1 Description of Functional Blocks

1.1 RF Receiver

The receiver features a near-zero Intermediate Frequency (IF) architecture that allows the channel filters to be integrated on to the die. Sufficient out-of –band blocking specification at the Low Noise Amplifier (LNA) input allows their radio to be used in close proximity to Global System for Mobile Communications (GSM) and Wideband Code Division Multiple Access (W-CDMA) cellular phone transmitters without being desensitized. The use of a digital Frequency Shift Keying (FSK) discriminator means that no discriminator tank is needed and its excellent performance in the presence of noise allows BlueCore2-External to exceed the Bluetooth requirements for co-channel and adjacent channel rejection.

1.1.1 Low Noise Amplifier

The LNA can be configured to operate in single-External to exceed the Bluetooth requirements for co-channel and adjacent channel rejection.

1.1.2 Analogue to Digital Converter

The Analogue to Digital Converter (ADC) is used to implement fast Automatic Gain Control (AGC). The ADC samples the Received Signal Strength Indicator (RSSI) voltage on a slot-by-slot basis. The front-end LNA gain is changed according to the measured RSSI value, keeping the first mixer input signal within a limited range. This improves the dynamic range of the receiver, improving performance in interference-limited environments.

1.2 RF Transmitter

1.2.1 IQ Modulator

The transmitter features a direct IQ modulator to minimize the frequency drift during a transmit timeslot which results in a controlled modulation index. A digital base band transmit filter provides the required spectral shaping.

1.2.2 Power Amplifier

The internal Power Amplifier (PA) has a maximum output power of 0dBm allowing BlueCore2-External to be used in Class 2 and Class 3 radios without an external RF PA. Support for transmit power control allows a simple implementation for Class 1 with an external RF PA.

1.3 RF synthesizer

The radio synthesizer is fully integrated onto the die with no requirement for an external Voltage Controlled Oscillator (VCO) screening can, varactor tuning diodes or LC resonators.

1.4 Base band and Logic

1.4.1 Memory Management Unit

The Memory Management Unit (MMU) provides a number of dynamically allocated ring buffers that hold the data, which is in transit between the host and the air or vice versa. The dynamic allocation of memory ensures efficient use of the available Random Access Memory (RAM) and is performed by hardware MMU to minimize the overheads on the processor during data/voice transfers.

1.4.2 Burst Mode Controller

During radio transmission the Burst Mode Controller (BMC) constructs a packet form header information previously loaded into memory-mapped registers by the software and payload data/voice taken from the appropriate ring buffer in the RAM. During radio reception, the BMC stores the packet header in memory-mapped registers and the payload data in the appropriate ring buffer in RAM. This architecture minimizes the intervention required by the processor during transmission and reception.

1.4.3 Physical Layer Hardware Engine DSP

Dedicated logic is used to perform the following:

- Forward error correction
- Header error control
- Cyclic redundancy check
- Encryption
- Data whitening
- Access code correlation
- Audio transcoding

The following voice data translations and operations are performed by firmware:

- A-law/μ-law/linear voice date(from host)
- A-law/μ-law/Continuously Variable Slope Delta(CVSD)(over the air)
- Voice interpolation for lost packets
- Rate mismatches

1.4.4 RAM

32Kbytes of on-chip RAM is provided and is shared between the ring buffers used to hold voice/data for each active connection and the general purpose memory required by the Bluetooth stack.

