MATRIX SM1251SMD Second-Generation Module User Manual

Contents

CHAPTER
ONE

FEATURES

- Ready-to-use System-on-Module for 125KHz proximity RFID applications. Requires only coil antenna and power supply to function.
- Integrated with analog-front-end, Arm Cortex microcontroller with property firmware flashed.
- Automatically demodulates and decodes RF signal and make the actual card data ready.
- Ultra Compact Size 2.2 x 2.0 cm SMD20 package (appropriate for automated assembly) and Compact Size 2.7 x 2.2 cm MINI20 package with 2mm pitch low profile pins.
- Compatible pinout and package with different modules to support same mother board design
- Wide supply voltage range, works between 3.3V and 5V without any firmware change.
- Firmware upgrade-able for custom specific applications
- Supports Atmel/Temic T55xx transponders with Manchester RF/32 and RF/64 modulations and EM4100/02. (Unique)
- UART Interface up to 115200bps – I2C Interface up to 400KHz.
- Supports Wiegand interface
- Comes with General Purpose Inputs and Outputs
- Wide range of supported mother boards available supporting RS232, RS485 and USB.

CHAPTER
TWO

INTRODUCTION

SM1251SMD is a second-generation module that is successor of the first generation 125 KHz RFID modules and chip. It supports same functionality and communication interface with the first generation solutions with more features and comes with smaller size. They have also better integrated bootloader, lower current consumption specifications and wide input supply voltage between 3.3V and 5V.

SM1251SMD is a second generation 125 kHz RFID Reader module integrated with an ARM® Cortex®M0 microcontroller, analog front-end and all necessary passive components except for only coil antenna in a small form factor.

SM1251SMD supports reading popular EM4100/02 (i.e. Unique) 5-byte read-only proximity cards and T55XX rewritable cards from Atmel/Temic (e.g. T5557/67/77) with Manchester RF/32 and Manchester RF/64 modulation. Writing to T55XX cards is also supported and these cards can be programmed to emulate EM4100/02 cards.

SM1251SMD runs IP (intellectual property) firmware versions (standard and application specific) that performs all the required analog and digital signal processes to handle the 125 kHz RFID protocol and provide easy to use communication interface, UART & I2C[1] and command API. Standard firmware provides commands for reading/writing card blocks, controlling I/O and configuring the module. Different requirements such as Wiegand, RS485 interface are also supported with the application specific firmware versions.

Standard firmware also supports ‘Auto Mode’ as default so it can report card ID with protocol or ASCII output as soon as it is detected, or do some operations such as driving buzzer and LED without any need of an external controller for access control or similar applications.

SM1251SMD is integrated with a bootloader program. It allows new firmware releases to be upgraded over UART.

[1] I2C is not enabled in default. It needs to be enabled thru configuration or it should be requested to be enabled when shipping from the factory.

[2] For custom firmware development or custom feature requests please contact with us. We are committed to develop new firmware versions for general industry requirements for different target applications to reduce overall system cost and provide flexibility and faster time to market. Please also check for the availability of the firmware versions for specific applications at our support page.

CHAPTER
THREE

CONNECTION PINOUT DIAGRAM

SM1251SMD power supply, VDD, can be between 3.3V and 5V. Output signals are at VDD level and CMOS/TTL compliant. For best read range performance, LDO supply is recommended for the VDD instead of a switch mode regulator.

Attention: Maximum input voltage tolerance for the input and communication pins must not exceed VDD + 0.5 V. If the module is supplied with 3.3V, it must not directly interfaced with 5V signals without any protection.

