



Fast Track Your Wireless Project  
自由无线 放飞梦想

## BT33 Datasheet

Amp'ed RF Technology, Inc.

## BT33/BT33LT Product Specification



11.6mm x 13.5mm

### Description

Our micro-sized Bluetooth module, with integrated antenna, is the smallest form factor available providing a complete RF platform. The BT33 is designed for maximum performance in a minimal space and includes 7 general purpose and ADC/DAC IO lines, several serial interface options, and up to 1.5M bps data throughput.

The BT33 is a surface mount PCB module that provides fully embedded, ready to use Bluetooth wireless technology. Our standard abSerial and Amp'edUP Stack are pre-flashed into the integrated flash memory, supporting the SPP and IAP profiles. Other popular Bluetooth profiles, such as OBEX, are also available.

Customized firmware for peripheral device interaction, power optimization, security, and other proprietary features may be supported and can be ordered pre-loaded and configured.

BT33LT is the "Lite" version of BT33, with lessFlash (128K) and RAM (16K) memory, with some reduced features.

## BT33 Features

### Bluetooth features

- FCC & Bluetooth licensed radio
- Bluetooth v3.0
- Class 1.5 radio
- Range up to 60m LOS
- 1.5Mbps data throughput
- 128-bit encryption security
- Multipoint capability up to 7 slaves

### Hardware configuration

- Cortex-M3 microprocessor up to 72MHz
- 256K bytes Flash memory
- 48K bytes RAM memory
- UART, up to 2.25M baud
- SPI and I2C interfaces
- 7 general purpose I/O
- 5x12-bit A/D inputs
- 1 DAC outputs
- 1 LPO input

### Embedded software

- Amp'edUP Bluetooth stack (SPP, IAP)
- Support Apple iOS/MFI Bluetooth devices
- abSerial, AT command set
- SDK, Software Development Kit (Optional)
- BlueGuard, data encryption software (Optional)
- Mobile application software (Optional)

### Additional documentation

- abSerial User Guide
- abSerial Reference Guide
- abSerial Configuration Guide

## Table of Contents

BT33/BT33LT Product Specification .....	2
Description .....	2
1 Software Architecture .....	4
1.1 Lower Layer Stack .....	4
1.2 Upper Layer Stack: Amp'ed UP .....	4
1.3 HCI Interface .....	4
1.4 AT Command Set: abSerial .....	4
2 Hardware Specifications .....	5
2.1 Recommended Operating Conditions .....	5
2.2 Absolute Maximum Ratings .....	5
2.3 Current Consumption .....	5
2.4 Selected RF Characteristics .....	6
2.5 I/O Operating Characteristics .....	6
2.6 Pin Assignment .....	7
2.7 Pin Placement Diagram (Top View) .....	8
2.8 Layout Drawing .....	9
3 Module Block Diagram .....	9
4 Hardware Design .....	10
4.1 Module Reflow Installation .....	10
4.2 GPIO Interface .....	10
4.3 UART Interface .....	11
4.4 PCB Layout Guidelines .....	12
4.5 Reset Circuit .....	12
4.6 External LPO Input Circuit .....	13
4.7 Apple iOS CP Reference Design .....	14
5 Regulatory Compliance .....	16
5.1 Modular Approval, FCC and IC .....	16
5.2 FCC Label Instructions .....	16
5.3 CE Certification .....	16
5.4 Bluetooth Certification .....	16
6 Ordering Information .....	17
7 Feature Comparison .....	17
8 Revision History .....	17

# 1 Software Architecture

## 1.1 Lower Layer Stack

- Bluetooth v3.0
- Device power modes: active, sleep and deep sleep
- Wake on Bluetooth feature optimized power consumption of host CPU
- Authentication and encryption
- Encryption key length from 8 to 128 bits
- Persistent FLASH memory for BD Address and user parameter storage
- All ACL packet types.
- eSCO packet types: 2-EV3, 2-EV5, 3-EV3, 3-EV5
- Point to multipoint and scatternet support: 3 master and 7 slave links allowed (10 active links simultaneously)
- Sniff, and hold modes: fully supported to maximum allowed intervals
- Master slave switch, supported during connection and post connection
- Dedicated Inquiry Access Code, for improved inquiry scan performance
- Dynamic packet selection, channel quality driven data rate to optimize link performance
- Dynamic power control
- Bluetooth test modes per Bluetooth specification
- 802.11b/g/n co-existence: AFH
- Vendor specific HCI commands to support device configuration and certification test modes

