AN214852

Collaborative Coexistence Interface Between Cypress-to-Cypress Solutions and Cypress-to-third-party Chips

Associated Part Family: CYW43XXX

This application note describes collaborative coexistence hardware mechanisms and algorithms of the CYW43XXX and how to connect the COEX wiring between Cypress-to-Cypress solutions or Cypress to a third-party chips. It is intended for hardware developers interested in using the CYW43XXX and CYW207XX in their product designs.

1 Introduction

The Cypress CYW43XXX family of products provide a highly integrated single-chip solution and offers the lowest RBOM (Rest of Bill of Materials) in the industry for wearables and a wide range of other embedded devices.

These chips implement the highly sophisticated Enhanced Collaborative Coexistence algorithms and hardware mechanisms, allowing for an extremely collaborative Bluetooth coexistence scheme along with coexistence support for external radios and a single shared 2.4 GHz antenna for WLAN/BT/ZigBee.

1.1 Cypress Part Numbering Scheme

Cypress is converting the acquired IoT part numbers from Broadcom to the Cypress part numbering scheme. Due to this conversion, there is no change in form, fit, or function as a result of offering the device with Cypress part number marking. The table provides Cypress ordering part number that matches an existing IoT part number.

Table 1. Mapping Table for Part Number between Broadcom and Cypress

Broadcom Part Number	Cypress Part Number
BCM43XXX	CYW43XXX
BCM4390X	CYW4390X
BCM207XX	CYW207XX
BCM43364	CYW43364
BCM43438	CYW43438
BCM43907	CYW43907
BCM20707	CYW20707

1.2 Acronyms and Abbreviations

In most cases, acronyms and abbreviations are defined upon first use. For a more complete list of acronyms and other terms used in Cypress documents, go to: http://www.cypress.com/glossary.

2 IoT Resources

Cypress provides a wealth of data at http://www.cypress.com/internet-things-iot to help you to select the right IoT device for your design, and quickly and effectively integrate the device into your design. Cypress provides customer access to a wide range of information, including technical documentation, schematic diagrams, product bill of materials, PCB layout information, and software updates. Customers can acquire technical documentation and software from the Cypress Support Community website (http://community.cypress.com/).

3 Background

Coexistence problems happen when multiple radios are operating simultaneously in adjacent or overlapping radio frequency spectrums. This can lead to performance degradation, which is manifested in reduced operating range and/or lower throughput. Collaborative coexistence provides a methodology by which WLAN/BT/ZigBee can be collocated on a small form-factor device.

There are three major cases for coexistence problems that range from very severe to less severe:

- Overlapping frequency spectrum between WLAN, BT, and ZigBee in 2.4 GHz range.
- Adjacent frequency spectrum
  (Eg., LTE band7 and band40)
- Harmonics and inter-modulation distortion

Coexistence mitigation may be achieved by:

- Hardware
  - Board layout of RF signal routing and component placement, e.g., antenna isolations, cellular RF and RFIC components, WLAN/BT/GPS/Zigbee RFIC and RF components, and adding extra filters in the receivers and transmitters.
- PHY/Software
  - Time Domain Multiplexing of radios with time synchronization of radio frames such as using Serial Enhanced Coexistence Interface (SECI) or Global Coexistence Interface (3-wire).

Coexistence happens at ALL levels—chip, board, antennas, and joint firmware.

4 Before You Begin

It is recommended that the users of this Application Note request the following items from Cypress's Customer Support Portal (CSP - community.cypress.com).

- A CYW43XXX reference design package that contains the schematic and layout.
- An nvram.txt file template (that includes the COEX parameters) for the reference board.

Note: Contact your Cypress Sales or Engineering support representative FAE for additional information or clarification.

5 Product Overview

The Cypress CYW43XXX WLAN, CYW207XX BT, or WLAN/BT combo chips provide the highest level of integration for wearables and other consumer/industrial embedded applications. The device includes integrated PMU, IEEE 802.11 MAC/baseband, radio, and Bluetooth for each combo chip. It supports all rates specified in the IEEE 802.11a/b/g/n/ac specifications. It also supports optional antenna diversity for improved RF performance in difficult environments.

An embedded wireless system-on-a-chip (SoC) CYW43907, which includes an ARM-based processor as well as WLAN, offers the lowest RBOM in the industry and is uniquely suited for Internet-of-Things (IoT) applications.

For the WLAN section, several alternative host interfaces are included: SDIO, SPI, and PCIe depending on the products. For the Bluetooth section, a host interface option using high-speed 4-wire UART and PCM (Pulse-Code Modulation) digital audio are provided.

