Technical Description

The Equipment under Test (EUT) is a gamepad for the Nintendo Wii console. It is powered by a 2-AA size batteries and setup to 3.2V

The main function of EUT is a gamepad included 13 keys, motion sensor, CMOS sensor, motor, sound chip, expansion port and Bluetooth module. It connects to the Wii console by Bluetooth protocol.

Operating Frequency Band: 2402 MHz ~ 2480 MHz
Sensitive: down to -81dBm
Spread Spectrum: FHSS
Modulation Method: GFSK.

The functions of main ICs are mentioned as below.
1) RF1 is a Bluetooth module, including the BT79313 and EEPROM. BT79313 acts as Bluetooth Chip performs Bluetooth function, EEPROM acts as external memory.
2) U1 acts as MCU for system and gaming control.
3) U2 acts as motion sensor for gaming.
4) U7 acts as CMOS sensor module for gaming.
5) U9 acts as sound chip for gaming.
6) J1 acts as expansion port for gaming
7) Q1 acts as setup voltage regulator provide 3.2VDC to all system.

BT79313 Specification

Printed: December 2009 in Taiwan

General Description

The BT79313 is a highly integrated single chip Bluetooth device with a stand-alone baseband processor and integrated 2.4 GHz transceiver and is compliant to Bluetooth 2.0. This chip is specifically designed for applications in wireless input devices including keyboards, mice, presenters and gaming controllers. Built-in firmware is fully compliant to Bluetooth® Human Interface Device (HID) profile.

Application

- Wireless mouse
- Wireless keyboard
- Game controllers
- Presenters
- Remote controls
- GPS mouse (G-mouse)

RF-Transceiver

- Clean, fast hopping synthesizer
- 0 dBm, 1 Mbps GFSK transmitter
- Analog and Digital filtered receiver
- Internal VCO resonator and PLL filter
- 50 ohm ant. port eliminates most external RF parts

Features

- Compliant with Bluetooth® Specification V2.0
- Compliant with Bluetooth® HID profile version 1.0
- Support AFH
- Embedded 8-bits 'C51 compatible Micro-Controller
- Internal 128 kB mask ROM and 8 kB SRAM
- On chip support for common mouse sensor interface eliminates external processor
- On chip support for Serial Peripheral Interface (SPI) (mater/slave mode)
- Optional I^2C compatible interface
- Built-in Power On Reset (POR)
- Built-in 8-bit accuracy/10-bit resolution ADC with 4 input channels for detecting low power of battery and reading various analog sensors such as 3-axis accelerometer, etc.
- Low Power 1.8V core operation
- Integrated Switch-mode Regulators (1 BUCK and 1 BOOST) to support external sensor, LED/Laser and MCU to reduce external BOM cost.
- Crystal oscillator with built-in digital trimming
- Power management includes digital shutdown and wake up commands with an integrated low power oscillator for sniff mode
- Support MCP option with 4 Megabit Flash
- Support COB (Chip on Board) option
- 56-Pin QFN package available (8 x 8 x 0.9 mm)

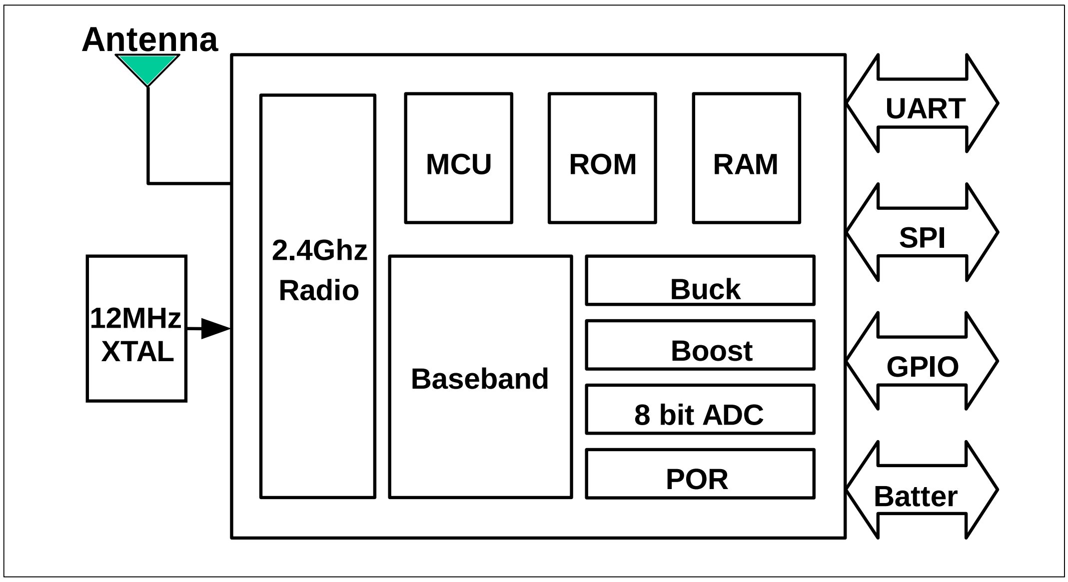


Figure 1 – Functional Block Diagram

1. Scope

The document is a specification of BT79313.

1.1 Document Information

Document No. :					
Version :	1.04	Total Page:	28	Date	2009/02/17
Title :	ASIC Data Sheet				
Product Name :	BT79313				

1.2 Update History

Versio	Date/nam	Description
0.0	2008/01/24	Established
--	--	(status= Preliminary)
1.0	2008/12/03	Change status from Preliminary to Product. Minor updates throughou Indicate Buck regulator output as 1.83V, not 1.8V, wherever applicable. Add Key Features page. Add vendor list for xtal. Add Buck converter output filter values.
1.01	2009/02/02	Fix spelling on all page headers. Page 25: change Rr t Effective
1.02	2009/02/09	P. 1, 13, 18: Update accuracy of ADC to 8-bit. P. 3: Update T.O.C. P. 6: RF Interface: Add pin 57 to table. Clarify pins that are Test Pts. P. 10: Redraw module schematic to eliminate multiple net names. Last page: Remove leading '0' from phone number.
1.03	2009/02/10	P. 5: Fix formatting of Fig. 2. Show pin 57. P. 9: Remove multiple net names on schematic. Correct spelling. P. 10: Additional schematic clean-up. Annotate photo.
1.04	2009/02/17	P. 10: Add/clarify annotations to photo. P. 16: Update Fig. 3 Bluetooth Software Stack. P. 19: Clarify first paragraph; add "optional" for Boost reg.

Key Features

- Common TX/RX terminal simplifies external matching.
- Full RF reference designs available
- Bluetooth v2.0 Specification compliant

Auxiliary Features

- Crystal oscillator with built-in digital trimming
- Power management includes digital shutdown and wake up commands with an integrated low power oscillator for sniff mode
- 8-bit ADC available with 4 input channels to applications
- Built-in power reset to secure IC stability while powering up and to re-start up IC while system power is unstable
- Programmable mouse sensor operations in EEPROM with internal HW support to be compatible to future new mouse sensors without ROM code change.
- Provide limited code patching from EEPROM to support more features without ROM code change.
- Built-in BUCK and BOOST to provide whole system power with 1.8V and 3.3V while using two batteries.

Baseband and Software

- Internal 1Mbit ROM
- Logic for forward error correction, header error control, access code correlation, CRC, encryption bit stream generation and whitening

Physical Interface

- Optional I^2C compatible interface
- Optional SPI interface with master/slave mode that can be used while BT79313 act as Bluetooth bridge.