## 1.2 Upper Layer Stack: Amp'ed UP

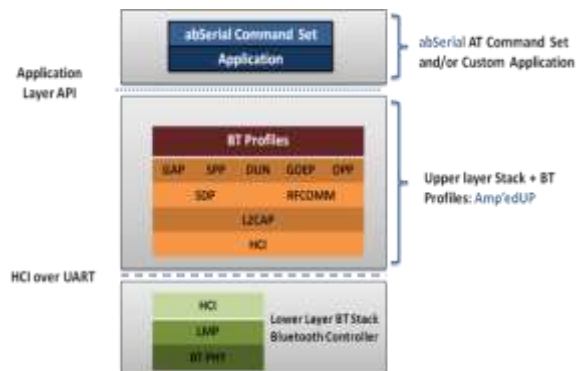
- SPP, OBEX, SDAP, GAP, and DUN protocols
- RFCOMM, SDP, and L2CAP supported
- Multipoint with 7 simultaneous slaves

## 1.3 HCI Interface

- Bluetooth v3.0 specification compliant
- HCI UART transport layer (H4)

## 1.4 AT Command Set: abSerial

- Please see *abSerial Reference Guide* for details



## 2 Hardware Specifications

General Conditions ( $V_{IN}= 2.5V$  and  $25^{\circ}C$ )

### 2.1 Recommended Operating Conditions

Rating	Min	Typical	Max	Unit
Operating Temperature Range	-40	-	85	$^{\circ}C$
Supply Voltage $V_{IN}$	2.1	2.5	3.6	Volts
Signal Pin Voltage	-	2.1	-	Volts
RF Frequency	2400	-	2483.5	MHz

### 2.2 Absolute Maximum Ratings

Rating	Min	Typical	Max	Unit
Storage temperature range	-55	-	+150	$^{\circ}C$
Supply voltage $V_{IN}$	-0.3	-	+5.0	Volts
I/O pin voltage $V_{IO}$	-0.3	-	+5.5	Volts
RF input power	-	-	-5	dBm

### 2.3 Current Consumption

High speed CPU mode, 32 MHz <ul style="list-style-type: none"> <li>▪ UART supports up to 921 Kbps</li> <li>▪ Data throughput up to 1.5 Mbps</li> <li>▪ abSerial v1.4 (installed firmware)</li> <li>▪ Shallow Sleep enabled</li> </ul>		
Modes (Typical Power Consumption)	Avg	Unit
ACL data 115K Baud UART at max throughput (Master)	23.0	mA
ACL data 115K Baud UART at max throughput (Slave)	27.5	mA
Connection, no data traffic, master	9.1	mA
Connection, no data traffic, slave	11.2	mA
Connection, 375ms sniff (external LPO required)	490	$\mu A$
Standby, without deep sleep	8.6	mA
Standby, with deep sleep, no external LPO	0.9	mA
Standby, with deep sleep, with external LPO	60	$\mu A$
Page/Inquiry Scan, with deep sleep, no external LPO	1.5	mA
Page/Inquiry Scan, with deep sleep, with external LPO	520	$\mu A$
Bluetooth power down / CPU standby	11	$\mu A$

Standard CPU Mode, 8 MHz <ul style="list-style-type: none"> <li>▪ UART supports up to 115 Kbps</li> <li>▪ Data throughput up to 200 Kbps</li> <li>▪ abSerial v1.4 (installed firmware)</li> <li>▪ Shallow Sleep enabled</li> </ul>		
Modes (Typical Power Consumption)	Avg	Unit
ACL data 115K Baud UART at max throughput (Master)	16.7	mA
ACL data 115K Baud UART at max throughput (Slave)	18.0	mA
Connection, no data traffic, master	4.9	mA
Connection, no data traffic, slave	7.0	mA
Connection, 375ms sniff, slave (external LPO required)	490	μA
Standby, without deep sleep	4.2	mA
Standby, with deep sleep, no external LPO	0.9	mA
Standby, with deep sleep, with external LPO	60	uA
Page/Inquiry Scan, with deep sleep, no external LPO	1.4	mA
Page/Inquiry Scan, with deep sleep, with external LPO	520	μA
Bluetooth power down / CPU standby	11	μA

## 2.4 Selected RF Characteristics

Parameters	Conditions	Typical	Unit
Antenna load		50	ohm
<b>Radio Receiver</b>			
Sensitivity level	BER < .001 with DH5	-86	dBm
Maximum usable level	BER < .001 with DH1	0	dBm
Input VSWR		2.5:1	
<b>Radio Transmitter</b>			
Maximum output power	50 Ω load	+6	dBm
Initial Carrier Frequency Tolerance		0	kHz
20 dB Bandwidth for modulated carrier		935	kHz

