Z-Wave Radio Module

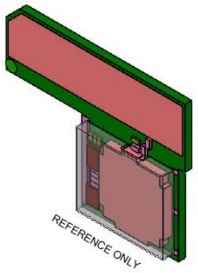
1.1 TECHNICAL SUMMARY

- FCC certification: Limited modular
- FLiRS[1] mode: low consumption operation
- UART communication: 115,200 bps
- Z-Wave software protocol stack included
- Integrated PCB antenna
- Output power: - 4 dBm
- Compact PCB footprint: 41 x 32 mm
- Based on an 8051 CPU core
- Power-On-Reset/Brown-Out detection
- TX mode: typical current 32 mA at - 4 dBm
- RX mode: typical current 32 mA
- Normal mode: typical current 15 mA
- Sleep mode: typical current 1 µA

1.2 APPLICATIONS

- Z-Wave slave and enhanced slave modules
- HVAC thermostat
- Light switch - dimmer
- Energy measurement device
- Security systems
- Sensor networks
- Remote control of household appliances
- Audio and video management

1.3 DESCRIPTION



The SYN-RF-ZW01Ux series of modules integrates a PCB antenna and a microcontroller with RF transmitter-receiver (ZM5202). An optional external non-volatile memory can be added according to the Z-Wave software stack variant included in the module.

The limited modular certification allows the integration of the module in a compatible product without requiring certifying the final product.

To ensure a reliable communication, the patented Z-Wave protocol supports automatic retransmissions, collision avoidance mechanisms, frame acknowledgement, CRCs, frequency agility, and mesh routing.

1.4 CERTIFICATION

Limited modular certification

- MODEL : SYN-RF-ZW01Ux-L
- FCC ID : OW7-ZW01L
- IC: 10525A-ZW01UL

[1] To use the module in FLiRS mode, please refer to the Sigma Design documentation.

TABLE OF CONTENT

2 NOMENCLATURE

SYN-RF	-	ZW01	U	RS	-	L
1		2	3	4		5

1. Functionality
   - **SYN-RF**: Radio product
2. Series
   - **ZW01**: Z-Wave protocol, series 01
3. Zone
   - **U**: US/CAN zone (908 MHz)
4. Software stack
   - **RS**: Routing slave
   - **ES**: Enhanced routing slave
5. Option
   - **L**: Limited modular certification

Model	Description	Zone*
SYN-RF-ZW01URS-L	Z-Wave radio module – routing slave software configuration	U
SYN-RF-ZW01UES-L	Z-Wave radio module – enhanced routing slave software configuration	U