Bluetooth Stack

- Customized builds with embedded application code

Package Options

- 56-pin QFN, 8 x 8 x 0.9 mm, 0.5 mm pitch

Pinout Information

Pin Assignment Diagram

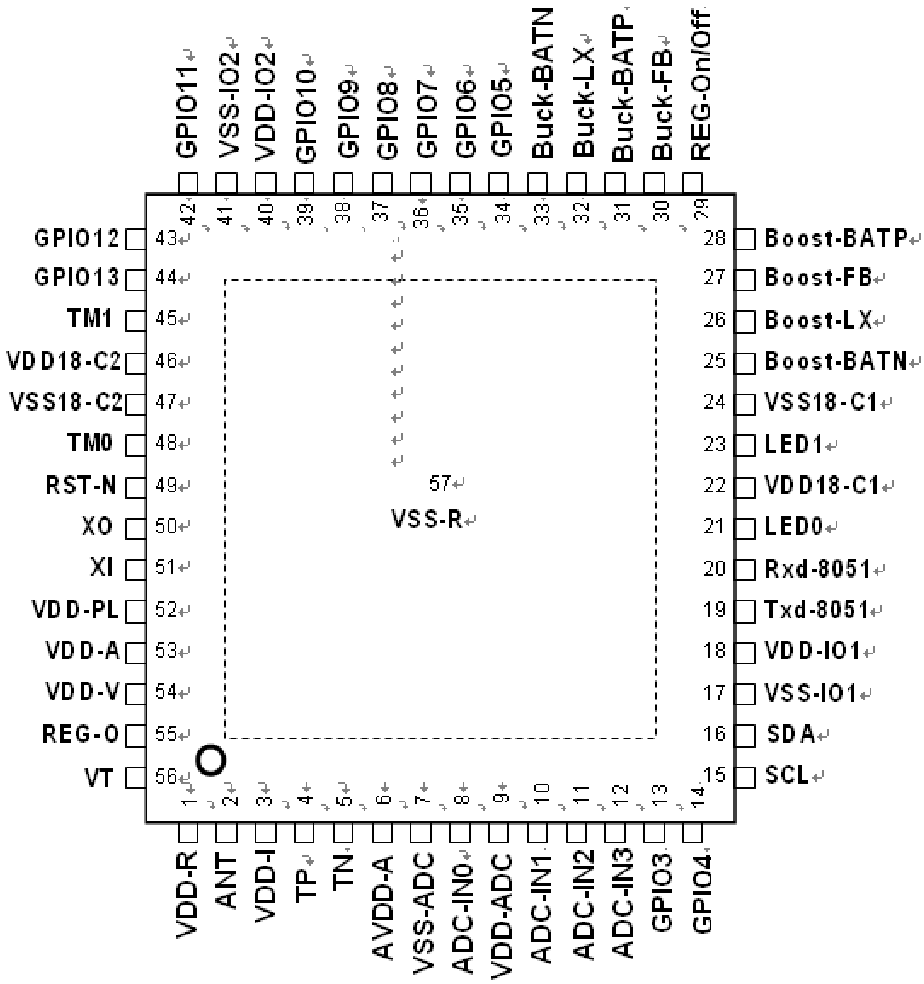


Figure 2 – Pin Assignment Diagram

Pin definition

Oscillator	Pin	Pad Type	Supply Pad	Description
XI	51	AI	VDD-R	For crystal
XO	50	AO	VDD-R	Drive for crystal

Test	Pin	Pad Type	Supply Pad	Description
TM0	48	I, PD	VDD-IO	For test mode
TM1	45	I, PD	VDD-IO	For test mode

RF Interface	Pin	Pad Type	Supply Pad	Description
VDD-R	1	P	N/A	1.8V input for RF power
VSS-R	57	P, AIO	N/A	Ground reference for RF.
VDD-I	3	P	N/A	1.8V input for RF power
AVDD-A	6	P	N/A	1.8V input for RF power
VDD-PL	52	P	N/A	1.8V input for RF power
VDD-A	53	P	N/A	1.8V input for RF power
VDD-V	54	P	N/A	1.8V input for RF power
REG-O	55	P	N/A	Regulator out
ANT	2	AIO	N/A	RF antenna for transceiver
VT	56	AIO	N/A	Test point VT
TP	4	AO	N/A	Test point TP
TN	5	AO	N/A	Test point TN

LED	Pin	Pad Type	Supply Pad	Description
LED0	21	OD	VDD-IO	Open-drain I/O for LED Drivers
LED1	23	OD	VDD-IO	Open-drain I/O for LED Drivers

8-bit ADC	Pin	Pad Type	Supply Pad	Description
VSS-ADC	7	G		ADC GND
ADC-IN0	8	AI	VDD-ADC	Low-voltage detector input
VDD-ADC	9	P		ADC power PAD
ADC-IN1	10	AI, PU	VDD-ADC	For ADC: ADC input For Others: GPIO with pull-up option
ADC-IN2	11	AI, PU	VDD-ADC	For ADC: ADC input For others: GPIO in others with pull-up option
ADC-IN3	12	AI, PU	VDD-ADC	For ADC: ADC input For others: GPIO in others with pull-up option

GPIO	Pin	Pad Type	Supply Pad	Description
GPIO3	13	IO, PU	VDD-IO	For mouse: wheel-Z1 option For others: see GPIO port description for details
GPIO4	14	IO, PU	VDD-IO	For mouse: wheel-Z2 option For others: see GPIO port description for details
GPIO5	34	IO, PU	VDD-IO	For mouse: button 4 option For others: see GPIO port description for details
GPIO6	35	IO, PU	VDD-IO	For mouse: button 5 option For others: see GPIO port description for details
GPIO7	36	IO, PU	VDD-IO	For mouse: button 8 option or connect to sensor shout-down pin For others: see GPIO port description for details
GPIO8	37	IO, PU	VDD-IO	For mouse: connect to sensor motion pin For others: see GPIO port description for details
GPIO9	38	IO, PU	VDD-IO	For mouse: MOSI or SDA to sensor For others: see GPIO port description for details
GPIO10	39	IO, PU	VDD-IO	For mouse: SCLK or SCLK to sensor For others: see GPIO port description for details
GPIO11	42	IO, PU	VDD-IO	For mouse: MISO to sensor For others: see GPIO port description for details
GPIO12	43	IO, PU	VDD-IO	For mouse: NCS to sensor or button 8 option For others: see GPIO port description for details
GPIO13	44	IO, PU	VDD-IO	For mouse: Button Right option For others: see GPIO port description for details

Note: GPIO-pin definition for various HID application, please refer to table-1 in part of GPIO Port of Description of Functional Blocks and Terminal.

I^2C	Pin	Pad Type	Supply Pad	Description
SDA	16	IO, PU	VDD-IO	SDA pin of I^2C bus, could be used for external
SCL	15	O	VDD-IO	SCL pin of I^2C bus, could be used for external EEPROM chip

UART	Pin	Pad Type	Supply Pad	Description
Txd-8051	19	IO, PU	VDD-IO	Low speed UART communication port for external controller
Rxd-8051	20	IO, PL	VDD-IO	Low speed UART communication port for external controller

Digital Power	Pin	Pad Type	Supply Pad	Description
VDD18-C1 VDD18-C2	22 46	P	N/A	Digital circuit power supply.
VDD-IO1 VDD-IO2	18 40	P	N/A	Digital I/O power supply.
VSS18-C1 VSS18-C2	24 47	G	N/A	Ground connections for digital circuit.
VSS-IO1 VSS-IO2	17 41	G	N/A	Ground connections for Digital IO ports.

