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WT11u

DATA SHEET

Monday, 12 December 2016

Version 0.9.6

VERSION HISTORY

Version	Comment
0.8	Initial versions
0.81	Ordering information updated
0.9	Reformatted tables, many WT11i->WT11u updates
0.9.1	Rest of tables reformatted
0.9.2	Updated dimension drawings
0.9.3	Certification information, RF parameters
0.9.4	Added sensitivity and current consumption measurements
0.9.5	Changed Transmit power variation over supply voltage range to 0.5 and typical transmit power to 16.5dBm
0.9.6	Small edits to specifications

TABLE OF CONTENTS

WT11u *Bluetooth®* Module

DESCRIPTION

WT11u is a fully integrated Bluetooth 2.1 + EDR, class 1 module combining antenna, Bluetooth radio and an on-board iWRAP Bluetooth stack. Silicon Labs WT11u provides an ideal solution for developers that want to quickly integrate long range and high performance Bluetooth wireless technology to their design without investing several months into Bluetooth radio and stack development. WT11u provides a 100dB link budget ensuring long rage and robust Bluetooth connectivity. WT11u uses Silicon Labs' iWRAP Bluetooth stack, which is an embedded Bluetooth stack implementing 13 different Bluetooth profiles and Apple iAP connectivity. By using WT11u combined with iWRAP Bluetooth stack and Silicon Labs' excellent technical support designers ensure quick time to market, low development costs and risk.

APPLICATIONS:

- Industrial and M2M
- Point-of-Sale devices
- Computer Accessories

KEY FEATURES:

Radio features:

- Bluetooth v.2.1 + EDR
- Bluetooth class 1 radio
- Transmit power: +17 dBm
- Receiver sensitivity: -84 dBm (DH5)
- Range: 350 meters line-of-sight
- Integrated chip antenna or U.FL connector

Hardware features:

- UART and USB host interfaces
- 802.11 co-existence interface
- 6 software programmable IO pins
- Operating voltage: 2.7V to 3.6V
- Temperature range: -40C to +85C
- Dimensions: 35.75 x 14.50 x 2.6 mm

Qualifications:

- *Bluetooth*
- CE
- FCC
- IC
- Japan

PHYSICAL OUTLOOK

1 Ordering Information

Firmware	U.FL Connector	Internal chip antenna
iWRAP 5.6 firmware	WT11u-E-AI56	WT11u-A-AI56
iWRAP 5.5 firmware	WT11u-E-AI55	WT11u-A-AI55
iWRAP 5.0.1 firmware	WT11u-E-AI5	WT11u-A-AI5
HCI firmware, BT2.1 + EDR	WT11u-E-HCI21	WT11u-A-HCI21

Table 1: Ordering information

2 Pinout and Terminal Description

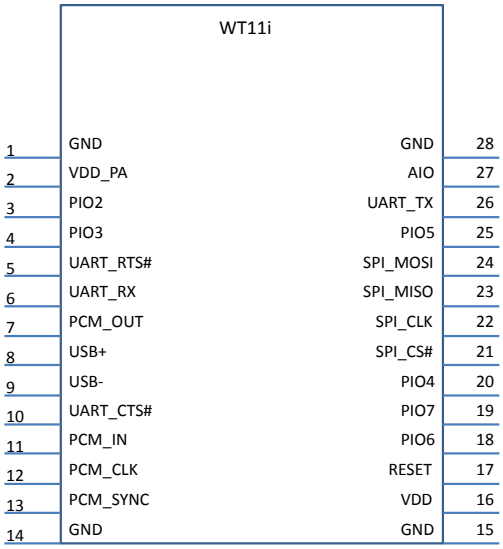


Figure 1: WT11u connection diagram

Pad name	Pad number	Pad type	Description
RESET	17	Input	Reset input, active high, internal 220kohm pull-down. Keep high for >5ms for reset
GND	1, 14, 15, 28	GND	Ground connection, connect all to a ground plane with minimal trace lengths
VDD_PA	2	Supply voltage	Supply voltage for RF power amplifier
VDD	16	Supply voltage	Chipset supply voltage

Table 2: Supply and RF Terminal Descriptions

PIO signal	Pad number	Description
PIO[2]	3	Bi-directional digital in/out with programmable strength and pull-up/pull-down
PIO[3]	4	Bi-directional digital in/out with programmable strength and pull-up/pull-down
PIO[4]	20	Bi-directional digital in/out with programmable strength and pull-up/pull-down
PIO[5]	25	Bi-directional digital in/out with programmable strength and pull-up/pull-down
PIO[6]	18	Bi-directional digital in/out with programmable strength and pull-up/pull-down
PIO[7]	19	Bi-directional digital in/out with programmable strength and pull-up/pull-down
AIO[1]	27	Bi-directional analog in/out

Table 3: GPIO Terminal Descriptions

PCM signal	Pad number	Pad type	Description
PCM_OUT	7	Output, weak internal pull-down	Synchronous data output
PCM_IN	11	Input, weak internal pull-down	Synchronous data input
PCM_SYNC	13	Bi-directional, weak internal pull-down	Synchronous data sync
PCM_CLK	12	Bi-directional, weak internal pull-down	Synchronous data clock

Table 4: PCM Terminal Descriptions

UART signal	Pad number	Pad type	Description
UART_TX	26	Output, weak internal pull-up	UART data output, active high
UART_RTS#	5	Output, weak internal pull-up	UART request to send, active low
UART_RX	6	Input, weak internal pull-down	UART data input, active high
UART_CTS#	10	Input, weak internal pull-down	UART clear to send, active low

Table 5: UART Terminal Descriptions

USB signal	Pad number	Pad type	Description
USB+	8	Bidirectional	USB data line with internal 1.5kohm pull-up
USB-	9	Bidirectional	USB data line

