ZE51/61-2.4 RF Module User Guide

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CHAPTER I. INTRODUCTION

I.1. Aim of the Document

The aim of this document is to present the features and the application of the ZE51/61-2.4 radio module. After the introduction, the characteristics of the ZE51/61-2.4 radio module will be described within the following distinct chapters:

- Requirements
- General Characteristics
- Technical description
- Process information
- Board Mounting Recommendations
- Antenna Considerations

I.2. Reference documents

[1] IEEE Std. 802.15.4-2006	Wireless MAC and PHY Specifications for Low Rate - WPANs
[2] ERC Rec 70-03	ERC Recommendation for SRD, June 2009
[3] EN 300 328-1 V1.7.1 (Europe)	ETSI Standards for SRD , October 2006
[4] EN 300 440-1 V1.4.1 (Europe)	ETSI Standards for SRD , March 2009
[5] 2002/95/EC	Directive of the European Parliament and of the Council, 27 January 2003
[6] CFR47 Part 15 (US)	FCC Standards for SRD
[7] ARIB STD-T66 (Japan)	ARIB Standards for SRD
[8] Z-One Pro Protocol Stack User Guide	
[9] 2006/771/EC	Harmonization of the radio spectrum for use by short-range devices
[10] 2009/381/EC	Amending Decision 2006/771/EC on harmonization of the radio spectrum for use by short-range devices

I.3. Document change log

Revision	Date	Changes
ISSUE # 0	11/05/10	First Release
ISSUE # 1	28/07/10	Added ZE61-2.4

I.4. Glossary

ARIB	Association of Radio Industries and Businesses
BER	Bit Error Rate
Bits/s	Bits per second (1000 bits/s = 1Kbps = 1Kbaud)
CER	Character Error Rate
CEPT	European Conference of Postal and Telecommunications Administrations
CFR	Code of Federal Regulations
Chips	Chip or chip sequence refers to a spreading-code used to transform the original data to DSSS
dBm	Power level in decibel milliwatt (10 log (P/1mW))
EMC	Electro Magnetic Compatibility
DSSS	Direct Sequence Spread Spectrum
EPROM	Electrical Programmable Read Only Memory
ERC	European Radiocommunications Committee
ETR	ETSI Technical Report
ETSI	European Telecommunication Standard Institute
FCC	Federal Communications Commission
IEEE	Institute of Electrical and Electronics Engineers
ISM	Industrial, Scientific and Medical
KB	1024 bytes (1 byte = 8 bits)
kbps	kilobits/s
LBT	Listen Before Talk
LNA	Low Noise Amplifier
MAC	Medium Access Control
MHz	Mega Hertz (1 MHz = 1000 kHz)
Mchip/s	Mega chips per second (A measure of the speed with which chips are generated in DSSS)
PCB	Printed Circuit Board
PROM	Programmable Read Only Memory
PER	Packet Error Rate
PHY	Physical Layer
NRZ	Non return to Zero
RF	Radio Frequency
RoHS	Restriction of Hazardous Substances
RSSI	Receive Strength Signal Indicator
Rx	Reception
SRAM	Static Random Access Memory
SRD	Short Range Device
SMD	Surface Mounted Device
Tx	Transmission
Via	Metal Hole on a printed circuit board
WPANs	Wireless Personal Area Networks

CHAPTER II. REQUIREMENTS

II.1. Regulations requirements

The ZE51/61-2.4 module is a [1],[2],[6],[7] compliant multi channel radio modem in the 2.4GHz band (unlicensed frequency band).

Europe Regulation:

The "ERC recommendation 70-03" [2] describes the limits band in the 2.4GHz license free band, in terms of bandwidth, maximum power, duty cycle, channel spacing and type of application. It gives the following limitations:

Class	Frequency band	Maximum radiated power	Channel spacing	Duty cycle	Notes
Annex 1h (Non-Specific Short range Devices)	2400 – 2483.5 MHz	10 mW e.i.r.p.	No channel spacing specified	No restriction	
Annex 3a (Wideband Data Transmission systems)	2400 – 2483.5 MHz	100 mW e.i.r.p. and 100 mW/100 kHz e.i.r.p. density applies when frequency hopping modulation is used, 10 mW/MHz e.i.r.p. density applies when other types of modulation are used.*	No channel spacing specified.	No restriction	For wide band modulations other than FHSS, the maximum e.i.r.p. density is limited to 10 mW/MHz

*Compliant to the EU Commission Decision [9], [10]. Techniques to access spectrum and mitigate interference that provide at least equivalent performance to the techniques described in harmonized standards adopted under Directive 1999/5/EC must be used.

Restrictions for non specific SR devices Annex 1h 2400-2483.5MHz:

Country	Restriction	Reason/Remark
Norway	Implemented	This subsection does not apply for the geographical area within a radius of 20 km from the centre of Ny-Ålesund
Russian Federation		Bluetooth

Restrictions for Wideband Data Transmission systems Annex 3a 2400-2483.5MHz:

Country	Restriction	Reason/Remark
France	Outdoor use limited to 10 mW e.i.r.p. within the band 2454-2483.5 MHz	Military Radiolocation use. Reforming of the 2.4 GHz band has been ongoing in recent years to allow current relaxed regulation. Full implementation planned 2012
Italy		For private use, a general authorisation is required if WAS/RLAN's are used outside own premises. For public use, a general authorization is required
Luxemburg	Implemented	General authorization required for network and service supply
Norway	Implemented	This subsection does not apply for the geographical area within a radius of 20 km from the centre of Ny-Ålesund
Russian Federation		Only for indoor applications

For the complete document please refer to [2] and EU Commission Decision [9], [10].

The 2.4 Ghz band is a harmonized band in most of Europe. So the product must be declared in compliance with the harmonized ETSI standards EN 300 440 (Class 1h) or EN 300 228 (Class 3a).

Finally, the module complies with the new European Directive 2002/95/EC concerning the Restrictive Usage of Hazardous Substances (RoHS).

USA Regulation:

In the United States the FCC is responsible for the regulation of all RF devices. Our module intended for unlicensed operation is regulated by CFR 47, Part 15 [6].
The 2.4 GHz band used for unlicensed radio equipment is regulated by section 15.247 and 15.249.

Japan regulation

In Japan the unlicensed use of short range devices in the 2.4 GHz ISM band is regulated by the ARIB standard STD-T66 [7].

II.2. Functional Requirements

The ZE51/61-2.4 module is a complete solution from serial interface to RF interface. The ZE51/61-2.4 module has a digital part and a RF part.

The digital part has the following functionalities:

- Communication interface
- I/O management
- Micro controller with embedded software

The RF part has the following functionalities:

- 2.4 GHz IEEE 802.15.4 compliant RF transceiver
- Half Duplex bi-directional link
- RF front-end component with low noise Rx amplification and Tx power amplification (ZE61-2.4 module only)

II.3. Software

The ZE51/61-2.4 module is provided pre-flashed with Telit in-house ZigBee® PRO stack (Z-ONE). Please refer to Z-One Protocol Stack user guide [8] for detail information.

In case the customer needs to develop his own software, different tools are available:

- 8051 compiler from IAR : http://www.iar.se/website1/1.0.1.0/244/1/
- STMicroelectronic M24C64-FMB6TG EEPROM Datasheet available at :

  http://www.st.com/stonline/products/literature/ds/16891/m24c64-f.pdf

The technical support for these tools will be done by the providing company.

A complete correspondence table of the connections between the CC2530 and the pin out of the module, as well as the connections to the included STM M24C64 EEPROM can be found in chapter IV.3.

➢ In case, the customer wants to test the RF performances of the module, Telit can provide its own proprietary test software that is available in the download zone together with description of all the functionalities.

II.4. Temperature Requirements

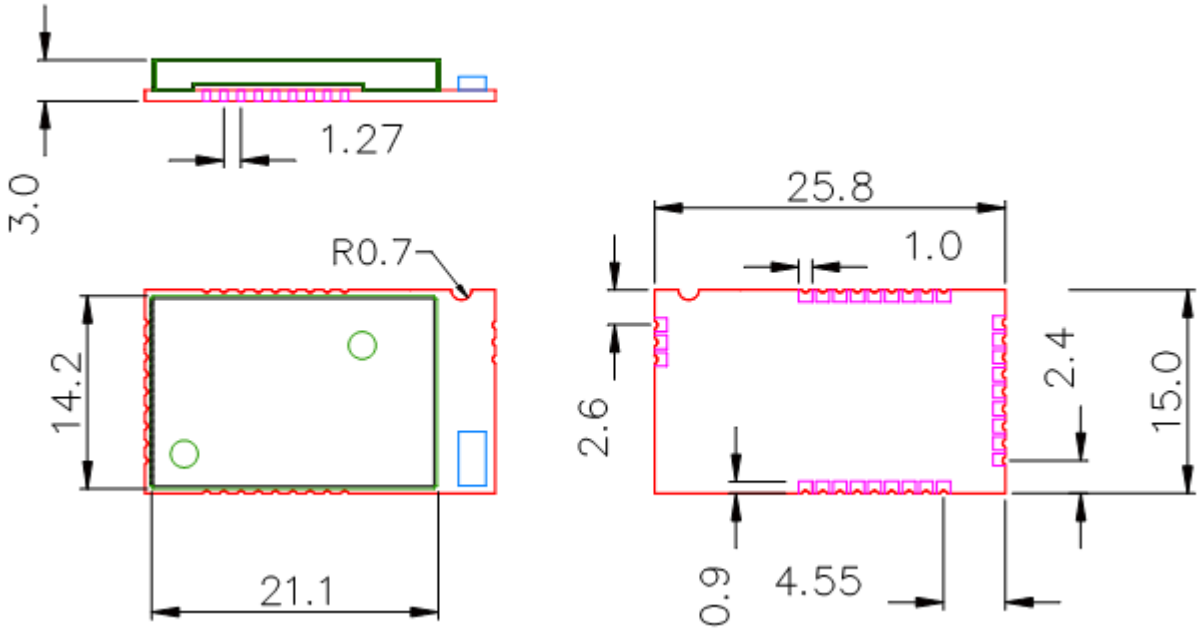
	Minimum	Typical	Maximum	Unit
Operating				
Temperature	- 40	25	+ 85	°C
Relative humidity @ 25°C	20		75	%
Storage				
Temperature	- 40	25	+ 85	°C

