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Generalities

1.1 Introduction

1.1.1 Overview

The main objectives for this board, discussed also with the marketing are:

- Get lowest cost solution to enable BT for a maximum of IP terminals
- Enable new usages like
    - The phone is seen as a carkit for a smartphone
    - The phone can exchange phonebook with a smartphone
    - The phone can support tags through BT Low Energy
- From R&D point of view:
    - The board must be small enough to be integrated easily into our ID.
    - The board must integrate the antenna to avoid a re-certification for each phone which would use it.

For this project, a pre-study has been done. See reference [1].

The choice is to do a daughter board with the chip CC2564C from Texas Instruments, with an integrated antenna on the layout (Printed antenna).

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.

Please note that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

—Reorient or relocate the receiving antenna.

—Increase the separation between the equipment and receiver.

—Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

—Consult the dealer or an experienced radio/TV technician for help.

This device complies with Industry Canada's licence-exempt RSSs. Operation is subject to the following two conditions:

(1) This device may not cause interference; and

(2) This device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

(1) l'appareil ne doit pas produire de brouillage;

(2)l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

CAN ICES-3 (B)/NMB-3(B)

1.1.2 Aim of the document

A pre-study has been done, in order to define the best choices for the whole solution, going from antenna to the BT management software in the phone.

This document is intended to give all the technical inputs in order to make a BT daughter board which will be used on the Alcatel-Lucent IP Phones.

A first step will be to use it on 8068s and 8078s, but we should care to make it possible to be used also on nextgen phones and other projects.

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1.2 Services provided by the feature or equipment

The BTDB will give a BT4.2 connectivity to the product where it is mounted into. The main reasons of this daughter board are to have:

- A common function usable on several phones without the need of RF expertise and full BT qualification
- A cost effective solution

1.3 External Interfaces

The interface signals are listed hereafter:

Pin N°	Name	Function	Type	Voltage
1	GND	Keep feet on the ground.	Power	0V
2	VDD_IO	Direct path supply for 1.8V I/O pads.	Power	1.8V
3	GND	Keep feet on the ground.	Power	0V
4	SLOW_CLK	32.768KHz +/- 250ppm	I	1.8V
5	GND	Keep feet on the ground.	Power	0V
6	HCI_RX	HS UART Receive up to 4Mbps	I /PU	1.8V
7	TX_DBG	TI internal debug messages. Not used.	O /PU	1.8V
8	HCI_CTS	HS UART flow control: data from BTDB to Host allowed when low	I /PU	1.8V
9	GND	Keep feet on the ground.	Power	0V
10	GND	Keep feet on the ground.	Power	0V
11	HCI_RTS	HS UART flow control: data from host to BTDB allowed when low	O /PU*	1.8V
12	HCI_TX	HS UART Transmit up to 4Mbps	O/PU*	1.8V
13	GND	Keep feet on the ground.	Power	0V
14	PCM_SYNC	Frame synchro for audio data	I/O /PD	1.8V
15	PCM_CLK	Clock for audio data	I/O /PD	1.8V
16	PCM_OUT	Output of audio data. Maybe in tristate	O /PD	1.8V
17	PCM_IN	Input of audio data	I	1.8V
18-23	GND	Keep feet on the ground.	Power	0V
24	ENABLE	Disables BT chip when low (Pull down) and performs internal reset of CC2564. Minimum low state duration: 5ms	I /PD	1.8V
25	GND	Keep feet on the ground.	Power	0V
26	VDD_IN	General supply	I	2.2V-4.8V
27	GND	Keep feet on the ground.	Power	0V

PU* : Pull-Up enabled only during ShutDown and DeepSleep phases (.

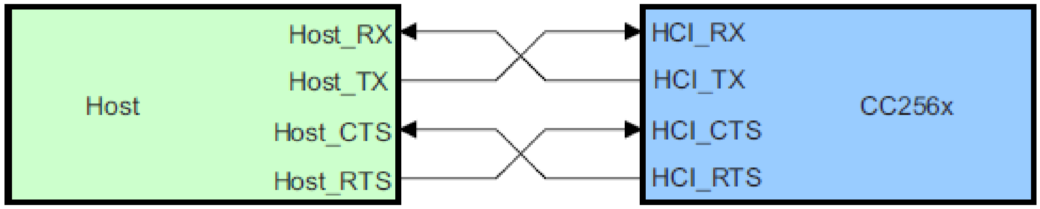
These correspond to the metal cut-holes. See chapter 7.4.3.

The VDD_IN pin can accept 2.2V to 4.8V. Typical value is 2.5V or 3.3V, but this depends on the motherboard.

Check the CC2564C datasheet for more information.

The UART has by default the following characteristics (can be reprogrammed to up to 4Mbps)

Parameter	Value
Bit rate	115.2 kbps
Data length	8 bits
Stop-bit	1
Parity	None



Check the CC2564C datasheet for more information.

This cabling supposes that the Host is in DTE mode. In case of DCE host, RTS and CTS are straight, and not crossed.

CAUTION:

Only the following interfaces are fail safe (can stand an applied voltage when the device interface, or the device is not powered (VDDio or VDDin not provided):

AUD_FSYNC, AUD_CLK, AUD_IN, AUD_OUT, SLOW_CLK

This means that the motherboard must not apply a voltage on HCI_RX, HCI_TX, HCI_CTS or HCI_RTS pins before the VDDio is supplied. Even when VDDio is present, it is not allowed to ENABLE the chip if VDDin is not present. See specification of CC2564 for more details.

The SLOW_CLK source must be stable within 2ms after the ENABLE LOW to HIGH transition.

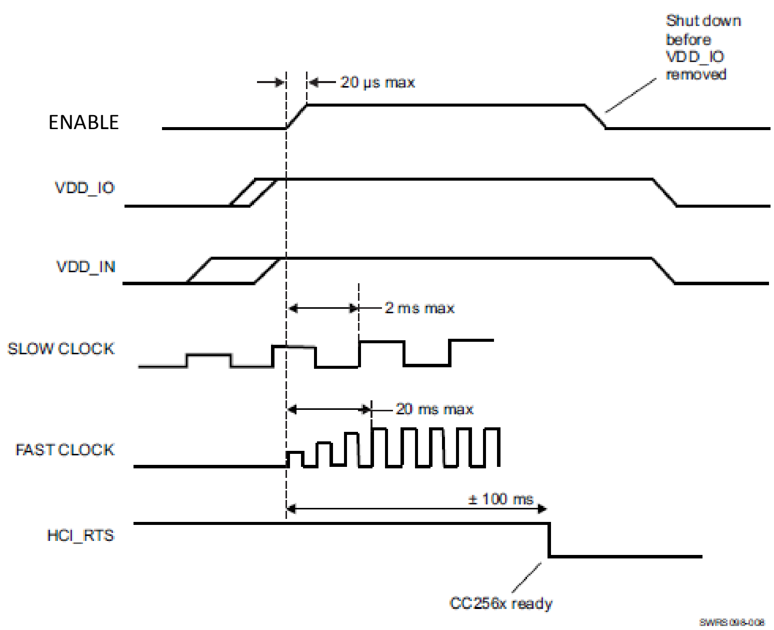


Figure 3-2. Power-Up and Power-Down Sequence

Note: FAST CLOCK must be stable within 20ms of nSHUTD(ENABLE) going high. But according to TI FAE's feedback, the 20ms limit only applies to TCXO. Crystal is used in BTDB, which doesn't need to follow the 20ms limit.