Table 6: USB Terminal Descriptions

SPI signal	Pad number	Pad type	Description
SPI_MOSI	24	Input, weak internal pull-down	SPI data input
SPI_CS#	21	Input, weak internal pull-up	Chip select, active low
SPI_CLK	22	Input, weak internal pull-down	SPI clock
SPI_MISO	23	Output, weak internal pull-down	SPI data output

Table 7: Terminal Descriptions

3 Electrical Characteristics

3.1 Absolute Maximum Ratings

Specification	Min	Max	Unit
Storage temperature	-40	85	°C
VDD_PA, VDD	-0.4	3.6	V
Other terminal voltages	VSS-0.4	VDD+0.4	V

Table 8: Absolute Maximum Ratings

3.2 Recommended Operating Conditions

Specification	Min	Max	Unit
Operating temperature	-40	85	°C
VDD_PA*, VDD	3.0	3.6	V

*) VDD_PA has an effect on the RF output power.

Table 9: Recommended Operating Conditions

3.3 Input / Output Terminal Characteristics

3.3.1 Input/Output Terminal Characteristics (Digital)

Digital Terminals		Min	Typ	Max	Unit
Input Voltage Levels					
V_{IL} input logic level low	2.7 V ≤ VDD ≤ 3.0 V	-0.4	-	0.8	V
	1.7 V ≤ VDD ≤ 1.9 V	-0.4	-	0.4	V
V_{IH} input logic level high		0.7 VDD	-	VDD + 0.4	V
Output Voltage Levels					
V_{OL} output logic level low (I_O = 4.0 mA) 2.7V ≤ VDD ≤ 3.0 V		-	-	0.2	V
VOL output logic level low (I_O = 4.0 mA) 1.7V ≤ VDD ≤ 1.9		-	-	0.4	V
VOL output logic level high (I_O = 4.0 mA) 2.7V ≤ VDD ≤ 3.0		VDD - 0.2	-		V
VOL output logic level high (I_O = 4.0 mA) 1.7V ≤ VDD ≤ 1.9		VDD - 0.4	-		V
Input and Tristate Current with					
Strong pull-up		-100	-40	-10	µA
Strong pull-down		10	40	100	µA
Weak pull-up		-5.0	-1.0	-0.2	µA
Weak pull-down		0.2	1.0	5.0	µA
I/O pad leakage current		-1	0	1	µA
C_I input capacitance		1.0	-	5.0	pF

3.3.2 Input/Output Terminal Characteristics (USB)

USB Terminals	Min	Typ	Max	Unit
VDD_USB for correct USB operation	3.1		3.6	V
Input Threshold				
V_{IL} input logic level log	-	-	0.3VDD_USB	V
V_{IH} input logic level high	0.7VDD_USB	-	-	V

3.4 PIO Current Sink and Source Capability

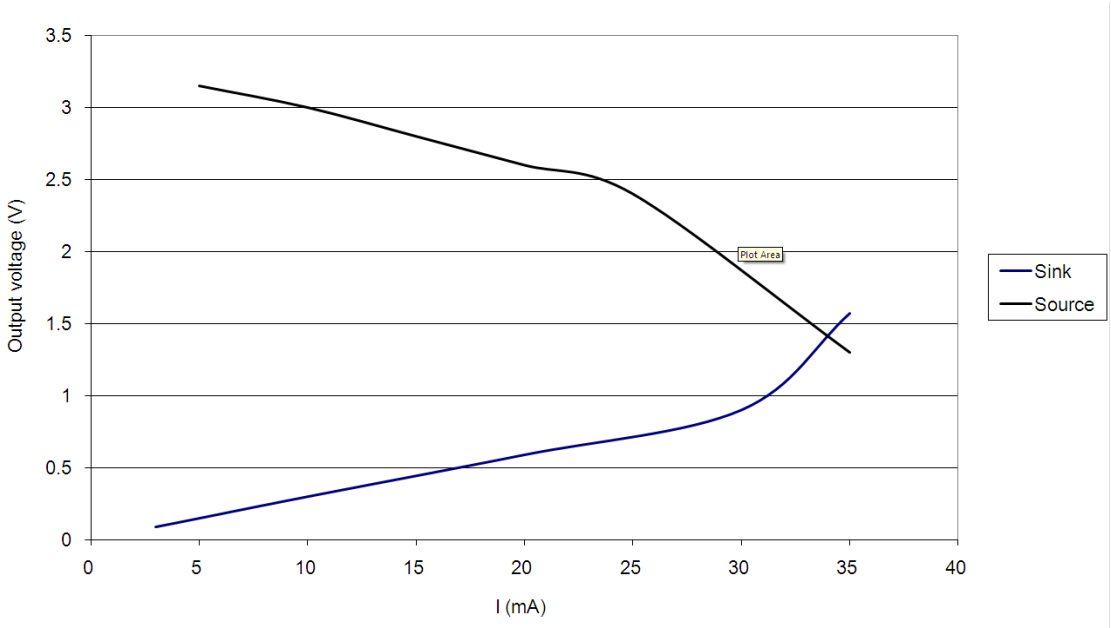


Figure 2: WT11u PIO Current Drive Capability

3.5 Transmitter Performance For BDR

RF characteristic	Min	Typ	Max	Bluetooth specification	Unit
Max transmit power		16.5		<20	dBm
Transmit power variation over temperature range	-2		2		dB
Transmit power variation over supply voltage range	-0.5		0.5		dB
Transmit power variation over frequency range	-0.5		0.5		dB
Transmit power control range	-15		15		dB
20dB bandwidth for modulated carrier		950		<1000	kHz
Avg drift	-10		3	±40	kHz
ΔF1avg		166		140 to 175	kHz