CHAPTER III. GENERAL CHARACTERISTICS

III.1. Mechanical Characteristics

Size :	Rectangular 26 x 15 mm
Height :	3 mm
Weight :	1,7 g
PCB thickness:	0.8 mm
Cover :	• Dimensions : 21 x 14 x 2.2mm • Thickness : 200µm
Components :	All SMD components, on one side of the PCB.
Connectors :	The terminals allowing conveying I/O signals are half-moons located around.
Mounting :	• SMD • Half moons on the 4 external sides
Number of pins :	30

III.2. Mechanical dimensions



III.3. DC Characteristics

Characteristics ZE51	Min.	Typ.	Max.
Power Supply (V_{DD}):	+2.0V	+3.0V	+3.6V
Consumption @ 3.0V and 25°C			
Transmission :		35mA	
Reception :		26mA	
Stand-by (32.768 khz On) :		2µA	
Sleep (wake up on interruption) :		1µA	
I/O low level :	GND	-	0.9 V
I/O high level :	V_{DD} - 0.7V	-	V_{DD}
Characteristics ZE61	**Min.**	**Typ.**	**Max.**
Power Supply (V_{DD}):	+2.0V	+3.0V	+3.6V
Consumption @ 3.0V and 25°C			
Transmission :		150mA	
Reception :		31mA	
Stand-by (32.768 khz On) :		2,5µA	
Sleep (wake up on interruption) :		1,5µA	
I/O low level :	GND	-	0.9 V
I/O high level :	V_{DD} - 0.7V	-	V_{DD}

III.4. Functional characteristics

Global			
Frequency band	2400 - 2483.5 MHz		
Channel spacing	5 MHz		
Channel number	16 Channel 11 (2405MHz) → Channel 26 (2480MHz)		
Technology	DSSS		
Modulation	O-QPSK with half sine pulse shaping		
Radio bit rate	250 kbps		
Transmit chip rate	2 Mchip/s		
Transmission ZE51	Min.	Typ.	Max.
Output Power	+4dBm ± 1 dB on the whole band (selectable by software)		
Harmonics *2nd harmonic* *3rd harmonic*		-53 dBc -47 dBc	
Spurious emission *30 - 1000 MHz* *1 - 12.75 GHz* *1.8 - 1.9 GHz* *5.15 - 5.3 GHz*			-36 dBm -30 dBm -47 dBm -47 dBm (required by [3], [4], [6],[7])
Error Vector Magnitude (EVM)		5%	15%
Transmission ZE61	Min.	Typ.	Max.
Output Power	+19dBm ± 1 dB on the whole band (selectable by software)		
Harmonics *2nd harmonic* *3rd harmonic*		-61 dBc -63 dBc	
Spurious emission *30 - 1000 MHz* *1 - 12.75 GHz* *1.8 - 1.9 GHz* *5.15 - 5.3 GHz*			-36 dBm -30 dBm -47 dBm -47 dBm (required by [3], [4],

			[6], [7])
Error Vector Magnitude (EVM)		5%	15%

Reception ZE51	Min.	Typ.	Max.
Sensitivity for PER=1%	-	-96 dBm under 50 Ohms	-97 dBm
Saturation for PER=1%	-3 dBm under 50 Ohms	-	-
Adjacent channel rejection + 5 MHz channel spacing	-	38 dB	-
	Wanted signal @ -82 dBm, adjacent modulated channel @ + 5 MHz, for CER = 1 %.		
Adjacent channel rejection - 5 MHz channel spacing	-	32 dB	-
	Wanted signal @ -82 dBm, adjacent modulated channel @ - 5 MHz, for CER = 1 %.		
Alternate channel rejection + 10 MHz channel spacing	-	44 dB	-
	Wanted signal @ -82 dBm, adjacent modulated channel @ + 10 MHz, for CER = 1 %.		
Alternate channel rejection - 10 MHz channel spacing	-	43 dB	-
	Wanted signal @ -82 dBm, adjacent modulated channel @ - 10 MHz, for CER = 1 %.		
Blocking/Desensitisation *@ ±5MHz* *@ ±10MHz* *@±20MHz* *@±50MHz*	- - - -	- 46 dBm - 39 dBm - 39 dBm - 29 dBm	- - - -
	Wanted signal 3 dB above the sensitivity level, CW jammer, for CER = 1%. (Maximum values according to EN 300 440 class 2)		
LO leakage	-	-	-47 dBm
Spurious emission in 30 MHz - 12.75 GHz	-	-	-47 dBm (required by [3], [4], [6],[7])

Reception ZE61	Min.	Typ.	Max.
Sensitivity for PER=1%	-	-99 dBm under 50 Ohms	-
Saturation for PER=1%	-3 dBm under 50 Ohms	-	-
Adjacent channel rejection + 5 MHz channel spacing	-	33 dB	-
	Wanted signal @ -82 dBm, adjacent modulated channel @ + 5 MHz, for CER = 1 %.		
Adjacent channel rejection - 5 MHz channel spacing	-	33 dB	-
	Wanted signal @ -82 dBm, adjacent modulated channel @ - 5 MHz, for CER = 1 %.		
Alternate channel rejection + 10 MHz channel spacing	-	50 dB	-
	Wanted signal @ -82 dBm, adjacent modulated channel @ + 10 MHz, for CER = 1 %.		
Alternate channel rejection - 10 MHz channel spacing	-	50 dB	-
	Wanted signal @ -82 dBm, adjacent modulated channel @ - 10 MHz, for CER = 1 %.		
Blocking/Desensitisation *@ ±5MHz* *@ ±10MHz* *@±20MHz* *@±50MHz*	 - - - -	 - 35 dBm - 31 dBm - 30 dBm - 30 dBm	 - - - -
	Wanted signal 3 dB above the sensitivity level, CW jammer, for CER = 1%. (Maximum values according to EN 300 440 class 2)		
LO leakage	-	-	-47 dBm
Spurious emission in 30 MHz - 12.75 GHz	-	-	-47 dBm (required by [3], [4], [6],[7])

III.5. Digital Characteristics

Microcontroller	8051 core
Microcontroller Memory	256KB Flash, 8KB SRAM,
Peripheral memory	8 KB EEPROM
Serial link*	Managed by application. • Full Duplex, from 1200 to 115200 bps • 7 or 8 bits, with or without parity, 1 or 2 stop bits • Protocol Type : RS-232, TTL level
Flow control*	Managed by application. None, Software (Xon/Xoff) or Hardware (RTS/CTS)
Other	Ultra low power voltage detector and µC supervisory circuit
Specific signals	• *Serial* : Tx, Rx, RTS, CTS • *Inputs* : Reset, Stand-By, Prog • *I/O* : 7 I/O (among those 5 analog inputs with 7 to 12 bits resolution)
Flashing	• *Through serial* • *Through the air :* DOTA (Download Over The Air) functionality
Embedded functionality	• Point-to-point stack for test purpose available in download zone • ZigBee Pro stack (Z-One Pro) from Telit

*: In ZigBee Democase :115.200 bps,8 bits, without parity, 1 stop bit, No flow control

III.6. Absolute Maximum Ratings

ZE51	
Voltage applied to V_{DD}	-0.3V to +3.9V
Voltage applied to any digital pin	-0.3V to V_{DD}+0.3V, max 3.9 V
Input RF level	10 dBm
ZE61	
Voltage applied to V_{DD}	-0.3V to +3.6V
Voltage applied to any digital pin	-0.3V to V_{DD}+0.3V, max 3.6 V
Input RF level	10 dBm

CAUTION
It must be noted that due to some components, ZE51/ZE61 module is an ESD sensitive device. Therefore, ESD handling precautions should be carefully observed.

III.7. Ordering information

The following equipments can be ordered:

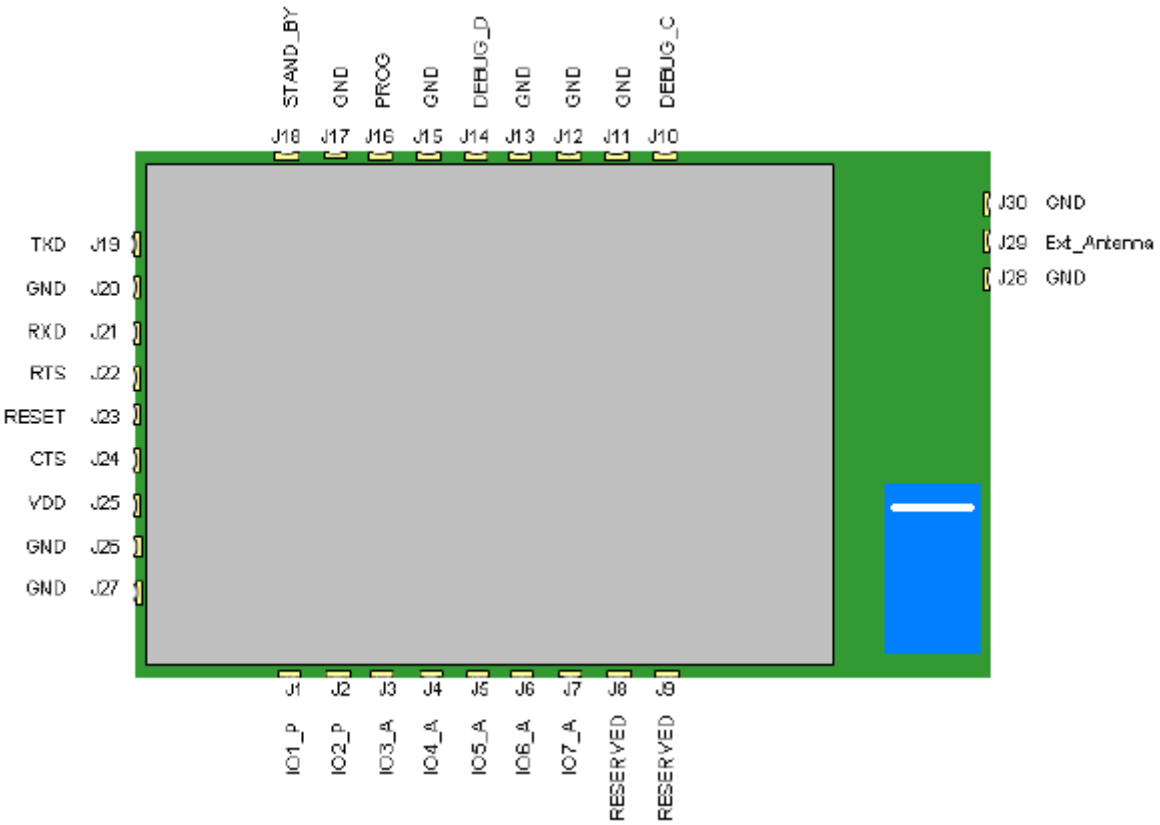
- The SMD version
- The DIP interface version
- The USB dongle
- The Demo Case

The versions below are considered standard and should be readily available. For other versions, please contact Telit. Please make sure to give the complete part number when ordering.

