

|  |   |                             |                             |                          |
|--|---|-----------------------------|-----------------------------|--------------------------|
| <b>Error! Unknown switch argument.</b> |   | <b>Written by:</b><br>TB/HK | <b>Doc. version:</b><br>1.0 | <b>Page:</b><br>1 of 5   |
| <b>Project:</b>                        | <b>GN Netcom Bluetooth Headset</b>          |                             | <b>Project no:</b><br>88    | <b>Date:</b><br>29-06-00 |
| <b>Subject:</b>                        | <b>0dBm Radio Block Diagram Description</b> |                             |                             |                          |

## 1 General

This document contains a Block description of the 0dBm Bluetooth Headset7.

The main focus I based on the radio module, which is more thoroughly described than the rest of the module.

The chapters in this document refers to the respective blocks in the block diagram on the last page of the document.

## 2 Radio Description

This section is a description of the 0dBm Digianswer Bluetooth generation 1 radio block diagram.

The 0dBm radio is shown as the content inside the hatched block in the block diagram below.

### 2.1 LMX3162 transceiver IC

The main block of the radio is the National Semiconductor LMX3162 radio transceiver, which in fact is an upbanded DECT transceiver.

The LMX3162 radio transceiver consists of a phase locked loop PLL, transmit and receive functions. The 1,3GHz PLL is shared between the transmit and receive sections. The data is transmitted and received in different time slots. The time length is dependent upon the packet type transmitted and received. The PLL is able to hop to the desired carrier frequency in a given amount of time before data transmission and reception starts.

The transmitter part of the LMX3162 includes a frequency doubler and it employs direct VCO modulation. The receiver part consists of a 2,5GHz low noise converting mixer, an intermediate frequency amplifier, a high gain limiting amplifier, a frequency discriminator. The RSSI circuit is not used in this 0dBm solution. The receiver section has a simple heterodyne receiver, ie. single conversion architecture and the received signal is demodulated using a quadrature discriminator. The transceiver IC has on-chip regulators in order to allow supply ranges from 3.0VDC to 5.5VDC.

The frequency reference to the transceiver IC is a divide by 4 version of the onboard 16MHz main clock. This main clock is fed to the radio controller (BTIC2/LMX5001, and internal divided by 4 and then fed as the PLL\_OSC (4MHz reference) signal to the transceiver IC.

The signals SER\_CLK, SER\_LE, SER\_DATA, REC\_CE, RX\_PD, TX\_PD and PLL\_PD are transceiver control signals to and from BTIC2.

### 2.2 Transmit Operation

A transmit RF signal is generated by very simple frequency modulation of the VCO. The VCO is seen external to the transceiver IC at the block diagram. The VCO is a none band-switching VCO, which in transmit mode varies in the frequency range of 1201-1247,5MHz dependent of the hopping scheme. It is done in open loop operation. The TX\_DATA transmitted from the BTIC2 IC is Gaussian filtered using a discrete filter before entering the VCO. The amplitude of the signal generated by BTIC2 (TX\_DATA) is adjusted by a resistive divider in order to obtain and control the amplitude such that frequency deviation within the Bluetooth specification is achieved.

The output of the VCO is fed to the LMX3162 transceiver IC, where the frequency is doubled and used as PLL input. The frequency-doubled signal is buffered and the output power of LMX3162 before entering the PA stage is app. -7dBm nominal. This signal is now amplified to app. +2dBm. In Transmit mode the PA power supply is turned on/off using the signal PAON\_BAR from BTIC2.

|   |  |                      |                      |                   |
|---|--|----------------------|----------------------|-------------------|
| Error! Unknown switch argument.               |  | Written by:<br>TB/HK | Doc. version:<br>1.0 | Page:<br>2 of 5   |
| Project: GN Netcom Bluetooth Headset          |  |                      | Project no:<br>88    | Date:<br>29-06-00 |
| Subject: 0dBm Radio Block Diagram Description |  |                      |                      |                   |

At the output of PA the signal is slightly “low-pass” filtered before passing through the RX/TX switch. The signal is band-pass filtered in order to reduce harmonic, sub-harmonic and the VCO signal power at the output.

Finally the signal enters the diversity switch before it is fed the antenna. The frequency range at the antenna output covers the entire Bluetooth band, ie. from 2402-2495MHz.

## 2.3 Receive Operation

In receive mode the signal enters the antenna. The signal first enters the band-pass filter which attenuates the IF conversion image and secures immunity to out of band blockers. After having passed the TX/RX switch the signal enters the LNA, which is build around the BFP420 from Siemens, which can achieve 13dB gain and 2dB noise figure.

After being amplified by the LNA the signal enters the LMX3162 down-converting mixer. In receive mode the VCO covers the frequency band 1146-1192,5MHz due to the heterodyne receiver structure. Due to frequency doubling in the LMX3162 the “doubled” VCO signal at the input of the mixer covers the frequency range 2292-2385MHz. The signal is bandpass filtered in a 110,0MHZ SAW filter. The only purpose of this filter is to secure as high as possible resistance for adjacent channel interferers. The bandwidth of this filter is approximately 1,2MHz.