Table 10: Transmitter performance for BDR (room temperature, VDD=3.3V)

3.6 Receiver Performance

Antenna gain not taken into account

Characteristic, VDD=3.3V, room temperature	Packet type	Typ	Bluetooth specification	Unit
Sensitivity for 0.1% BER	DH1	-86	-70	dBm
	DH5	-83.5		dBm
	2-DH1	-88		dBm
	2-DH5	-86.5		dBm
	3-DH1	-81.5		dBm
	3-DH5	-79.5		dBm
Sensitivity variation over temperature range		+/- 2		dB

3.7 Current Consumption

Operating mode	Peak	Average	Unit
Stand-by, page mode 0 2000 1		1.7	mA
TX 3-DH5, max duty cycle	111	88	mA
TX 2-DH5, max duty cycle	110	88	mA
TX DH5, max duty cycle	176	138	mA
RX	43	36	mA
Deep sleep, page mode 0 2000 1		51	µA
Inquiry	117	58	mA

Table 11: WT11u Current Consumption

3.8 WT11u-A Antenna Specification

WT11u-A uses a monopole type on a chip antenna with maximum gain of 0.5 dBi. The radiation pattern and the total radiated efficiency are dependent on the layout and any metal around the antenna has an effect on the radiation characteristics. Typically the efficiency is 30 … 50%.