Equipment and Part Number	
SMD Version	
ZE51/61-2.4/SMD-IA (With Integrated Antenna)	**ZE51/61-2.4/SMD-WA** (Without Integrated Antenna)
	
DIP Version	
ZE51/61-2.4/DIP-IA (With Integrated Antenna)	**ZE51/61-2.4/DIP-WA** (Without Integrated Antenna)
	
USB Dongle	
M ZE51/USB	
	
Demo Case	
D ZE51/61 DEMO	
	

CHAPTER IV. TECHNICAL DESCRIPTION

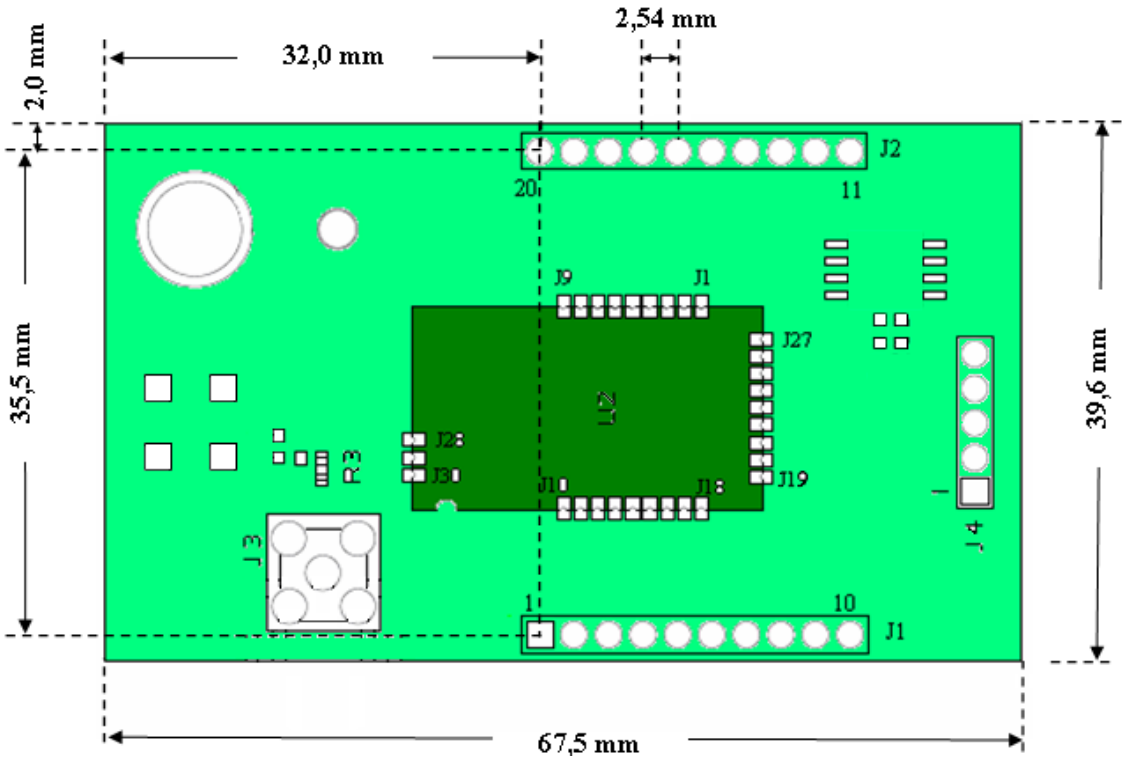
IV.1. Pin-out of the SMD Module

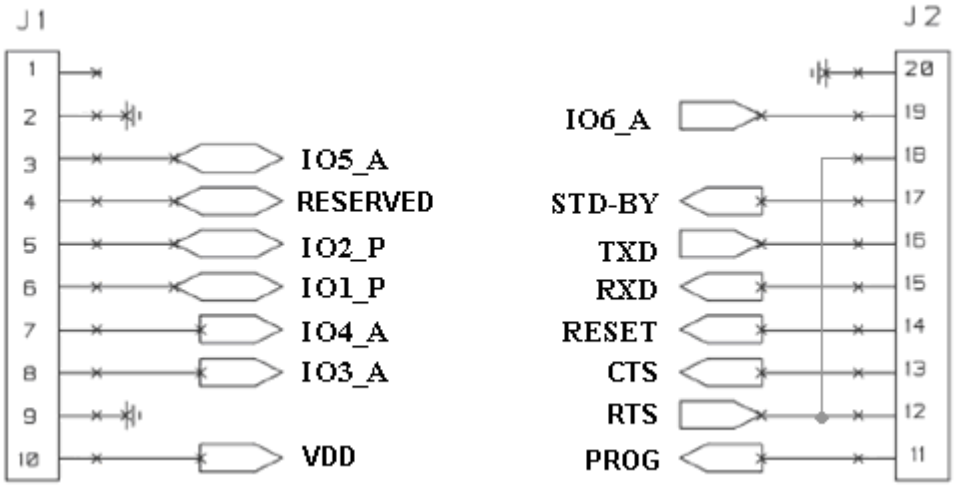


Pin	Pin name	Pin type	Signal level	Function
J30	GND	Gnd		RF Ground connection for external antenna
J29	Ext_Antenna	RF		RF I/O connection to external antenna
J28	GND	Gnd		RF Ground connection for external antenna
J27	GND	Gnd		Ground
J26	GND	Gnd		Ground
J25	VDD	Power		Digital and Radio part power supply pin
J24	CTS	I	TTL	Clear To Send
J23	RESET	I	TTL	µC reset (Active low with internal pull-up)
J22	RTS	O	TTL	Request To Send
J21	RXD	I	TTL	RxD UART – Serial Data Reception
J20	GND	Gnd		Ground
J19	TXD	O	TTL	TxD UART – Serial Data Transmission
J18	STAND_BY	I	TTL	Standby (Active high with internal pull-down)
J17	GND	Gnd		Ground
J16	PROG	I	TTL	Signal for serial µC flashing (Active high with internal pull-down)
J15	GND	Gnd		Ground
J14	DEBUG_D	I/O	TTL	Debug data.
J13	GND	Gnd		Ground
J12	GND	Gnd		Ground
J11	GND	Gnd		Ground
J10	DEBUG_C	I/O	TTL	Debug clock
J9	RESERVED	-	-	-
J8	RESERVED	-	-	-
J7	IO7_A	I/O	analog	Analog Input N°7 (Digital I/O capability)
J6	IO6_A	I/O	analog	Analog Input N°6 (Digital I/O capability)
J5	IO5_A	I/O	analog	Analog Input N°5 (Digital I/O capability)
J4	IO4_A	I/O	analog	Analog Input N°4 (Digital I/O capability)
J3	IO3_A	I/O	analog	Analog Input N°3 (Digital I/O capability)
J2	IO2_P	I/O	TTL	Digital I/O N°2 with 20mA sink/source capability
J1	IO1_P	I/O	TTL	Digital I/O N°1 with 20mA sink/source capability

NOTE: reserved pins must not be connected

IV.2. Pin-out of the DIP Module





IV.3. Correspondence

Pin-Out correspondence between ZE51/61-2.4/DIP, ZE51/61-2.4/SMD and CC2530 SOC.

ZE51/61-2.4/DIP Pin-out		ZE51/61-2.4/SMD Pin-out		CC2530 SOC Pin-out		Comments
Pin n°		Pin n°	Pin name	Pin n°	Pin name	
J1	1					Not connected
J1	2		GND		GND	
J1	3	J5	IO5_A	15	P0_4	
J1	4	J9	reserved	38	P1_6	
J1	5	J2	IO2_P	9	P1_1	
J1	6	J1	IO1_P	11	P1_0	
J1	7	J4	IO4_A	16	P0_3	
J1	8	J3	IO3_A	17	P0_2	
J1	9		GND		GND	
J1	10	J25	VDD		AVDD,DVDD	
J2	11	J16	PROG	36	P2_0	
J2	12	J22	RTS	7	P1_3	
J2	13	J24	CTS	8	P1_2	
J2	14	J23	Reset	20	Reset_N	
J2	15	J21	RxD	6	P1_4	
J2	16	J19	TxD	5	P1_5	
J2	17	J18	STAND_BY	37	P1_7	
J2	18	J22	RTS	7	P1_3	
J2	19	J6	IO6_A	14	P0_5	
J2	20		GND		GND	
J4 Connector for debugging and programmation						
J4	1	J14	Debug D	35	P2_1	
J4	2	J10	Debug C	34	P2_2	
J4	3	J23	Reset	20	Reset_N	
J4	4	J25	VDD		AVDD,DVDD	
J4	5		GND		GND	
Eeprom connections						
SCL	I2C Eeprom U1 (Not Mounted)	J7	IO7_A	13	P0_6	
SDA		J8	reserved	12	P0_7	
RF connection						
J3 or J5 :	SMA connector for RF I/O	J29	Ext_Antenna (Unbalanced RF)			Connection to 50 Ohm antenna
ANT1	Not mounted					A small chip Antenna “FR05-S1-N-0-001 from Fractus can be tested

