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APPLICATION NOTE

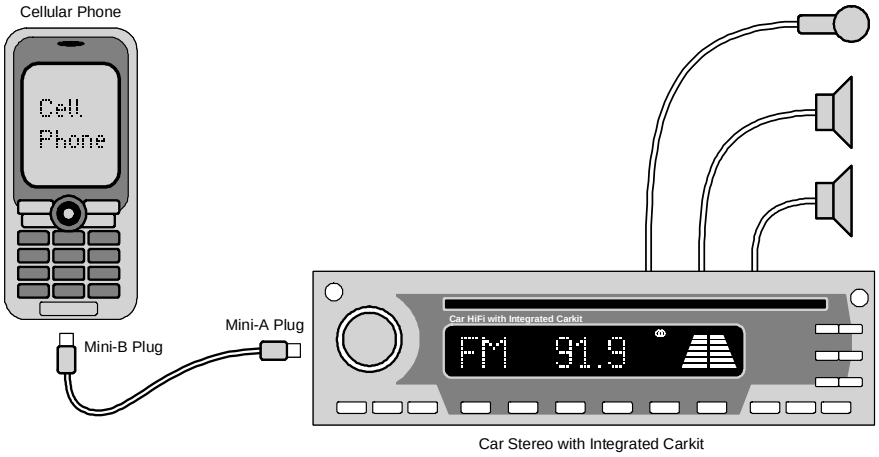
STOTG04 IN AUDIO CARKIT ENVIRONMENT

1 - INTRODUCTION

This application note describes the application of the STOTG04 full-speed USB-OTG transceiver in an audio carkit environment. The paper also illustrates the carkit use and operation, connection between cellular phone and the carkit, physical connection and external circuitry of the STOTG04 required for a correct operation. Proper setup of the internal registers of the STOTG04 needed for audio mode is also described. The information in this application note is intended for system design engineers who plan to use the STOTG04 transceiver as a USB-OTG physical layer device in equipment using the universal serial bus even for audio signals.

Specification [3] defines a standard method for routing audio and UART signals to an analog carkit and other accessories (chargers and RS232 devices) through a phone's Mini-AB USB receptacle. A carkit consists of a microphone, speaker, and Mini-B plug to connect a phone. It may also contain a button, LED, and a cradle for the phone. The carkit may be integrated into a car stereo as shown in Figure 1. The connection between a phone and a carkit can be provided using either a standard Mini-USB cable with four wires plus shield or a captive cable with five wires plus shield.

Figure 1 : Car Stereo Carkit Implementation



The carkit interface is intended to enable the following features between a phone and a car stereo:

– phone charging

– hands free speakerphone

– push-to-talk

– stereo playback

– others (like telematics, navigation system, etc.)

As most phones currently support USB signaling, it is planned that car stereos will support USB too. It will allow the transfer of following data using the universal serial bus:

– audio files

– video files

– images

– data

2 - CARKIT INTERFACE ARCHITECTURE

The phone‘s Mini-AB USB receptacle consists of four signal lines (VBUS, D+, D-, and ID), ground, and a shield. The carkit interface allows the use of these wires in three different signaling modes:

– UART mode

– mono mode

– stereo mode

Alternate functions of the USB signal lines are described in Table 1 for each particular carkit signaling mode.

Table 1 : Alternate Functions of a USB Signal Lines

Line	UART Mode	Mono Mode	Stereo Mode
VBUS	VBUS	VBUS	VBUS
D+	RXD	MIC	SPKR_R
D-	TXD	SPKR	SPKR_L
ID	CTL*	CTL*	CTL*
GND	GND	GND	GND
SHLD	SHLD	CMR	CMR

Note (*) The ID line is not required for 4-wire carkit interface

In all three modes, the VBUS, GND, SHLD, and ID lines perform the same function. The VBUS line carries a 5V supply voltage from the carkit to the phone. The GND line is a common ground carrying return current from the phone to the carkit. The SHLD acts as an analog reference between the phone and the carkit. The ID line is used to signal interrupt and control information for the five-wire protocol. If a phone is connected to a carkit using standard Mini-USB cable, it is not possible to use the ID line for signaling. In this case, it is necessary to use the four-wire communication protocol between the phone and carkit. When the carkit contains captive cable with an ID wire, then it is possible to use either the four-wire or five wire protocol. Both these protocols are defined in the specification [3].