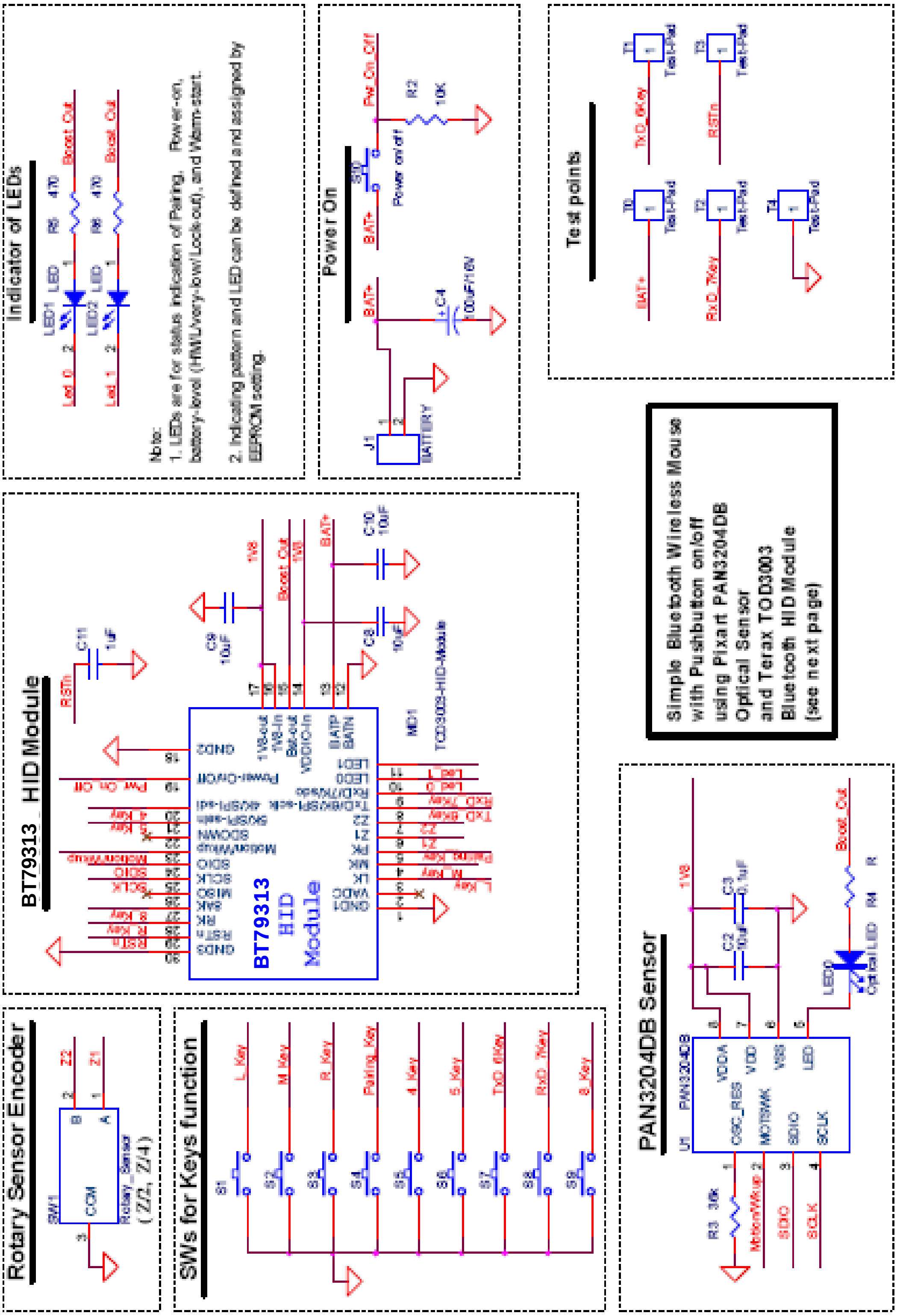
Switch-mode power regulator		Pin	Pad Type	Supply Pad	Description
REG-On/Off		29	AI	BATP	Button push high to Enable/Disable Boost
BUCK	Buck-FB	30	AI	Buck-BATP	Feedback voltage
	Buck-BATP	31	P	N/A	Battery+ input
	Buck-LX	32	P	Buck-BATP	Regulator output
	Buck-BATN	33	G	N/A	Battery- input
BOOST	Boost-BATN	25	G	N/A	Battery- input
	Boost-LX	26	P	Boost-BATP	Regulator output
	Boost-FB	27	AI	Boost-BATP	Feedback voltage
	Boost-BATP	28	P	N/A	Battery+ input

Auxiliary	Pin	Pad Type	Supply Pad	Description
RST-N	49	I, PU	VDD-IO	Active low system reset. Contain a weak pull up.

Notes:

1. P: power pad, G: ground pad, I: input, O: output,
2. A: analog, OD: open-drain, PU: pull-up, PD: pull-down,
3. AIO: analog I/O,

Reference Circuits
Bluetooth Wireless Mouse



Bluetooth HID Module

Schematic:

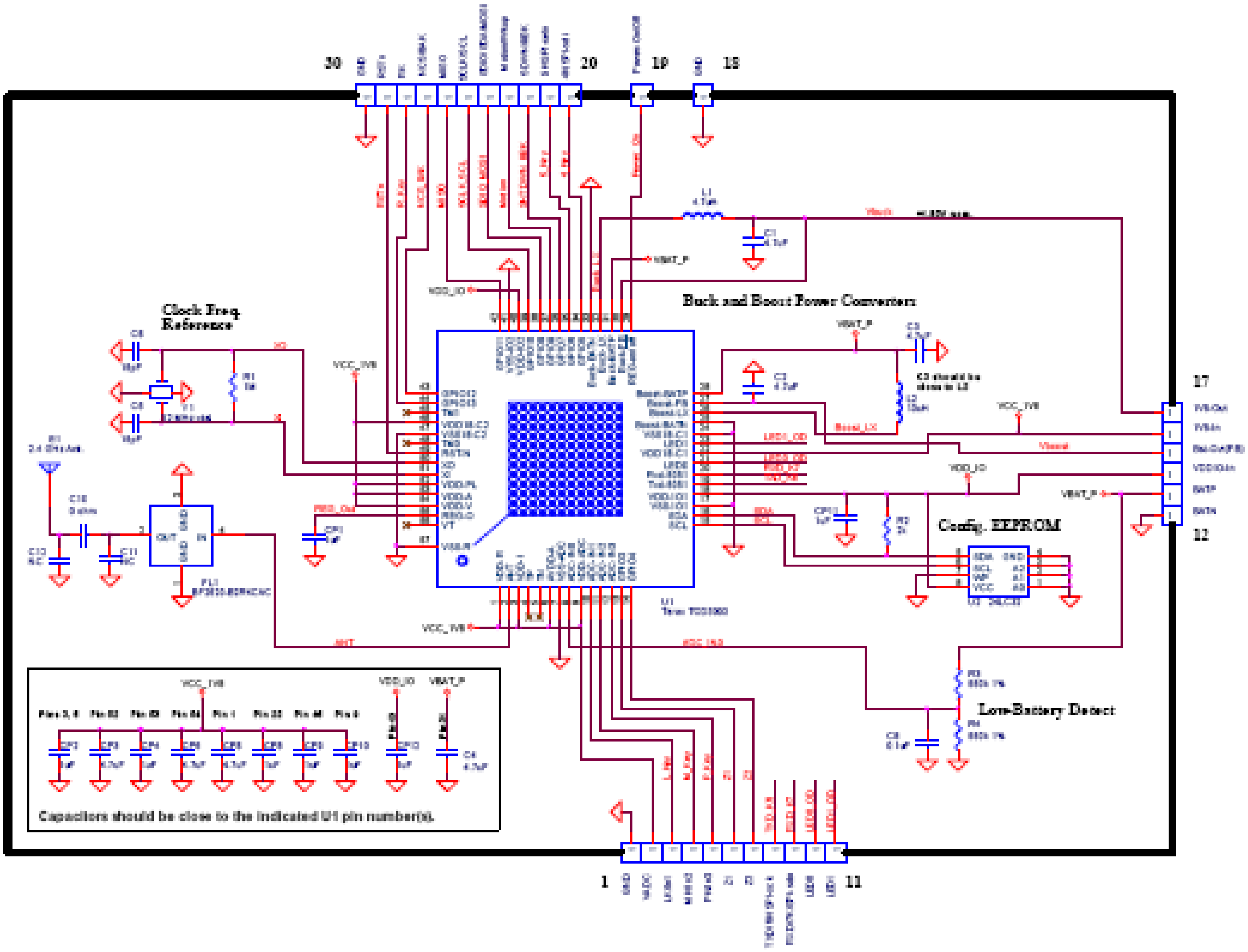
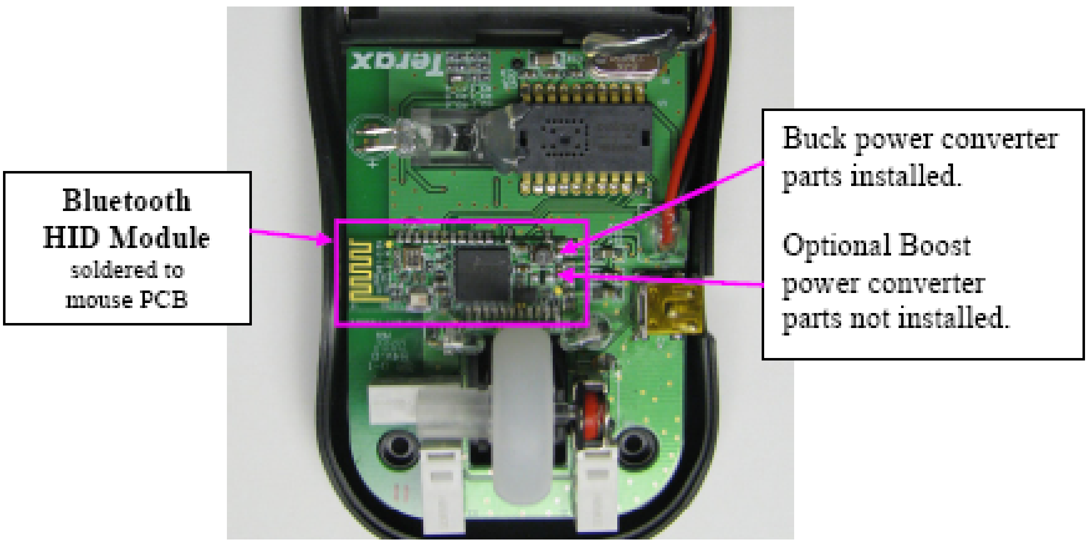