1.4 Terminology / Abbreviations

BTDB: BlueTooth Daughter Board

BT: BlueTooth

LE: Low Energy

1.5 Related Documents

	Document	Reference number
Alcatel documents		
[1]	Bluetooth: Pre-study of a low cost solution for BT in Desktop Phones	3AK_29000_0041_BEZZA
[2]	8088 Hardware external specification	3AK_29000_0080_EDZZA
[3]	ESD CSBU R&D - PB Design/Layout rules	8AL 51074 0003 DSZZA
[4]	NOE3G INDUSTRIAL REQUIREMENTS	3BN 69030 1403 MCASA
External documents		
[5]	All TI documents for CC2564 (upload)	3AK_29_CC256X_BLUETOOTH_02278
[6]		

2. General Requirements

2.1 Features

The board must provide the following features:

- Give dual mode BT connectivity (Classic & Low Energy), so BT4.1
- Integrate the antenna, done with copper tracks on the PCB
- Interface to the motherboard with UART and PCM, USB not required.
- Permit a very low cost solution.
- Give ease of re-use for other products (simple process, no RF expertise).

2.2 Standards

2.2.1 BT related certification

On the Bluetooth.org website, the existing certifications of BT solutions are listed.

The certification strategy will be as follows:

- Make a certification for the board, with embedded low part of the BT stack, and antenna
- Make a product certification, where the BTDB is in the Phone. Here we can take benefit of the module certification
- Following the first product certification (ex: NOE3GEE), the next products which use the BTDB will need minimum or no certification, on condition that the used upper BT stack (in host processor) is the same as the one of NOE3GEE.

It is necessary to make a BT qualification for the BTDB with its antenna.

This will qualify:

- The hardware, radio parts
- The Lower part of the BT stack (below HCI interface) located in the BT chip
- The Upper part of the BT stack, which runs on the Host processor.

This is why, if we re-use this board, a big part of the certification does not need to be done.

See chapter 4.5.1 for discussion about the “module” aspect for BT certification.

2.3 Environmental requirements

These are the same as for the terminal for which this board is intended. The tests are made on the daughter board mounted in a final product, so they are part of the product qualification.

This BTDB board cannot be co-located with other transmitters. If mount this board on final product, Should add FCC ID and IC information in the product label (FCC ID: OL3BTMOD02, IC: 1737D-BTMOD02).

For a host manufacture's using a certified modular, if (1) the module's FCC ID is not visible when installed in the host, or (2) if the host is marketed so that end users do not have straightforward commonly used methods for access to remove the module so that the FCC ID of the module is visible; then an additional permanent label referring to the enclosed module: "Contains Transmitter Module FCC ID: OL3BTMOD02, IC: 1737D-BTMOD02" or "Contains FCC ID: OL3BTMOD02, Contains IC: 1737D-BTMOD02" must be used. The host OEM user manual must also contain clear instructions on how end users can find and/or access the module and the FCC ID.

This equipment complies with radio frequency exposure limits set forth by the Innovation, Science and Economic Development Canada for an uncontrolled environment.

This equipment should be installed and operated with a minimum distance of 15mm between the device and the user or bystanders.

This device must not be co-located or operating in conjunction with any other antenna or transmitter.

Cet équipement est conforme aux limites d'exposition aux radiofréquences définies par la Innovation, Sciences et Développement économique Canada pour un environnement non contrôlé.

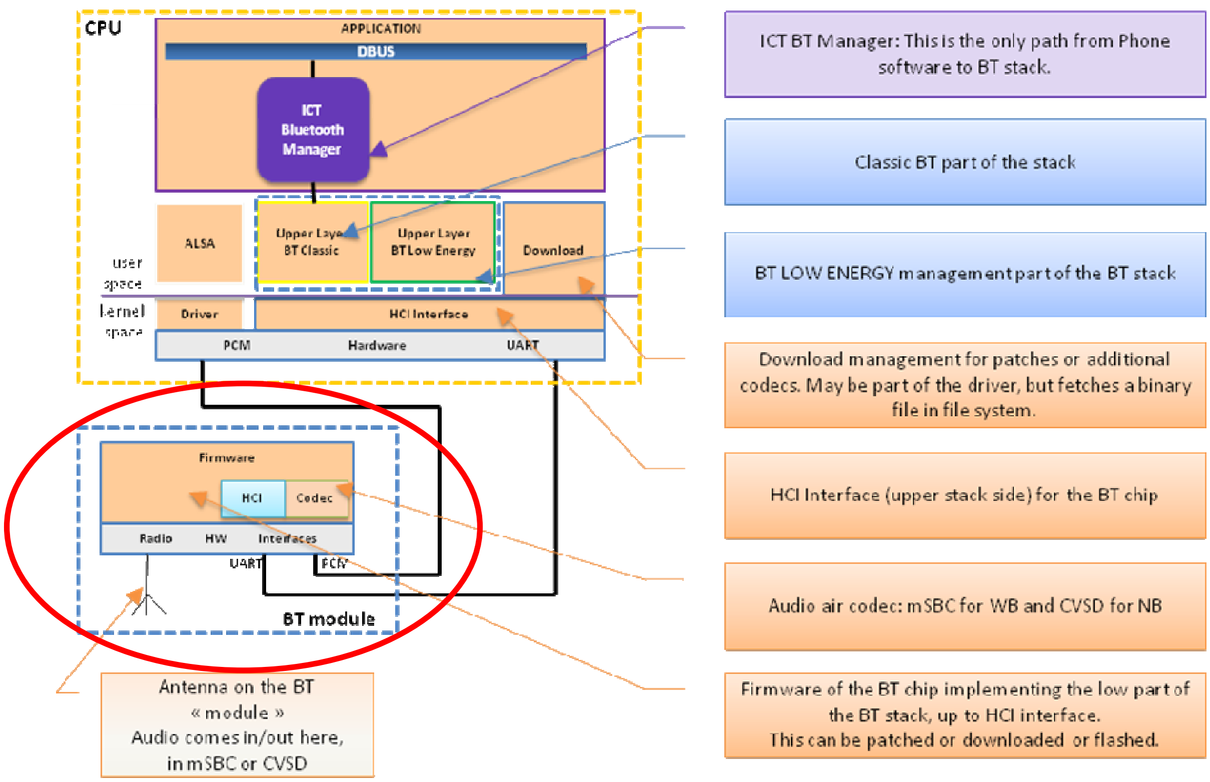
Cet équipement doit être installé et utilisé avec un minimum de 15mm de distance entre le dispositif et l'utilisateur ou des tiers.

Ce dispositif ne doit pas être utilisé à proximité d'une autre antenne ou d'un autre émetteur.