Table 1 – Available options

3 FUNCTIONAL BLOCK DIAGRAM

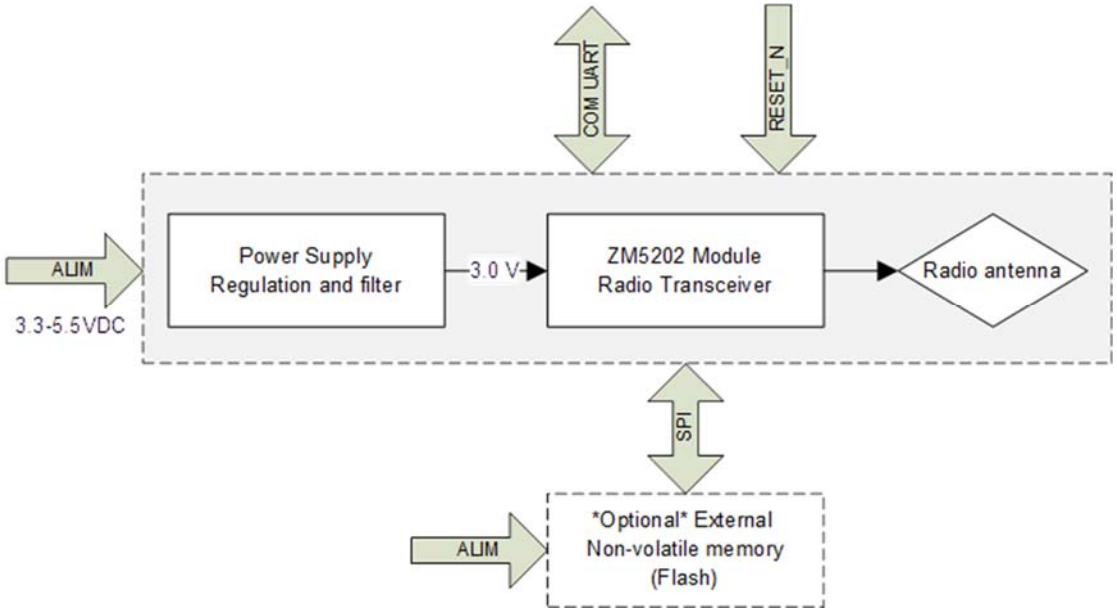


Figure 1 – Block diagram - SYN-RF-ZW01Ux module

4 PIN MAP

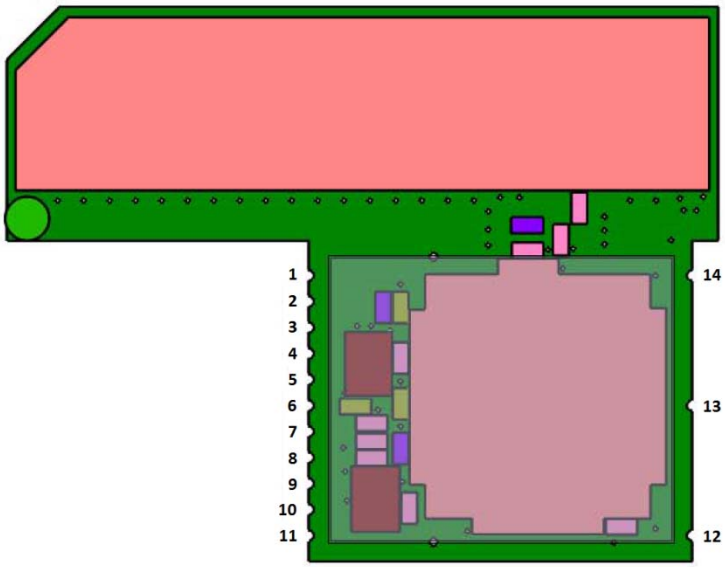


Figure 2 – Pin map

Pin #	Name	MCU Pin	Type	Description
1	RESET_N			RESET function is active on low level – default to a high level via a 10K Ohm pull-up resistor embedded in the module
2	GND1		GND	Power supply and circuit ground
3	NVM_SCK	P2.4 / SPI1_SCK		SPI serial memory port – Data clock signal
4	NVM_MOSI	P2.2 / SPI1_MOSI		SPI serial memory port – Data signal, module to external memory
5	NVM_MISO	P2.3 / SPI1_MISO		SPI serial memory port – Data signal, external memory to module
6	NVM_CS	P0.4	I/O	SPI serial memory port – Memory selection (enable)
7	GND2		GND	Power supply and circuit ground
8	UART_B2RF	P3.4 / UART0_RX		UART serial communication port – Data signal, master to module
9	UART_RF2B	P3.5 / UART0_TX		UART serial communication port – Data signal, module to master
10	GND3		GND	Power supply and circuit ground
11	VCC		VCC	Power rail
12	GND4		GND	Power supply and circuit ground
13	GND5		GND	Power supply and circuit ground
14	GND6		GND	Power supply and circuit ground

Table 2 - Pin map

5 ELECTRIC SPECIFICATIONS

5.1 Absolute maximal ratings

Symbol	Settings	Min	Typical	Max	Units
V_{DD-GND}	Supply voltage	3.2	-	6	VDC
V_{IN-GND}	Voltage applied on an input	- 0.5	-	6	VDC
T_{STOR}	Storage temperature	- 55	-	85	°C
T_{AMB}	Operating ambient temperature	- 40	-	85	°C

Table 3 – Absolute maximal ratings[2]

5.2 Recommended operating conditions

Symbol	Settings	Min	Typical	Max	Units
V_{DD-GND}	Supply voltage	3.3	-	5.5	VDC
V_{IN-GND}	Voltage applied on an input	0	-	5.5	VDC
V_{RIPPLE}	Maximum supply voltage ripple	-	-	0.1	ΔV
T_{AMB}	Operating ambient temperature	- 10	25	80	°C

Table 4 – Recommended operating conditions

5.3 Electrical specifications

Symbol	Parameter	Min	Typical	Max	Units
V_{IH}	High-level threshold voltage, digital input	2.2	-	-	V
V_{IL}	Low-level threshold voltage, digital input	-	-	0.6	V
V_{IL_RESET}	Low-level threshold voltage, RESET_N input	-	-	0.9	V
I_{IL}	Leakage current, any digital input	-	-	10	µA
PU_{IN}	Internal pull-up resistor, any digital input except RESET_N	15	-	20	kΩ
PU_{IN_RESET}	Internal pull-up resistor, RESET_N input	9.9	10.0	10.1	kΩ
V_{OH}	High-level voltage, digital output port	2.4	3.0	3.06	V
V_{OL}	Low-level voltage, digital output port	-	-	0.4	V
I_O	Maximum current, digital output port	-	-	6	mA
I_{DD_ACTIVE}	Supply current, processor clocked at 32 MHz	-	14.9	15.9	mA
I_{DD_RX}	Supply current, Z-Wave receiving	-	32.4	35.1	mA
$I_{DD\_TX\_-4}$	Supply current, Z-Wav transmission at - 4 dBm	-	32	-	mA
I_{DD_SLEEP}	Supply current, sleep mode, wake-up timer inactive	-	1	-	µA
I_{DD_WUT}	Supply current, sleep mode, wake-up timer active	-	2	-	µA