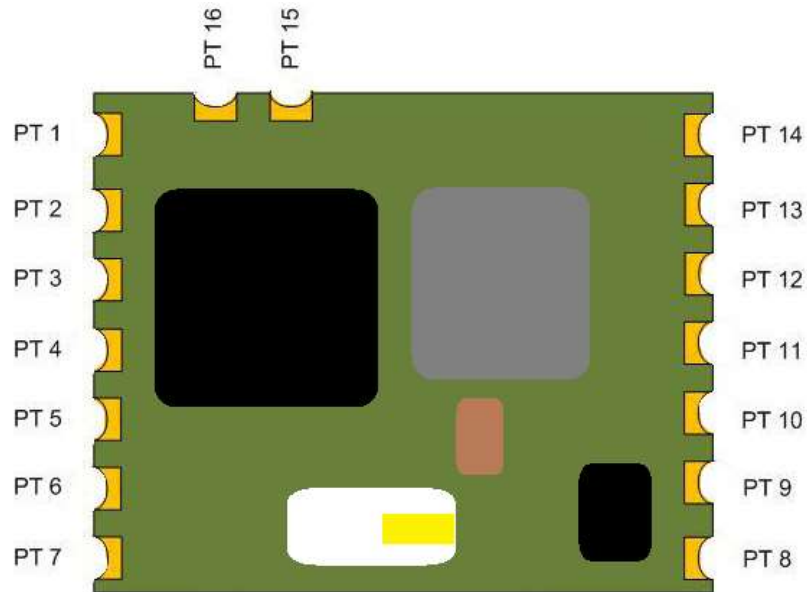
## 2.5 I/O Operating Characteristics

Symbol	Parameter	Min	Max	Unit	Conditions
V <sub>IL</sub>	Low-Level Input Voltage	-	0.6	Volts	V <sub>IN</sub> , 2.1V
V <sub>IH</sub>	High-Level Input Voltage	1.4	-	Volts	V <sub>IN</sub> , 2.1V
V <sub>OL</sub>	Low-Level Output Voltage	-	0.4	Volts	V <sub>IN</sub> , 2.1V
V <sub>OH</sub>	High-Level Output Voltage	1.8	-	Volts	V <sub>IN</sub> , 2.1V
I <sub>OL</sub>	Low -Level Output Current	-	4.0	mA	V <sub>OL</sub> = 0.4 V
I <sub>OH</sub>	High-Level Output Current	-	4.0	mA	V <sub>OH</sub> = 1.8V
R <sub>PU</sub>	Pull-up Resistor	80	120	KΩ	Resistor Turned On
R <sub>PD</sub>	Pull-down Resistor	80	120	KΩ	Resistor Turned On

## 2.6 Pin Assignment

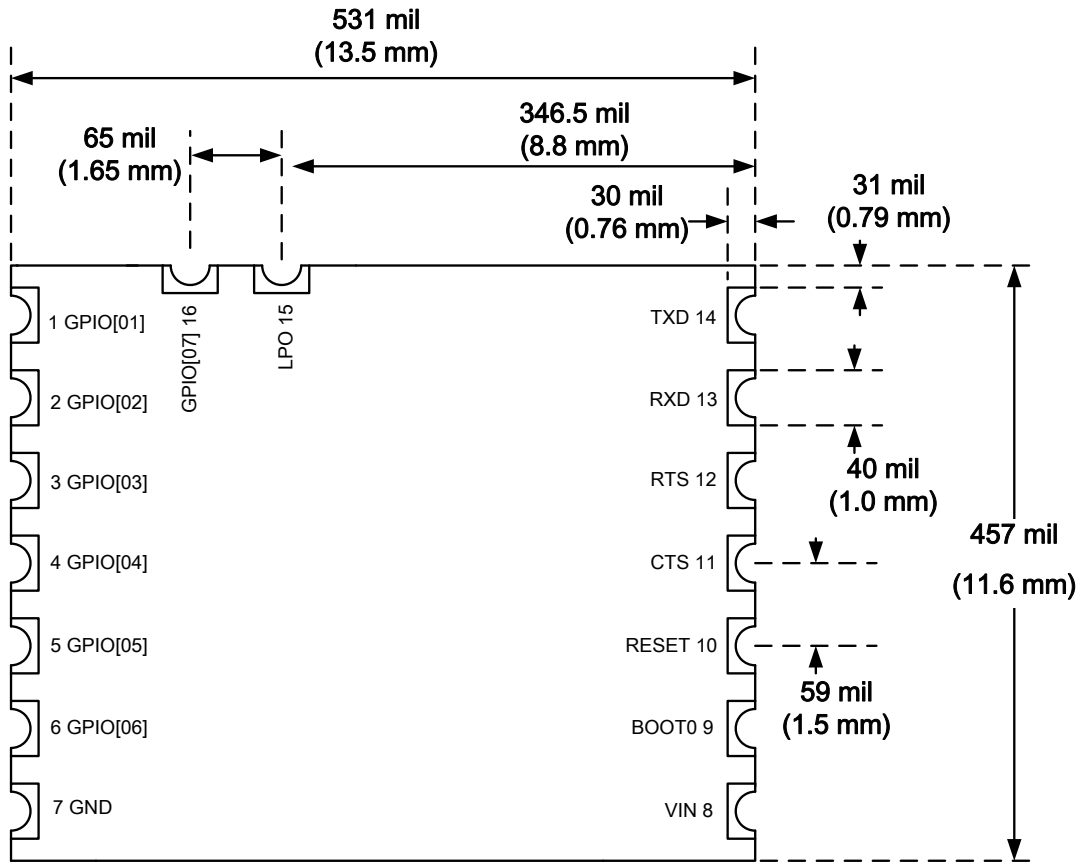
Name	Type	Pin #	Description	ALT Function	5V Tolerant	Initial State
<b>UART Interface</b>						
RXD	I	13	Receive data		Y	
TXD	O	14	Transmit data		Y	
RTS	O	12	Request to send (active low)	I2C Data/ADC 3	Y	
CTS	I	11	Clear to send (active low)	I2C Clock/ADC 2	Y	
<b>Reserved</b>						
BOOT 0	I	9	Boot 0/Reserved			
<b>Power and Ground</b>						
V <sub>in</sub>		8	V <sub>in</sub>			
GND		7	GND			
<b>Reset</b>						
RESETN	I	10	Reset input (active low for 5 ms);		2.5V max	
<b>LPO</b>						
LPO	I	15	LPO input			
<b>GPIO – General Purpose Input/Output</b>						
GPIO [1]	I/O	1	General Purpose Input/Output	SPI MISO	Y	Input pull down
GPIO [2]	I/O	2	General Purpose Input/Output	SPI MOSI/I2S_SD	Y	Floating
GPIO [3]	I/O	3	General Purpose Input/Output	SPI SCLK/ I2S_CK	Y	Input pull down
GPIO [4]	I/O	4	General Purpose Input/Output	SPI SS/I2S_WS	Y	Input pull down
GPIO [5]	I/O	5	General Purpose Input/Output		Y	Input pull down
GPIO [6]	I/O	6	General Purpose Input/Output	DAC	2.5V max	Input pull down
GPIO [7]	I/O	16	General Purpose Input/Output	ADC 4	2.5V max	Input pull down