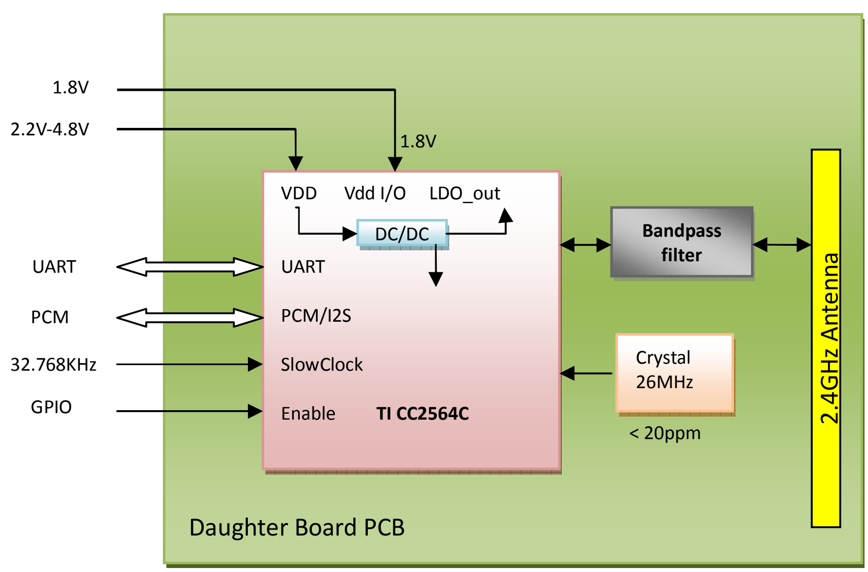
For details see for example the Smart Deskphone 8088 HW external specification (see ref [2])

3. General Description

3.1 BT function global logical bloc diagram



3.2 BT daughter board bloc diagram



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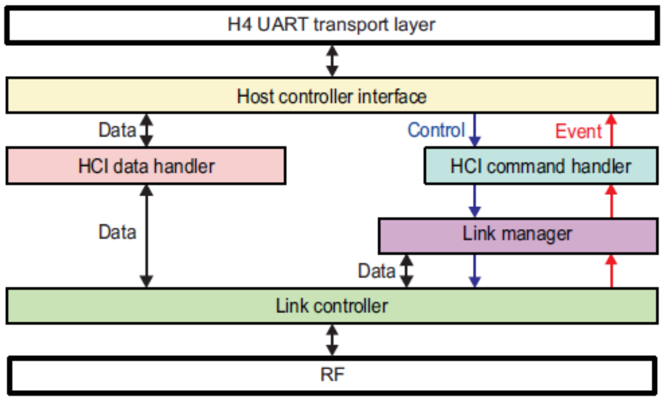
The CC2564C communicates with a standard HCI through the UART interface.

Here is a representation of the lower part of the stack, which is inside the CC2564C:



This means that the upper part of the stack must be hosted in the mother board cpu.

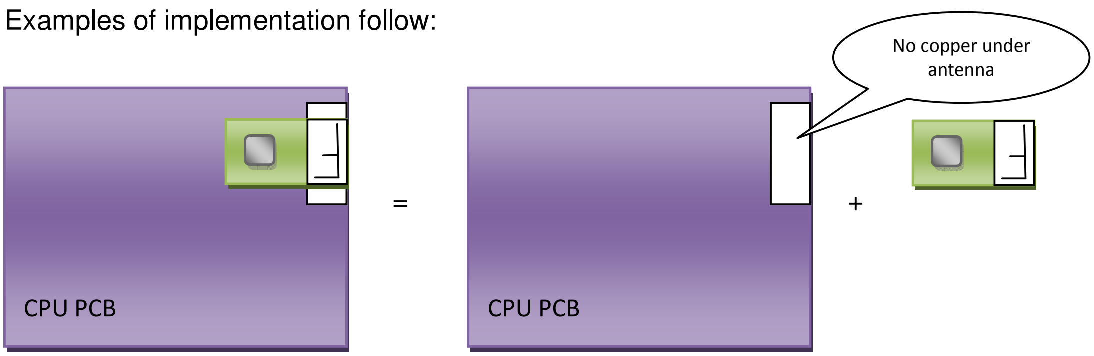
3.3 Mechanical aspects and integration

This board will be mounted on a IP Phone CPU board or BT handset CPU board.

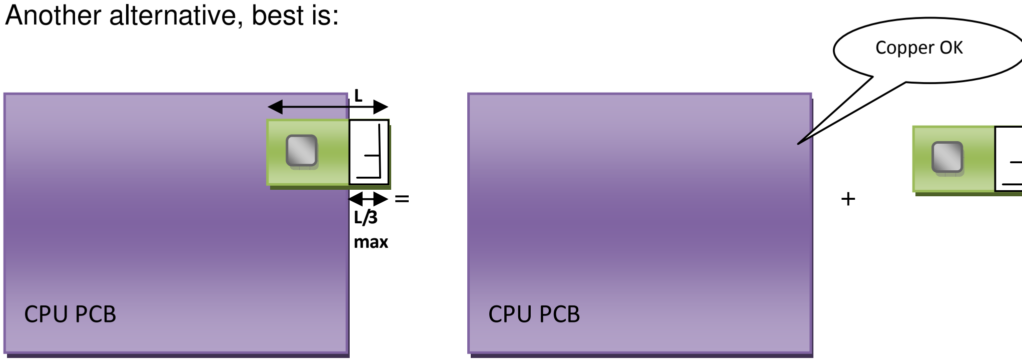
For radiofrequency propagation reasons, the antenna area must not cover any copper plane.

For industrial reasons, the board must lay on the CPU board on at least 2/3 of it's surface.

Examples of implementation follow:



Another alternative, best is:



3.4 Specification

Parameter	Value	
Standard support	Bluetooth 2.1 + EDR, BLE 4.2	
Host interface	HCI UART	
V_{BAT} Min, Max	1.7 Volts, 4.8 Volts	
V_{DD_IO} Min, Max	1.62 Volts, 1.92 Volts	
Temperature range (board)	-5 to +65℃	
Frequency range	2402 MHz to 2480 MHz	
Transmit power GFSK, and EDR	+4 dBm typ +6dBm max	
Transmit power BLE	-6dBm typ -4dBm max	
RX Sensitivity BR	-91.5 dBm, GFSK at 0.1% BER	Max
RX Sensitivity EDR	-81 dBm, 8DPSK at 0.01% BER	Max
RX Sensitivity BLE	-93 dBm, PER=30.8%	Max
Full throughput current	42 mA, GFSK or EDR	Max
SCO link HV3	15 mA	Max
Idle current BR and EDR	5 mA	Max
BLE Scanning	310 uA	Max
BLE Advertising	150 uA	Max
Shutdown current	10 uA	Max

4. Detailed Technical Description

4.1 Electronic

4.1.1 BT chip solution to be implemented

The chosen chip to implement BT4.2 compliant connectivity is the Texas Instruments CC2564C chip.

This is a dual mode (Classic + Low Energy) one chip solution.

This chip comes in several versions:

- Version A (CC2564A) which is on the market already a while, and for which it is necessary to download a patch to implement mSBC codec.
- Version B (CC2564B) which will be in mass production in Q4/2013. It integrates all patches for mSBC and other bug corrections in ROM.
- Version C (CC2564C) which is BT4.2 compliant.