In UART mode, the D- line carries the TXD signal from the phone to the carkit, and the D+ line carries the RXD signal from the carkit to the phone.

In mono mode, the D- line carries the mono speaker signal from the phone to the carkit and the D+ line carries the microphone signal from the carkit to the phone.

In stereo mode, the D- line carries the left speaker signal from the phone to the carkit and the D+ line carries the right speaker signal from the phone to the carkit.

The carkit connection architecture is shown in the two figures below. Figure 2 shows the interface between a phone and a carkit using standard Mini-USB cable.

Figure 2 : Carkit Four-Wire Interface

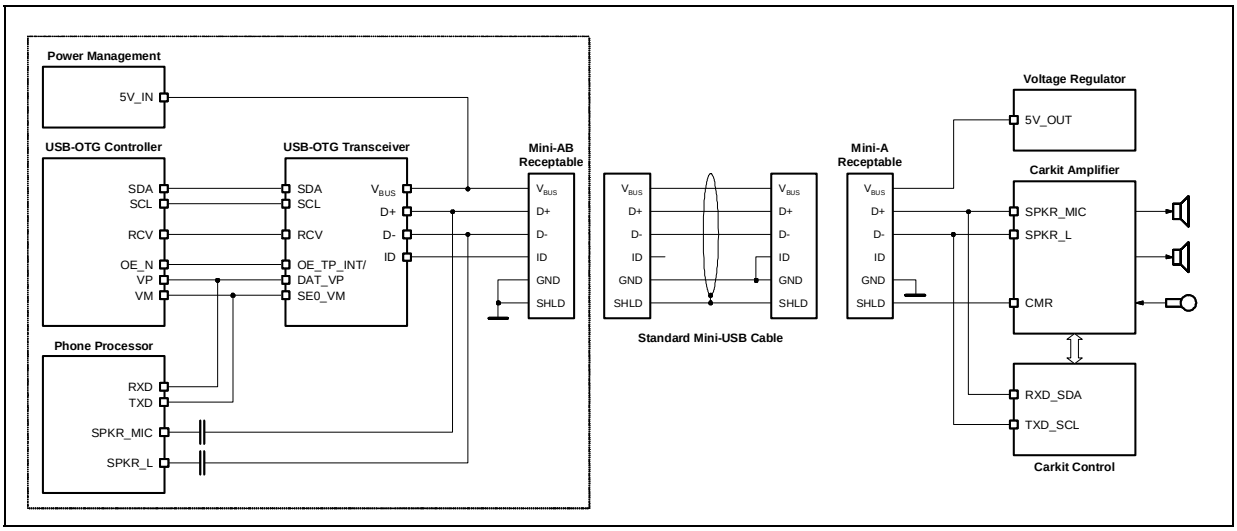
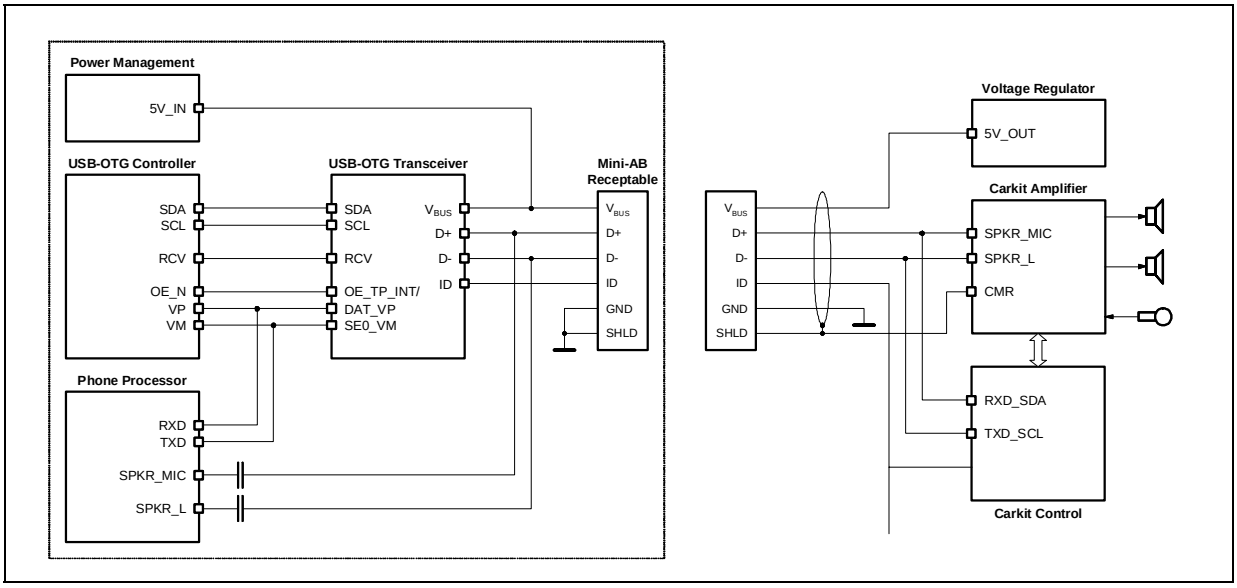