Photo:



Electrical Characteristics

Absolute Maximum Ratings

Rating	Min	Max
Storage temperature, deg. C	-40	+125

Recommended Operation Conditions

Operating Condition	Min	Typ	Max
Operating temperature, deg. C (1)	-40	+25	+85
Supply voltage: All RF power	1.76V	1.8V	1.92V
Supply voltage: VDD18-C	1.65V	1.8V	1.98V
Supply voltage: VDD-IO	1.65V		3.63V
Supply voltage: Buck_BATP	2.1V		3.5V
Supply voltage: Boost-BATP	2V		3.5V
Supply voltage: VDD-ADC		1.8V	

Note: (1) Design guarantee.

Typical Current for BT79313 at 1.83V

Operation Mode	Typical Current at Core 1.83V	Unit
Receive (1)	49	mA
Transmit (2)	43	mA
Sniff Mode, 10ms interval	5	mA
Sniff Mode, in advanced power saving mode	450	uA
Deep Sleep (disconnected, wake on interrupt)	27	uA

Note: (1) Max current when receiver and baseband are both operating, 100% on.

(2) Max current when transmitter and baseband are both operating, 100% on.

Switch-mode Regulator

Buck Step-down DC-DC converter

Switching regulator Parameter	Min	Typ	Max	Unit
Input voltage	2.1		3.5	V
Output Voltage (IL = 150 mA)		1.83		V
Switching frequency		1		MHz
Normal Operation				
Guarantee Output Current			150	mA
Current limit			400	mA
Conversion efficiency (Vin =3V, I_{load} =80 mA)		90		%
Low Power Mode				
Guarantee output current			40	mA
Conversion efficiency (Vin=3V I_{load}=20 mA)		85		%
Quiescent current		160		uA
Disable Mode				
Disable current		2		uA

Boost Step-Up DC-DC converter

Switching regulator Parameter	Min	Typ	Max	Unit
Input voltage	2		3.5	V
Output Voltage (I_L = 100 mA)	Programmable output voltage from 2.7V to 3.3V with 0.1V step			V
Normal Operation in LDO mode				
Guarantee Output Current			100	mA
Quiescent current		170		uA
Normal Operation				
Guarantee Output Current			100	mA
Conversion efficiency (I_{load} 100mA)		80		%
Quiescent current		170		uA
Disable Mode				
Disable current		1		uA

Digital Terminals

Digital Terminals	Min	TYP	Max	Unit
Input Voltage Levels				
Vil @ (2.7v ≤ VDD-IO ≤ 3.6v)	0	-	0.8	V
Vil @ (1.7v ≤ VDD-IO ≤ 1.9v)	0	-	0.4	V
Vih	VDD-IO*0.7	-	VDD-IO + 0.4	V
Output Voltage Levels				
Vol @ (2.7v ≤ VDD-IO ≤ 3.6v, I = - 4mA)	-	-	0.4	V
Vol @ (1.7v ≤ VDD-IO≤ 1.9v, I = - 4mA)	-	-	0.2	V
Voh @ (2.7v ≤ VDD-IO ≤ 3.6v, I = 4mA)	VDD-IO - 0.4	-	-	V
Voh @ (1.7v ≤ VDD-IO ≤ 1.9v, I = 4mA)	VDD-IO - 0.2	-	-	V
I/O pad leakage current	-1	0	1	μA
Pad Input Capacitance	2	-	5	pF

Auxiliary ADC

Parameter	Min	Typ	Max	Unit
Supply voltage		1.8		V
Supply current		0.3		mA
Operating frequency		1.5		MHz
Shutdown current		1		uA
Resolution		10		bits
Accuracy		8		bits
DNL @ 1.8V supply voltage	-4		+4	LSB
INL @ 1.8V supply voltage	-4		+4	LSB
Gain error		5		LSB
Offset error		5		LSB