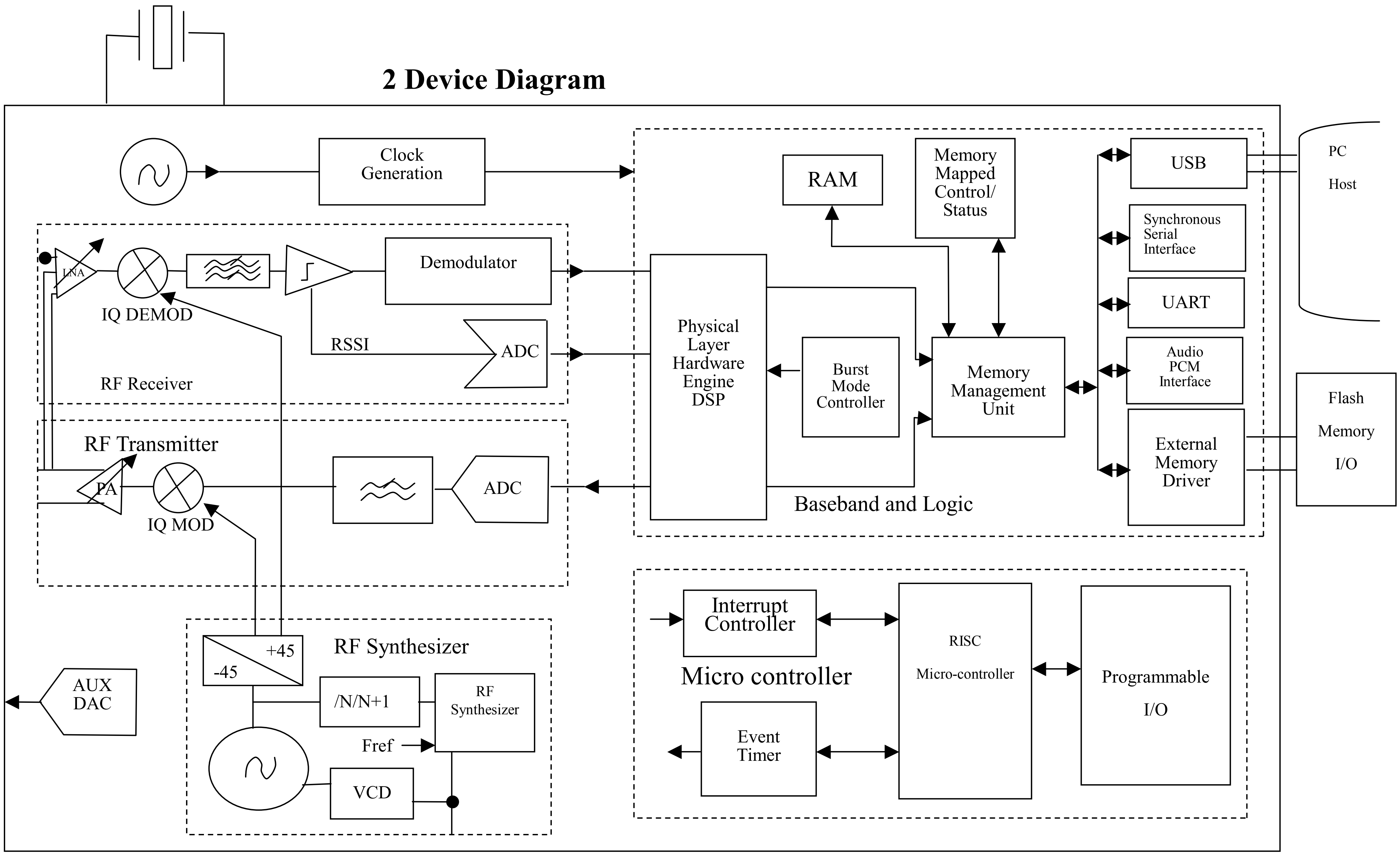
1.4.5 External Memory Driver

The External Memory Driver interface can be used to connect to the external Flash memory and also to the optional external RAM for memory intensive applications.

1.4.6 USB

This is a full speed Universal Serial Bus interface for communicating with other compatible digital devices. BlueCore2-External acts as a USB peripheral, responding to requests form a Master host controller such as a PC.

2 Device Diagram



3 Device Terminal Descriptions

3.1 RF Parts

The BlueCore2-External RF_IN terminal can be configured as either a single-ended or differential input. The operational mode is determined by setting the Persistent Store Key PSKEY_TXRX_PIO_CONTROL (0x209). Using a single-ended RF input to be used for Class 2 operation, as shown in figure3.1.