3.1 SM1251SMD Pin-out

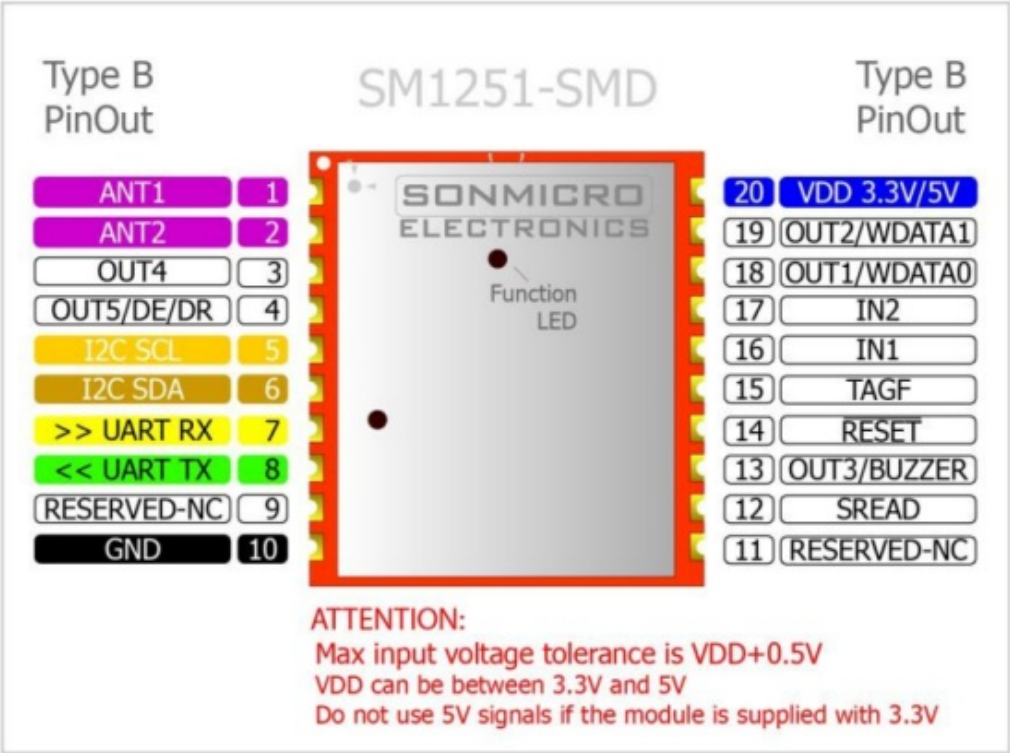

Figure: SM1251SMD Pin-out

3.2 PIN DESCRIPTIONS

Pin #	Name	Notes
1	ANT1	Antenna Pin 1. (Coil antenna value should be 860uH %2) The first end of the coil wire antenna should be connected to this pin. This pin drives the antenna with ~125 kHz square wave signal, %50 duty cycle. The other end of the antenna should be connected to ANT2 pin of the module.
2	ANT2	Antenna Pin 2. (Coil antenna value should be 860uH %2) The second end of the coil wire antenna should be connected to this pin The other end of the antenna should be connected to ANT1 pin of the module.

3	OUT4 / Output1	General Purpose Input Output. This pin matches with the Output1 of the previous generation module (SM125-M1 and SMRFID 3.0.7 software) It can be controlled w ith the supported firmware command CMD_WRITE_OUPUT_PINS.
4	OUT5/DE/DR	For RS485, this pin controls DE (Data Enable) pin of the RS485 IC. It is high when transmitting data. For I2C, this pin is used (optional) to notify i2c master by asserting high to indicate that data is ready so that master can poll data.
5	I2C CLK	I2C Clock. External 4.7K pull-up resistor is required. I2C must be enabled thru con figuration.
6	I2C SDA	I2C Data. External 4.7K pull-up resistor is required. I2C must be enabled through c onfiguration.
7	UART RX	UART RX. UART Receive pin of the module. It is required to be connected to UAR T TX (CMOS/TTL Transmit) of the external controller, or RS232/RS485/FT232 inte rface chip relevant TTL/CMOS pin. If you do not use this pin then connect a pull- up resistor to prevent it floating. Otherwise it will process random noise data contin uously. ** It is strongly recommended to have connection to UART pins and isolate UART RX pin of the module by jumpers (or 0R resistors) from your external MCU whereas possible to support on-board upgrading, and/or configure settings by US B-UART converter.
8	UART TX	UART TX. UART Transmit pin of the module. It can be connected to UART RX (C MOS/TTL Receive) of the external controller, or RS232/RS485/FT232 interface ch ip relevant CMOS/TTL pin. It is strongly recommended to have connection to UAR T pins to support on-board upgrading, and/or configure settings by USB-UART con verter.
9	RESERVED NC	Reserved – No Connection. This pin is reserved for internal use only and must be l eft floating and must not be connected to any signal.