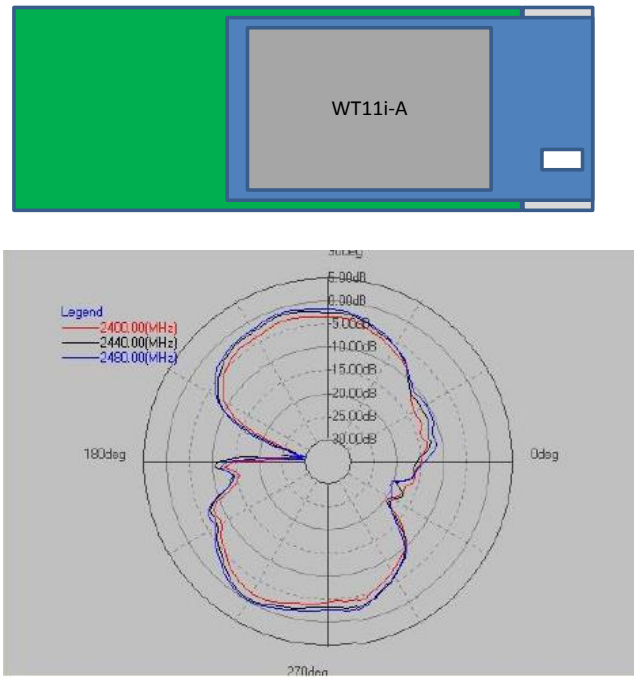


Figure 3: Antenna radiation pattern in a USB dongle layout

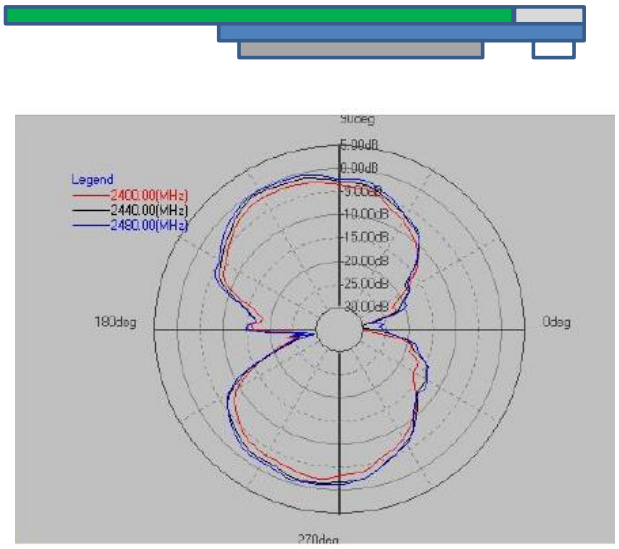


Figure 4: Antenna radiation pattern in a USB dongle layout

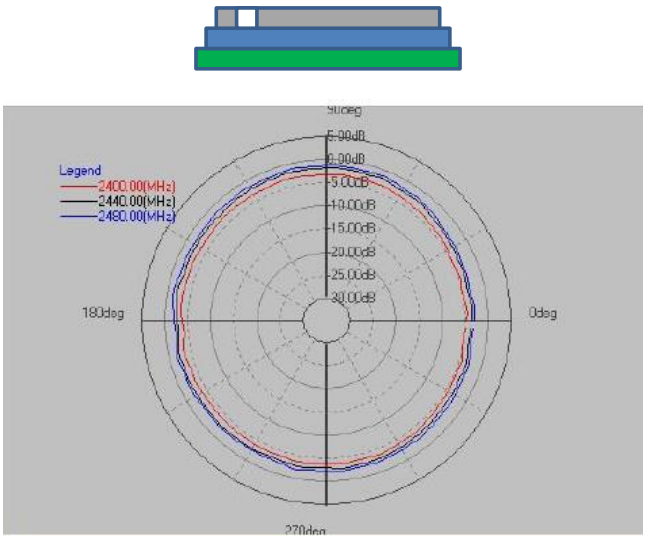


Figure 5: Antenna radiation pattern in a USB dongle layout

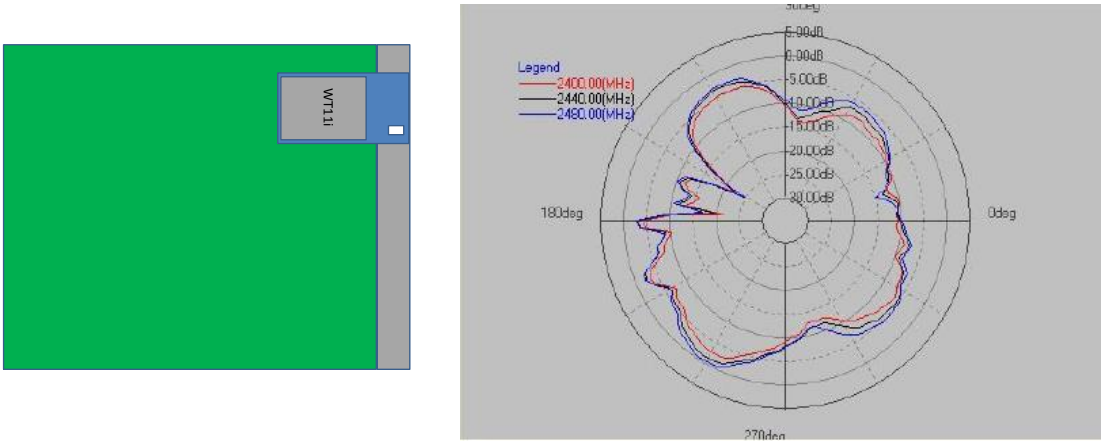


Figure 6: Antenna radiation pattern in the WT11 evaluation kit

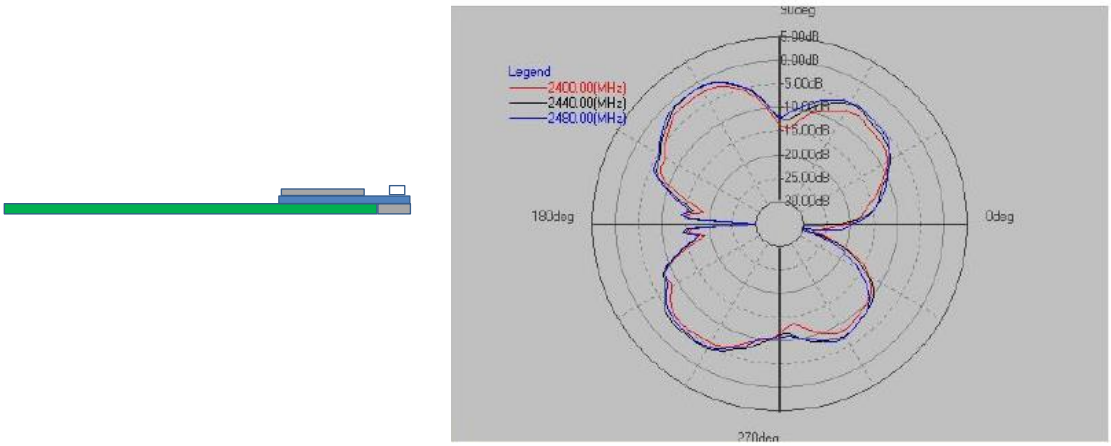


Figure 7: Antenna radiation pattern in the WT11 evaluation kit

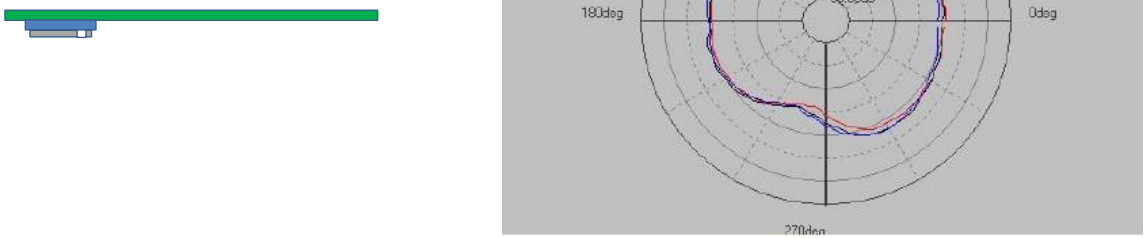


Figure 8: Antenna radiation pattern in the WT11 evaluation kit

4 Physical Dimensions

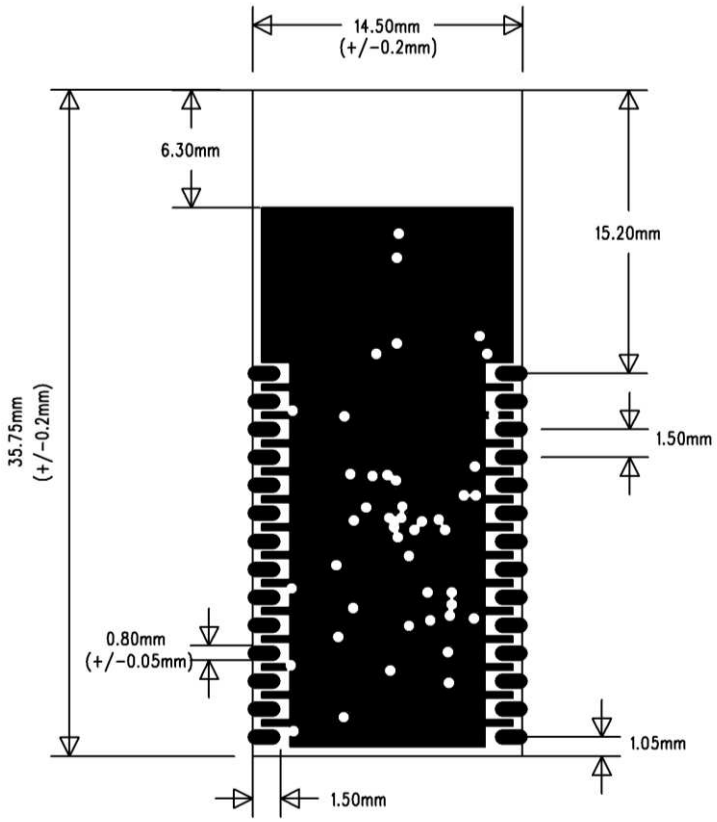


Figure 9: Physical dimensions (top view)