Table 5 – Electrical specifications

[2] The absolute maximal characteristics must not be exceeded under any circumstance. Exceeding these limits could cause permanent damage to the module.

5.4 Radio specifications (RF)

Data rate	9.6 kbps	40 kbps	100 kbps	Zone
Modulation	FSK	FSK	GFSK	
Frequency deviation	$F_C \pm 20$ kHz	$F_C \pm 20$ kHz	$F_C \pm 29.3$ kHz	
Channel bandwidth	90 kHz	90 kHz	110 kHz	
Encoding	Manchester encoded	NRZ	NRZ	
Frequency (Canada/US)	908.42 MHz	908.40 MHz	916 MHz	U

Table 6 – Z-Wave radiofrequency specifications

Symbol	Settings	Min	Typical	Max	Units
$P_{9.6}$	Sensibility at 9.6 kbps	-	- 102.7	- 101.0	dBm
P_{40}	Sensibility at 40 kbps	-	- 99.0	- 97.2	dBm
P_{100}	Sensibility at 100 kbps	-	- 93.0	- 91.8	dBm

Table 7 – Receiver sensibility (excluding the antenna)

Symbol	Settings	Min	Typical	Max	Units
P_{RF}	Current transmitter power (RFPOW = 17 , 0x11)	-	-4	-	dBm
P_{H2}	Second harmonic (RFPOW = 20 (- 3 dBm))	-	- 59.6	-	dBc
P_{H3}	Third harmonic (RFPOW = 20 (- 3 dBm))	-	- 47.6	-	dBc
PN_{30kHz}	Phase noise at 30 kHz	-	- 88.1	-	dBc/Hz
PN_{100kHz}	Phase noise at 100 kHz	-	- 95.2	-	dBc/Hz
PN_{1MHz}	Phase noise at 1 MHz	-	- 107.3	-	dBc/Hz
PN_{10MHz}	Phase noise at 10 MHz	-	- 113.1	-	dBc/Hz
PN_{100MHz}	Phase noise at 100 MHz	-	- 113.8	-	dBc/Hz

Table 8 – Transmitter performances (excluding the antenna)

5.5 Resetting the module

The module is reset by pulsing the RESET_N input low one time, as per the T_{Reset_L} specification in Table 9. To keep the module in 'reset', the RESET_N input must be continuously pulsed as per the specifications in Table 9.

Symbol	Settings	Min	Typical	Max	Units
T_{Reset_L}	Hold time, RESET_N low	3	-	4,000	us
T_{Reset_H}	Hold time, RESET_N high	2	-	4	us
T_{Reset_PU}	Maximum time after a reset to return in active mode and be ready to execute the software	-	-	1	ms

Table 9 – Reset mode

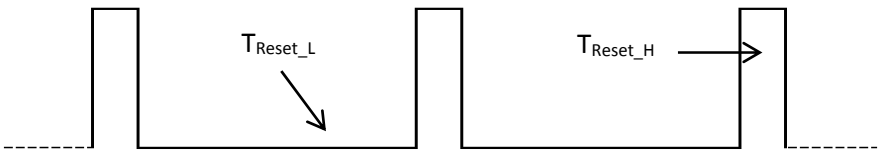


Figure 3 – Pulsing the RESET_N input to maintain the reset mode

The RESET_N input of the module must be driven by an open collector circuit. Driving this input with a push-pull circuit could damage the module. The RESET_N input integrates a pull-up resistor to maintain this input high when not driven.
Do not add any external filter on this port; the module already includes a filter.

5.6 Unused pins

All unused pins must be left unconnected. There default level is internally fixed at 3.0 V typical on the module. The only exception is the MISO input port that must be connected to GND when unused

5.7 Module communication

The communication with the module is performed via the serial UART (Universal Asynchronous Receiver/Transmitter), using the *UART_RF2B* and *UART_B2RF* ports. The UART operating specifications must be configured as per Table 10 and Figure 4.