### 2.7 Pin Placement Diagram (Top View)



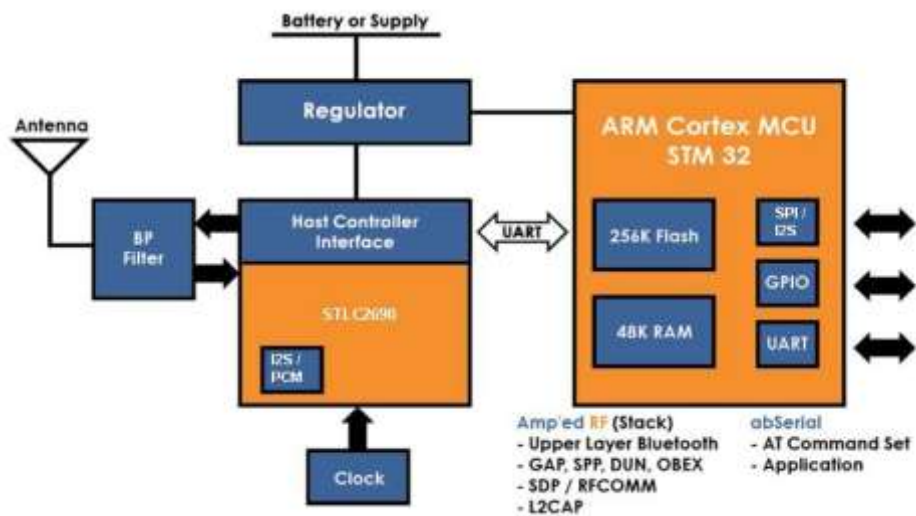


### 2.8 Layout Drawing



BT33A: 11.6 mm x 13.5 mm x 2.5 mm  
 BT33-NS/BT33LT: 11.6 mm x 13.5 mm x 2.3 mm  
 BT33LT-F: 11.6 mm x 13.5 mm x 2.0 mm  
 (Edge tolerances +/- 0.5mm, height tolerance +/- 0.2mm)

### 3 Module Block Diagram



## 4 Hardware Design

Amp'ed RF modules support UART, USB, SPI, and GPIO hardware interfaces. Please note that the usage of these interfaces is dependent upon the firmware that is loaded into the module, and is beyond the scope of this document. The AT command interface uses the main UART by default.

### Notes

- All unused pins should be left floating; do not ground.
- All GND pins must be well grounded.
- The area around the antenna should be free of any ground planes, power planes, trace routings, or metal for at least 6 mm in all directions.
- Traces should not be routed underneath the module.

### 4.1 Module Reflow Installation

The BT33 is a surface mount Bluetooth module supplied on a 16 pin, 6-layer PCB. The final assembly recommended reflow profiles are:

For RoHS/Pb-free applications, Sn96.5/Ag3.0/Cu0.5 solder is recommended.