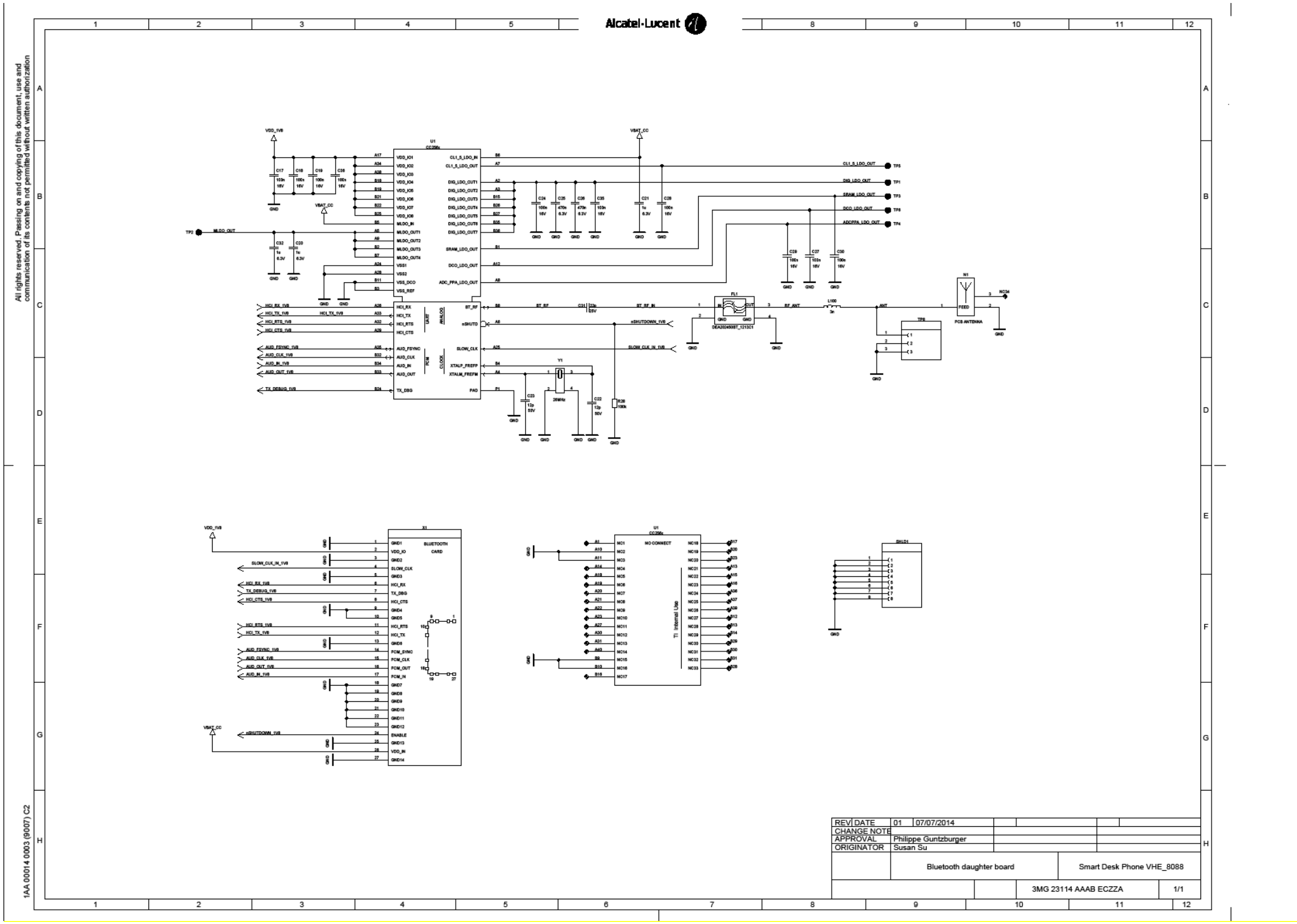
This chip integrates the baseband, the RF amplifier, balun, and power regulator.

It needs externally:

- a bandpass filter (SAW filter) + antenna
- an accurate 26MHz source (crystal with less than 20ppm initial+ temperature+aging)
- a standard slow clock at 32.768KHz for low power modes (100ppm), which will be provided by the CPU
- Some passive components.

We will implement the reference design from Texas Instrument, with minor adaptation to our needs (no level shifters, or test probe headers…).

4.1.2 Schematic



4.2 Radiofrequency

4.2.1 Antenna choice

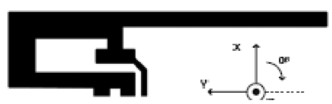
Two major types of antennas could be implemented:

- Ceramic antenna: very compact, these are easy to mount, but have a cost of around 13 cents. Their performance is medium.
- PCB antenna: this uses a track of copper on the PCB. It gives good performance at 2.4GHz, very low cost, but needs more surface and may need some tuning. The PCB antenna designs are well known.

The BTDB will use the PCB antenna.

In this type, we have for BT two main choices:

- The inverted F antenna, well known, good performance, very low dependence to the environment . It has a large bandwidth. Typical size is 26mm x 8mm. This is too large for our module.



- The meandered inverted F antenna, which is a variant to have more compacity: 16mm x 6mm. This one is good for our design. This antenna is sensitive to small dimension changes, and has a narrow bandwidth. So an exact copy of the reference dimensions must be done. This antenna is typically used in BT USB dongle designs.

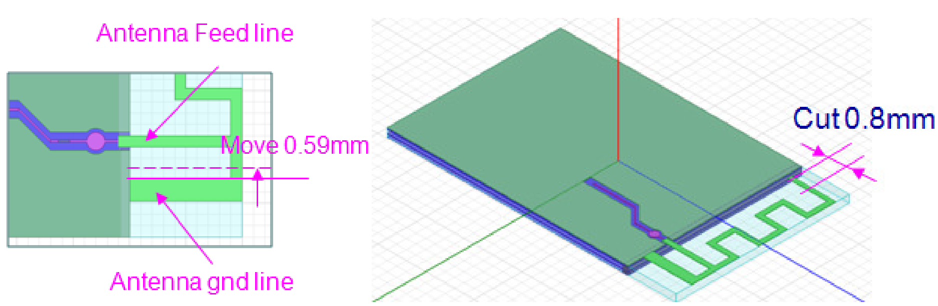
The meandered inverted F antenna will be used for the design.

Check the following document for the antenna specification and implementation:

http://www.ti.com/litv/pdf/swra117d (also available in doc ref [3]).

To improve the antenna efficiency, we changed the antenna shape data as the following figure and table: GND move to feed line 0.59mm (D5, L3), cut antenna 0.80mm (L1).

The antenna gain is 5.1dBi.



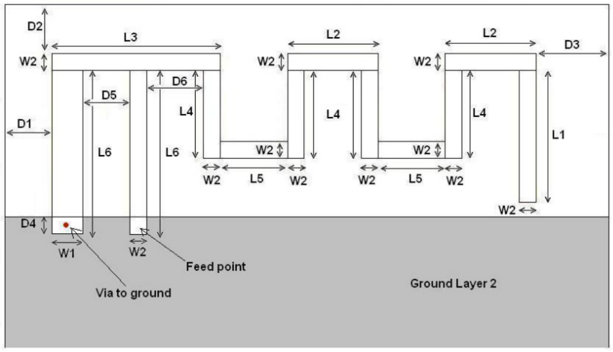


Figure 3: Antenna Dimensions

L1	3.94 mm
L2	2.70 mm
L3	5.00 mm
L4	2.64 mm
L5	2.00 mm
L6	4.90 mm
W1	0.90 mm
W2	0.50 mm
D1	0.50 mm
D2	0.30 mm
D3	0.30 mm
D4	0.50 mm
D5	1.40mm
D6	1.70 mm

Table 1: Antenna Dimensions

L1	3. 14mm
L2	2.70 mm
L3	4. 41mm
L4	2.64 mm
L5	2.00 mm
L6	4.90 mm
W1	0.90 mm
W2	0.50 mm
D1	0.50 mm
D2	0.30 mm
D3	0.30 mm
D4	0.50 mm
D5	0. 81mm
D6	1.70 mm

Table 1: Antenna Dimensions

4.2.2 Immunity to external spurious and interferences

The BT radio can be perturbed by external high amplitude radiofrequency fields. In this case, the BT may show high bit error rate for example.