Figure 3 shows the interface between a phone and a carkit using captive cable with five wires.

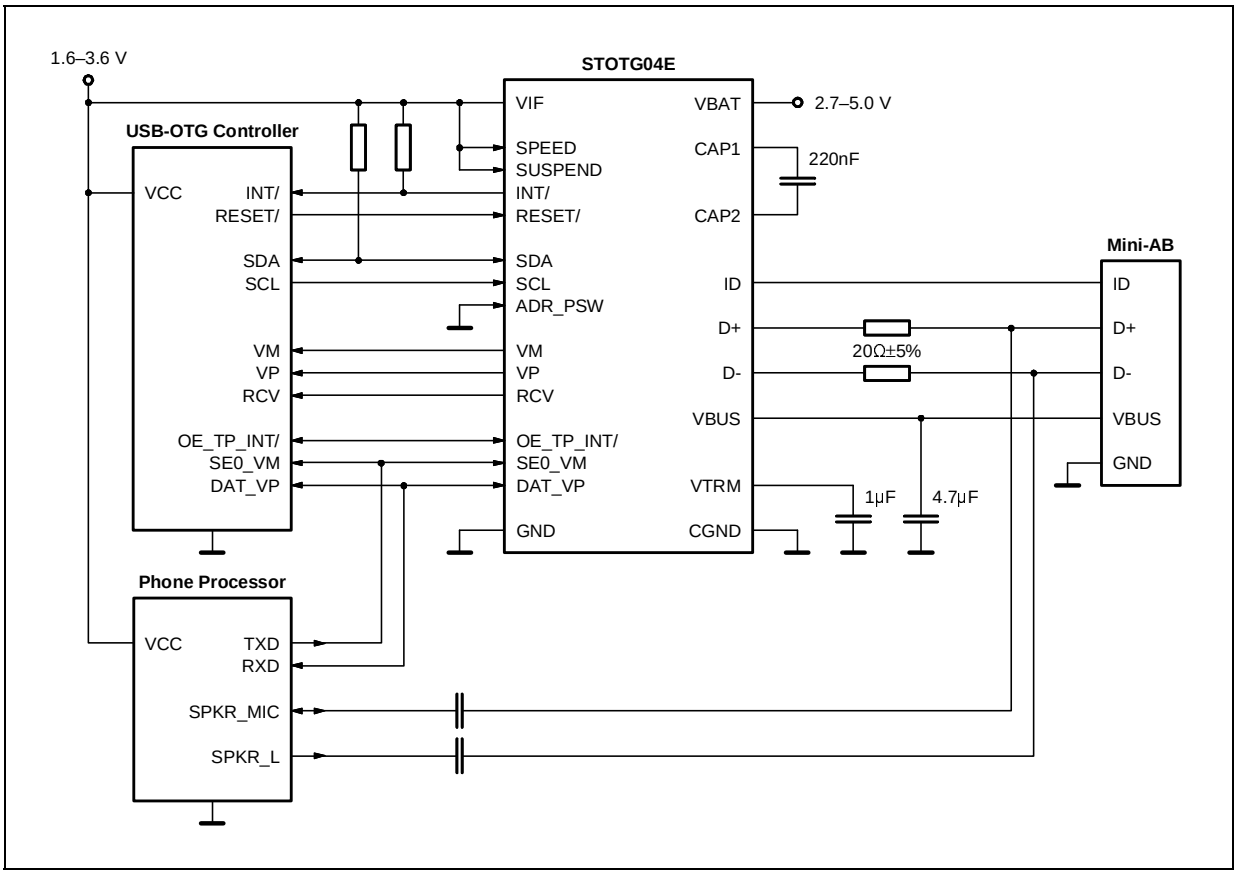
Figure 3 : Carkit Five-Wire Interface



3 - STOTG04 APPLICATION

The STOTG04 transceiver supports carkit signaling on both D+ and ID lines. Therefore, it is able to operate with both four-wire and five-wire protocol. It is up to the carkit accessory which protocol will be used. Figure 4 shows connection of the STOTG04 full-speed USB-OTG transceiver in an application requiring even audio mode operation.

Figure 4 : Carkit Five-Wire Interface



The transceiver in Figure 4 can operate in all four operating modes: USB, I^2C, UART, and audio. For operation in audio mode it is necessary to release internal drivers to force the D+ and D- lines into high impedance state. The UART mode is also needed for carkit. To use the transceiver in the UART mode it is necessary to properly set the direction of UART drivers. The correct setup of control registers of the transceiver is described in Table 2 for both audio and UART modes.

Table 2 : Alternate Functions of a USB Signal Lines

Register	UART Mode	Audio Mode
Control 1	x 1 x x 0 x x x (transp_en = 0, uart_en = 1)	x 0 x x 0 x x x (transp_en = 0, uart_en = 0)
Control 2	0 0 0 0 0 0 0 0 (release all PU/PD resistors)	0 0 0 0 0 0 0 0 (release all PU/PD resistors)
Control 3	x x x 1 0 x x x (bdir[0] = 0, bdir[1] = 1)	x x 1 x x x x x (audio_en = 1)