Settings	Value
Bits per second	115 200
Data bits	8
Parity	non
Stop bit	1
Flow control	non

Table 10 – UART configuration settings

Figure 4 – UART communication waveform

6 EXTERNAL NON-VOLATILE MEMORY (FLASH)

Depending on the Z-Wave network type desired, the module may require an external memory to operate.

Code	Software stack	External memory needed
RS	Routing Slave	No
ES	Enhanced Routing Slave	Yes

Table 11 – External memory requirement

In the case of an enhanced routing slave application, the memory needed shall meet the following requirements:

Settings	Value
Size	1 Mbits
SPI modes supported	(CPOL = 0, SPHA = 0) & (CPOL = 1, CPHA = 1)
SPI clock frequency	4 MHz
Page Write size	256 Bytes
Page Erase size	256 Bytes
Software protection	Yes
Page Read	85 µs
Page Write cycle	25 ms
Endurance	100 000 cycles typical
Data Retention	> 20 years
Temperature	- 40 °C to 85 °C

Table 12 – Serial Flash memory specifications

Command	Opcode	Description
WREN	0x06	Write Enable
WRDI	0x04	Write Disable
RDID	0x9F	Read Identification
RDSR	0x05	Read Status Register
WRSR	0x01	Write Status Register
READ	0x03	Read Data Bytes
FAST_READ	0x0B	Read Data Bytes at Higher Speed
PW	0x0A	Page Write (256 B)
PP	0x02	Page Program
PE	0xDB	Page Erase (256 B)
SSE	0x20	Sub-Sector Erase
SE	0xD8	Sector Erase
BE	0xC7	Bulk Erase
DP	0xB9	Deep Power-down
RDP	0xAB	Release from Deep Power-down

Table 13 – Flash memory instructions

Bit	Name	Description
7	SRWD	Status Register Write Disable
6, 5, 4	X	Undefined
3	BP1	Block Protect 1
2	BP0	Block Protect 0
1	WEL	Write Enable Latch
0	WIP	Write in Progress

Table 14 – Flash memory status registers

Synapse Electronics recommends the following memory model that meets the requirements.

Type	Manufacturer	Part number	Memory space
Flash	Micron Technology	M25PE20	256 kB

Table 15 – External memory recommended

7 INTEGRATION GUIDELINES

The SYN-RF-ZM01Ux is a surface mount module. Its shape and dimensions are illustrated in Figure 8. The PCB has a thickness of 1.6 mm and an interconnection footprint of castellation type. Figure 7 illustrates the recommended PCB footprint.

A PCB antenna is integrated on the module. The ground plane of the master PCB (receiving the module) acts as a counterbalance for the PCB antenna. The ground plane's dimensions have a major impact on the antenna performance. It is recommended to maximize the surface of this ground plane on the master PCB.

All GND pins shall be directly connected to the ground plane of the master PCB. If thermal-relief connexion vias are used, the combined width shall be no less than 0.5 mm.

7.1 Environmental considerations

The radio performances of the module are greatly affected by its environment. The annexes at the end of this document provide guidelines to integrate the module in different master products. The integration of this module in products other than the ones presented would require careful verification of the radio performances and characterization.

7.2 Soldering

The module must be hand soldered. It has not been designed for reflow soldering, as it could result in a permanent damage of the module.