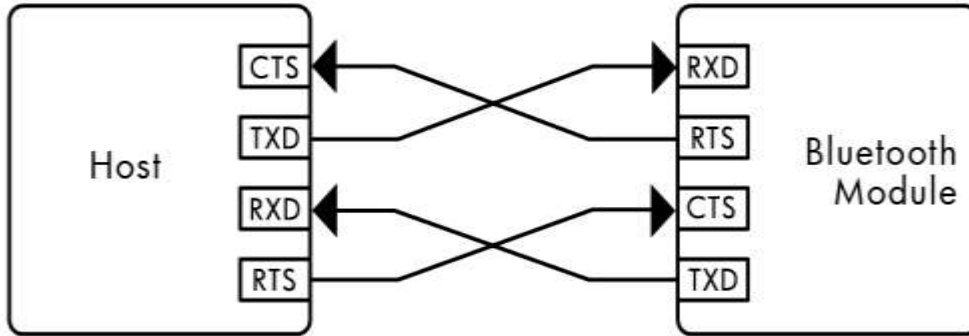
- Maximum peak temperature of 230° - 240°C (below 250°C).
- Maximum rise and fall slope after liquidous of < 2°C/second.
- Maximum rise and fall slope after liquidous of < 3°C/second.
- Maximum time at liquidous of 40 – 80 seconds.

### 4.2 GPIO Interface

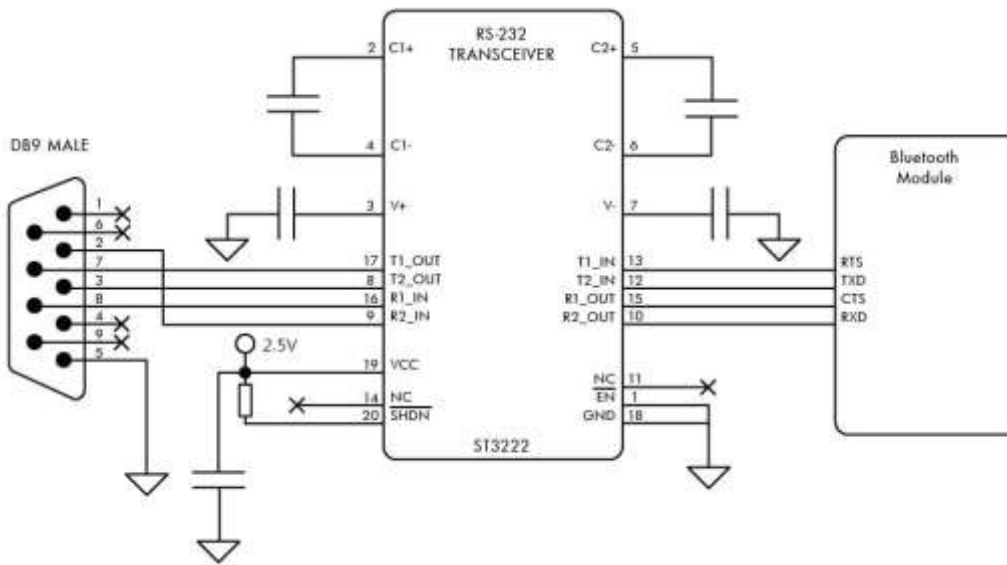
All GPIOs are capable of sinking and sourcing 4mA of I/O current.

### 4.3 UART Interface

The UART is compatible with the 16550 industry standard. Four signals are provided with the UART interface. The TXD and RXD pins are used for data while the CTS and RTS pins are used for flow control.