In the UART mode after a proper setup it is possible to transmit data from the SE0_VM pin to the D- line and to receive data from the D+ line on the DAT_VP pin.

In audio mode it is necessary to tie the OE_TP_INT/ pin to a high level to deactivate the USB driver. When all the pull-up and pull-down resistors are disconnected, the D+ and D- USB lines will be in high impedance state and it is possible to send audio signals over the lines. To be able to detect carkit interrupts, it is necessary to set the audio_en bit of the Control Register 3. Then, depending on the protocol used (either four-wire or five-wire) it is necessary to set the proper bits of the Interrupt Mask False and Interrupt Mask True registers. If a four-wire protocol is used then D+ carkit interrupt should be utilized and therefore the cr_int bit of interrupt mask registers should be set. If a five-wire protocol is used then ID line carkit interrupt can be utilized and therefore the id_gnd bit of interrupt registers should be set.

4 - REFERENCES

The following publications contain detailed information regarding the topic of this application note:

1 STOTG04 USB-OTG Full-Speed Transceiver Datasheet
2 CEA-2011, OTG Transceiver Specification
3 CEA-936-A, Mini-USB Analog Carkit Interface
4 OTG Carkit Transceiver, revision 0.63

5 - REVISON HISTORY

Table 3 : Revision History

Date	Revision	Description of Changes
12-May-2005	1	First Release.

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