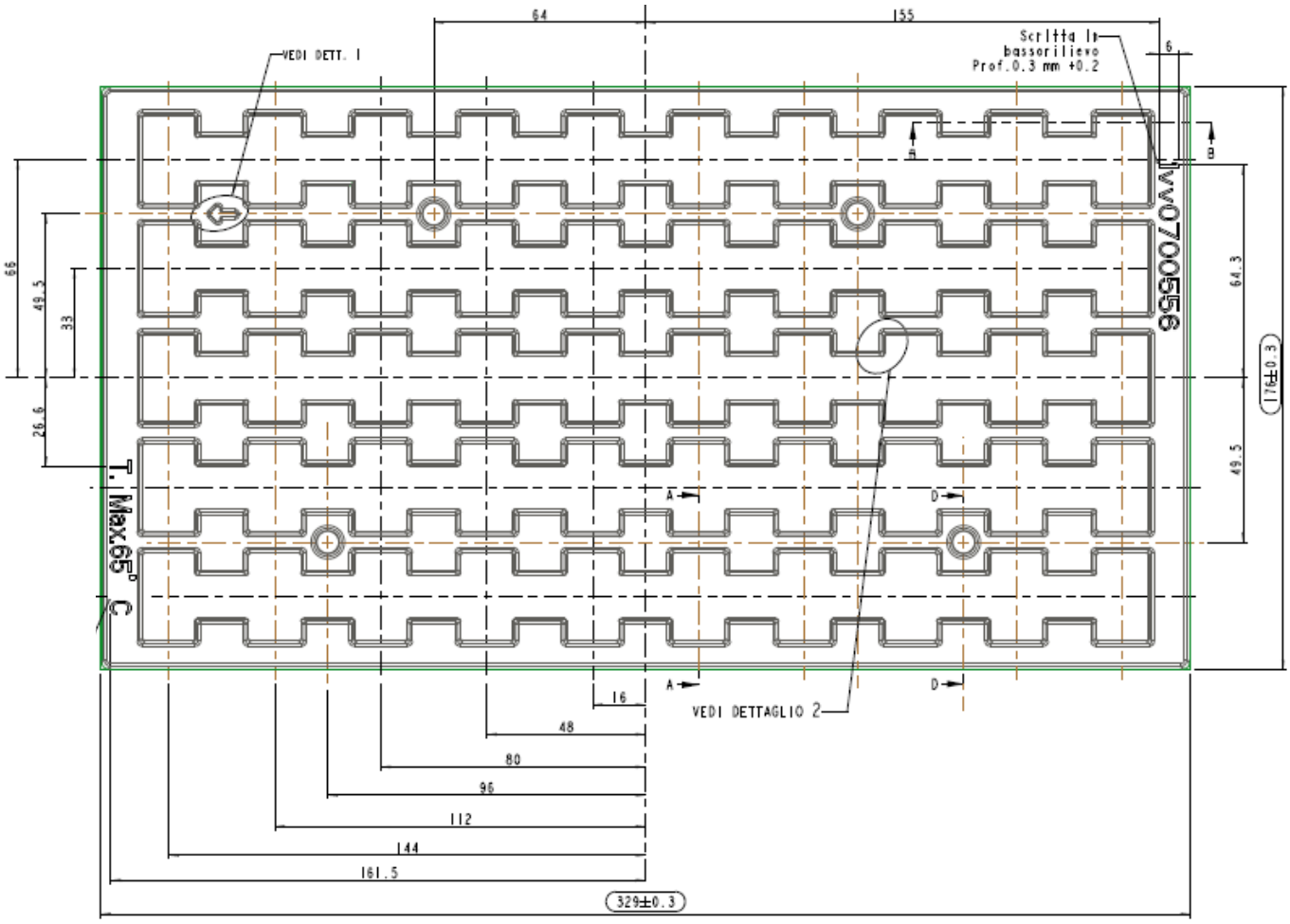
IV.4. Description of the Signals

Signals	*Description*
Reset	External hardware reset of the radio module. Active on low state.
TXD, RXD	Serial link signals, format NRZ/TTL: TXD is for outgoing data. RXD is for incoming data. The '1' is represented by a high state.
CTS	Incoming signal. Indicates whether the module can send serial data to user (Active, on low state) or not (inactive, on high state).
RTS	Outgoing signal. Indicates whether the user can transmit serial data (active, on low state) or not (inactive, on high state).
IO	I/O, configurable as input or as output. (Available upon request only)
STAND_BY	Indicates to the module to switch to pre-selected low-power mode. (Available upon request)

CHAPTER V. PROCESS INFORMATION

V.1. Delivery

ZE51/61-2.4/SMD modules are delivered in plastic tray packaging, each tray including 50 units. The dimensions of the tray are the following: 329 mm x 176 mm x 5.6 mm. Each unit is placed in a 26.6 mm x 16 mm location. An empty tray weights 45 g and a loaded tray weights around 130 g.



V.2. Storage

The optimal storage environment for ZE51/61-2.4/SMD modules should be dust free, dry and the temperature should be included between -40°C and +85°C.

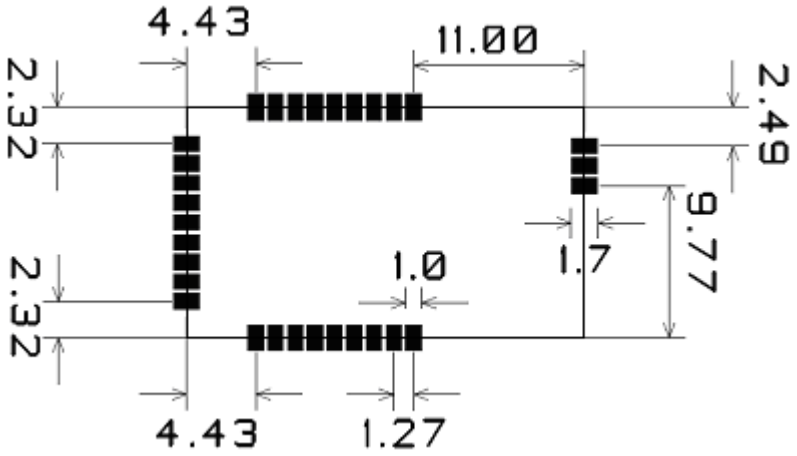
In case of a reflow soldering process, tiny radio modules must be submitted to a drying bake at +60°C during 24 hours. The drying bake must be used prior to the reflow soldering process in order to prevent a popcorn effect. After being submitted to the drying bake, tiny modules must be soldered on host boards within 168 hours.

Also, it must be noted that due to some components, ZE51/61-2.4/SMD modules are ESD sensitive device. Therefore, ESD handling precautions should be carefully observed.

V.3. Soldering pad pattern

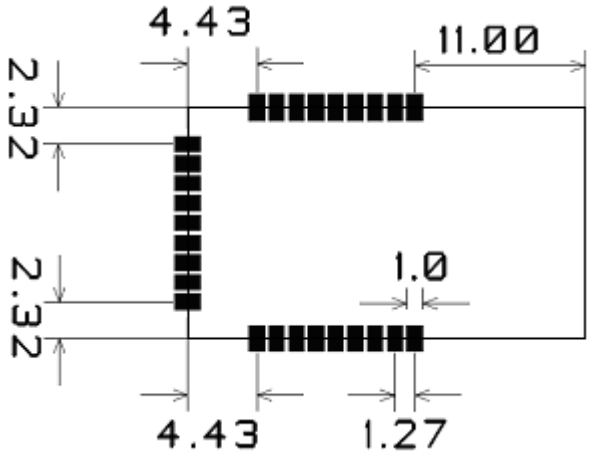
The surface finished on the printed circuit board pads should be made of Nickel/Gold surface.

The recommended soldering pad layout on the host board for the **ZE51/61-2.4/SMD-WA**, is shown in the diagram below:



All dimensions in mm

The recommended soldering pad layout on the host board for the **ZE51/61-2.4/SMD-IA**, is shown in the diagram below:



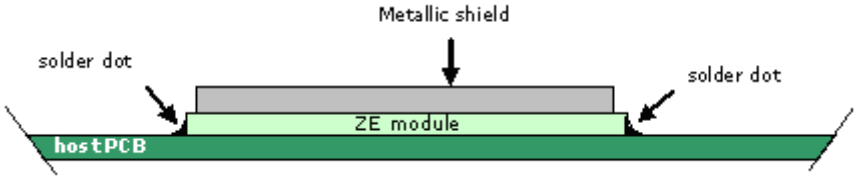
All dimensions in mm

Neither via-holes nor wires are allowed on the PCB upper layer in area occupied by the module.

V.4. Solder paste composition (RoHS process)

ZE51/61-2.4/SMD module is designed for surface mounting using half-moon solder joints (see diagram below). For proper module assembly, solder paste must be printed on the target surface of the host board. The solder paste should be eutectic and made of 95.5% of SN, 4% of Ag and 0.5% of Cu. The recommended solder paste height is 180 µm .

The following diagram shows mounting characteristics for tiny integration on host PCB:



V.5. Placement

The ZE51/61-2.4/SMD module can be automatically placed on host boards by pick-and-place machines like any integrated circuit.