Radio Characteristics

Parameter	Symbol	Specification			Units	Test Condition and Notes
		Min	Typ	Max		
Overall Transceiver						
Operating Frequency Range	F_{OP}	2400	-	2482	MHz	
Antenna port mismatch (Z_0=50 ohms)	$VSWR_I$	-	<2:1	-	VSWR	Receive mode
	$VSWR_O$	-	<2:1	-	VSWR	Transmit mode
Receive Section						While BER ≤ 0.1% at 25 deg. C with LDO
Receiver sensitivity			-81	-72	dBm	Meas. at antenna pin of IC
Maximum Input level		-20			dBm	
Input 3rd order intercept point	IIP_3	-14	-11	-	dBm	
Data (Symbol) rate	Ts	-	1	-	uS	
Min. Carrier/Interference ratio						For BER ≤ 0.1% at 25 deg. C
Co-chan. Interference	$CI_{co-chan}$	-	9		dB	-60 dBm desired signal.
Adjacent Ch. Interference, 1MHz offset	CI_1	-	-1.5	0	dB	-60 dBm desired signal.
Adjacent Ch. Interference, 2MHz offset	CI_2	-	-	-30	dB	-60 dBm desired signal. Interference at 2 MHz below desired signal.
Adjacent Ch. Interference, ≥ 3MHz offset	CI_3	-	-	-40	dB	-67 dBm desired signal.
Image Frequency Interference	CI_{image}	-	-23	-9	dB	-67 dBm desired signal. Image freq. is always 2MHz higher than desired signal.
Adjacent (1MHz) Interference to Image	$CI_{image11}$	-	-34	-20	dB	-67 dBm desired signal. Always 3MHz higher than desired signal.
Out-of-Band Blocking						Measure with ACX ceramic filter on antenna pin.
	OBB_1	-10	-	-	dBm	30 MHz to 2000 MHz
	OBB_2	-27	-	-	dBm	2000 MHz to 2400 MHz
	OBB_3	-27	-	-	dBm	2500 MHz to 3000 MHz
	OBB_4	-10	-	-	dBm	3000 MHz to 12.75 GHz

Parameter		Symbol	Specification			Units	Test Condition and Notes	
			Min	Typ	Max			
Transmit section								
RF output power		P_{AV}	-	0	-	dBm	Under Max. Power level, Measure at antenna pin of IC.	
Modulation Characteristics								
Peak FM Deviation	00001111 pattern	$\Delta f1_{avg}$	140	157	175	kHz		
	01010101 pattern	$\Delta f2_{max}$	115	-	-	kHz	For at least 99.9% of all $\Delta f2_{max}$ measure.	
ISI, % Eye Open		$\Delta f2_{avg}$ / $\Delta f1_{avg}$	80	-	-	%	1010 data sequence referenced to 00001111 data sequence.	
Zero Crossing Error		ZC_{ERR}	-125	-	125	nS	+/- 1/8 of symbol period	
In-Band Spurious Emission								
(+/- 500 kHz)		IBS_1	-	-	-20	dBc		
2 MHz offset		IBS_2	-	-	-20	dBm		
≥ 3 MHz offset		IBS_3	-	-	-40	dBm		
Out-of-Band Spurious Emission, Operation								
		OBS_{O1}	-	< -60	-36	dBm	30 MHz ~ 1 GHz	
		OBS_{O2}	-	-45	-30	dBm	1 ~ 12.75 GHz, excludes desired signal	
		OBS_{O3}	-	<-60	-47	dBm	1.8 ~ 1.9 GHz	
		OBS_{O4}	-	<-65	-47	dBm	5.15 ~ 5.3 GHz	
RF VCO and PLL Section								
Typical PLL lock range		F_{LOCK}	2340	-	2560	MHz		
Tx, Rx Frequency tolerance			-	-	-	ppm	Same as crystal oscillator frequency tolerance.	
Channel (Step) Size			-	1	-	MHz		
SSB Phase Noise			-	-95	-	dBc/Hz	550 kHz offset	
			-	-115	-	dBc/Hz	2 MHz offset	
RF PLL Settling Time		T_{HOP}	-	75	150	uS		
Out-of-Band Spurious Emission		OBS_1	-	<-75	-57	dBm	30 MHZ ~ 1 GHz	IDLE state, Synthesizer and VCO ON
		OBS_2	-	-68	-47	dBm	1 ~12.75 GHz	

Clocks

Crystal Oscillator	Min	TYP	Max	Unit
Crystal frequency	-	12	-	MHz

Description of Functional Blocks

BTE Bluetooth Software Stacks

BT79313 is supplied with Bluetooth v2.0 compliant stack firmware that runs on the internal MCU.

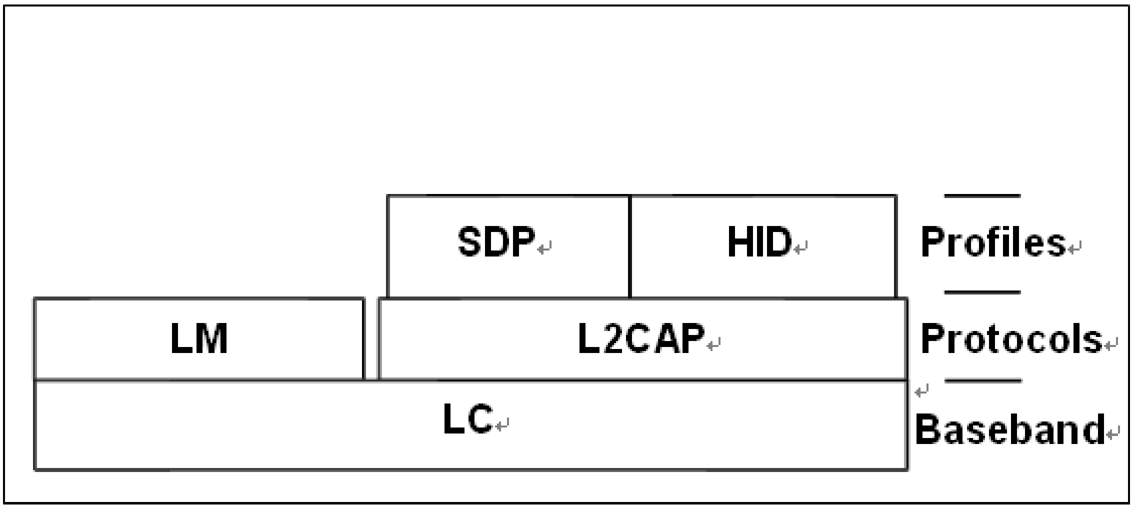


Figure 3 – Bluetooth HID Software Stacks

Key Features of the Bluetooth HCI Stack

–Bluetooth v2.0 mandatory functionality:

Adaptive frequency hopping (AFH), including classifier

Faster connection - enhanced inquiry scan (immediate FHS response)

LMP improvements

–The firmware was written against the Bluetooth v2.0 specification.

Bluetooth components:

Baseband (including LC)

LM

–All standard radio packet types

–Bluetooth data rate 1Mbps

–Active ACL connections: 1

–Standard operating modes: Page, Inquiry, Page-Scan and Inquiry-Scan

–All standard pairing, authentication, link key and encryption operations

–Standard Bluetooth power saving mechanisms: Sniff

–Master switch to Slave

–Support loop-back test modes

The firmware's supported Bluetooth features are detailed in the standard Protocol Implementation Conformance Statement (PICS) documents.

Baseband and Logic

⌘Physical Layer Hardware Engine DSP

FEC (forward error correction)
HEC (header error correction)
CRC (cyclic redundancy check)
Encryption
Data whitening
Access code correlation

⌘Memory (ROM & RAM)

8k bytes RAM: Support the MCU to hold data for each active connection and the general purpose memory required by the Bluetooth stack.

1M bits ROM: Provided for system firmware.

⌘External FLASH

External FLASH pads are available for stacked/external FLASH package.

Micro-controller

The 8-bit micro-controller (MCU), interrupt controlled and event timer run the Bluetooth software stack and control the radio and host interface.

GPIO PORT

There are 14 programmable GPIO including 3 input only IO (ADC-IN1, ADC-IN2, ADC-IN3). Except ADC-INx, all GPIO is programmable for direction, pull-up and pull-low. At reset stage all GPIOs are input with pull-up. Moreover, there is built-in HW to support different mouse sensor and communication interface. Following please see the support table.

