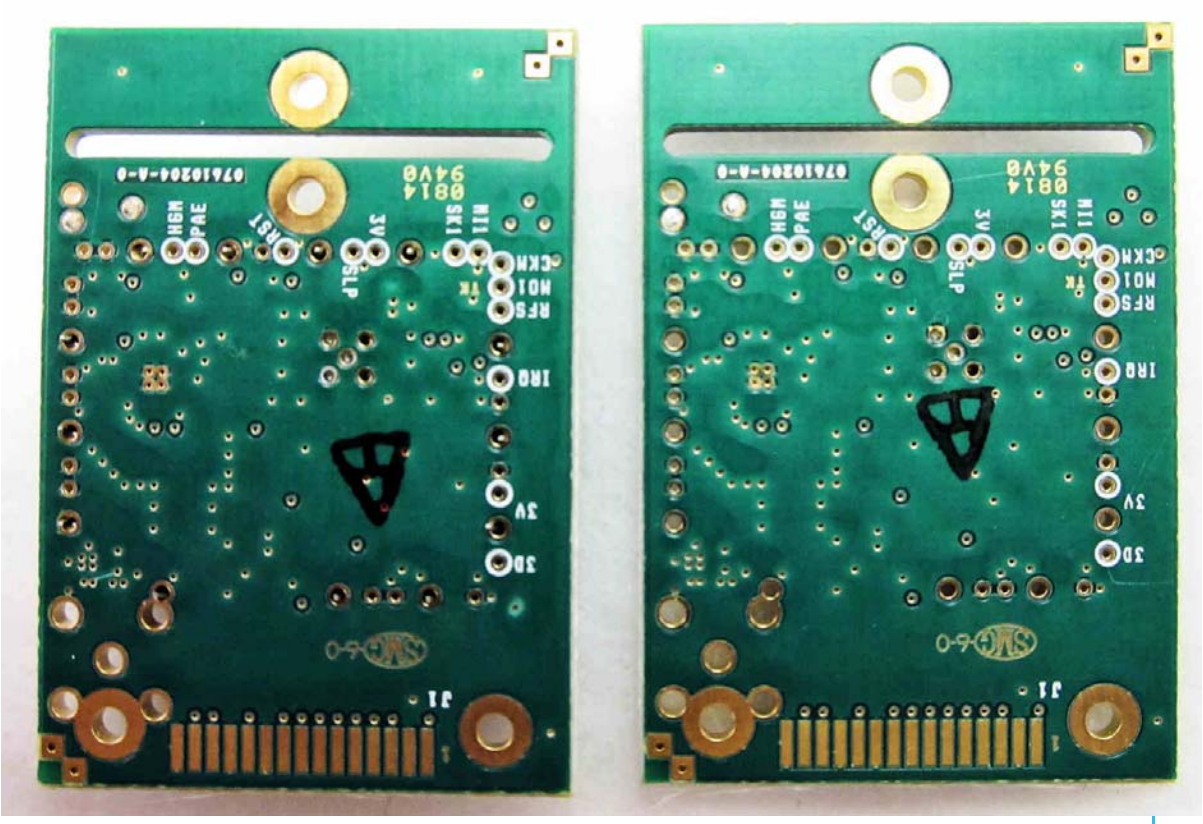

Figure 6. 07610304-2H-U, bottom side.

Table 4. 07100266 PCB – solder-down connector J1 (preliminary)

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 150mA max.
10	GND	ground	Low impedance ground
11	RF1_3VA	+3.3V	RF analog power. Low noise 15mA 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 SRF305 Input to SPI master
15	GND	ground	Low impedance ground
16	RF	RF signal, in/out	50-Ohm RF connection to antenna
17	GND	ground	Low impedance ground
18	GND	ground	Low impedance ground
19	GND	ground	Low impedance ground
20	GND	ground	Low impedance ground

The 07100366-2H PCB assembly is similar to the approved 07440305-2H-x-12R PCB assembly, except for elimination of non-RF circuits and a change in the shape and connector to accommodate use in host applications that utilize the form-factor of the 07100366-2H. Except for some minor differences outside the shielded RF section, the operation of 07610366-2H is compliant with the SRF305 modular approval, as demonstrated by testing.

The RF connection of 07100366-2H-x is always via a soldered connection to a suitable 50 Ohm RF transmission line.

The 07100366-2H PCB assembly is factory-installed by direct soldering to a matching footprint on a PCB that is part of the host application. The host application PCB must also provide a suitable RF connection to either a fixed internal antenna or a coaxial cable connection to a unique connector for attaching an approved, supplied external antenna.

The 07100366-2H PCB assembly includes all circuits and features required for properly implementing the SRF305 RTM.

Insert image of 07100366-2H when available

Figure 6. 07100366-2H, component side, shield, internal label

2.0 SRF305 Installation

When integrating an SRF305 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 SRF305 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 SRF305 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 SRF305 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 2450 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 SRF305 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 SRF305 Electrical Characteristics

4.1 Supply Voltage and Current

The SRF305 RTM by itself requires a low noise regulated 3.0-3.3 VDC source that can provide 150mA without losing regulation. The module does not provide under-voltage, over-voltage, or reverse polarity protection so use caution when applying power. It is the responsibility of the host application to provide an appropriate source of 3.0-3.3V adequate to power the RTM, plus any other non-RF circuits that may also be implemented on the same PCB.

All external connection points designate as signal “GND” should be connected to the host application “GND” circuit so as to maintain a low resistive and reactive impedance as practical.

The PCB hosting the RTM should be fabricated with low impedance copper floods that connect to “GND”.

The SRF305 RTM can safely operate with a supply voltage over the range of 3.0-3.3V with minimal changes in RF performance.

4.2 Operating Current

The SRF305 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, ~15-100mA, 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 +19.95dBm 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. Muste 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 SRF305 RF Characteristics

The RFIC used in the SRF305 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 At86RF231 RFIC data sheet.

The SRF305 supports four data bitrates: 250, 500, 1000 and 2000 kbps. The general spread spectrum scheme is the same for all, O-QPSK and DSSS. There are differences in the spreading methods that result in slightly different spectral distributions within the nominal 5MHz channel width. Conducted and radiated emissions testing will need to be performed for all data bitrates that are to be approved.

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