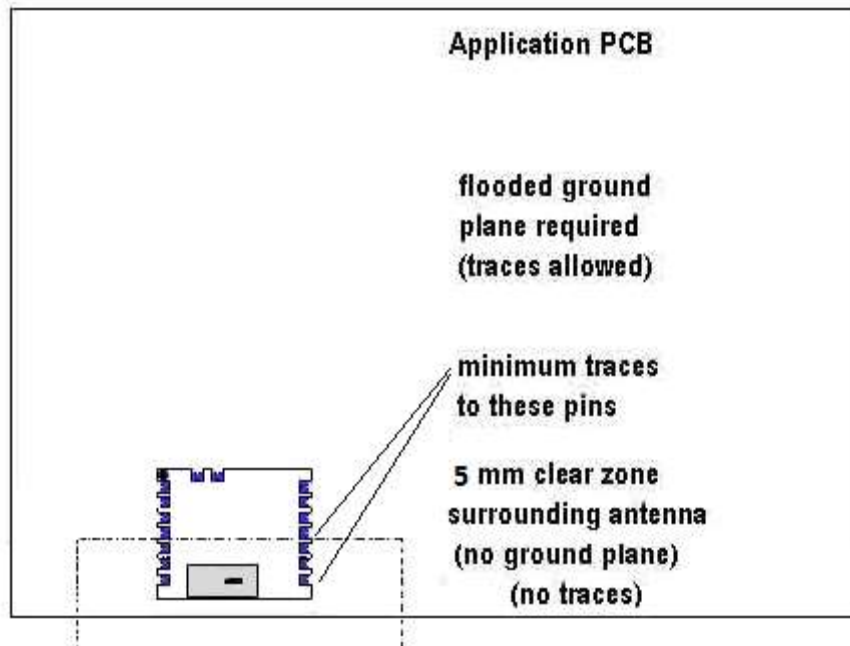


Connection to Host Device



Typical RS232 Circuit

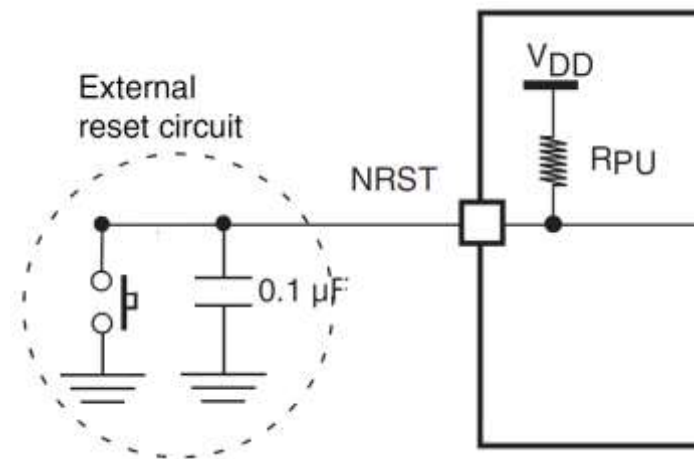
#### 4.4 PCB Layout Guidelines



#### 4.5 Reset Circuit

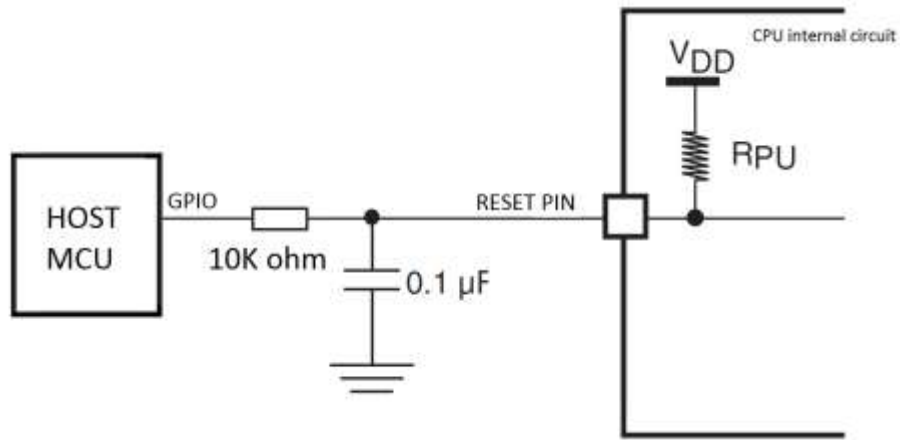
Two types of system reset circuits are detailed below.

##### 4.5.1 External Reset Circuit:



Note: R<sub>PU</sub> ranges from 30K ohm to 50K ohm internally.

#### 4.5.2 Internal Reset Circuit:



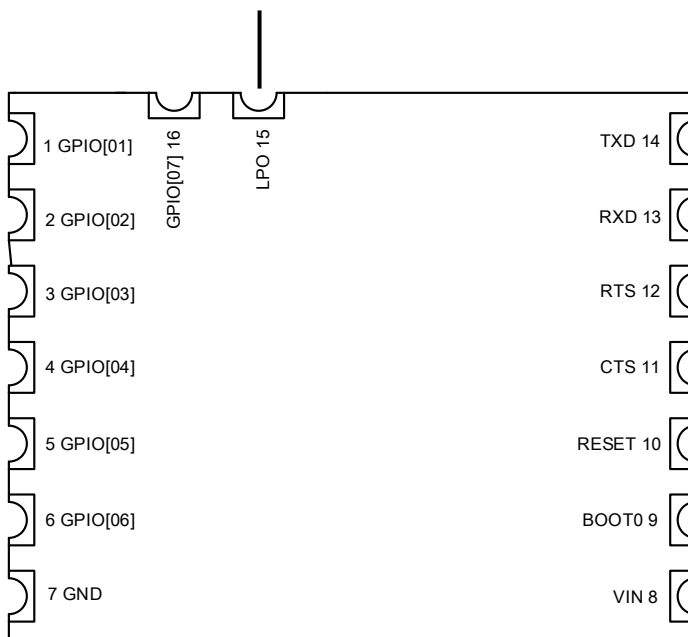
**Notes:**

- $R_{PU}$  ranges from 30K ohm to 50K ohm internally.
- $R_{RST}$  should be from 1K ohm to 10K ohm

#### 4.6 External LPO Input Circuit

An optional low power oscillator input may be added to allow deep sleep and sniff modes.