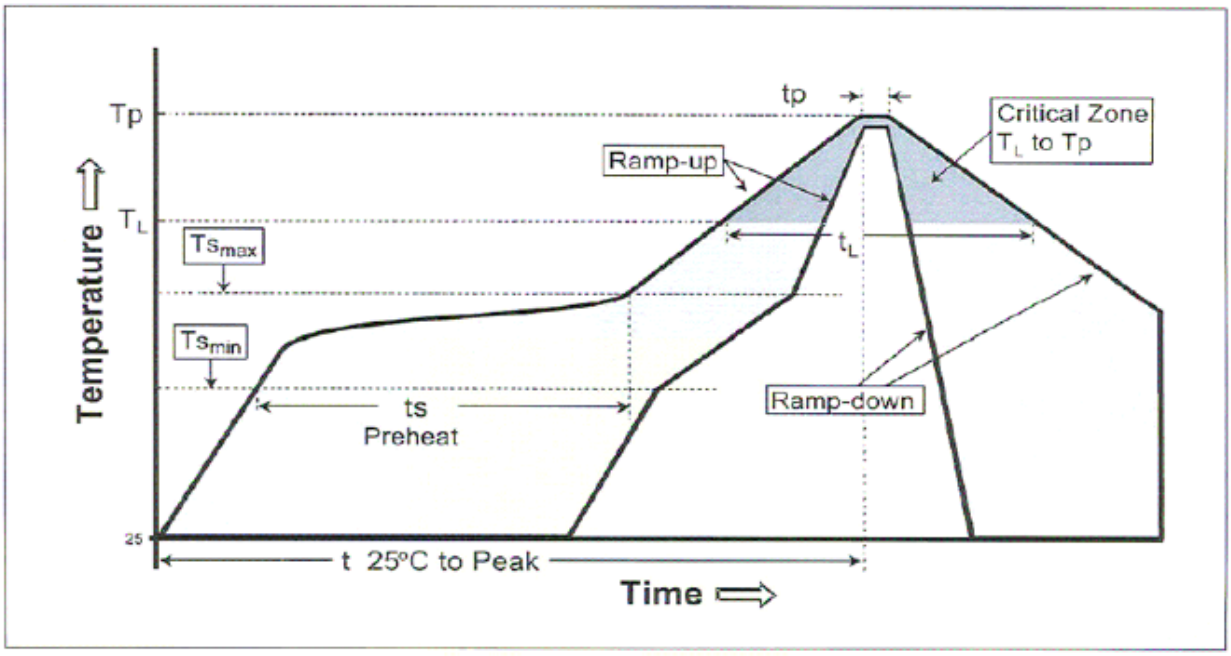
V.6. Soldering profile (RoHS process)

It must be noted that ZE51/61-2.4/SMD module should not be allowed to be hanging upside down during the reflow operation. This means that the module has to be assembled on the side of the printed circuit board that is soldered last.

The recommendation for lead-free solder reflow in IPC/JEDEC J-STD-020D Standard should be followed.

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Average Ramp-UP Rate (Ts max to Tp)	3°C/second max.	3°C/second max.
Preheat - Temperature Min (Ts min) - Temperature Max (Ts max) - Time (ts min to ts max)	 100°C 150°C 60 - 120 seconds	 150°C 200°C 60 - 120 seconds
Time maintained above: - Temperature (TL) - Time (tL)	 183°C 35 - 90 seconds	 221°C 45 - 90 seconds
Peak/Classification Temperature (Tp)	max. Peak Temp. 225°C	max. Peak Temp. 260°C
Time within 5°C of actual Peak Temperature (tp)	10 - 30 seconds	10 seconds
Ramp-Down Rate	4°C/second max.	4°C/second max.
Time 25°C to Peak Temperature	6 minutes max.	8 minutes max.
Minimum Solderjoint Peak-Temperature		235°C/ 10sec.

Note 1: All temperatures refer to topside of the package, measured on the package body surface.



The barcode label located on the module shield is able to withstand the reflow temperature.

CAUTION

It must also be noted that if the host board is submitted to a wave soldering after the reflow operation, a solder mask must be used in order to protect the tiny radio module's metal shield from being in contact with the solder wave.

CHAPTER VI. BOARD MOUNTING RECOMMENDATION

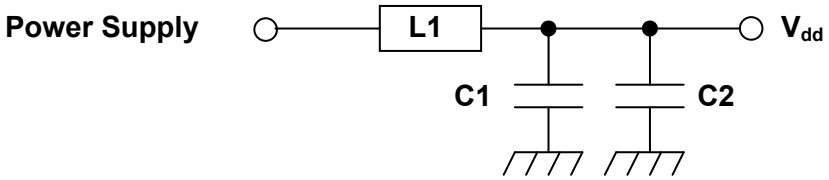
VI.1. Electrical environment

The best performances of the ZE51/61-2.4 module are obtained in a “clean noise” environment. Some basic recommendations must be followed:

- Noisy electronic components (serial RS232, DC-DC Converter, Display, Ram, bus ,...) must be placed as far as possible from the ZE51/61-2.4 module.
- Switching components circuits (especially RS-232/TTL interface circuit power supply) must be decoupled with a 100 µF tantalum capacitor. And the decoupling capacitor must be as close as possible to the noisy chip.

VI.2. Power supply decoupling on ZE51/61-2.4 module

The power supply of ZE51/61-2.4 module must be nearby decoupled. A LC filter must be placed as close as possible to the radio module power supply pin, V_{DD} .

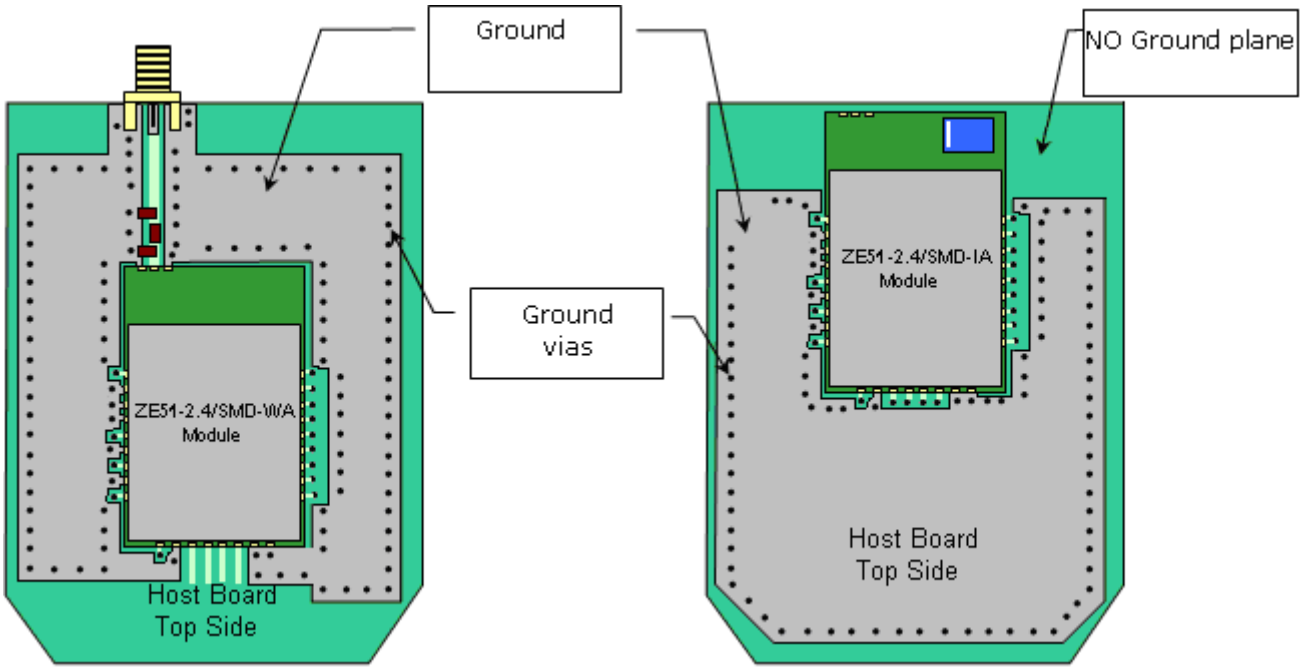


Symbols	*Reference*	*Value*	*Manufacturer*
L1	LQH31MN1R0K03	1µH	Murata
C1	GRM31CF51A226ZE01	22µF	Murata
C2	Ceramic CMS 25V	100nF	Multiple

VI.3. RF layout considerations

Basic recommendations must be followed to achieve a good RF layout :

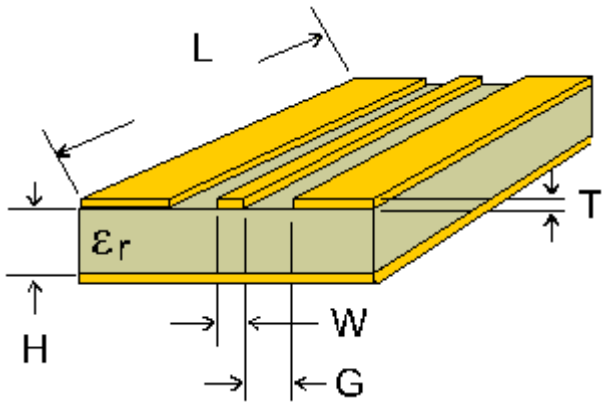
- It is recommended to fill all unused PCB area around the module with ground plane, except in case of integrated antenna (no ground plane must be placed in front of the antenna and on the bottom side).
- The radio module ground pin must be connected to solid ground plane.
- If the ground plane is on the bottom side, a via (Metal hole) must be used in front of each ground pad. Especially J28 and J30 (RF Gnd) pins should be grounded via several holes to be located right next to the pins thus minimizing inductance and preventing mismatch and losses.



Example of GND layout Top View (with and without integrated antenna)

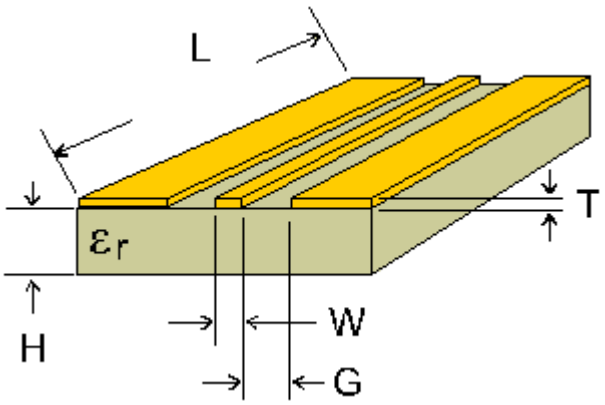
VI.4. Antenna connection on Printed Circuit Boards

Special care must be taken when connecting an antenna or a connector to the module. The RF output impedance is 50 ohms, so the strip between the pad and the antenna or connector must be 50 ohms following the tables below. Ground lines should be connected to the ground plane with as many vias as possible, but not too close to the signal line.