10	GND	Ground.
11	RESERVED NC	Reserved – No Connection. This pin is reserved for internal use only and must be l eft floating and must not be connected to any signal.
12	SREAD	Status Read. General Purpose Input Output. This pin indicates with a logic high that ‘Read is active’ and module is Searching fo r a tag. It flashes continuously while the tag is in RF field. It can be connected to a LED for visual effects.
13	OUT3/BUZZER O utput0 (previously named Output0)	General Purpose Input Output. This pin matches with the Output1 of the previous generation module (SM125-M1 and SMRFID 3.0.7 software) It can be controlled w ith the supported firmware command CMD_WRITE_OUTPUT_PINS. If configured in settings, this pin will be logic high (or generate PWM) for a determined period au tomatically when a card is detected to drive a DC or PWM buzzer
14	RESET	Active Low Reset Pin. A logic low pulse will reset the module. It can be left floating , it has an internal pull-up resistor and capacitor to prevent parasitic resets or it can be connected to the external microcontroller output pin.
15	TAGF	Tag Found. General Purpose Input Output. This pin will generate a single pulse when a valid tag is detected. It can be connect ed to a LED for visual effects or can be used to notify an external controller or circuit.
16	IN1	General Purpose Input Output. IRQ is not supported on state change in standard fi rmware versions. Input state can be read by relevant command.

17	IN2	General Purpose Input Output. IRQ is not supported on state change in standard firmware versions. Input state can be read by relevant command.
18	OUT1/WDATA0	Weigand Data 0. General Purpose Input Output. This pin can be used as general purpose output and can be controlled with the supported firmware command CMD_WRITE_OUTPUT_PINS Alternatively, this pin can be used as Wiegand Data 0 output if Wiegand is enabled in device settings. Weigand signal can be inverted (Low or High) by configuration.
19	OUT2/WDATA1	Weigand Data 1. General Purpose Input Output. This pin can be used as general purpose output and can be controlled with the supported firmware command CMD_WRITE_OUTPUT_PINS Alternatively, this pin can be used as Wiegand Data 1 output if Wiegand is enabled in device settings. Weigand signal can be inverted (Low or High) by configuration.
20	VDD	Input Supply voltage. It can be anywhere between 3.3V and 5V however read performance may vary depends on the VDD. 3.3V operation may provide better read range performance (1 or 2 centimetres more). I/O and communication input tolerances are defined as max VDD + 0.5V. Thus if the module is supplied with 3.3V then the inputs shall not be tolerant to 5V and special care must be taken in this case when interfacing with a 5V system

Table: SM1251SMD Pin Description

3.3 FLED (Function LED)

There is a red colored on-board LED on SM1251SMD module for assisting purpose. This LED is useful to understand the following states:

- When module first powers up, FLED blinks one time at startup indicating that the module is successfully running the firmware.
- When a command is received through UART, FLED blinks for one time indicating that the command is received successfully.
- When a tag is read, FLED blinks for one time indicating that the valid card is detected successfully.
- FLED blinks continuously indicating that it is in boot mode and ready for the upgrade operation.

3.3. FLED (Function LED)

CHAPTER
FOUR

EXTERNAL DOCUMENTS & RESOURCES

4.1 Communication Interface & Protocol

For UART & I2C protocol details, frame structure and usage please check for the

- 125 kHz RFID Readers UART/I2C Communication Protocol

You can reference this document if you want to communicate with the module over UART, including RS232, RS485 and virtual com port, or I2C by directly using low level command API that is provided with the firmware manual.

You can skip checking this document if you are using a software tool, SDK or ready-to-use microcontroller code library if provided. Software tools, SDK and MCU code library already handles with the communication protocol and serves higher level, easy to use API or examples to user by hiding inner details of the communication and the protocol.

4.2 Firmware and User Manuals

125 kHz RFID modules comes with standard and application specific firmware versions. Each firmware may differ by usage and has different user manual document. Please check for the relevant firmware manual document for full command API and functional behavior.

4.3 Software Tools

There are software tools supporting full command API (hardware control, configuration and card operations) to quickly evaluate and test the 125 kHz RFID Modules and Readers.

- SMRFID 3.0.7 is a software tool for Windows.
- Prox Panel is a cross platform software tool supports also new features comes with stdProxB
- SBoot Upgrader is a firmware upgrade tool for windows.
- Firmware Upgrader is a cross platform firmware upgrade tool.

Firmware upgrade files are distributed by email upon request. They are not available for download.

CHAPTER
FIVE

HARDWARE INTERFACE PRECAUTIONS

Please first read the precautions to protect your reader and external controller before you make any connections.

5.1 Signal Levels

All I/O and communication interface (e.g. UART/I2C) signals are at supplied VDD level (can be between 3.3V – 5V) and CMOS/TTL compliant. But they are tolerant to VDD + 0.5V max. Thus, when module is supplied with 3.3V, I/O and communication interface should be protected if interfaced with a 5V system directly.

UART communication bit level protocol is exactly same for RS232, RS485 and USB Virtual Com Port. However, hardware interface is required for RS232, RS485 or USB Virtual Serial port.

