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Bluetooth Audio Data Transfer between Bluetooth chipset (PMB6752&PMB6625) and TriCore Host TC1920

Abstract

The paper describes the interfaces and the handling of Audio Data via Bluetooth. The application example was equipped with the Bluetooth chipset PMB6752 & PMB6625 (PCM interface) and the Tricore 32 bit microcontroller (SSC interface) from Infineon Technologies. It will also described how emulate a PCM communication with the SSC peripheral on TC1920.

Infotainment

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Never stop thinking.

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1 Application Overview

As a main application in the Car Infotainment environment, Bluetooth is used to transfer voice or audio data for example between a mobile phone and the car audio system. The driver of the car is able to phone over the free voice system and the voice data will be transferred via BT to the personal mobile phone located for example in the jacket on the back seats.

In order to enable this hands-free application, the car audio system needs to control the mobile phone like to establish a BT link, place a call or accept/reject an incoming call. The HMI (Human Machine Interface) is different dependent what application and equipment is used. The user control can be done by speech recognition or push buttons.

In **Figure 1-1** the hardware structure of a BT node is shown. The BT node is based on Infineon devices, the TriCore microcontroller TC1920 and a BT module, which contains the Infineon Bluetooth chipset (PMB6752 & PMB6625).

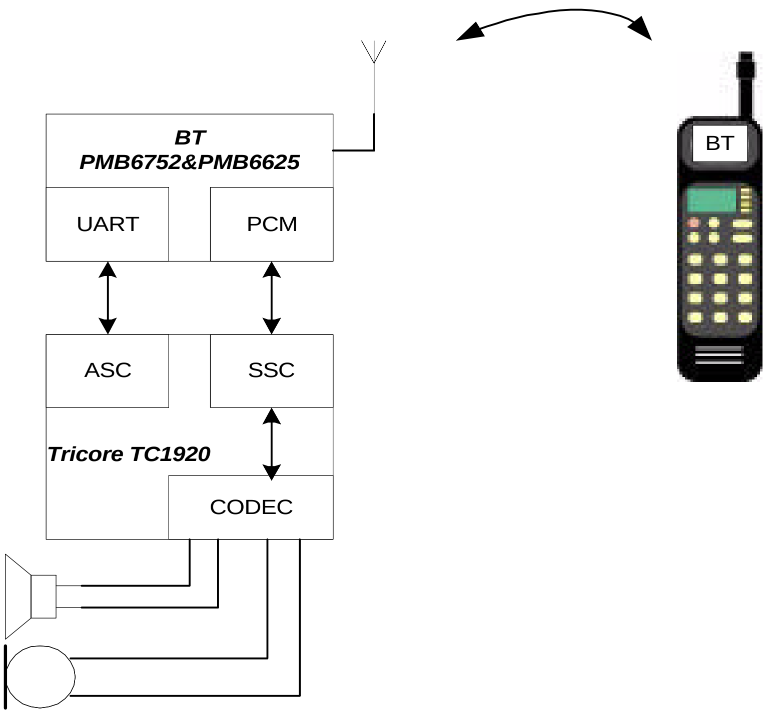

Figure 1-1 Bluetooth Node Structure

The UART interface is used to exchange BT control data and asynchronous data. The same interface can also be used for synchronous audio data. In order to split audio data from control or asynchronous data, a second interface (PCM) can be used to transfer synchronous audio data. The Tricore devices TC1920 does not support a PCM channel. Therefore this application note describes how to emulate a PCM interface using a Synchronous Serial Interface (SSC).

2 Audio Data Flow

The audio data, which are transferred via Bluetooth, are modified and coded several times. In the following figure the flow of Audio data is shown from analog data to Bluetooth air coded data and vice versa.