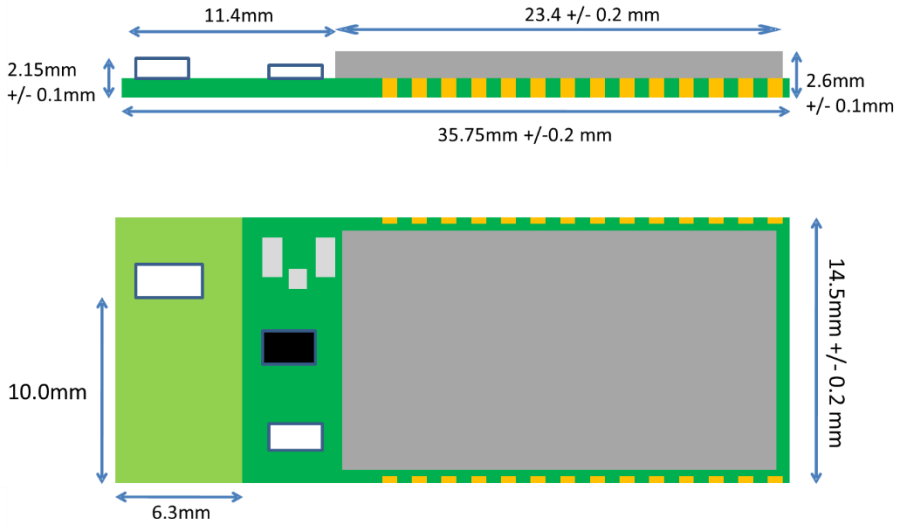


Figure 10: Dimensions of WT11u-A

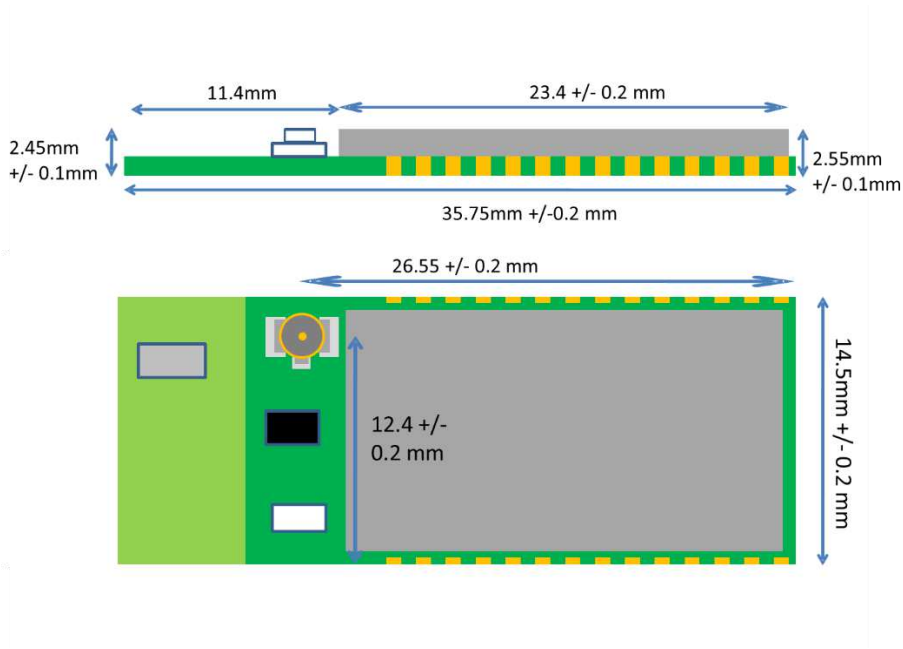
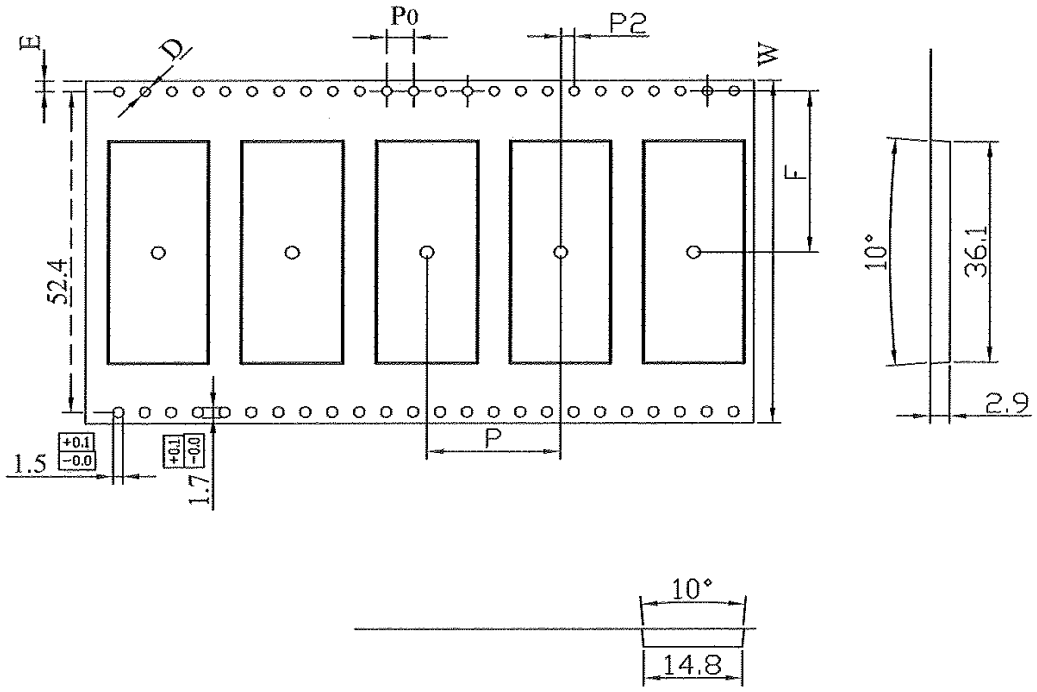