Attention: Protect your external controller

- Be aware that the evaluation kit or USB-UART converter with 5V supply may damage your external none-5V-tolerant controller e.g. Raspberry Pi.

Attention: Protect SM1251SMD Module

- Never connect SM1251SMD UART pins (or any other pin) to an RS232 device directly. RS232 have +/- 12V signals, shares the same bit level protocol with the UART but they have different electrical characteristics. Direct RS232 connection will damage the module. You should avoid connecting your module directly to the PC com port or any USB/RS232 converter. In such a requirement, USB To UART converter or UART To RS232 (e.g. st232/max232) hardware interface is required between the module-UART and RS232 (e.g. PC) sides.

5.2 RS485

RS485 interface is supported by using DE (Data Enable) signal and node address byte in the protocol frame if enabled in configuration.

SM1251SMD can be connected to RS485 interface (e.g. ST485/MAX485). There are also ready to use RS485 readers and boards available with bias, diode protection and simple filter circuits integrated for MINI20 and SMD20 package RFID modules.

Attention:

- RS485 infrastructure (cabling, termination resistors etc.) is extremely important for reliable communication. It is assumed that you have understanding of RS485 interface and experience with the infrastructure. Extended support is not offered for RS485 caused problems. It is highly recommended to investigate RS485 networks. For example, a star or random style connections should be avoided. Even the application confirmed to be working good, you may have problems in midterm.
- Upgrading the module firmware over RS485 is not supported.

5.3 I2C

SM1251SMD supports the I2C communication with provided command set and is disabled by default. It requires to be enabled by relevant set configuration command (it is sent over UART) or it should be requested to be enabled in factory.

Modules' I2C signal levels are at VDD level and CMOS/TTL level compliant. Maximum input tolerance is VDD +

0.5V. Depending on the pull up resistor circuit used on the mother board, the output signal level can be 3.3V or 5V. For SonMicro mother boards, please check relevant board's hardware manual document for the pull-up resistor connections.

Attention: Protect your external controller

- It is important to know about if the pull up resistors is connected to 5V or 3.3V on the mother board to protect external none-5V-tolerant controller.

CHAPTER
SIX

DESIGN NOTES

6.1 ESD Handling

Attention:

- SM1251SMD is an Electrostatic Sensitive Device. Do not open, carry or handle except at a static-free environment.
- Do not carry or store the modules with Non-Antistatic bags such as nylon, plastic, Styrofoam type of general usage materials.
- Please be aware that static electricity may cause partial damages inside the chips which cannot be observable at the time of misusage, and may result in failure in long term. ESD is one of the important source for damaged electronic devices.

6.2 Antenna & Read Range

Read range depends on many factors. Please be aware and take care of the following guides. Please always test your setup or final product practically before going into the production.

- SM1251SMD is designed to work best with a 860uH coil wire antenna with %2 tolerance. SonMicro 125 kHz module have RADF, Reader Antena Drive Frequency, parameter that can be used to calibrate the read range for the used antenna for fine tuning (inside the %2 tolerance range). Best RADF value for your custom antenna or application can be programmed in factory.
- SM1251SMD also comes optionally with a crystal oscillator for stable read range over ambient temperature changes.
- 3.3V operation may provide few centimeters better read range.
- Connecting the antenna outside of the module's board with a cable may result in poor performance (must be observed). It may also cause EMI problems affecting the other surrounding devices. Please test your setup practically in the application field or lab.
- Better read range can be achieved by using a bigger antenna and bigger tag. If you need to achieve maximum read range then consider using biggest antenna size that your design permits.

- Antenna and card communicates each other with magnetic field variations. Thus, communication between the reader and the card is affected by the metallic objects. Metallic objects surrounding the antenna including the printed circuit board, copper, LCD will decrease the read range. Try to place antenna as far as possible away from such metallic objects or components. Please be aware that it is not possible to read a card completely below a metal plane. If the surrounding is a metal frame then using the antenna even 1 cm away from it yields better results. Please test your setup practically in such a case.
  None metallic objects, such as plastic, wood, acrylic, glass etc. has no effect on read range performance. You can place the antenna below none metallic planes reliably.
- RFID card also has integrated antenna that is tuned by the card manufacturer. Unfortunately, small variations of the tuning may vary by the card manufacturers and this may result in different read ranges. Thus, the type of the card, or the manufacturer, other than the size, is also important for read range performance.
- Try to use linear low dropout voltage regulators where as possible. LDO regulators if compared with switch mode regulators, have less signal noise ratio and yields better results for the read range. If you are using switch mode power regulator please make sure you have back EMF and voltage protection diode or circuit to prevent transient high voltage ramping to prevent damage to the module or your system.