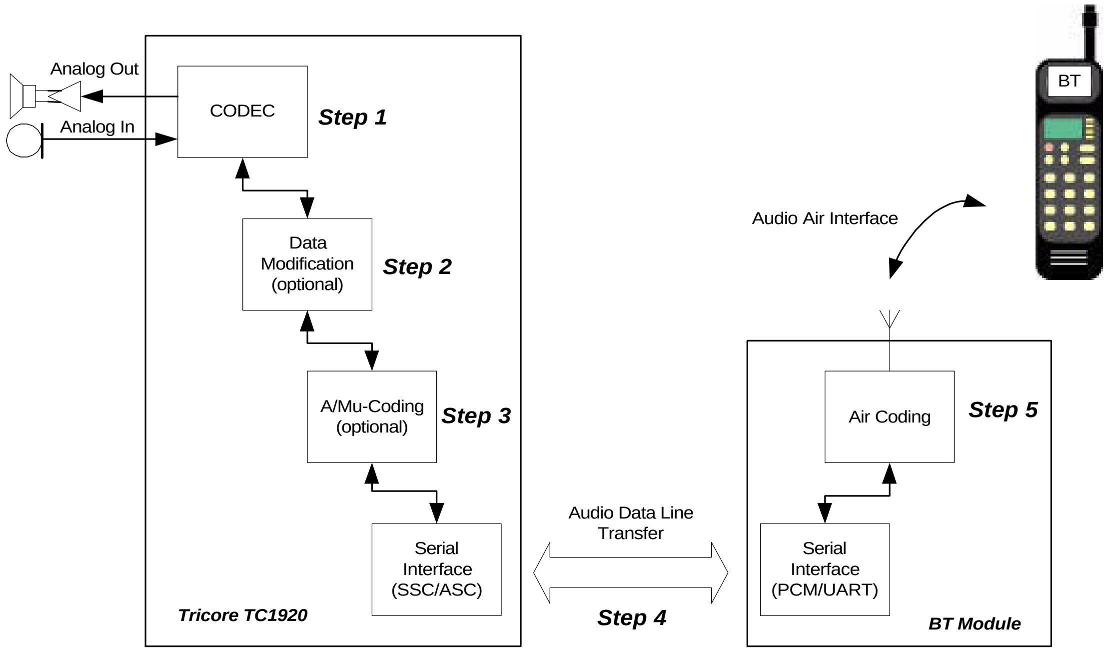

Figure 1 Audio Data Flow and Modification

As it is shown in the figure above, the audio data flow is working in both directions, from step1 to step5 and step5 to step1.

Description of the steps:

Step 1

Audio data will be transferred into digital data or vice versa in a CODEC module.

Step 2

Depending on the application, audio will be modified like sample conversion between 11 and 8 kHz, echo cancellation or noise reduction.

Step 3

There are two different audio formats specified transferring audio data to the Bluetooth module and vice versa:

- 8 bit logarithmic PCM format (A-law or Mu-law)
- 8/16 bit linear data

The following table gives an overview about Audio coding on Bluetooth:

Table 2-1 Audio Input Coding Bluetooth

Formats	sample size in bits	Input Interface	sample rate/kHz	bitrate in kbit/s
A-law or Mu-law coding	8 bit	UART/PCM	8	64
linear	8/16 bit	UART/PCM	8	64/128

Step 4

Synchronous Audio Data can be transferred either via PCM Interface or via UART interface from Bluetooth baseband to host controller. The transfer on bit stream is handled bidirectional in both directions from and to the BT module.

Step 5

Up to three bidirectional audio channels can be tranferred via the BT network simultanously. Each synchronous channel is transferred with 64kbit/s.

Transferring logarithmic data, the Bluetooth chipset supports encoding and decoding from line to air data from A-law to Mu-law or vice versa. Moreover A/Mu-law coded data as well as linear data can be converted into CVSD (Continous Variable Slope Delta Modulation) format.

3 Audio Communication Tricore - BT Module

The following example describes how to transfer audio data on a Tricore based Bluetooth node.