7.3 Connection diagram examples

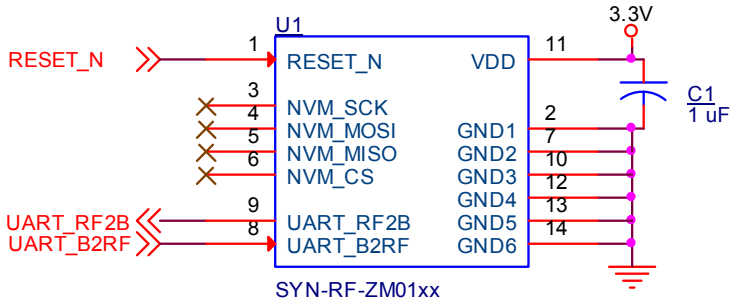


Figure 5 – Connection without external memory

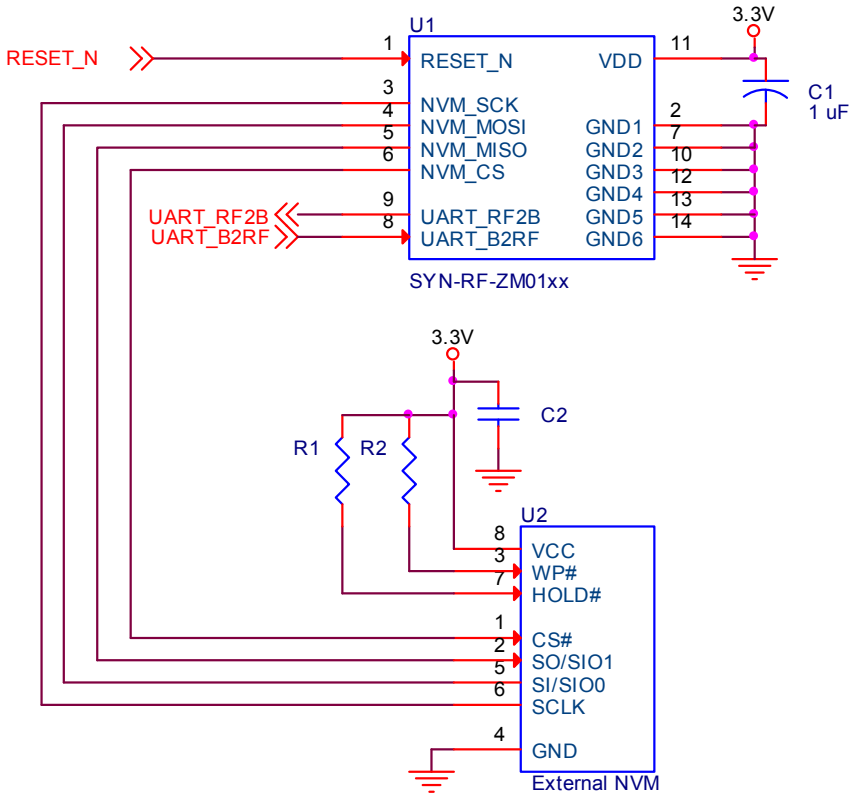


Figure 6 – Connection with external memory

8 MECHANIC INFORMATION

8.1 PCB footprint

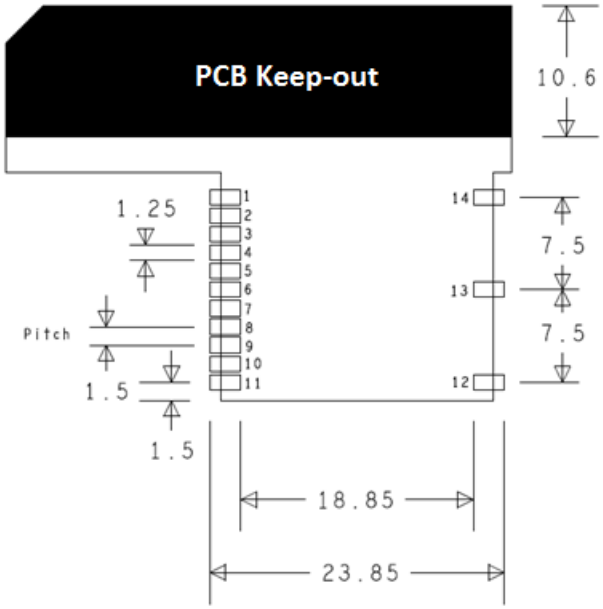


Figure 7 – Recommended PCB footprint

Notes:

1. Dimensions are in mm;
2. No material must be in the PCB keep-out zone, including FR4 dielectric. Perform an opening in the master PCB, or place the module in periphery, with the keep-out zone lying outside the master PCB;
3. The module includes vias on its bottom layer, facing the master PCB. Make sure that there is no conductive material exposed on the master PCB, under the module. Exposed conductive material could cause a short circuit on the module or the master PCB, and potentially damage them.

The solder joint between the module's castellated pads and the master PCB pads shall meet the appropriate IPC requirements. Please refer to the document '***IPC-A-610 Acceptability of Electronic Assemblies',*** *section 8.2.4 Castellated Terminations.*