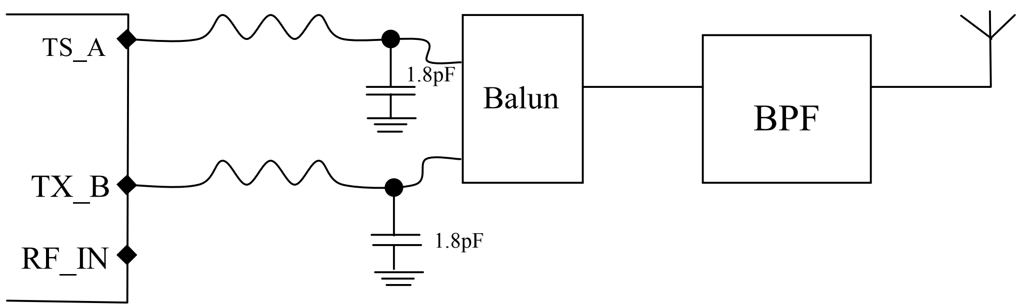


Figure 3.1: RF Parts (Class2)

4 General Description of Bluetooth

Bluetooth is a short-range radio link intended to replace the cable(s) connecting portable and/or fixed electronic devices. Key features are robustness, low complexity, low power, and low cost.

Bluetooth operates in the unlicensed ISM band at 2.4 GHz. A frequency hop transceiver is applied to combat interference and fading. A shaped, binary FM modulation is applied to minimize transceiver complexity. The symbol rate is 1 Ms/s. A slotted channel is applied with a nominal slot length of 625 μs. For full duplex transmission, a Time-Division Duplex (TDD) scheme is used. On the channel, information is exchanged through packets. Each packet is transmitted on a different hop frequency. A packet nominally covers a single slot, but can be extended to cover up to five slots.The Bluetooth protocol uses a combination of circuit and packet switching.Slots can be reserved for synchronous packets. Bluetooth can support an asynchronous data channel, up to three simultaneous synchronous voice channels, or a channel which simultaneously supports asynchronous data and synchronous voice. Each voice channel supports a 64 kb/s synchronous (voice) channel in each direction. The asynchronous channel can support maximal 723.2 kb/s asymmetric (and still up to 57.6 kb/s in the return direction), or 433.9 kb/s symmetric. The Bluetooth system consists of a radio unit ,a link control unit, and a support unit for link management and host terminal interface

functions, see Figure 4.1

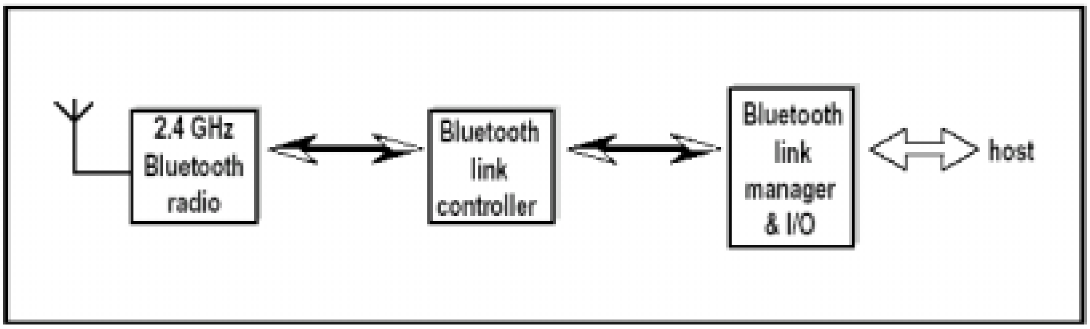


Figure 4.1

The current document describes the specifications of the Bluetooth link controller, which carries out the baseband protocols and other low-level link routines. Link layer messages for link set-up and control are defined in the Link Manager Protocol.

The Bluetooth system provides a point-to-point connection (only two Bluetooth units involved), or a point-to-multipoint connection.