PCB material	PCB thickness H (mm)	Coplanar line W (mm)	Coplanar line G (mm)
FR4	0.8	1	0.3
	1.6	1	0.2

Table 1 : Values for double face PCB with ground plane around and under coplanar wave guide (recommended)

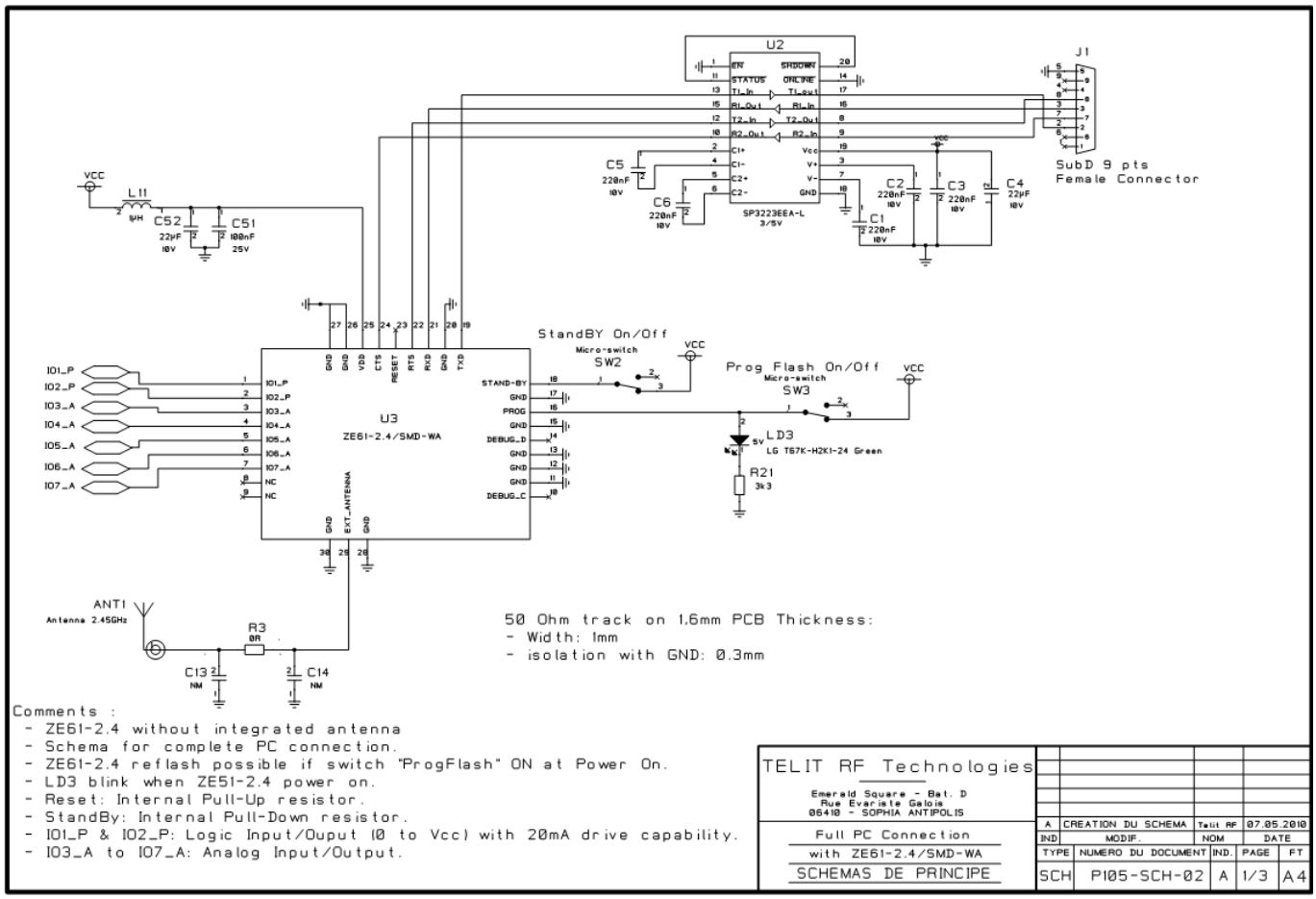


PCB material	PCB thickness H (mm)	Coplanar line W (mm)	Coplanar line G (mm)
FR4	0.8	1	0.22
	1.6	1	0.23

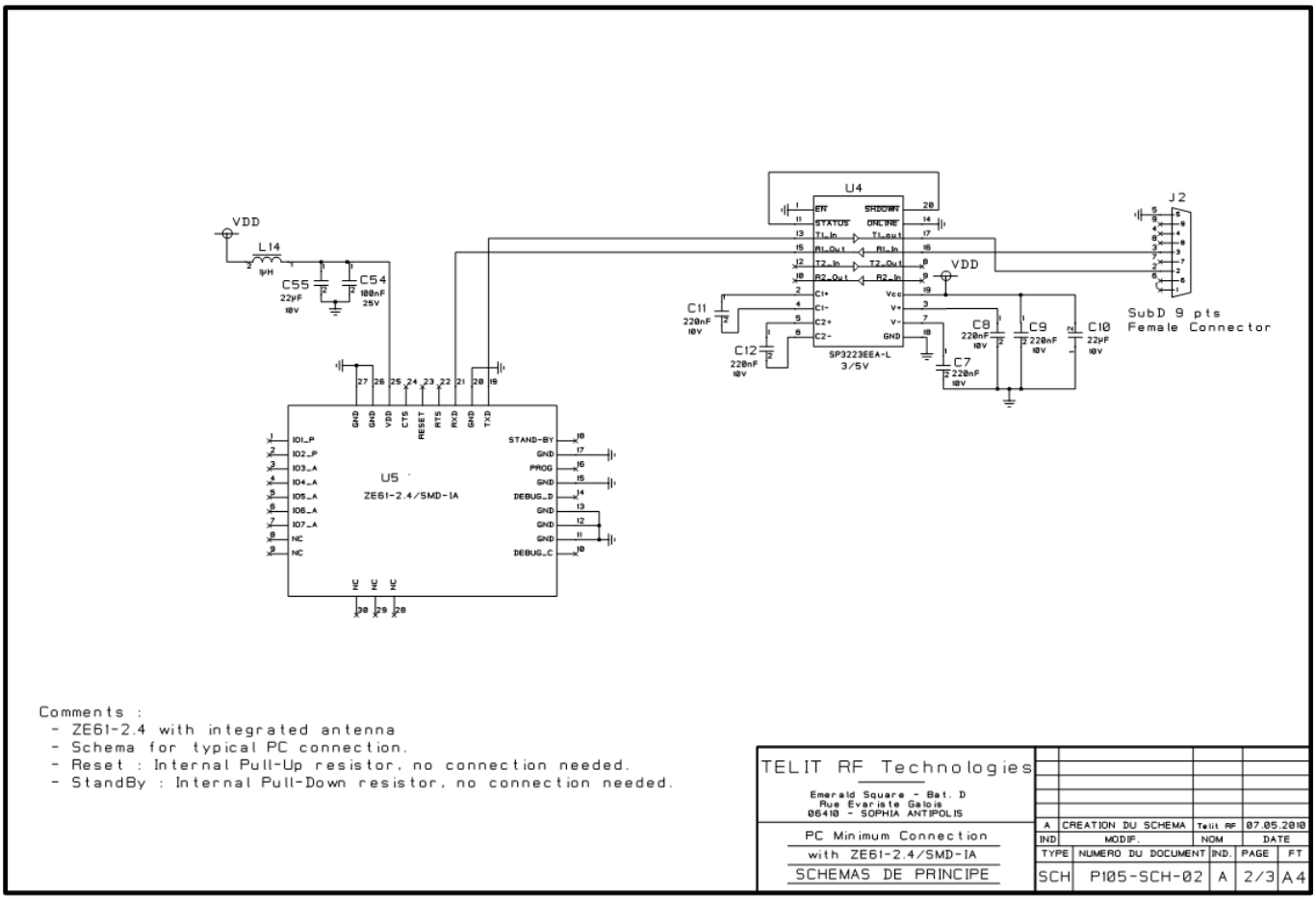
Table 2 : Values for simple face PCB with ground plane around coplanar wave guide (not recommended)

VI.5. ZE51/61-2.4 interfacing :