To improve the immunity of the BTDB, we will foresee a soldered shield, for risk mitigation. In our application, there are no nearby emitters (like WIFI or GSM a few centimeters far from the BT radio).

Neither TI, nor Broadcom put a shield by default in their implementations.

The shield will be the one which is on the reference design (16.5 x 16.5mm), if this is not limiting size reduction.

4.2.3 Quality of supply

The radio is sensitive to wideband noise on the power supply.

The CC2564 integrates high rejection linear regulators, able to provide a clean supply from typically battery voltage with high voltage dips.

Voltage dips are allowed up to 400mV for a duration less than 2.3ms. This means that no special care needs to be taken when feeding the board with 3.3V (on mother board).

An 1.8V feed is provided for the I/O. This is not a sensitive supply and no special care is needed for this in terms of noise (the typical noise level found on digital boards on 1.8V is acceptable).

4.3 Layout

4.3.1 BTDB layout

The layout recommendations from Texas Instruments must be followed.

Refer to document:

http://www.ti.com/lit/an/swra420/swra420.pdf (also available in doc ref [3]).

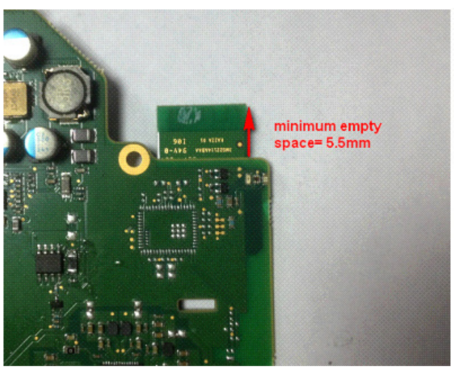
The layout MUST be based on the evaluation kit of TI. The main page for this follows:

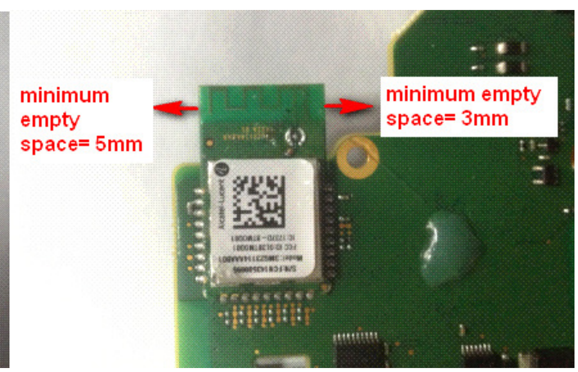
http://processors.wiki.ti.com/index.php/CC256x

4.3.2 Place requirements of BTDB on mainboard

To make the BTDB on mainboard has similar antenna resonant frequency as BTDB alone, there are some BTDB place requirements:

1. The under space of the BTDB antenna need to be empty, at least 5.5mm empty space.
2. The right side of BTDB antenna need to be at least 3mm empty space.
3. The left side of BTDB antenna need to be at least 5mm empty space.





4.4 Software

A set of patches and features improvements must be downloaded to the CC2564 chip. This is named as “service pack”.

It depends on the device version (A, B or C), and MUST be downloaded when the device is powered up, before any RF usage.

4.5 Certification

4.5.1 General aspects on the "module" concept

This gives some clarifications about the "module" definition given by FCC.

Single-modular **transmitter has to comply with all eight following requirements:**

i. The radio elements must have the radio frequency circuitry shielded. Physical components and tuning capacitor(s) may be located external to the shield, but must be on the module assembly;

ii. The module must have buffered modulation/data inputs to ensure that the device will comply with Part 15 requirements with any type of input signal;

iii. The module must contain power supply regulation on the module;

iv. The module must contain a permanently attached antenna, or contain a unique antenna connector, and be marketed and operated only with specific antenna(s), per Sections 15.203, 15.204(b), 15.204(c), 15.212(a), 2.929(b);

v. The module must demonstrate compliance in a stand-alone configuration;

vi. The module must be labelled with its permanently affixed FCC ID label, or use an electronic display (See KDB Publication 784748 about labelling requirements);

vii. The module must comply with all specific rules applicable to the transmitter including all the conditions provided in the integration instructions by the grantee;

viii. The module must comply with RF exposure requirements (see discussions below).

Single-modular transmitter can demonstrate compliance (EMC, SAR, HAC) independent of the host.

Limited single-modular **transmitter:**

Limited single-modular transmitter is a transmitter that does not meet all eight requirements, but may rely on a specific host and applicable operating conditions for compliance. For instance, the shielding, buffered I/O or power regulation may be provided by a specific host. In these cases the module would be "Limited" to the specific host providing those requirements.

A modular is designated as "limited" when compliance is demonstrated in a particular product configuration. For example, it may be installed in a specific host for demonstrating compliance for EMC, SAR or HAC requirements.

For Limited single- modular transmitter, compliance with EMC, SAR, HAC can only be demonstrated for particular product configurations. Certification must be tested in the particular host.

Check the document **996369.pdf** from FCC for more details.

5. Thermal management

No thermal issue is foreseen for this board, as power levels are low (about 130mW in EDR full throughput). So no special thermal care must be taken.

6. Reliability

It can be calculated with CADRE tool according to the reliability database user guide.

http://alda.web.alcatel-lucent.com/transition_docs/CADRE_SR332/SR332-CADRE-main.html

Usually the calculation is done within the final product (the phone)

7. Industrial Considerations

7.1 Manufacturing

Trimming

The radio has an auto-calibration feature. This means that once the radio parameters have been defined by engineering, and stored in the chip, there is **no need of trimming in manufacturing.**

During engineering, care must be taken to define the right RF level output taking into account the losses in the bandpass filter and potential impedance adaptation cells.

7.2 Requirements

The module is considered as a component for the manufacturing, and must be stores in a reel, in vacuum packing until is mounted on the mother board.

Refer to doc: [3] and [4] for more information

7.3 Testability

This proposal is based on a discussion with NPI. This may be refined in a second step.

7.3.1 Testpoints

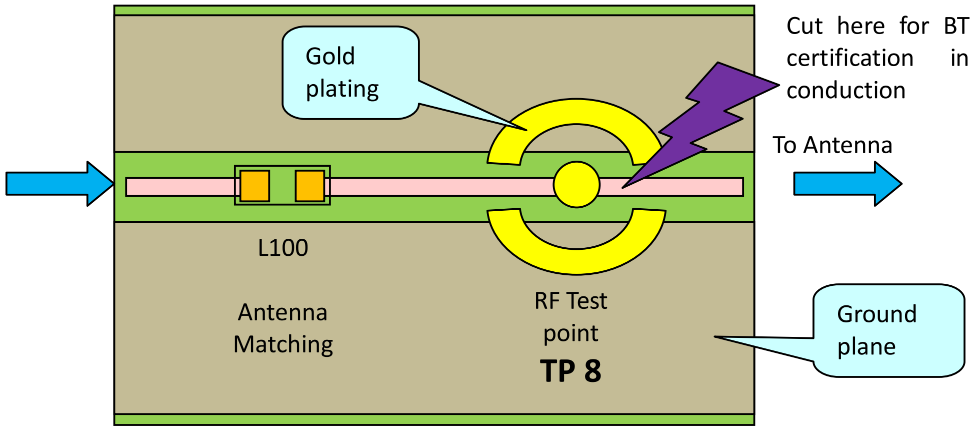
There is no need of having one test-point per trace, as the board will not use ICT.