In the example the Bluetooth Module is configured via the UART connection and audio data are transferred via PCM. On host side a PCM channel is emulated by a Synchronous Serial Interface (SSC) and an external interrupt is used to trigger incoming and outgoing data.

3.1 Audio Interface Line Description

The following figures shows the physical connection between Tricore host and the Bluetooth Module.

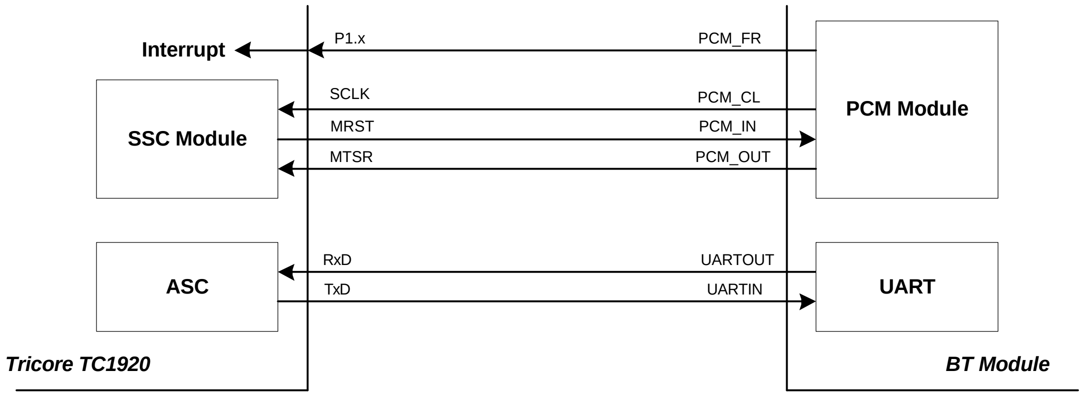

Figure 3-1 Signal Connection TC1920 to BT Module

The UART based interface is mainly used to exchange control data and application data in a package format. In the system proposal, the UART is not used to transfer audio data. This is done with the PCM interface. Audio data are handled independently of the Bluetooth protocol and control software integrated e.g. in a BT stack and BT profile.

As the TC1920 has no integrated PCM interface, an example is shown how to emulate PCM data transfer via a Synchronous Serial Channel (SSC). For this proposal the PCM interface on the BT module acts as the communication master. It generates the shift clock and the trigger signal PCM_FR. The PCM_FR signal indicates that on the next active edge of the shift clock data are transferred.

The problem on SSC side is firstly to handle the trigger signal and secondly to handle the continuous PCM clock. If the data transfer is active, the PCM module generates a continuous clock. This is not compliant with the synchronous serial philosophy. Usually the SSC clock is only toggling in case of data transfer. In order to manage this significant difference, the shift counter in the SSC module should only be enabled in case of data transfer. This is done by software for each sampling. Of course this will increase the

TriCore CPU load. Therefore it is recommended to handle this procedure by the PCP coprocessor, in order to spare Tricore CPU load.

3.2 BT Module PCM handling

The initialization of the BT module is handled from the Tricore host via the UART interface. Basically a mono audio connection is required for the BT system with a bit rate of 64kbit/s and a sample rate of 8kHz. The data will be coded to 8bit u-law or a-law. For BT Air coding, CVSD coding is required.

The PCM interface on the BT module is configured to master mode. In this case the PCM module generates the clock signal PCM_CL and the trigger signal PCM_FR. In master mode the clock (PCM_CL) frequency is fixed to 500kbit/s. On PCM bit transfer Short Frame Synchronization is used and MSB is shifted first. Data will be shifted on the falling edge of the shift clock. After a rising edge of PCM_FR valid data are shifted on the next falling edge.

3.3 Host SSC handling

The SSC interface on TC1920 is configured to Slave mode. The data are transferred in full duplex mode on 8 bit data format. The MSB is shifted first on a falling edge of the shift clock SCLK. In addition to the SSC configuration, an external interrupt on TC1920 is generated after each rising edge of PCM_FR signal.