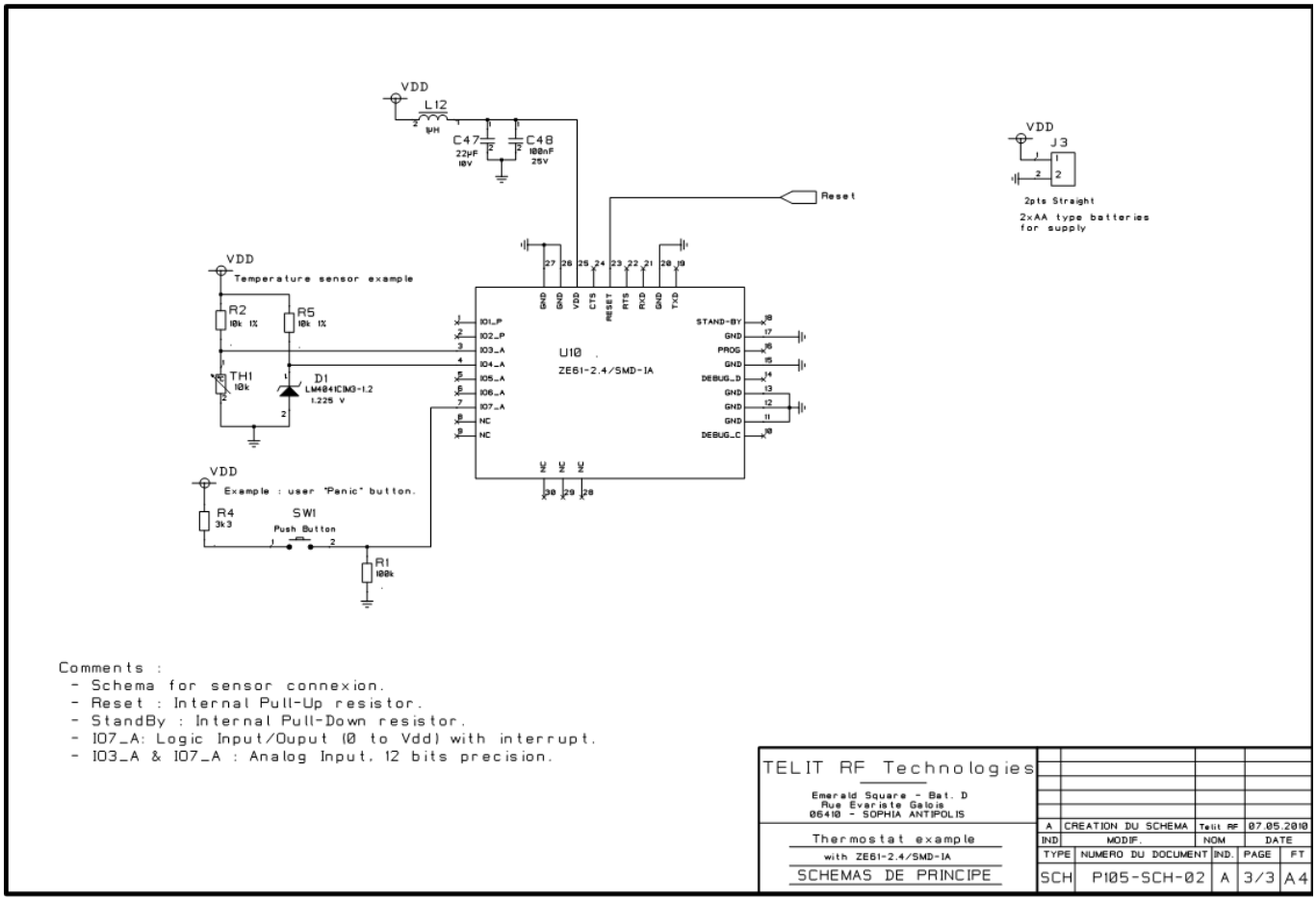
Example of a full RS-232 connection between a PC or an Automat (PLC) and **ZE51/61-2.4/SMD-WA**



Example of a minimum PC connection with **ZE51/61-2.4/SMD-IA .**



Example for sensor connection with **ZE51/61-2.4/SMD-IA**.



CHAPTER VII. ANTENNA CONSIDERATIONS

VII.1. Antenna recommendations

ZE51/61-2.4 performances when used in a product are strongly dependent on the antenna type and its location. Particular cautions are required on the following points:

- Use a good and efficient antenna designed for the 2.4 GHz band.
- Antenna must be fixed in such a location that electronic noise cannot affect the performances. (Outside location is ideal if available).
- Antenna directivity must be low (Omni directional antenna is usually the best choice).

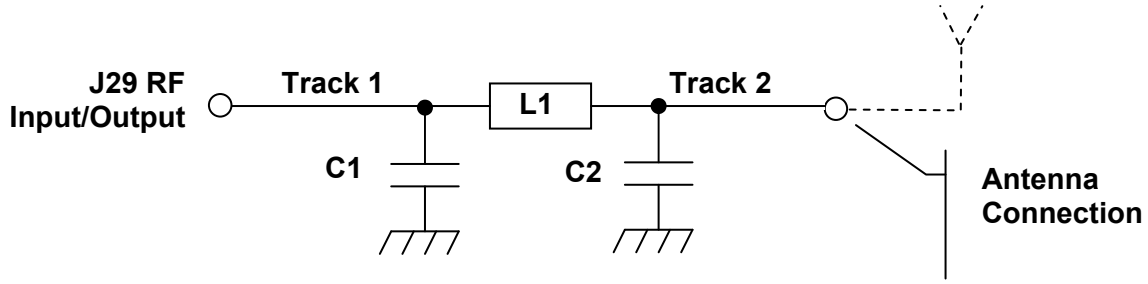
Recommended antenna specifications:

- Frequency Band : 2440MHz +/- 100MHz
- Radiation Pattern : Omni directional
- Nominal Impedance: 50 Ω
- VSWR: 1.5:1 max.
- Gain: 0dBi
- Polarization: Vertical

VII.2. Antenna matching

Impedance matching can be required to deliver the maximum possible power from the module to the antenna and vice versa. This is typically accomplished by inserting a matching network into a circuit between the source and the load.

This matching network must be established as close as possible to the ZE51/61 module. Here after an example of matching network between a ZE51/61-2.4 module and an antenna.



Symbols	*Reference*	*Package*	*Value*	*Comments*
L1	Coil	0603 or 0402	-	These values should be measured and optimized with a Network Analyzer. If no impedance matching is necessary, replace L1 by a 0 Ohm resistor, and let C1 and C2 not mounted.
C1, C2	Capacitor	0603 or 0402	-	
Track 1, Track 2	Coplanar Waveguide	• Track 1 length (as short as possible) • Track 2 length (as short as possible)		
Via	Ideally, ground vias and the RF output Via will have : drill of 0,35 mm pad of 0,75 mm			
Antenna connection	Coaxial cable Pad: Hot point: 2*2mm Ground pad:2*4mm Or a specific SMA connector can be used.			

See the layouts §VI.3 to have an idea of the antenna matching implantation :

- Antenna connection via a SMA connector (Top View)

VII.3. Antenna types

The following are the antenna examples that may be suitable for ZE51/61-2.4/SMD-WA applications. We distinguish two types of antenna:

- External antenna (antenna is mounted outside of the device)
- Embeddable antenna (antenna is integrated inside the device)

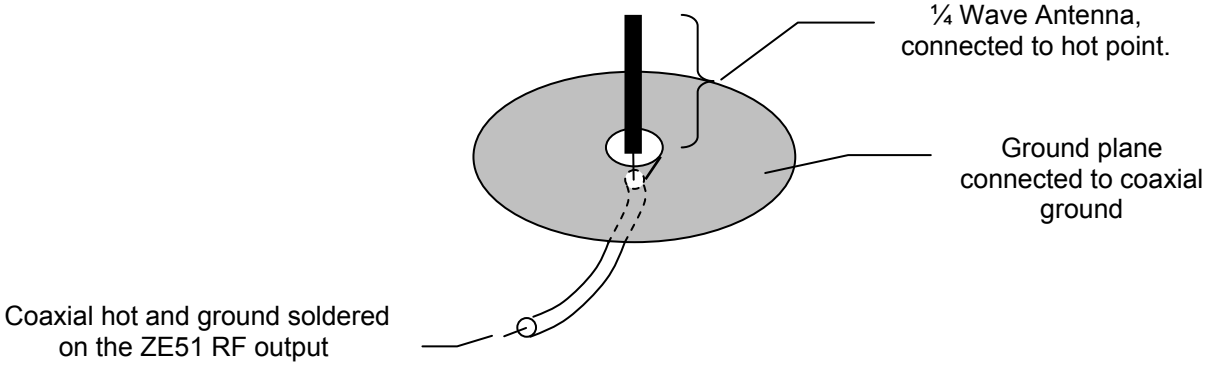
VII.4. External antenna

External antenna is recommended when the range performance is primordial. For example, for base stations and access points, where a better antenna gain may be required.

¼ Wave Monopole antenna:

The ¼ Wave antenna is 3 cm long @ 2.4 Ghz. Shorter compensated antennas could be used as long as they are adapted to 2.4 GHz frequency.

Best range may be achieved if the ¼ Wave antenna is placed perpendicular in the middle of a solid ground plane measuring at least 5 cm radius. In this case, the antenna should be connected to the module via some 50 ohm characteristic impedance coaxial cable.



WARNING
The metallic plane must be ideally under the antenna (balanced radiation). Never short-circuit the hot and cold pins!

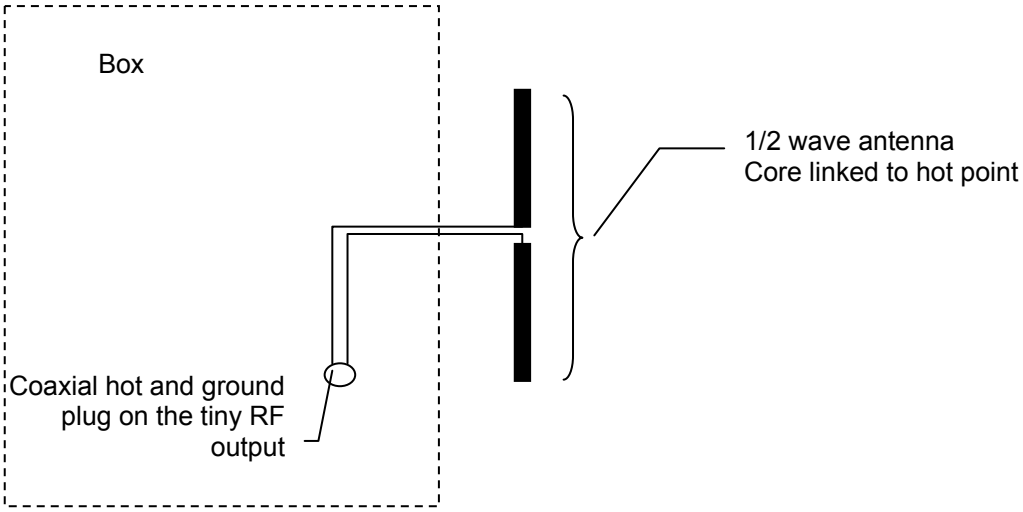
The installation directives are the following:

- Solder the coaxial cable on the hot and ground pad antenna (of the ZE51/61-2.4 module.)
- Fix the antenna on a metallic plane or on a metallic box with the metallic screw provided with the antenna.
- If the ZE51/61-2.4 module is integrated in a plastic box, use a metal tape (copper) glued on the plastic side under the antenna.