8.2 Module dimensions

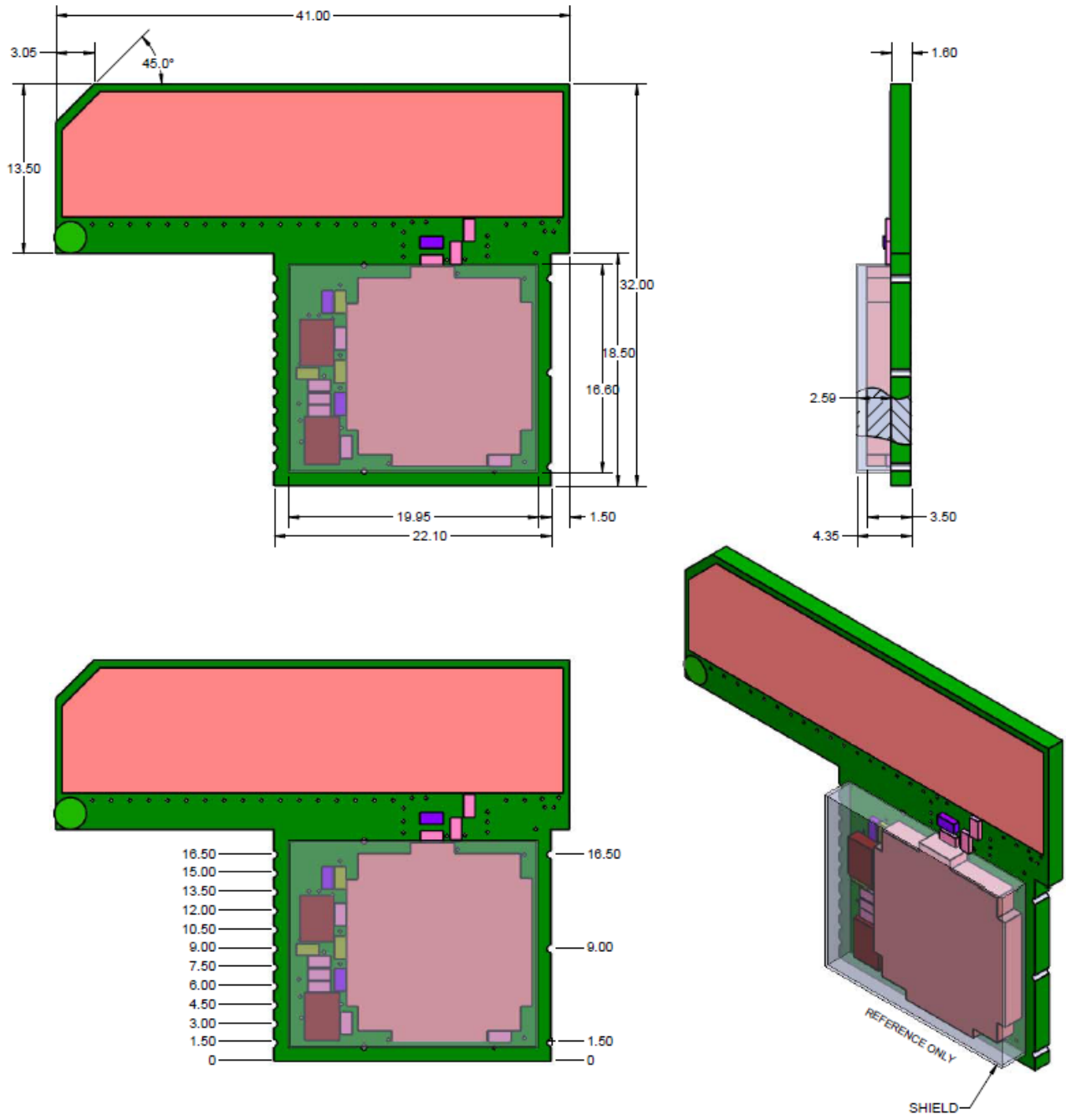


Figure 8 – Module dimensions in mm

Note: The shielding box is not included in the ***SYN-RF-ZW01Ux-L versions.***

9 FCC COMPLIANCE STATEMENT

FCC Warning

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.

Caution

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.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

10 IC COMPLIANCE STATEMENT

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, même si le brouillage est susceptible d'en compromettre le fonctionnement.

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.

11 MODIFICATION HISTORY

Rev.	Date	Description
0	January 2015	Initial release
1	April 2015	Global update following the module revision
2	September 2015	Official release – Certification information added
3	September 2015	Regulatory – FCC & IC – Statement added