6.3 General Notes

- Use a 10uF tantalum capacitor close to the module VDD on your board. In addition to this, please be aware it is experienced that other ICs on your board, especially the ST232/MAX232 or FT232 may add noise to the overall system. It is strongly recommended to use a 10uF tantalum and 100nF bypass capacitors close to these chips. Otherwise you may experience communication problems, functional failures or poor read range performance.
- Critical components just beneath the antenna may cause unwanted signal disturbances or failures. One of the affected component is DC Buzzer. If you have to use a buzzer just beneath the antenna then it is strongly recommended to use a PWM Buzzer (supported TypeB pinout modules). Otherwise you can observe weak or deformed buzzer sounds.

CHAPTER
SEVEN

MECHANICAL DRAWINGS

7.1 SM1251SMD Mechanical Drawings

7.1.1 SM1251SMD Top View

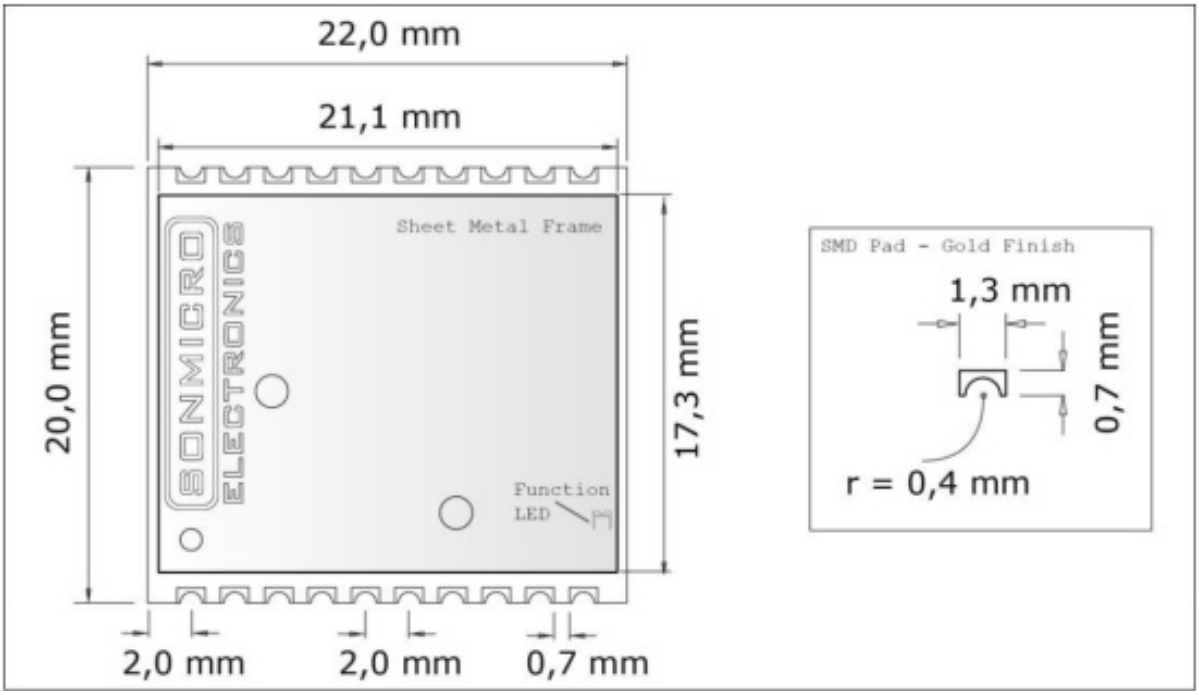

Figure: SM1251SMD Top View & SMD Pad Dimensions

7.1.2 SM1251SMD Side View

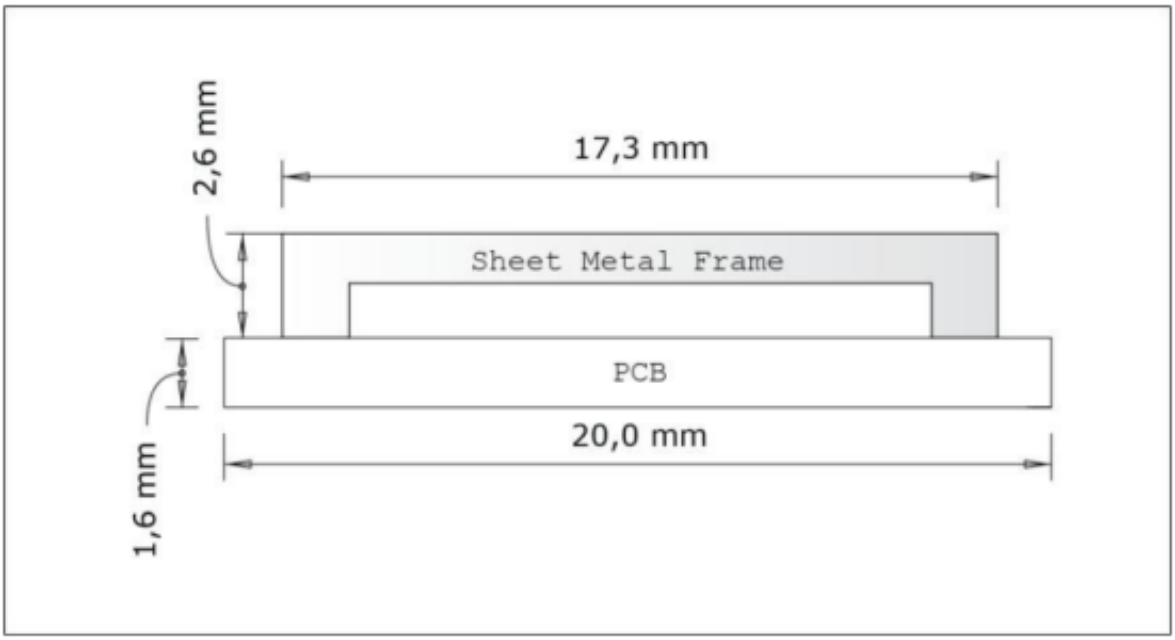

Figure: SM1251SMD Side View

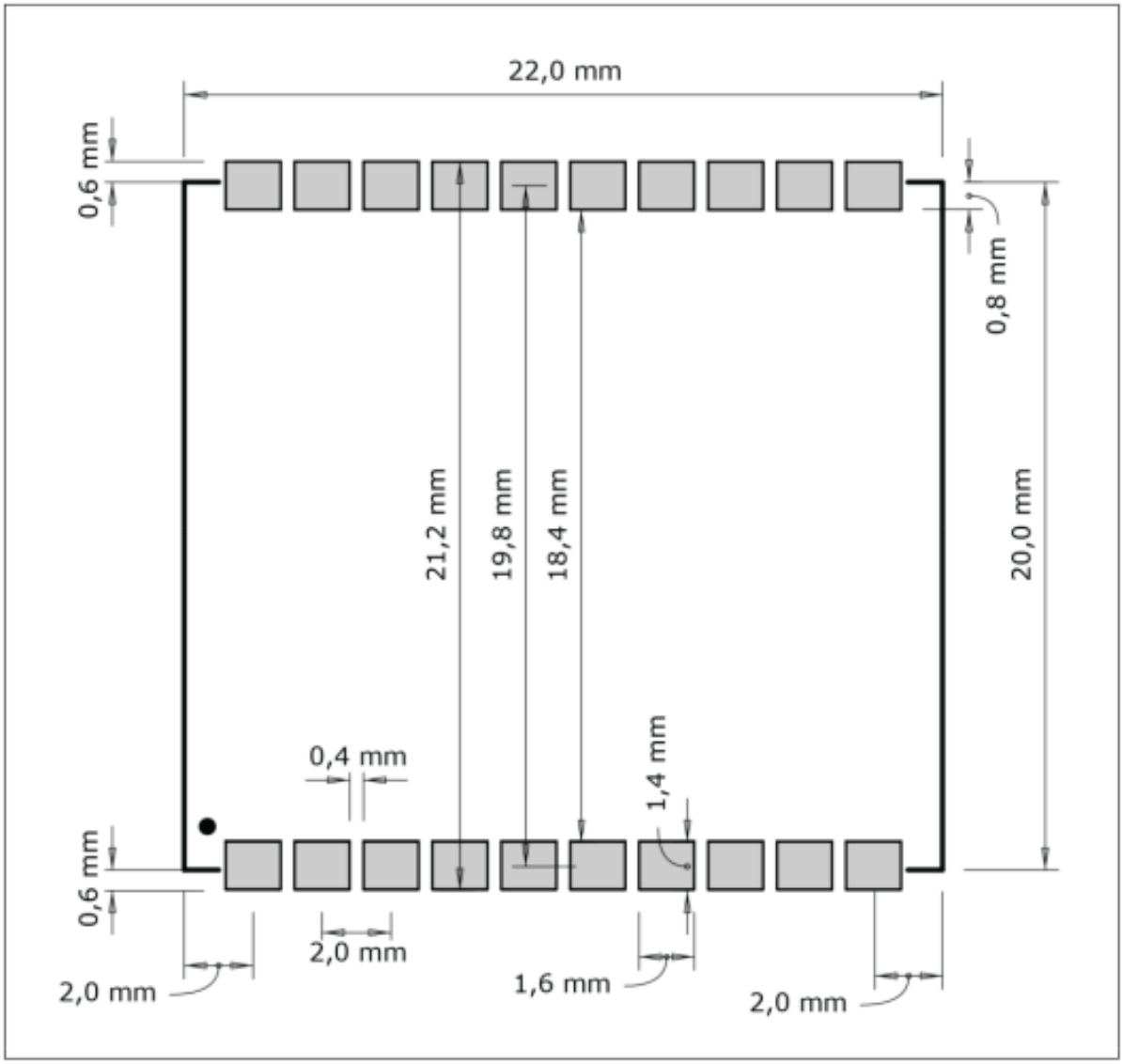

Figure: Recommended PCB layout for SM1251SMD module (SMD20 package)

CHAPTER
EIGHT

PACKING INFORMATION

8.1 SM1251SMD Packing Information

SM1251SMD modules are packaged with Antistatic ESD PET trays contain 25 of each or shipped as bulk packing with antistatic shielding bags. While the ESD tray option protects the module, they are also useful for automated assembly machines to pick up.

Figure: SM1251SMD Antistatic ESD Tray Packing.