Half Wave Dipole antenna:

The ½ Wave Dipole antenna is around 6 cm long. In a ½ Wave Dipole antenna the metallic plane is replaced by a second ¼ Wave antenna balancing the radiation.

Half wave monopole antenna typically offers a ground-independent design with favorable gain, excellent radiation pattern. It has a high impedance and requires an impedance-matching circuit (See paragraph IX.3)



WARNING

It is recommended to place the ½ wave dipole antenna away from all metallic object, which will detuned it.

Particularity it is not recommended to place this type of antenna directly on a metallic box, but the antenna can be deported away through a 50 Ohm coaxial cable.

VII.5. Embeddable antennas

In this section you will find antennas designed to be directly attached to ZE51/61-2.4/SMD-WA module, inside the product casing. These antennas are only used in application where security, cosmetics, size or environmental issues make an external antenna impractical. This type of antenna is used when the integration factor becomes primordial (for mobile and handheld devices) to the range performances.

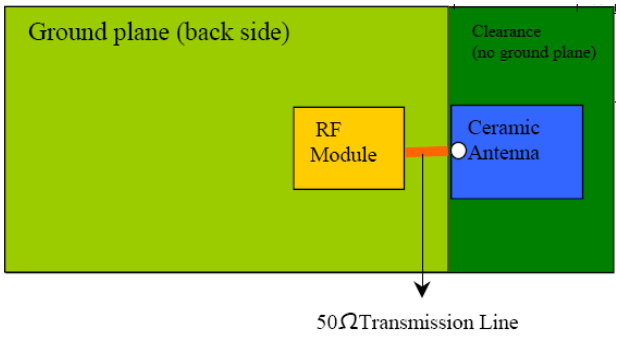
The basic recommendations are:

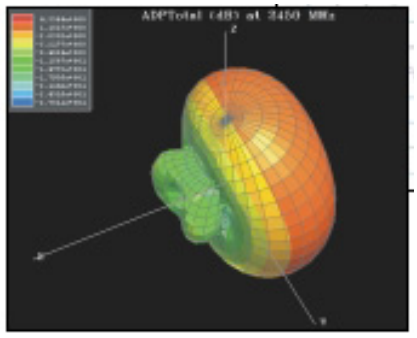
- The radio module must not be placed in a metallic casing or close to metallic devices.
- The internal antenna must be far from noisy electronic.

Ceramic antenna:

Ceramic antenna is a SMD component to be mounted directly on the PCB. It is designed so that it resonates and be 50 Ohms at the desired frequency. But we recommended to place an impedance-matching circuit (See paragraph VII.2).

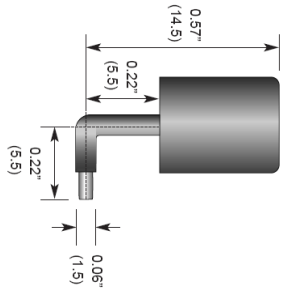
The place under and around the ceramic antenna must be free of any track or ground plane. (refer to the antenna constructor requirements). It usually has a hemispherical radiation pattern has described below.

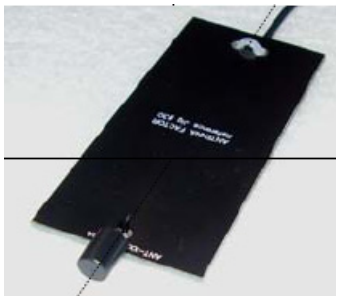


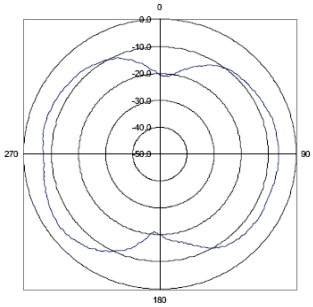


Miniaturized antenna:

This type of antenna features a through-hole feedline to directly attach it to the PCB. This antenna acts like a ¼ wave antenna so that a minimum ground plane is required.

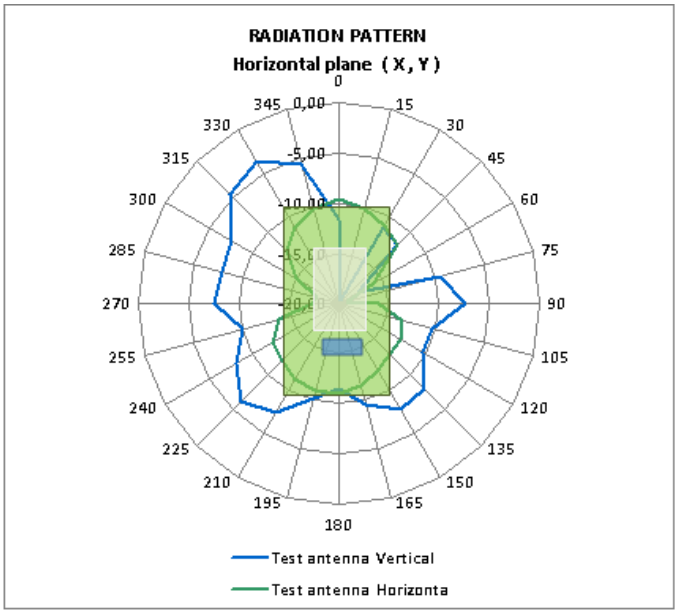


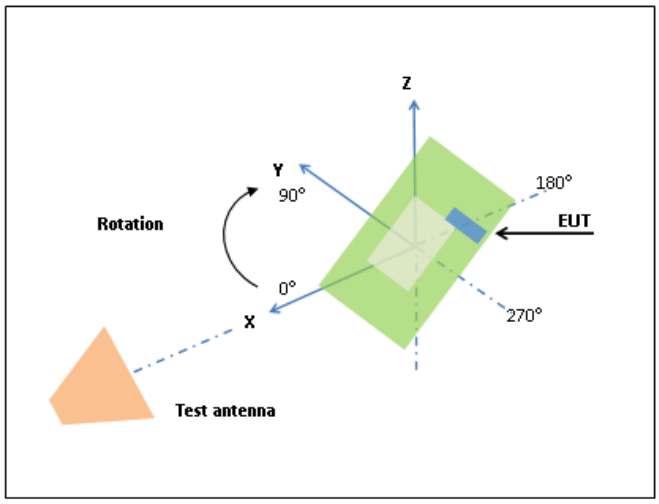


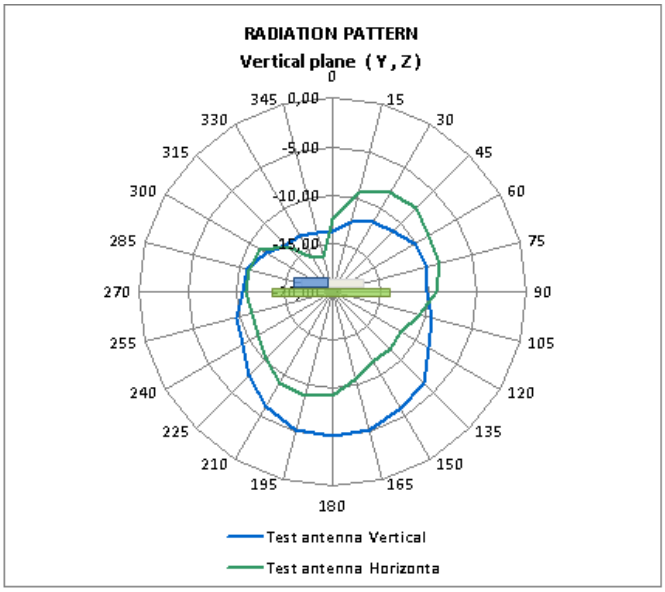


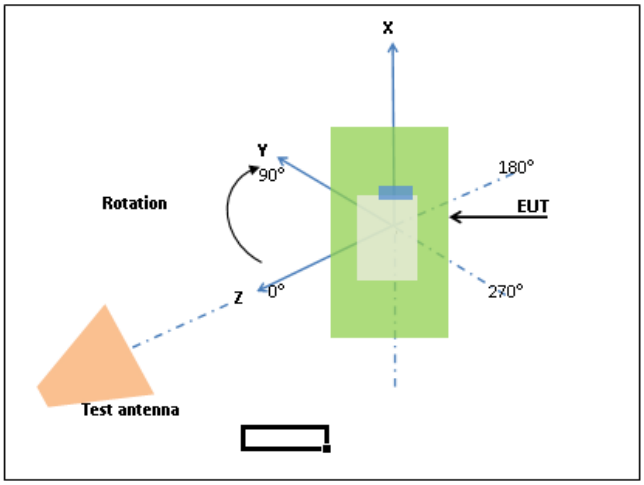
ZE51/61-2.4/SMD-IA: Integrated antenna:

ZE51/61-2.4 module is available with an integrated chip antenna, allowing very compact integration for small space application.









Radiation Pattern of ZE51-2.4/DIP board

It is very important to avoid ground plane around and below the antenna, so ZE51/61-2.4/SMD-IA must be implemented as described in paragraph VI.3 and schematics VI.5.

CHAPTER VIII. ANNEXES

VIII.1. Examples of propagation attenuation

Factor	433 MHz	868 MHz	2.4 GHz
	Attenuation	Attenuation	Attenuation
Open office	0 dB	0 dB	0 dB
Window	< 1 dB	1 – 2 dB	3 dB
Thin wall (plaster)	3 dB	3 – 4 dB	5 – 8 dB
Medium wall (wood)	4 – 6 dB	5 – 8 dB	10 – 12 dB
Thick wall (concrete)	5 – 8 dB	9 – 11 dB	15 – 20 dB
Armoured wall (reinforced concrete)	10 – 12 dB	12 – 15 dB	20 – 25 dB
Floor or ceiling	5 – 8 dB	9 – 11 dB	15 – 20 dB
Armoured floor or ceiling	10 – 12 dB	12 – 15 dB	20 – 25 dB
Rain and/or Fog	20 – 25 dB	25 – 30 dB	?? *

** =* *Attenuations increase along with the frequency. In some cases, it is therefore difficult to determine loss and attenuation value.*

Note = *The table above is only indicative. The real values will depend on the installation environment itself.*