Table 16 – Modification history

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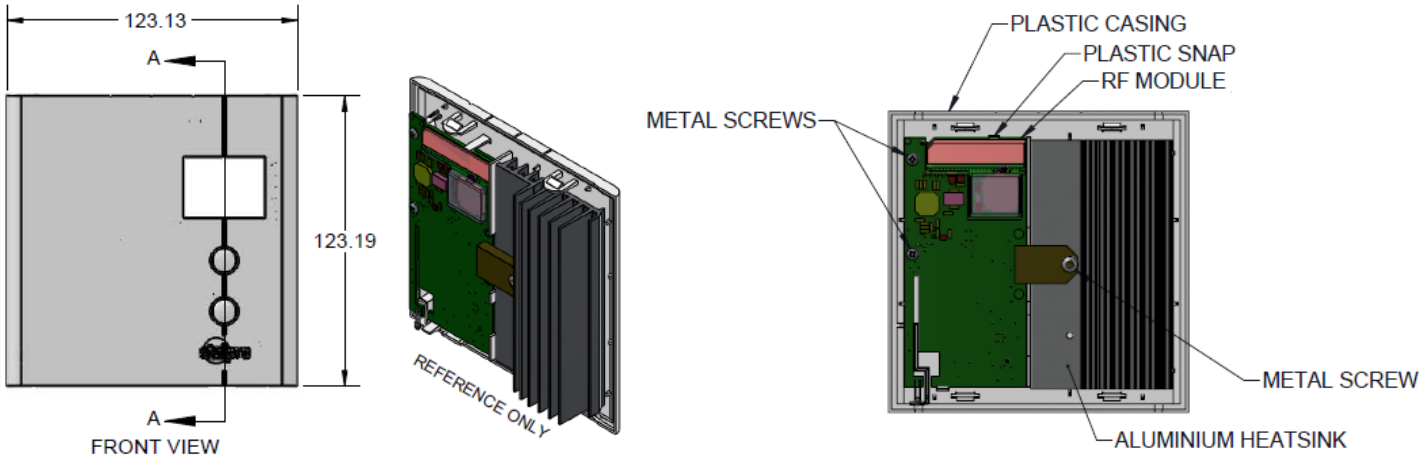
ANNEXES

1 INTEGRATION CONSIDERATIONS FOR THE STE402NP+ THERMOSTAT

1.1 Mechanic considerations

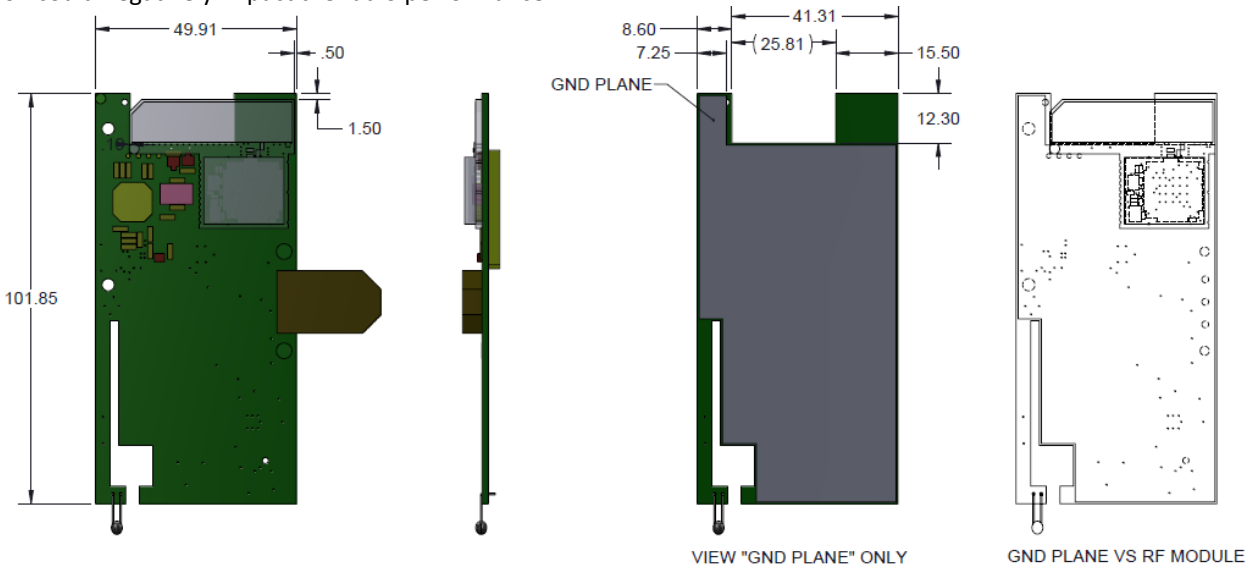
The design and verifications on the STE402NP+ thermostat were performed in accordance with the following specifications. Doing otherwise than indicated in this section could negatively impact the radio performance.



Mechanic integration in the STE402NP+ in mm

1.2 PCB integration considerations

Development and tests were done with the layout and the ground plane illustrated hereunder. Doing otherwise than indicated in this section could negatively impact the radio performance.