The signal is now amplified and limited prior to quadrature detection at the output of LMX3162. The detected signal is now fed to the bit slicer, which consists of a 5.order lowpass filter, and a comparator. The 5. order filter will along with the 110.0MHz SAW filter secure that the Bluetooth ACI receiver requirements are fulfilled.

The bit slicer uses a fast and a slow time constant in order to have carrier track on only 4 preamble bit's, and at the same time detect long sequences of 0's and 1's in the packet payload. These time constant's are changed using S\_FIELD2\_BAR from BTIC2. The hardcoded detected bits are transferred to BTIC2 as RX\_DATA.

## 3 Bluetooth Base Band

The Base Band Circuit consists of a single chip solution.

The main feature of this chip is to establish the communication between the DSP and the Radio.

This means that the Base Band chip uses two different sets of very different interfaces.

The interface with the DSP is a general synchronous serial data communication using a DSP Sport. Through the serial connection with the Base Band chip, the DSP controls the Bluetooth settings and transmit/receive data from the Bluetooth Radio connection.

The interface with the Radio consists a serial connection, which provides communication with the radio chip. Then there are several special connections regarding the Bluetooth Radio.

These connections are more thoroughly described in chapter 2 (Radio Description).

The Base Band chip is configured by the DSP. This means that the DSP makes a setup of the Base Band chip. In other cases the DSP tells the Base Band chip whether to transmit or receive data from the Bluetooth Radio or in general the Bluetooth neighborhood and thereby other Bluetooth devices.

When transmitting or receiving data the Base Band converts the DSP data into Bluetooth packages and vice versa, as defined in the Bluetooth standard.

|  |   |                             |                             |                          |
|--|---|-----------------------------|-----------------------------|--------------------------|
| <b>Error! Unknown switch argument.</b> |   | <b>Written by:</b><br>TB/HK | <b>Doc. version:</b><br>1.0 | <b>Page:</b><br>3 of 5   |
| <b>Project:</b>                        | <b>GN Netcom Bluetooth Headset</b>          |                             | <b>Project no:</b><br>88    | <b>Date:</b><br>29-06-00 |
| <b>Subject:</b>                        | <b>0dBm Radio Block Diagram Description</b> |                             |                             |                          |

Furthermore the Base Bands chip controls the power down mode of the Clip In device. When running in normal mode the Base Band chip runs on a 16MHz clock crystal. This generates the main clock in the system and therefore needs to be very accurate.

The Power Down mode is initiated from the DSP. The Base Band chip then shuts down the Power Supply for all the devices not needed, and puts the DSP in Power Down mode.

After a certain amount of time the Base Band chip wakes up the system again.

When the Base Band chip is in power down mode, the chip shifts to the 128kHz clock to lower the power consumption of the chip.

## 4 Memory

This block contains a Flash memory. All the user software is saved in Flash memory.

Splitting up the software, the Flash contains the application software and a debugger, the latter used for development purposes. The application software can again be divided into two software parts: the first part contains the application specific software, which is unique for each product, in this case the software for the Clip In module, and the second part is the general Bluetooth Base Band software.

## 5 DSP

The DSP has interfaces to 3 surrounding segments:

- the Flash memory through the Address and Data bus through which the DSP loads the user software from the Flash memory and executes the loaded program, controlling the other segments and data transmission on the board.
- An AUDIO interface with a microphone and an earphone. The interface to the AUDIO part is using a SPORT and a RESET for the CODEC. The AUDIO functionality is described in chapter 6.
- the Base Band chip using a SPORT. The Base Band functionality is described in chapter 3 (Bluetooth Base Band).

## 6 AUDIO

The AUDIO part contains a CODEC with an AD-/DA-converter which converts the MIC input to a digital signal which then is transmitted from the radio. In the same way, it converts the received radio audio signal to an analog signal which then is output on the earphone.

## 7 Power Supply

The power supply consists of two general blocks. One block for the 'general' part of the module and one for the 'Radio' part.

|  |  |                             |                             |                          |
|--|--|-----------------------------|-----------------------------|--------------------------|
| <b>Error! Unknown switch argument.</b>               |  | <b>Written by:</b><br>TB/HK | <b>Doc. version:</b><br>1.0 | <b>Page:</b><br>4 of 5   |
| <b>Project: GN Netcom Bluetooth Headset</b>          |  |                             | <b>Project no:</b><br>88    | <b>Date:</b><br>29-06-00 |
| <b>Subject: 0dBm Radio Block Diagram Description</b> |  |                             |                             |                          |

## 7.1 General supply

The general supply is based on a switch mode supply. This switch mode is the main supply for the board. It converts a variable input single-cell battery voltage (From 1.0 to 1.5 Volts) to a fixed output voltage of 3.3 Volts. The output voltage of the main supply either supplies the components directly, or it is converted into other voltage levels, which then supplies the components on the board.

## 7.2 Radio supply

As shown on the Block diagram the Radio supply consists of a main supply (The dotted box) and two additional blocks.

The main Radio supply is based on the output voltage of the switch mode. This is slightly filtered to avoid interference from the switch mode.

The VCO supply enables the Base Band to turn the VCO on and off.

The PA supply also enables the Base Band to turn the PA stage on and off.

When the Radio is either not in use, or the module is in power down mode, this feature is used to save power.