Figure 11: Dimensions of WT11u-E

4.1 Package Drawings

ITEM	W	A0	B0	K0	K1	P	E	F	D	D1	P0	P2
DIM	$56^{+0.3}_{-0.3}$	$14.8^{+0.1}_{-0.1}$	$36.1^{+0.1}_{-0.1}$	$2.9^{+0.1}_{-0.1}$	$0^{+0.1}_{-0.1}$	$20^{+0.1}_{-0.1}$	$1.75^{+0.1}_{-0.1}$	$26.2^{+0.1}_{-0.1}$	$1.5^{+0.1}_{-0.0}$	$2.0^{+0.25}_{-0.0}$	$4.0^{+0.1}_{-0.1}$	$2.0^{+0.1}_{-0.1}$



NOTE:

1.10 sprocket hole pitch cumulative tolerance±0.2
2.Carrier camber is 1mm in 100mm
3.A0 and B0 measured on a plance 0.3mm above the bottom of the pocket
4.K0 measured from a plane on the inside bottom of the pocket to the top surface of the carrier
5.All dimensions meet EIA-481-2 requirements
6. 22" 1R= 65M 3000PCS 13"1R= 500PCS

Figure 12: WT11u taping

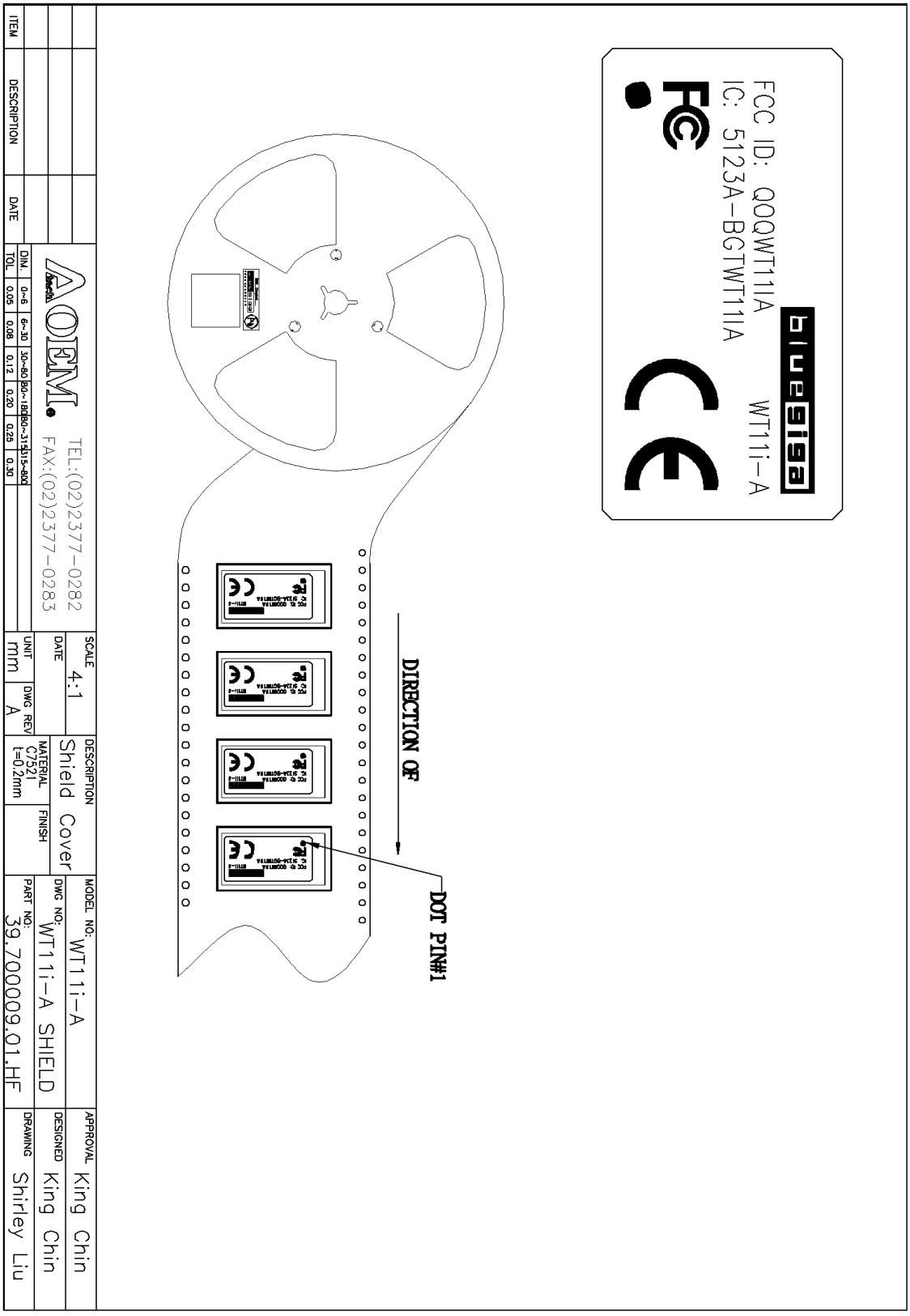


Figure 13: WT11u orientation in the reel

5 Layout Guidelines

WT11u is pin compatible with WT11i and WT11, despite slightly different external dimensions compared to WT11. For a new design it recommended to follow the land pattern shown in the figure below.