Table-1: GPIO-pin definition for various HID application

PIN-Name	Mouse application	Mouse + SPI application	SPI + UART application
ADC-IN1	L-Key	L-Key	ADC-IN1/GPI-1
ADC-IN2	M-Key	M-Key	ADC-IN2/GPI-2
ADC-IN3	P-Key	P-Key	ADC-IN3/GPI-3
GPIO3	Z1	Z1	GPIO3
GPIO4	Z2	Z2	GPIO4
Txd-8051	6th-Key	SPI-SCLK	Txd-8051
Rxd-8051	7th-Key	SPI-SDO	Rxd-8051
GPIO5	4th-Key	SPI-SDI	GPIO5
GPIO6	5th-Key	SPI-SELn	GPIO6
GPIO7	8Bth-Key/SHTDWN/GPIO7/ (Ext-REG-En)	8Bth-Key/SHTDWN/GPIO7/ (Ext-REG-En)	GPIO7
GPIO8	Wkup/Motion/GPIO/(Ext-REG-En)	Wkup/Motion/GPIO/(Ext-REG-En)	GPIO8
GPIO9	MOSI/SDIO/SDA	MOSI/SDIO/SDA	SPI-SCLK
GPIO10	SCLK/SCL	SCLK/SCL	SPI-SDO
GPIO11	MISO/GPIO/(Ext-REG-En)	MISO/GPIO/(Ext-REG-En)	SPI-SDI
GPIO12	NCS/8Ath-Key	NCS/8Ath-Key	SPI-SELn
GPIO13	R-key	R-key	GPIO13

Note: Please refer to the Application Note of BT79313 HID Module for pin definition detail.

Table-2: mouse sensor list with built-in HW interface support of BT79313

Suppliers	Products
Avago	ADNS2030, ADNS-3040/3030, ADNS-5030, ADNS-6030, ADNS-7050, ADNS-7530/7550
Pixart	PAN3101, PAN3201, PAN3204, PAN3601, PAN3603, PAN3607
Sunplus	SPCP6510A

Note: 1) The Sensor and interface selection option can be modified by external EEPROM.

SPI interface

−Support SPI master/slave mode.

−Programmable SCLK frequency, range 25kHz~3MHz, data latch at SCLK rising / falling edge, data shift at MSB/LSB first.

−Support DMA mode, data transfer length 1~255 bytes, programmable byte transfer interval (20 us ~ 694ms) at master mode

I^{2}C interface

SCL and SDA are used to form a master I^{2}C interface. The interface is formed using software or HW to drive these lines.

POR

This is a Power On Reset (POR) circuit by monitoring VDD18-C to provide system reset for typically at least 200ms while system power up. Or provide system reset while system unstable such as dropping bellow 1.4V and release the reset after 200ms while power resumes above 1.5V.

External RESET

The RST-N pin is an active low system reset with weak pull up. At reset the digital I/O pins are set to inputs with pull-high enabled except pin Rxd-8051 for bi- directional pins.

Auxiliary ADC

The 8-bit accuracy/10-bit resolution Successive Approximation ADC (analog to digital converter) is used to digitize battery voltage for battery check application, and provide 3 additional analog inputs for custom applications, such as reading a 3- axis accelerometer.

LED Drivers

BT79313 includes two open-drain pads dedicated to driving LED indicators. Both pads may be controlled by firmware. The terminals are low output impedance open- drain outputs, so the LED must be connected in series with a current limiting resistor between positive supply and the pad.

Switch-mode Regulators

BT79313 contains two regulated switch-mode power converters -- one Buck mode, and one Boost mode. The Buck regulator is for +1.83V to support the 1.8V power of this chip, and other devices. The optional Boost regulator can provide +2.7 to 3.3V, to support an external device of the same voltage level.

Each regulator requires an external energy storage inductor L, and output capacitor, C. Please refer to figure below.

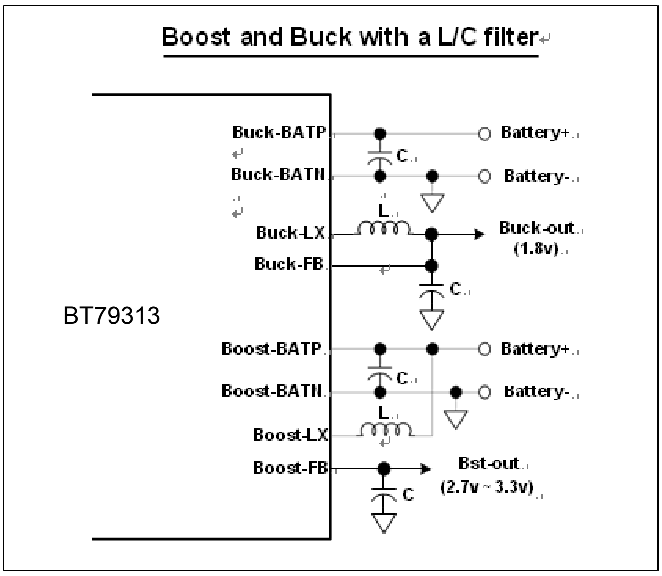


Figure 4 – Boost and Buck with a L/C filter

Circuit	Typical Energy Storage Inductor, L, uH	Typical Output Capacitor, C, uF
Boost converter	10	4.7
Buck converter	4.7	4.7

Because switching regulators draw input current in the form of switching pulses, it is important that an input filter be used. The most common input filter is the simple input capacitor, as shown in the figure above. It is OK to have one input capacitor be shared by both regulators.

The power supplies for VDD18-C, VDD-R are all 1.83V. The VDD-IO power can be connected to 1.8V or 2.7~3.3V, depending on application.

The REG-On/Off pin may be used to enable/disable the regulators. When a regulator is not used, its terminals must be grounded or left unconnected.

External Component Selection for Switch-mode Regulators

When selecting external inductor and capacitor components, please keep in mind the following:

- **Inductor current rating:** Be sure the inductor can support both the average and peak inductor current for the application. This means the inductance does not significantly degrade while delivering DC load current. This information is usually supplied by the inductor manufacturer in the form of an inductance vs. current graph. In lieu of the graph, the max-I specification provides this indication.
- **Inductor loss factors:** Look for low DC resistance, and high Q- factor at the switching frequency, and several harmonics of the switching frequency.
- **Input and output capacitors:** Look for low ESR at the switching frequency, and also at several harmonics beyond the switching frequency. Excessive ESR will increase output ripple voltage at the switching frequency. Be sure capacitors have sufficient voltage rating. Typically a voltage de-rating factor of 2 is applied to capacitors, to ensure long life.
- **Parallel capacitors:** Because the capacitor current waveform is usually large for a switching regulator input or output capacitor, it is a good design practice to provide a backup capacitor in parallel with each capacitor. This can reduce effective ESR while providing redundancy. Sometimes a cost reduction can also result.
- **LC Values may vary:** The L and C values provided herein are suggested guidelines. Since each custom application may provide different output voltage and/or DC load (HID, mouse, keyboard, etc.). The best LC values may depend on the application.

Switch-mode Regulator PCB Layout Considerations

The RF (radio) portion of this device contains low level analog circuitry that could be impaired by poor PCB layout. The switching regulator is a common source of noise when PCB layout is poor. In an extreme case, the switching regulator could generate noise in the passband of the RF receiver, causing throughput and/or range problems. To eliminate these types of problems, please note the following suggestions:

1. Understand that each power converter has a switching element on- chip. There is also an integral catch diode, or synchronous switch, providing a path for the inductor current, whenever the main switching transistor turns off. By keeping the external interconnecting traces short and to-the-point, electromagnetic radiation of switching noise can be minimized.

2. Be sure the input and output capacitors return to a quality, low-impedance ground. This should be the same ground used for the remainder of the design.

3. Remember that inductors can radiate an external magnetic field, as well as be susceptible to an external magnetic field. For this reason, if two inductors are close to each other on the PCB layout, they should also be at right angles to each other.