The AOI (automatic vision) test is foreseen to be made before the shield is put on the board, but before the soldering.

For the RF track to antenna, there will be a pad in series, in order to disconnect the PCB antenna by cutting the track. The pad will then be used to get the RF signal, and the GND surrounding for the shield. See other IP-Phones CPUs for reference.

This is used during certification where conducted tests are done.

The RF test point will be at top side, with the center point on the RF wire. **This is TP 8**



Note: After the tuning, matching circuits are reduced from PI filter(2 capacitors and 1 resistor) to single 0402 size inductor L100 3nH.

7.3.2 Test strategy

The board is simple enough to be tested in functional, without ICT.

The other point is that the shield may be mounted, so we have no access to the possible test points under it. On the other PCB side, there must be no test point, as this side is in direct contact with the CPU board.

7.3.2.1 Test of the daughter board alone

So the test on the daughter board will be done by functional checks:

- Each interface is activated (see chapter 7.3.3)
- The RF is checked through a tester antenna (through the air or on the RF testpoint)
- Some test points will be available on the bottom side for the integrated power regulators.

These tests will validate the solders of components on the daughter board

As usual, two tests are done:

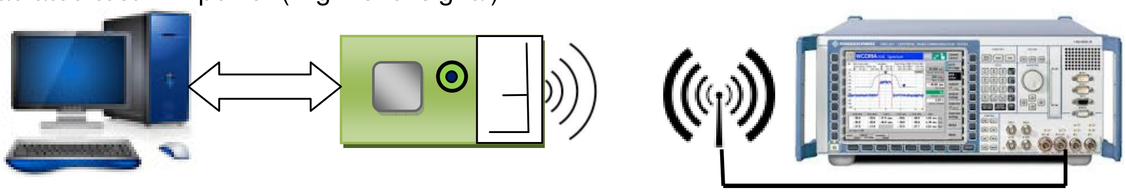
- Radiated test (with tester antenna) for the RF power which covers emission
- Conducted test (the signal is taken on TP8) for BER, which covers reception

Remark: the conducted test means that the RF tester is in parallel of the printed antenna, which cannot be disconnected without unsoldering a component (which can't be done in production).

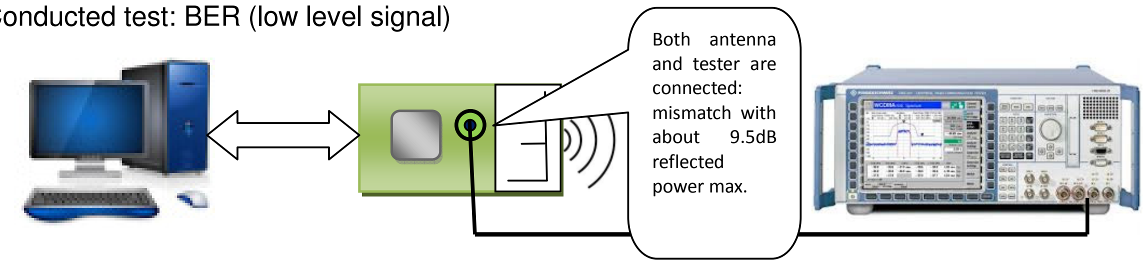
We look for GO/NOGO test and not radio setting. A basic calculation shows that the Voltage Standing Wave Ration (VSWR) will be around 2, which gives a maximum of 9.5dB reflected RF power in worst case.

In consequence, the generated RF signal at the tester must be increased to compensate this. The best reliable solution is to take a golden sample of the board to setup the RF level for conducted BER measurement. This will simplify the procedure in manufacturing.

Radiated test: RF power (High level signal)



Conducted test: BER (low level signal)



7.3.2.2 Test of the daughter board mounted in a phone

For the tests of the BTDB on the mother board, we must consider it as a component.

- The connections to the BTDB are checked by functional test of the interfaces
- The RF is tested through the air.

Only the RF radiated test is done to check:

- RF power level
- BT connection (for example by pairing a device)

7.3.3 Test method

Here is an overview of the means to test the connections within the BTDB.

The board can be individually tested (no need of mounting it on the CPU).

Many functions of the chip can be driven through UART Vendor Specific commands.

The list is given in the following document:

http://processors.wiki.ti.com/index.php/CC256x_VS_HCI_Commands (also available in doc ref [3]).

Some test method can also be taken from the following page:

http://processors.wiki.ti.com/index.php/CC256x_Testing_Guide (also available in doc ref [3]).

Before any RF is activated, the Service Pack (SP) must be downloaded to the CC2564C. For manufacturing, this ServicePack will be stored in PDM.

It may evolve with time, but the manufacturing tools do not need to have the latest version, because the phone software will have it integrated, and download it at phone start-up.
Only if there is an identified but which could impact the manufacturing tests, the SP will be updated.

Here is a table that gives examples of tests for each feature:

Function	Nbr of connections	Method	Test OK if	On test Point:
Power and power-up	VDD_IN VDD_IO Slow_CLK Fast_CLK	Enable must be LOW. Start VDD_IN, then VDD_IO. Apply Slow Clock. Apply Fast Clock. Make a transition LOW to HIGH on Enable.	HCI_RTS goes from HIGH to LOW.	Pin 11
SP download	NA	The service pack must be downloaded before any RF test is possible. Check testing guide. This patch will be stored in PDM, associated to the board.	NA	NA
HCI UART	HCI_TX HCI_RX HCI_RTS HCI_CTS	Setup the tester UART to 115.2k 8N1, with HW flow control. Read the Local version info (send 0x01 0x01 0x10 0x00). Other commands are available	The chip replies with the version.	Pin 12 Pin 6 Pin 11 Pin 8
PCM	PCM_IN PCM_OUT PCM_FSYNC PCM_CLK	Make a loop back of PCM with HCI_VS_Set_Pcm_Loopback_Enabl e (0xFE28) command, and send PCM data to bus	The received PCM data is same as sent data	Pin 17 Pin 16 Pin 14 Pin 15
Slow_Clk	SLOW_CLK	If this is not provided, no way to boot the device, after enable. The HCI_RTS signal will stay high.	HCI_RTS goes from HIGH to LOW.	Pin 11
Fast_Clk	FREFP/FREFN	If this is not running, no way to make a communication through UART. If the PCM is put in master mode, the clock is 4096kHz and is based on the Fast_Clk. This permits to measure the precision.	UART test is OK. The PCM_CLK generated is at +/- 15ppm.	Pin 15
Enable	nSHUTD	Make a transition LOW to HIGH on Enable, and check the HCI_RTS state	HCI_RTS goes from HIGH to LOW.	Pin 11
Debug	TX_DBG	Check state of the test point when the chip is shutdown.	Level should be “1” ie close to 1.8V.	Pin 7
Clock request	CLK_REQ_OUT	Not used, no need to test.	No test	NA

Function	Nbr of connections	Method	Test OK if	On test Point:
Power regulators	DIG_LDO_OUT MLDO_OUT SRAM_LDO_OUT ADCPPA_LDO_OUT CL1.5_LDO_OUT DCO_LDO_OUT	The 6 testpoints will be available on the bottom side of the board. Test the value, and the ripple (in AC).	Voltages are close to those on a golden sample.	TP 1 TP 2 TP 3 TP 4 TP 5 TP 6
Power IN	VDD_IO CL1.5_LDO_IN MLDO_IN	If one of these supplies are not available, the BT emission will not pass the test.	BT emission is compliant.	NA
BT RF	BT RF BT RF IN RF ANT	Check the emitted RF level and frequency with a tester antenna. Second test for reception (optional): put the chip in continuous reception, emit RF with the tester, and check the level of RSSI with HCI_VS_Read_RSSI (0xFDFC) command	RF is present and at the right level. RF is received at the right RSSI level.	TP 8