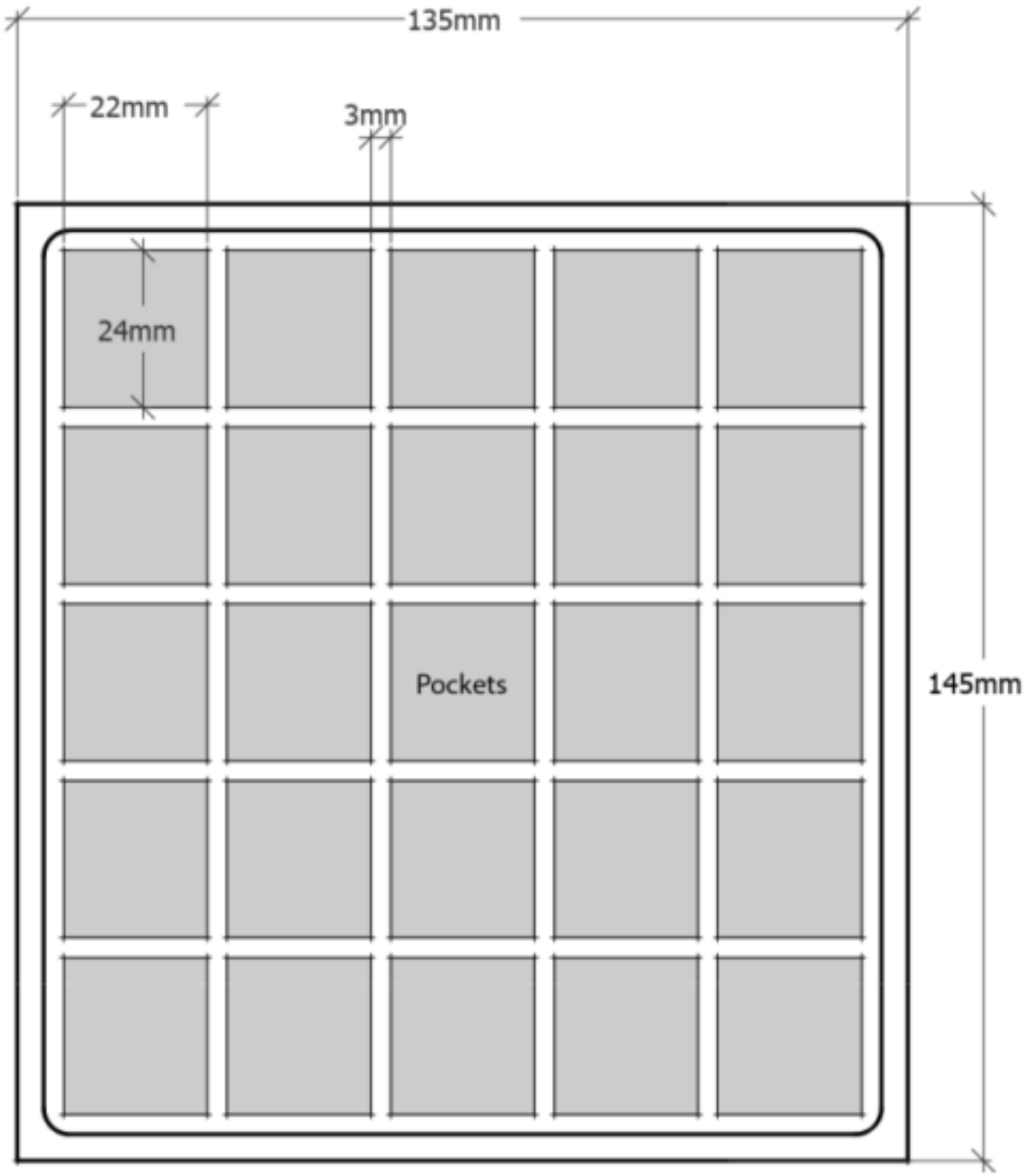

Figure: SM1251SMD Antistatic ESD Tray Dimensions for 5×5 pcs

CHAPTER
NINE

HARDWARE SPECIFICATIONS

9.1 DC ELECTRICAL CHARACTERISTICS

Symbol	Name	Min	Typ	Max	Units	Notes
VDD	Supply Voltage	3.0	3.3V – 5 V	5.5	V	Performance may vary depends on V DD. 3.3V operation provides 1-2 centi metres better read range
Io-5V	Supply Current @5 V	20	40	100	mA	Supply current may vary depends on t he VDD, antenna and I/O used
Io-3V3	Supply Current @3. 3V	15	25	100	mA	Supply current may vary depends on t he VDD, antenna and I/O used
It	Input Tolerance	-0.5	VDD	VDD + 0.5	V	I/O & Comm pins max input voltage tol erance
Imax	Max I/O Current	-25	•	25	mA	Maximum I/O current per GPIO
Trst	Reset Pulse	1	•	•	uS	Reset pulse signal width
ESD	ESD_HBM	2000	•	•	V	Electrostatic discharge human body m odel

Table: DC Electrical Characteristics of SM1251SMD Module

9.2 OPERATING TEMPERATURE

Symbol	Name	Min	Typ	Max	Units	Notes
TA	Ambient Temperatur e	-40	•	+85	°C	Can be extended to [-40°C,+125°C] wi th custom production

Table: Operating Temperature of SM1251SMD Module

CHAPTER
TEN

TRADEMARKS

- ARM® and Cortex are registered trademarks of ARM Limited (or its subsidiaries) in the EU and/or elsewhere.

CHAPTER
ELEVEN

DOCUMENT REVISON HISTORY
FCC CAUTION
IC CAUTION

Version 1.0.0
Initial release.

FCC CAUTION: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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.

Host product manufacturers need to provide a physical or e-label stating, "Contains FCC ID: 2ADHNSM1251SMD" with their finished product. Only those antennas with same type and lesser gain filed under this FCC ID can be used with this device. The host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. The final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