In the point-to-multipoint connection, the channel is shared among several Bluetooth

units. Two or more units sharing the same channel form a ***piconet***. One Bluetooth unit acts as the master of the piconet, whereas the other unit(s)
acts as slave(s). Up to seven slaves can be active in the piconet. In addition, many more slaves can remain locked to the master in a so-called parked state. These parked slaves cannot be active on the channel, but remain synchronized to the master. Both for active and parked slaves, the channel access is controlled by the master. Multiple piconets with overlapping coverage areas form a ***scatternet***. Each piconet can only have a single master. However, slaves can participate in different piconets on a time-division multiplex basis. In addition, a master in one piconet can be a slave in another piconet. The piconets shall not be frequencysynchronized. Each piconet has its own hopping channel.

4.1 CHANNEL DEFINITION

The channel is represented by a pseudo-random hopping sequence hopping through the 79 or 23 RF channels. The hopping sequence is unique for the piconet and is determined by the Bluetooth device address of the master; the phase in the hopping sequence is determined by the Bluetooth clock of the master. The channel is divided into time slots where each slot corresponds to an RF hop frequency. Consecutive hops correspond to different RF hop frequencies. The nominal hop rate is 1600 hops/s. All Bluetooth units participating in the piconet are time- and hop-synchronized to the channel.
Here is a real example of the hopping sequence.

Pkt Num	M/S	Freq (MHz)	Master Clk	AM Addr	Pkt Type
0	M	2445	0x034a40a4	AM1	DM1
1	S	2406	0x034a40aa	AM1	DM1
2	M	2465	0x034a40d0	AM1	DM1
3	S	2466	0x034a40d6	AM1	DM1
4	M	2404	0x034a4104	AM1	DM1
5	S	2458	0x034a410a	AM1	DM1
6	S	2411	0x034a410e	AM1	DM1
7	M	2461	0x034a412c	AM1	DM1
8	M	2442	0x034a41d8	AM0	FHS
9	M	2463	0x0012eb20	AM1	DM1
10	M	2467	0x0012eb24	AM1	DM1
11	S	2434	0x0012eb76	AM1	DM1
12	S	2438	0x0012eb7a	AM1	DM1

13	M	2457	0x0012eb7c	AM1	DM1
14	S	2466	0x0012eb7e	AM1	DM1
15	M	2418	0x0012eb84	AM1	DM1
16	S	2411	0x0012ebd6	AM1	DM1
17	S	2413	0x0012ebda	AM1	DM1
18	M	2446	0x0012ebdc	AM1	DM1
19	M	2448	0x0012ebe0	AM1	DM1
20	S	2477	0x0012ec32	AM1	DM1

4.2 TIME SLOTS

The channel is divided into time slots, each 625 μs in length. The time slots are numbered according to the Bluetooth clock of the piconet master. The slot numbering ranges from 0 to 2^{27}-1 and is cyclic with a cycle length of 2^{27}. In the time slots, master and slave can transmit packets.

A TDD scheme is used where master and slave alternatively transmit, see Figure 4.2 The master shall start its transmission in evennumbered time slots only, and the slave shall start its transmission in oddnumbered time slots only. The packet start shall be aligned with the slot start. Packets transmitted by the master or the slave may extend over up to five time slots.

The RF hop frequency shall remain fixed for the duration of the packet. For a single packet, the RF hop frequency to be used is derived from the current Bluetooth clock value. For a multi-slot packet, the RF hop frequency to be used for the entire packet is derived from the Bluetooth clock value in the first slot of the packet. The RF hop frequency in the first slot after a multi-slot packet shall use the frequency as determined by the current Bluetooth clock value. Figure 4.3 illustrates the hop definition on single- and multi-slot packets. If a packet occupies more than one time slot, the hop frequency applied shall be the hop frequency as applied in the time slot where the packet transmission was started.