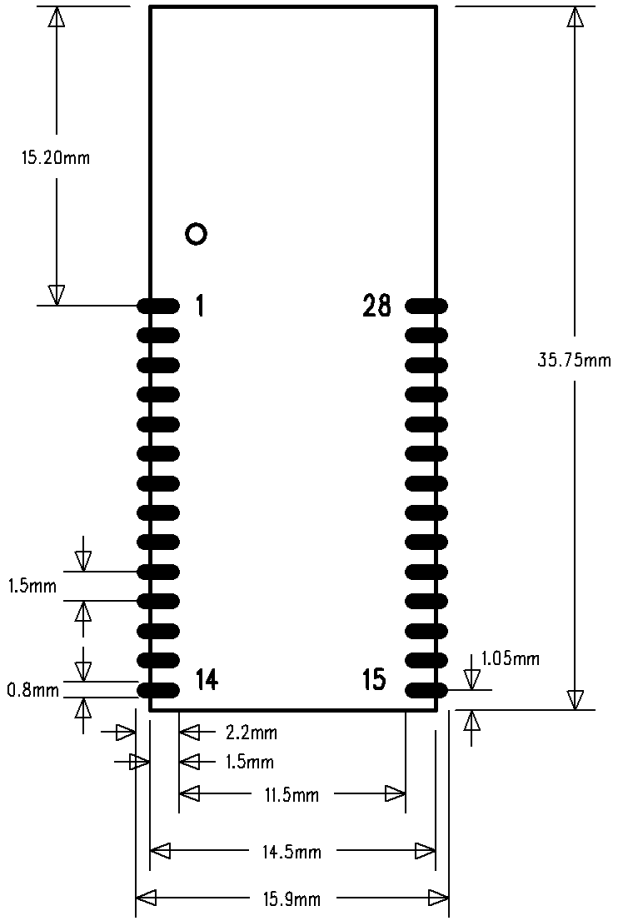


Figure 14: Recommended PCB land pattern for WT11u

Do not place any copper under the antenna. The minimum recommended keep out area is shown in the Figure 15. Any dielectric material in close proximity to the antenna will effect on the impedance matching of the antenna by lowering the resonance frequency. Figure 16 shows how different FR4 thickness under the antenna effect on the resonance frequency. Recommended PCB thickness for the PCB is 1.6 mm – 2.8 mm. Avoid placing plastic cover closer than 3 mm from the antenna as this will also tune the resonance frequency downwards.