The following figure gives an explanation of the PCM signals.

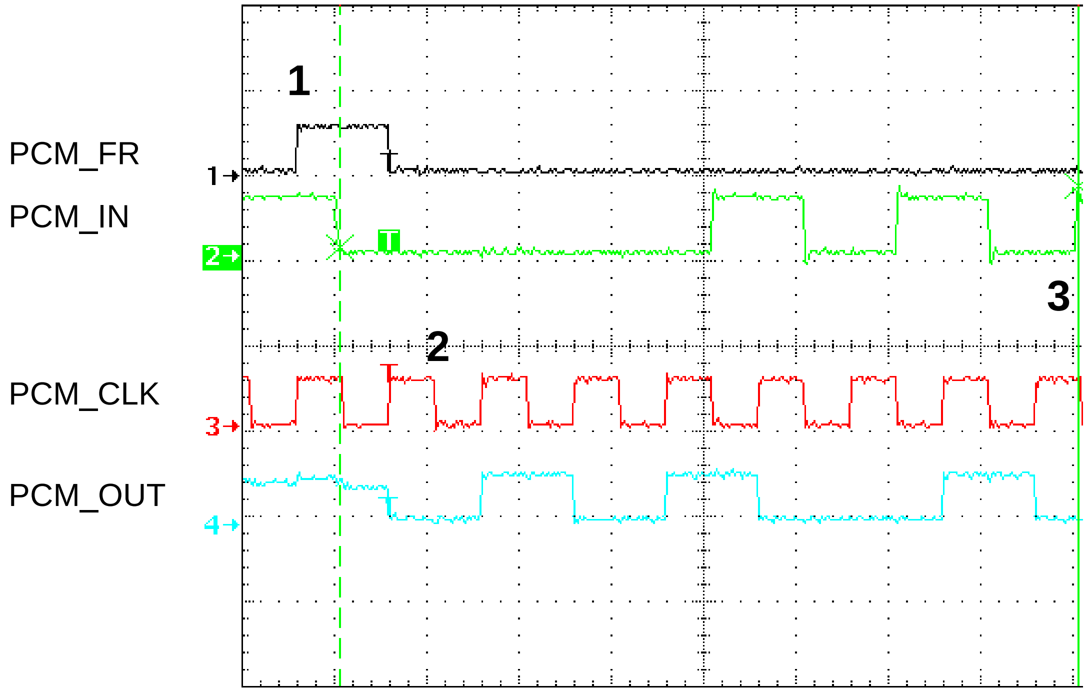

Figure 2 PCM data communication

Note 1:

After a rising edge of PCM_FR an interrupt on TC1920 is generated. In the interrupt routine transmit data will be copied into SSC transmit buffer and the SSC module is enabled. This will be reached by setting the SSC bit EN(SSC_CON register) to “1”. The PCM_FR pulse is generated every 125uS by a sampling rate of 8kHz.

Note 2:

On this falling edge the MSB of SSC transmit data (PCM_IN) and the MSB of PCM transmit data (PCM_OUT) are transferred.

Note 3:

After shifting of the complete byte the receive interrupt of the SSC module is executed. In this interrupt routine, the received data from PCM_OUT are read from SSC receive buffer. In order to avoid unexpected behavior due to the continuous PCM shift clock, the SSC module is disabled. Then the system is waiting on the next rising edge of PCM_FR.

4 Acronyms ad Abbreviations

BT	Bluetooth
CODEC	COder DECoder
CVSD	Continuous Variable Slope Delta modulation
MSB	Most Significant Bit
PCM	Pulse Code Modulation
PCP	Peripheral Control Processor
SSC	High Speed Synchronous Serial Interface (Tricore peripheral)
TC1920	Tricore Infotainment Microcontroller

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Dr. Ulrich Schumacher

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