**Ext 32.768 KHz Clock Input (LPO)**



**LPO Parameters:**

Frequency: 32.768 KHz

Tolerance: 150 ppm

Voltage Levels:

Low: 0.5 V

High: 1.8 V

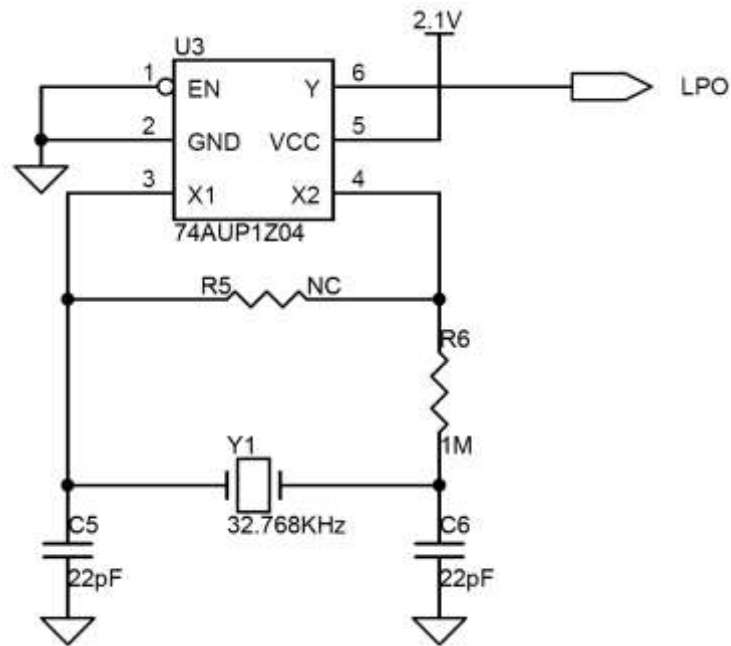
Input Capacitance: 2.5 pF maximum

**Configurations:**

See configuration guide:

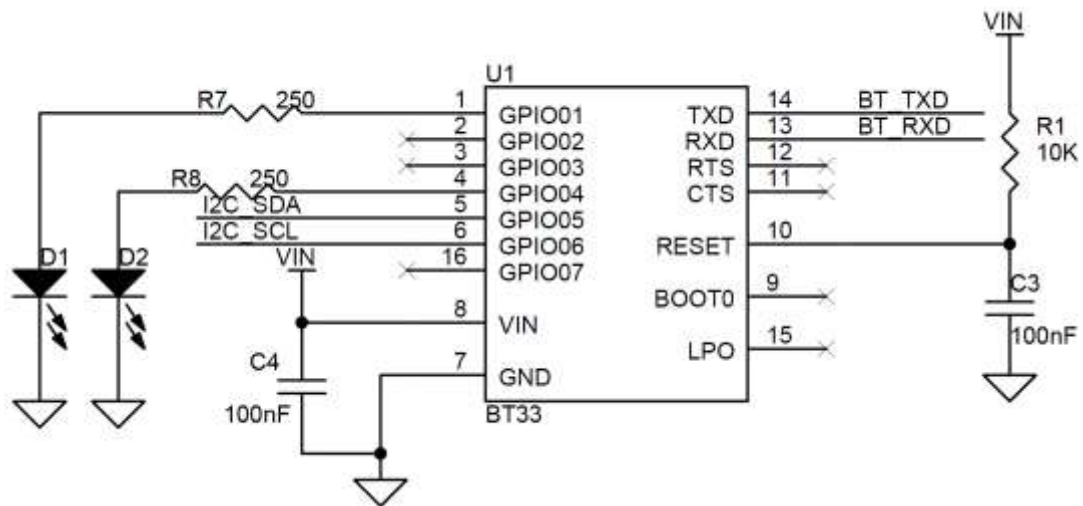
UseExtLPO

AllowSniff

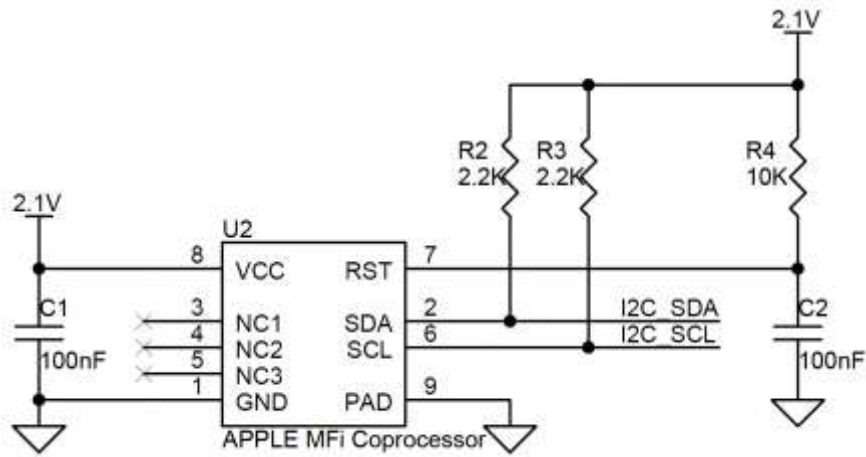


External LPO Reference Circuit

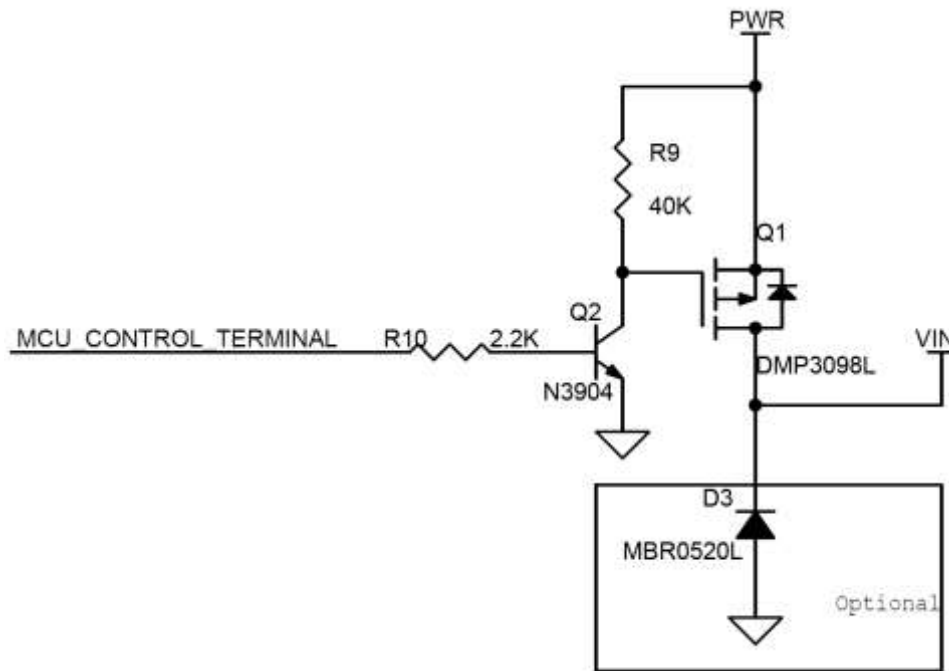
#### 4.7 Apple iOS CP Reference Design



Part 1. BT module



**Part 2. Co-processor**



**Part 3. Power switch**

## 5 Regulatory Compliance

This module has been tested and found to comply with the FCC Part15 and IC RSS-210 rules. These limits are designed to provide reasonable protection against harmful interference in approved installations. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. 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.

Modifications or changes to this equipment not expressly approved by Amp'ed RF Technology may void the user's authority to operate this equipment.

### 5.1 Modular Approval, FCC and IC

FCC ID: X3ZBTMOD4

IC: 8828A-MOD4

In accordance with FCC Part 15, the BT33 is listed above as a Limited Modular Transmitter device.

### 5.2 FCC Label Instructions

The outside of final products that contain a BT33 device must display a label referring to the enclosed module. This exterior label can use wording such as the following:

Contains Transmitter Module

FCC ID: X3ZBTMOD4

IC: 8828A-MOD4

Any similar wording that expresses the same meaning may be used.

### 5.3 CE Certification

**CE ID:** Expert Opinion N. 0448-ARAM00003

### 5.4 Bluetooth Certification

**Bluetooth QDID:** B019224



## 6 Ordering Information

Part Name	Description
BT33A	Standard version
BT33A-NS	No shielding version
BT33LT	Lite version, limited features
BT33LT-F	Lite version, limited features, low profile

## 7 Feature Comparison

Features	BT33A	BT33A-NS	BT33LT/LT-F
CPU Speed	72MHz Max.	72MHz Max.	36MHz Max.
CPU Memory	256K Flash, 48K RAM	256K Flash, 48K RAM	128K Flash, 16K RAM
Bluetooth Profile Support	SPP, IAP, OBEX, DUN	SPP, IAP, OBEX, DUN	SPP and IAP
Bluetooth Stack	Amp'edUP, BT v3.0	Amp'edUP, BT v3.0	Amp'ed UP, BT v3.0
Apple iOS Support	Supported	Supported	Supported
AT Command Interface	abSerial	abSerial	abSerial Lite
Multiple Connections	7 Max.	7 Max.	1 Max.
Link Throughput	2M bps Max.	2M bps Max.	300K bps Max.
Serial Interface	UART, I2C, SPI	UART, I2C, SPI	UART or SPI, I2C
General I/O Lines	7	7	7
A/D Lines	4	4	4
DAC Lines	1	1	0
Shield	Yes	No	No

## 8 Revision History

Date	Revision	Description
23-June-2011	1	First release
6-April-2012	2	Updated for the LT model
15-Feb-2013	3	Added BT33A-NS option
10-June-2013	4	Added BT33LT-F option BT33 part number change to BT33A
14-July-2015	5	Updated the reference circuits.