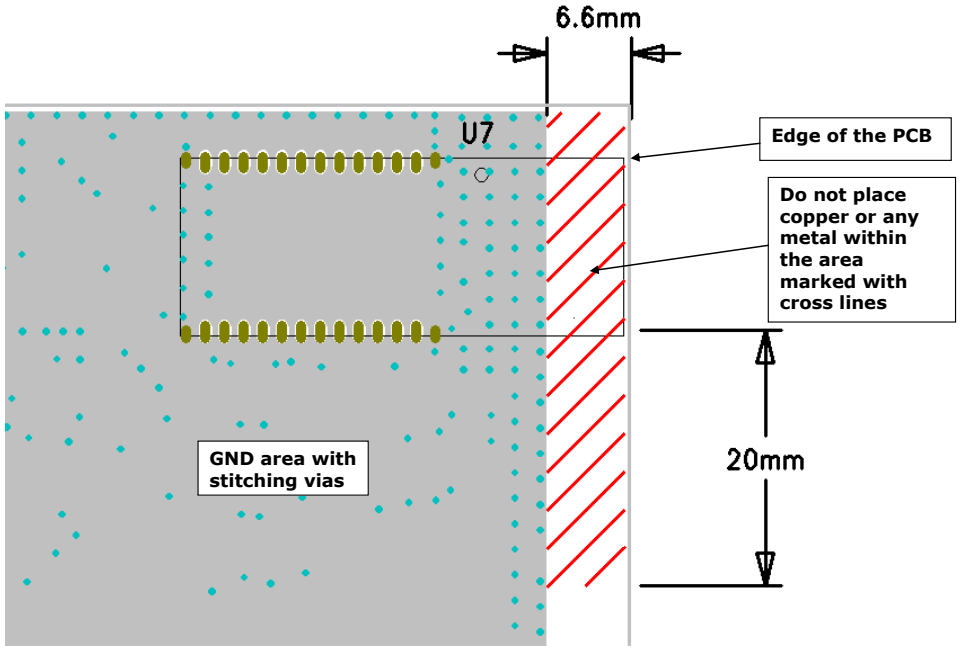


Figure 15: Recommended metal keep put area for WT11u

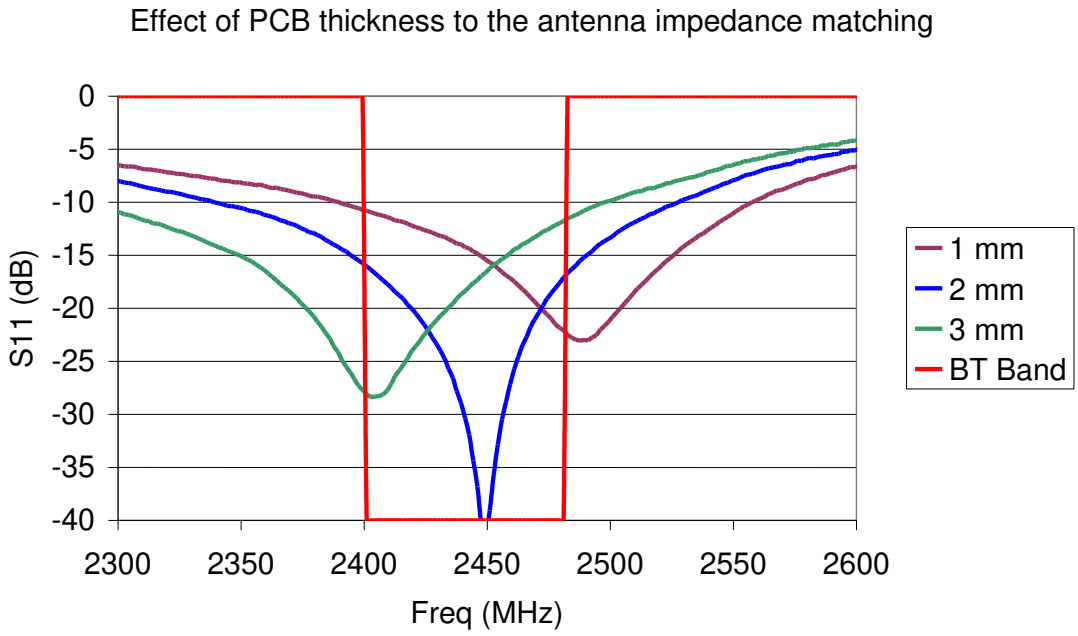


Figure 16: Effect of FR4 under the antenna to the resonant frequency

Use good layout practices to avoid excessive noise coupling to supply voltage traces or sensitive analog signal traces, such as analog audio signals. If using overlapping ground planes use stitching vias separated by max 3 mm to avoid emission from the edges of the PCB. Connect all the GND pins directly to a solid GND plane and make sure that there is a low impedance path for the return current following the signal and supply traces all the way from start to the end.

A good practice is to dedicate one of the inner layers to a solid GND plane and one of the inner layers to supply voltage planes and traces and route all the signals on top and bottom layers of the PCB. This arrangement will make sure that any return current follows the forward current as close as possible and any loops are minimized.

Figure 17: Typical 4-layer PCB construction

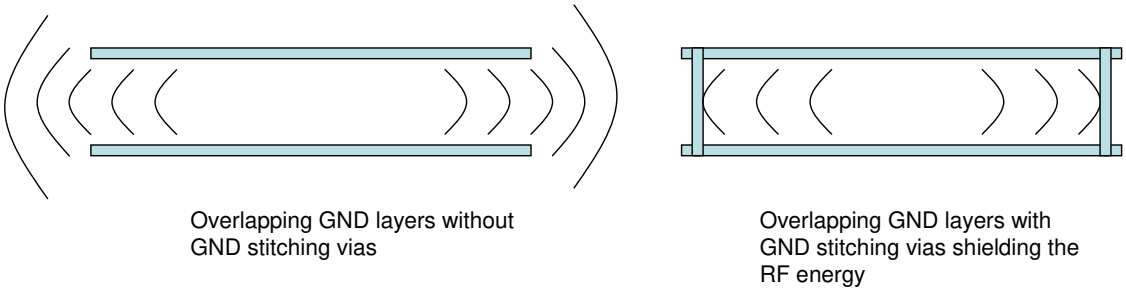


Figure 18: Use of stitching vias to avoid emissions from the edges of the PCB

6 UART Interface

This is a standard UART interface for communicating with other serial devices.WT11u UART interface provides a simple mechanism for communicating with other serial devices using the RS232 protocol.

Four signals are used to implement the UART function. When WT11u is connected to another digital device, UART_RX and UART_TX transfer data between the two devices. The remaining two signals, UART_CTS and UART_RTS, can be used to implement RS232 hardware flow control where both are active low indicators. All UART connections are implemented using CMOS technology and have signalling levels of 0V and VDD.

UART configuration parameters, such as data rate and packet format, are set using WT11u software.

Note:

In order to communicate with the UART at its maximum data rate using a standard PC, an accelerated serial port adapter card is required for the PC.

Parameter	Possible values	
Data rate	Minimum	1200bps (2% error)
		9600bps (1% error)
	Maximum	3Mbps (1% error)
Flow control	RTS/CTS or None	
Parity	None, Odd or Even	
Number of stop bits	1 or 2	
Bits per channel	8	

Table 12: Possible UART Settings

The UART interface is capable of resetting WT11u upon reception of a break signal. A break is identified by a continuous logic low (0V) on the UART_RX terminal, as shown in Figure 19. If tBRK is longer than the value (in microseconds), defined by PSKEY_HOST_IO_UART_RESET_TIMEOUT, (0x1a4), a reset will occur. Values below 1000 are treated as zero and values above 255000 are truncated to 255000. This feature allows a host to initialise the system to a known state. Also, WT11u can emit a break character that may be used to wake the host.

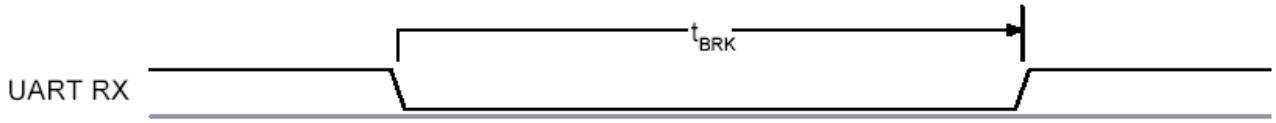


Figure 19: Break Signal

Table 13 shows a list of commonly used data rates and their associated values for PSKEY_UART_BAUD_RATE (0x204). There is no requirement to use these standard values. Any data rate within the supported range can be set in the PS Key according to the formula in Equation 1