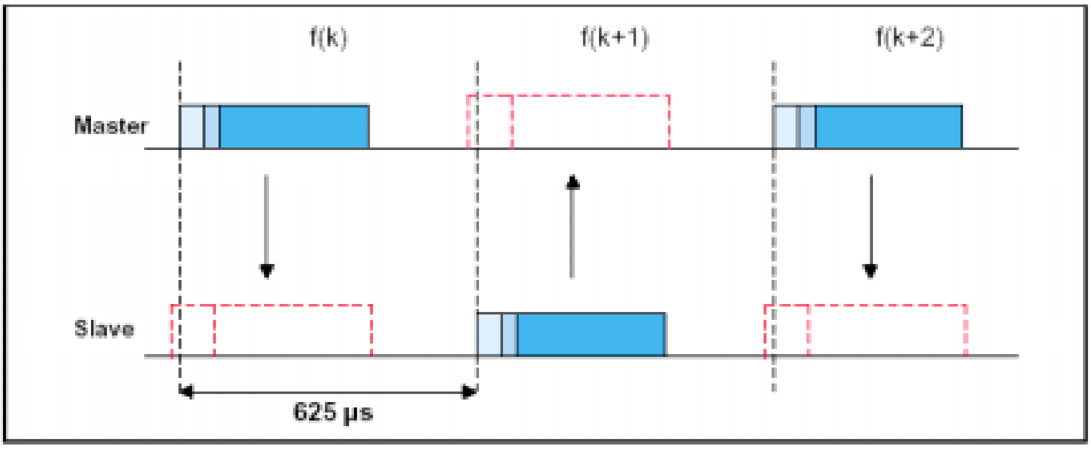

f(k)
f(k+1)
f(k+2)
Master
Slave
625 µs

Fig 4.2

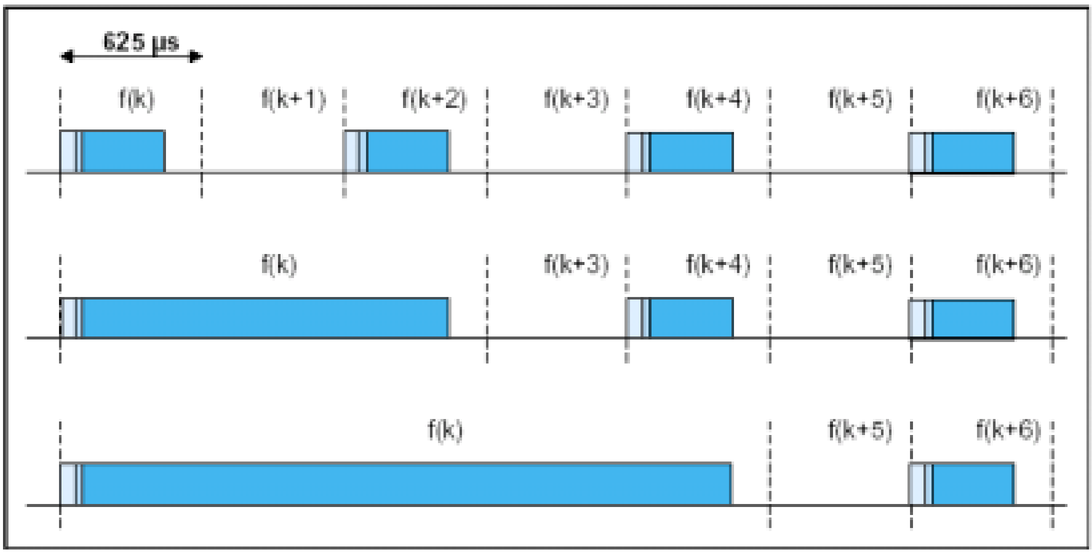

625 µs
f(k)
f(k+1)
f(k+2)
f(k+3)
f(k+4)
f(k+5)
f(k+6)
f(k)
f(k+3)
f(k+4)
f(k+5)
f(k+6)
f(k)
f(k+5)
f(k+6)

Fig 4.3