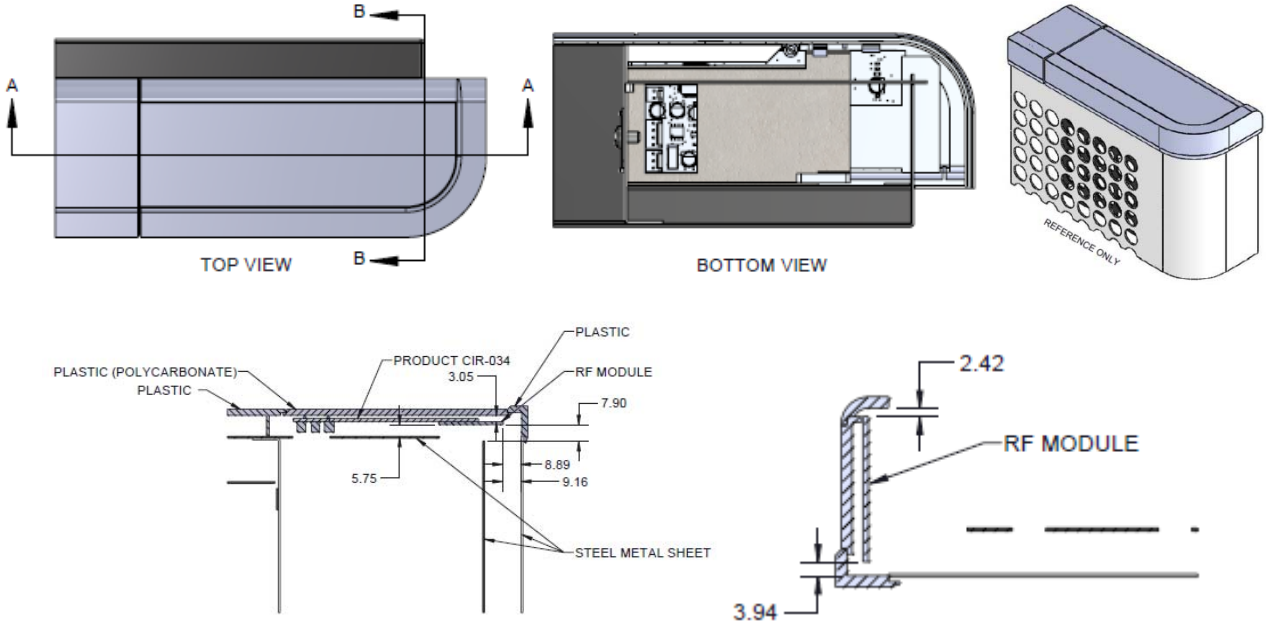


Module integration on the STE402NP+ PCB in mm

2 INTEGRATION CONSIDERATIONS IN THE STE-CIR034 HEATING CONVECTOR

2.1 Mechanic considerations

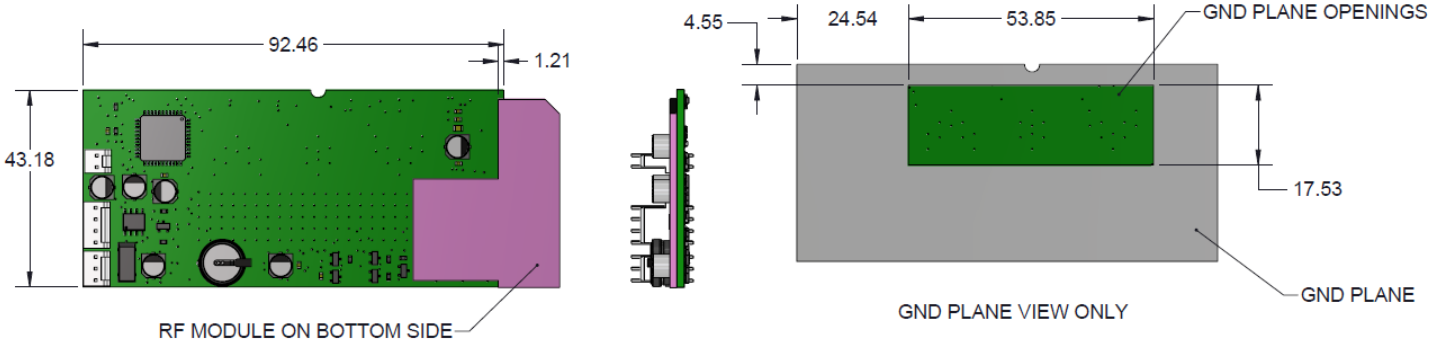
The design and verifications were done according to the following specifications. Doing otherwise than indicated in this section could negatively impact the radio performance.



Mechanic integration in the CIR034 (convector) in mm

2.2 PCB integration considerations

Development and tests were done with the layout and the ground plane illustrated hereunder. Doing otherwise than indicated in this section could have an impact on the radio performance.



Module integration in the CIR-034 heating convector in mm