One option could be to use the development kit from TI as test tool, which is composed of:

- The CPU board MSP430F5438, connected through USB to a computer
- The BTDB which makes the BT function and is connected to the MSP430 CPU

Therefore, see the wiki about the test tool available:

http://processors.wiki.ti.com/index.php/CC256x_Bluetooth_Hardware_Evaluation_Tool

The associated PC software provides the following features;

- Configuration download, service pack download
- Sleep mode activation
- Output power setting
- Radio testing through test modes (see below)
- Debug Traces monitor

The individual test modes are:

Test Mode	Description
Continuous TX	BT device continously transmits at a particular frequency, modulation, and power
Continuous RX	Sets BT device to receive continuously at a particular channel
Packet TX/RX	BT device continously transmits packets at particular frequency, packet type, etc...
BT RF SIG Mode	Put the device into Device Under Test mode to be used with Bluetooth Tester

Of course, all the commands are available through a standard UART, connected to a Tester.

7.4 Mechanical assembly / Industrial feasibility

7.4.1 Board outline

The board must be as small as possible.

Nevertheless, this depends on the antenna type implemented, and to routing optimizations that could be done. This size may be changed if smaller.

Provision is also made for a soldered shield, in case of high interferers.

See chapter 7.4.4 for size of the module.

7.4.2 Board technology

The board is based on the development kit from Texas instrument.The files related to this contain the schematics, the layout, and the BOM.

We will change the TI reference design PCB thickness from 1.7mm to 0.8mm. Nevertherless the thickness of the prepreg layers will stay the same, so the layout can be unchanged.

This was checked with Elec&Eltek PCB vendor . Their answer is:

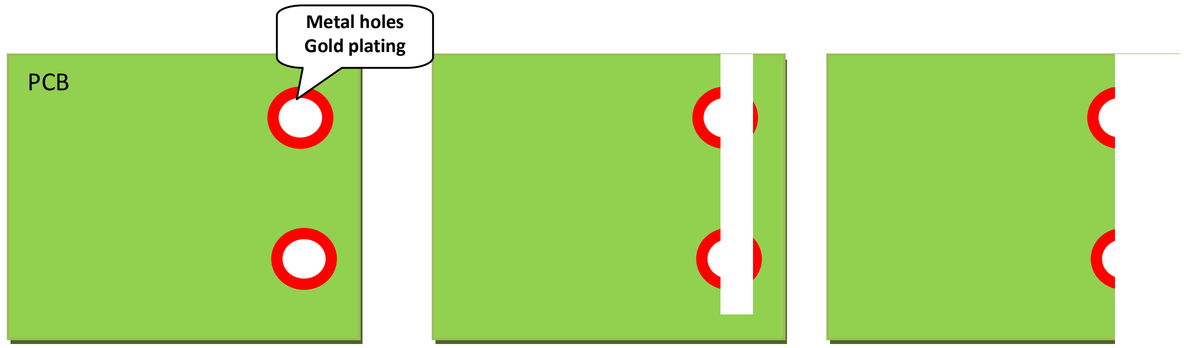
```
“We are ok with the customer original stackup. We also recommend a 1.0mm thickness
stackup as per your requiement. Materials will be PIC FL170 instead of IT180.
Please note that the gold plating is mandatory, we need to know the gold plating
area (with location) for our cost and process capability evaluation.
Yes, we propose to use 16mil of the core to meet total thickness 0.8mm.”

The proposed stackup for 0.8mm thickness is:
Type                 Thickness
L1: Cupper 0.5oz + ENIG plating
2116 pp              4.4 mil
L2: Cupper 1oz
core                 16 mil
L3: Cupper 1oz
2116 pp              4.4 mil
L4: Cupper 0.5oz + ENIG plating

Finished board thickness 0.8+/-0.1mm
```

The PCB is a 4 Layers FR4 controlled impedance with 50 Ohms tracks for the 2.45 GHz radio signals between layers L1 and P2.

7.4.3 Connections

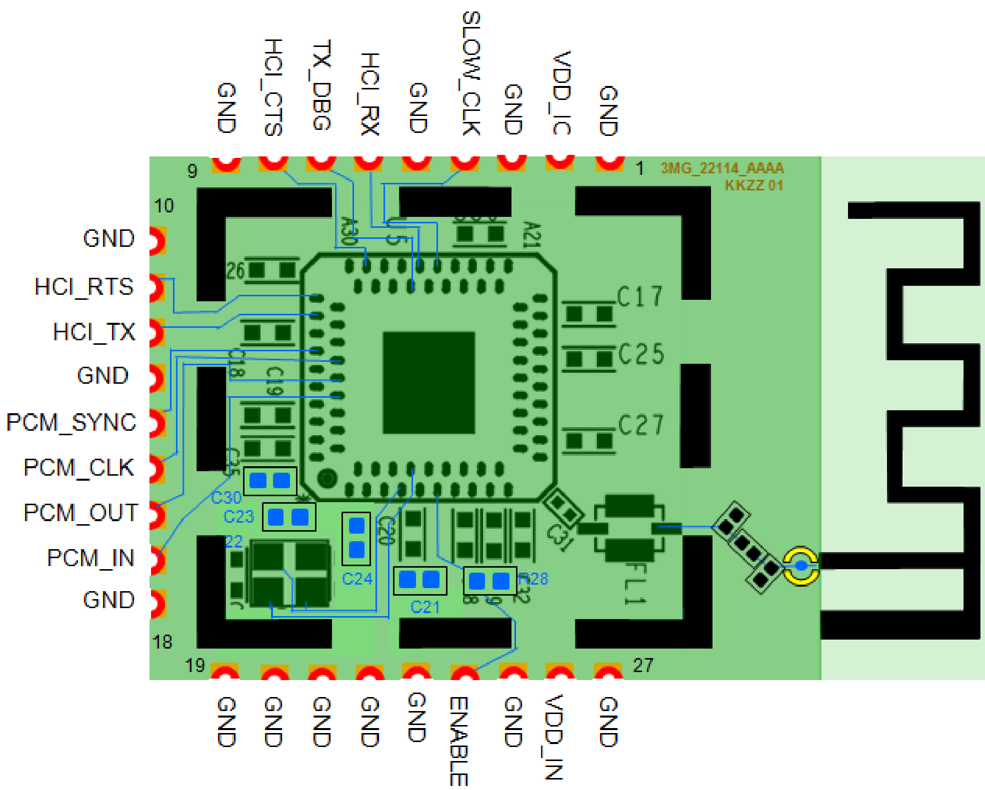
To reduce cost, we want to avoid a board to board connector.