4. Early in the design verification stage, a simple oscilloscope or wide- band AC voltmeter should be used to verify that the output switching noise voltage does not exceed approximately 10% of the average DC voltage at each regulator output.

Noise from other devices

Because the BT79313 can connect to other peripheral hardware such as keyboard/mouse/dongle, etc., the designer should be careful not to couple excess digital noise back to the BT79313 device. In particular, the +1.8V power is most sensitive. This is because the RF portion of the device is powered by the +1.8V.

For these reasons, it is best to use caution when connecting these devices. If in doubt, use a sensitive oscilloscope or AC voltmeter, to make sure there is not an excess amount of noise being coupled onto the +1.8V bus.

RF

BT79313 RF contains transmit, VCO and PLL functions, including an on-chip
channel filter, thus minimizing the need for external components. The receiver utilizes extensive digital processing for excellent overall performance, even in the presence of interference and transmitter impairments.
The RF transmitter is fully compliant with the Bluetooth® Class 2 operation, which allows -6 to +4 dBm output power. The low-IF receiver architecture produces low DC offsets and a 2 MHz spur below -40 dBc. Digital RSSI values are available to monitor channel quality.

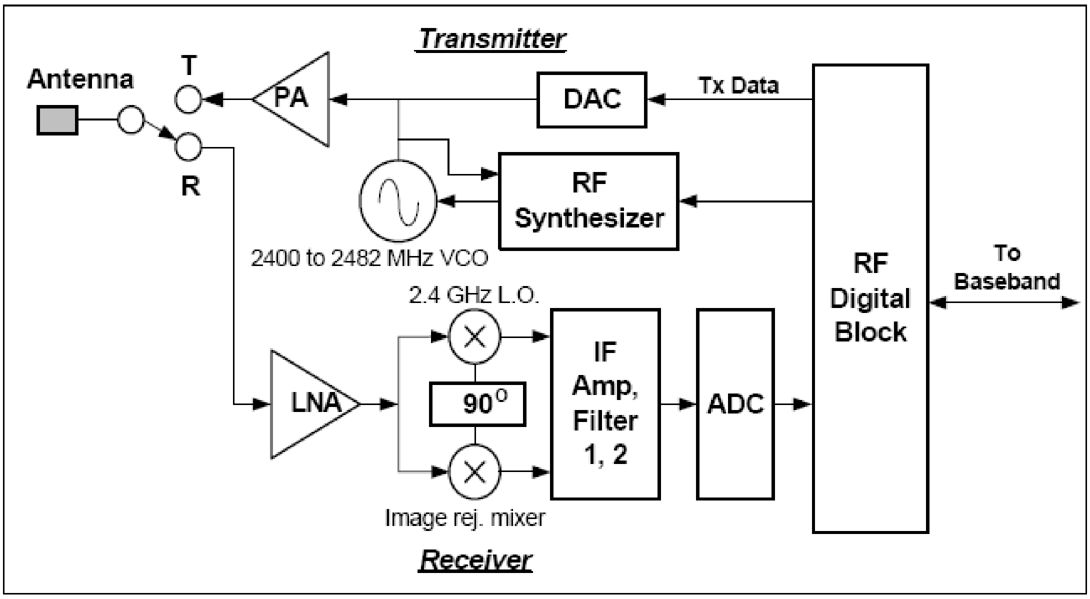


Figure 5 – RF Block Diagram

Clock Generation

The clock for the device is generated from a 12MHz crystal oscillator. The gain block for the oscillator is on-chip, utilizing an external quartz crystal and load capacitors. The circuit is shown in Figure 6.

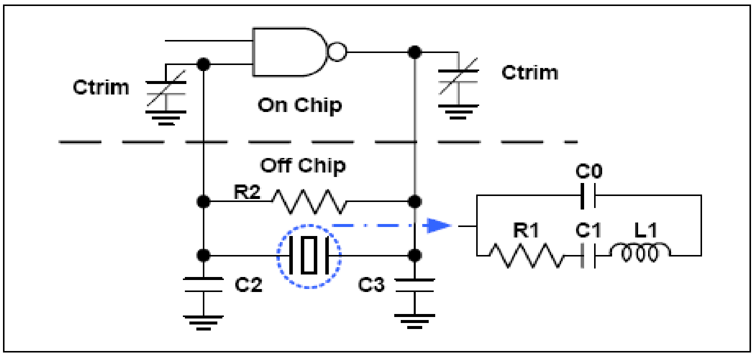


Figure 6 – Crystal Oscillator Block Diagram

- **Load Capacitance**

  For resonance at the correct frequency the crystal should be loaded with its specified load capacitance, which is defined for the crystal. This is the total capacitance across the crystal viewed form its terminals. TOD3003 provides some of this load with the capacitor C_{trim} and C_{int}. The remainder should be from the external capacitors labeled C2 and C3. Crystal load capacitance, C_{laod} is calculated by below equation.

$$C_{load} = C_{int} + \frac{C_{trim}}{2} + \frac{C2 \bullet C3}{C2 + C3}$$

  Where:

  C_{trim} = 3.52pF nominal (mid-range setting)

  C_{int} = 3.88pF

  Note:

  C_{int} doesn't include the crystal internal self capacitance, it is the driver self capacitance.

- **Frequency Trim**

  TOD3003 enable frequency adjustment to be made. This feature is typically used to remove initial tolerance frequency errors associated with the crystal. Frequency trim is achieved by adjusting the crystal load capacitance with on-chip trim capacitors, C_{trim}. The value of C_{trim} is set by a 6-bit word in the CLKTrim (0x1f6). Its value is calculates

$$C_{trim} = 110fF \times CLKTrim$$

  There are two C_{trim} capacitors, which are both connected to ground. When views from the crystal terminals, they appear in series so each least significant bit (LSB) increment of frequency trim presents a load across the crystal of 55fF. The frequency trim is described by

$$\Delta Fx = \text{pull-ability} \times 55fF \times Fx$$

Where Fx is the crystal frequency, and pull-ability is a crystal parameter with units of ppm/pF. Total trim range is 63 times the value above.

If not specified, the pull-ability of a crystal may be calculated from its motional capacitance with

$$\text{Pull ability} = \frac{C_m}{2(C_{load} + C_0)^2}$$

Where:

C_0 = Crystal self capacitance (shunt capacitance)
C_m = Crystal motional capacitance (series branch capacitance in crystal model)

- **Transconductance Driver Model**

The crystal and its load capacitors should be viewed as a trans-impedance element, whereby a current applied to one terminal generates a voltage at the other. The transconductance amplifier in TOD3003 uses the voltage at its input (XI) to generate a current at its output (XO). Therefore, the circuit will oscillate if the trans-conductance, trans-impedance product is greater than unity. For sufficient oscillation amplitude, the product should be greater than three. The transconductance requires for oscillation is defined by the relationship shown:

$$g_m > \omega^2 R_m \frac{[(C2 + C_{trim})(C3 + C_{trim}) + (C2 + C_{trim})C_{int} + (C3 + C_{trim})C_{int}]^2}{(C2 + C_{trim})(C3 + C_{trim})}$$

- **Negative Resistance Model**

An alternative representation of the crystal and its load capacitors is a frequency dependent resistive element. The driver amplifier may be considered as a circuit that provides negative resistance. For oscillation, the value of the negative resistance must be greater than that of the crystal circuit equivalent resistance. Although the TOD3003 crystal driver circuit is based on a trans-impedance amplifier, an equivalent negative resistance may be calculated for it with the following formula in equation