The final host integrator must ensure that there is no instruction provided in the user manual or customer documentation indicating how to install or remove the transmitter module except such device has implemented two-ways authentication between module and the host system.

The final host manual shall include the following regulatory statement: This equipment has been tested and found to comply within the limits. 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. This module has been tested and found to comply with part 15.209 requirements for Modular Approval. This module is intended for OEM integrator. The OEM integrator is responsible for the compliance to all the rules that apply to the product into which this certified RF module is integrated. Additional testing and certification may be necessary when multiple modules are used.

IC CAUTION:

User manuals for licence-exempt radio apparatus shall contain the following or equivalent notice in a conspicuous location in the user manual or alternatively on the device or both.
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.

The ISED certification label of a module shall be clearly visible at all times when installed in the host product; otherwise, the host product must be labelled to display the ISED certification number for the module, preceded by the word “contains” or similar wording expressing the same meaning, as follows: Contains IC: 10317A-SM1251SMD

This radio transmitter [IC: 10317A-SM1251SMD] has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Antenna Manufacturer:	Zycoil Electronics Co. Ltd.
Antenna Model:	ZY4037
Antenna type:	Coil Antenna

Documents / Resources

	**MATRIX SM1251SMD Second-Generation Module** [pdf] User Manual SM1251SMD, 2ADHNSM1251SMD, SM1251SMD Second-Generation Module, Second-Generation Module