The daughter board will use the technique of the cut metal holes on the board edge (top view):



Before milling During milling Resulting connections

The connections number is 27, spread over three sides of the board as following:



7.4.4 Mounting on the main board

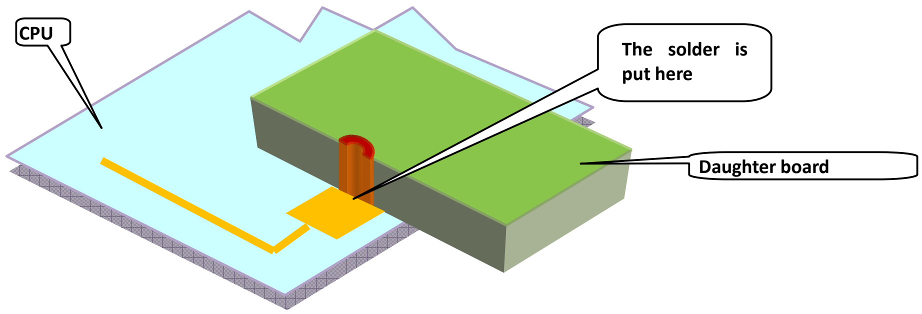
The daughter board is mounted flat directly on the CPU board.

This means that:

- There is no component on the bottom side of the BTDB

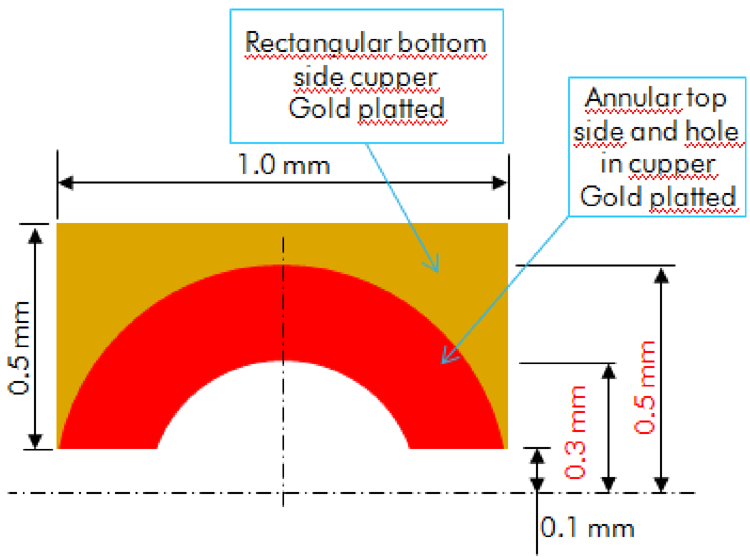
- Also signal vias shall be prohibited to avoid risks of short-circuit with main board GND.

- There is no component on top of the CPU

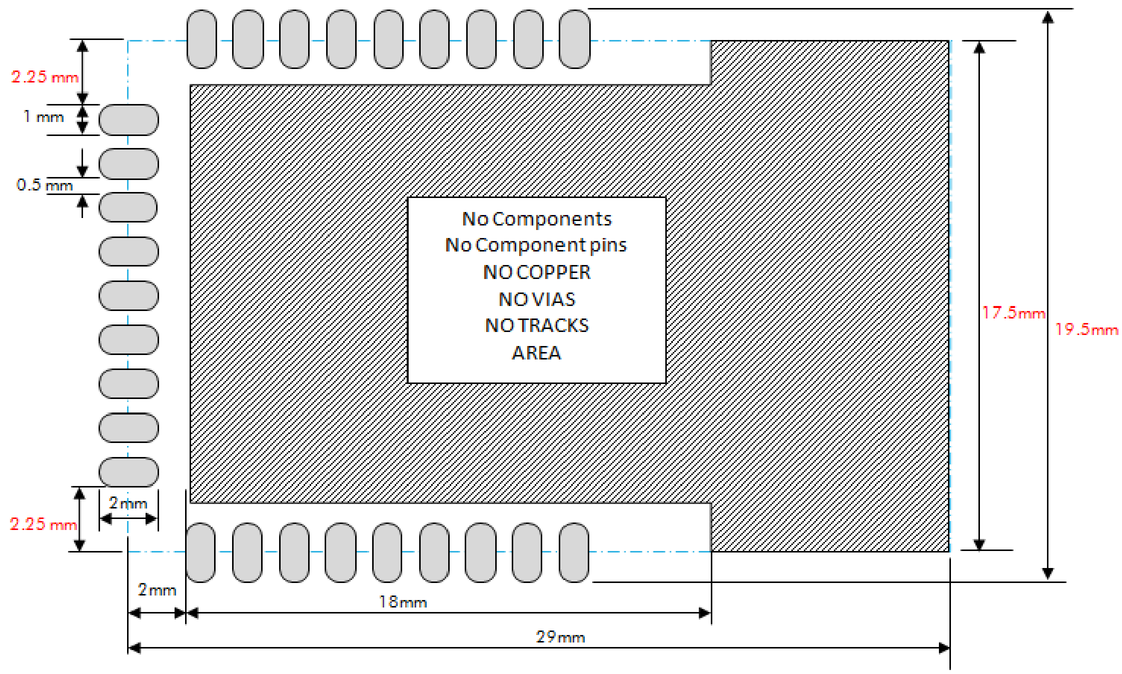


Care must be taken in order to equilibrate the layout, to avoid that the PCB becomes curved during soldering process (due to differential thermal expansion of the copper layers).

The cut-hole size must be defined big enough in order to get a solid solder area, and to avoid that the copper of the hole is snatched during milling process.



On Main board, the recommended footprint is as follows:

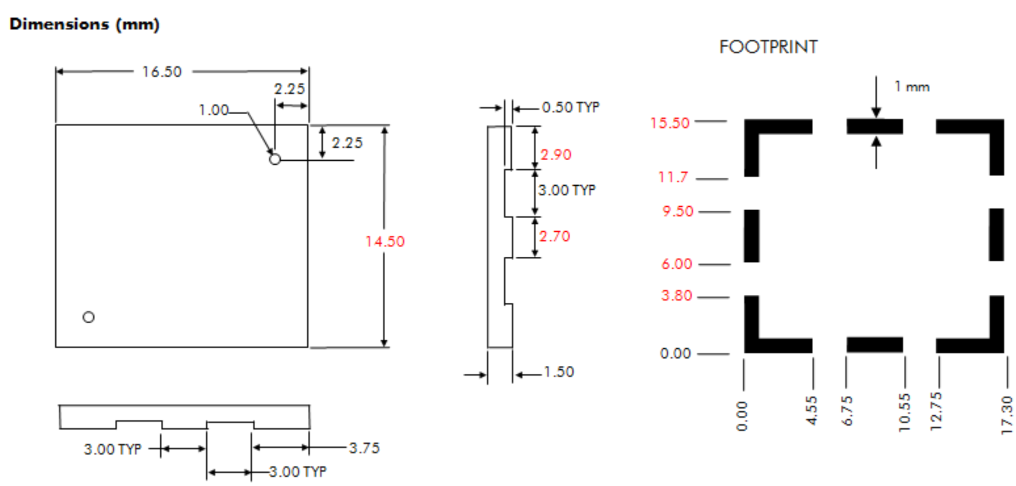


The GND pins must be connected to the GND plane as short as possible, with enough vias. Dotted line is the board outline.

7.4.5 Shielding Mounting

The target is to deliver a BTDB without shielding. All modules on the market have a shielding. It is required when the chip and sensitive RF parts are exposed to strong perturbations (WIFI, Cellular,..). It is not yet clear if our products using the BTHS will be exposed to such conditions. Also for full Bluetooth and RF certification of this board, the shield may be required.

Therefore we have foreseen provision to equip a one-piece surface mount shield. It is preferred to a two pieces part for manufacturing reasons. The following reference shall be used:



END OF DOCUMENT