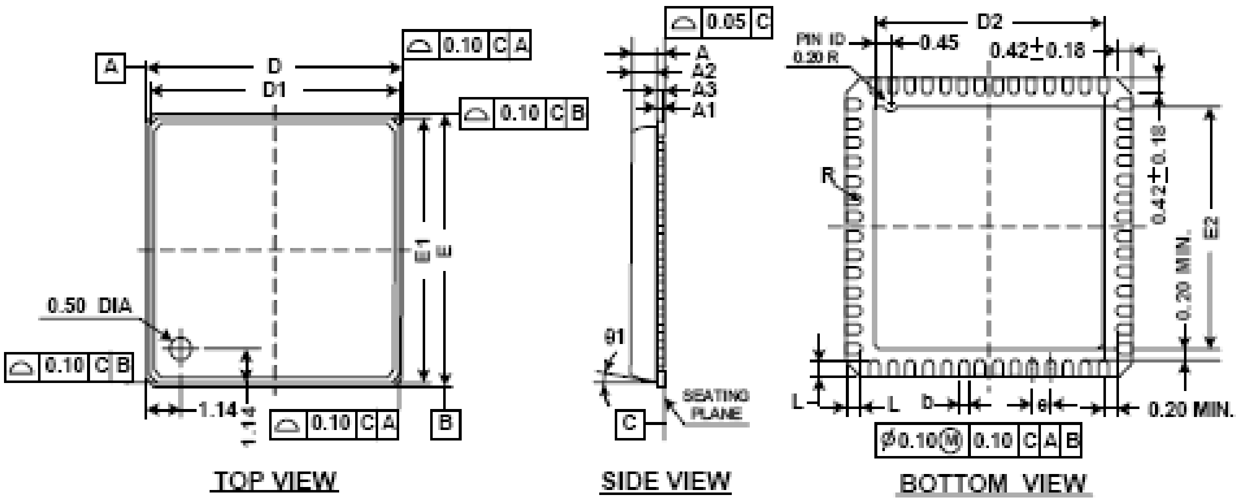
$$R_{neg} > \omega^2 g_m \frac{[(C2 + C_{trim})(C3 + C_{trim}) + (C2 + C_{trim})C_{int} + (C3 + C_{trim})C_{int}]^2}{(C2 + C_{trim})(C3 + C_{trim})}$$

⌘ Recommendation for XTAL component

Parameter	Symbol	Min	Typ	Max	Unit	Note
Package		3225	-	5032	mm	3225: L: 32mm W: 25mm 5032: L: 50mm W: 32mm
Nominal Frequency	FL	-	12	-	MHz	
Load Capacitance	CL	-	12	-	pF	
Frequency Tolerance		-10	-	10	ppm	@25±3℃
Frequency Stability		-10	-	10	ppm	Over Operating Temp. Range
Operating Temperature		-20	-	75	℃	
Aging		-3	-	3	ppm	
Drive Level		-	10	-	uW	
Effective Series Resistance	Rs	-	-	100	Ohm	
Shunt Capacitance C0	C0	-	-	5	pF	

Recommended Specifications

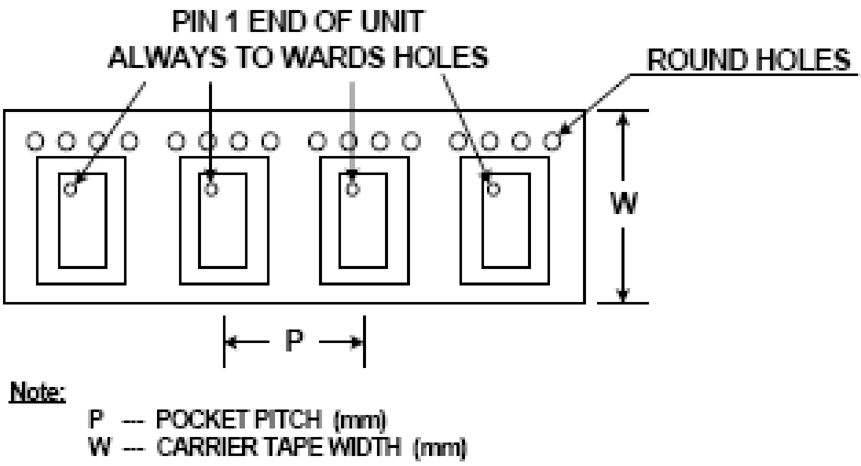
Package and Ordering Information



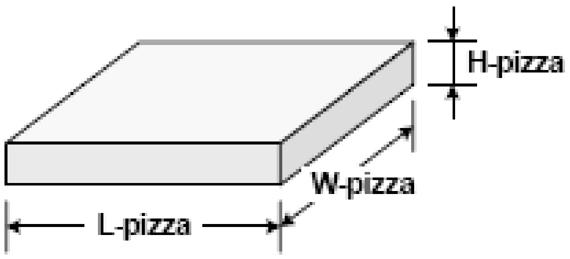
CONTROLLING DIMENSION : MM

SYMBOL	MILLIMETER			INCH		
	MIN	NOM	MAX	MIN	NOM	MAX
A	—	---	0.90	---	---	0.035
A1	0.00	0.01	0.05	0.00	0.0004	0.002
A2	—	0.65	0.70	---	0.026	0.028
A3	0.20 REF.			0.008 REF.		
b	0.20	0.25	0.30	0.008	0.010	0.012
D	8.00 bsc			0.315 bsc		
D1	7.75 bsc			0.305 bsc		
D2	6.30	6.50	6.70	0.248	0.256	0.264
E	8.00 bsc			0.315 bsc		
E1	7.75 bsc			0.305 bsc		
E2	6.30	6.50	6.70	0.248	0.256	0.264
L	0.30	0.40	0.50	0.012	0.016	0.020
e	0.50 bsc			0.020 bsc		
θ1	0°	---	12°	0°	---	12°
R	0.09	---	---	0.004	---	—
TOLERANCES OF FROM AND POSITION						
aaa	0.10			0.004		
bbb	0.10			0.004		
ccc	0.05			0.002		

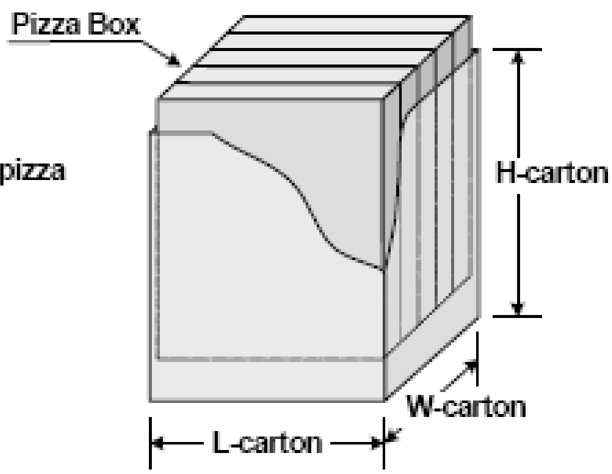
Figure 7 – Package Dimension of 56-pin QFN



Dimension of Tape & Reel



Dimension of Pizza Box



Dimension of Carton

Part Number # - BT79313			
Package			
Type	**Size**	**Shipment Method**	**Pieces per Reel**
56-Lead QFN (Pb free)	8 x 8 x 0.9 mm	Tape and reel	2.5kpcs

Tape & Reel Packing Specification			
Carrier Tape Width (W mm)	**Pocket Pitch (P mm)**	**Trailer# of Pockets (pcs)**	**Leader# of Pockets (pcs)**
16	12	58	88

Pizza-Box Packing Specification		
L-pizza (mm)	**W-pizza (mm)**	**H-pizza (mm)**
360	345	50

Carton Packing Specification		
L-carton (mm)	**W-carton (mm)**	**H-carton (mm)**
380	375	290