In an integrated single-chip combo solution, the CYW43XXX implements highly sophisticated enhanced collaborative coexistence hardware mechanisms and algorithms to enable the WLAN and Bluetooth to operate simultaneously and to ensure maximum medium access time, high throughput, and audio quality. Collaborative coexistence between WLAN and Bluetooth is implemented according to IEEE 802.15.2 Packet Traffic Arbitration (PTA) and through Cypress's Enhanced Coexistence Interface (ECI). ECI augments PTA signaling by enabling exchange of additional information required for implementing more advanced collaborative coexistence methods. As a result, overall quality for simultaneous voice, video, and data transmission on an embedded system is achieved.

In a discrete, separated WLAN and Bluetooth solution, or other external radios such as LTE and Zigbee, collaborative coexistence supports through SECI, UART, or 3-wire hardware signaling through a unique set of Serial Enhanced Coexistence Interface (SECI) or Global Coexistence Interface (GCI) protocols. Using the prioritization approach between data types and applications, optimum performance can be achieved, resulting in maximum WLAN throughput, voice quality, and link performance.

6 Serial Enhanced Coexistence Interface

An example of the COEX connection between the CYW43364 WLAN and CYW20707 Bluetooth is shown in Figure 1. Serial Enhanced Coexistence Interface (SECI) is enabled for Cypress-to-Cypress solutions only (including the BT/Zigbee combo device). System designers who want to use a third-party chip (Zigbee) to connect to Cypress's WLAN devices must use a 3-wire coexistence interface.

6.1 SECI Coexistence Interface

The SECI is a proprietary Cypress interface between Cypress-to-Cypress solutions. It is an optimal replacement to the legacy 3-wire coexistence feature. The exact contents of the SECI are Cypress confidential. The following key features are associated with this interface:

- Enhanced coexistence data can be exchanged over SECI_IN and SECI_OUT.
- Only two wires are required (using fewer I/Os than the 3-wire coexistence scheme).
- Supports generic UART communication between WLAN and Bluetooth devices.
- Supports automatic resynchronization upon waking from sleep mode.
- Baud rate up to 4 Mbps.
- 48-bit/64-bit coexistence data can be exchanged, both WLAN and Bluetooth devices must be operated at the same data rate.

Below is an example on how to interface with Cypress-to-Cypress solutions using a SECI scheme.

Figure 1. SECI Scheme

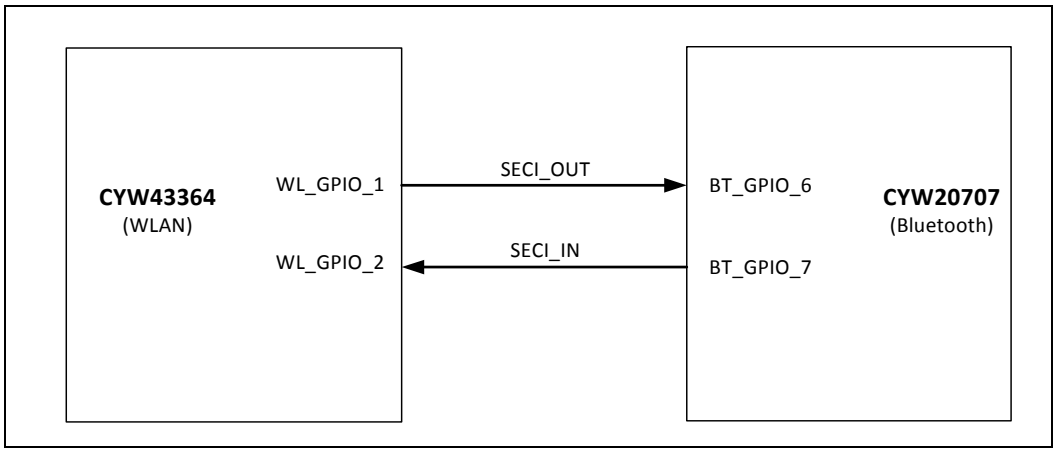


Table 2 summarizes the available GPIO pins, which can be used for the SECI interface. Unless otherwise specified, the GPIO pins can be programmed to be either SECI_IN or SECI_OUT. Note that WL_GPIO_0 is normally reserved for WLAN_HOST_WAKE or interrupt events, and therefore is not recommended for coexistence hardware interface.

Table 2. WICED Discrete Chips and Its GPIOs which are used for SECI interface

Chips	Signal Name	Available I/Os	Purpose/Comments
CYW43364	WL_GPIO_x	1, 2, 4	1 for SECI_Out; 2 for SECI_In and 4 is used for Switch_Ctrl line
CYW43907	RF_SW_CTRL_x	6, 7, 8, 9	6 and 8 for SECI_IN
CYW20707	BT_GPIO_x	6, 7	6 for SECI_IN
CYW20739	WICED_GPIO_X	16, 17	16 for SECI_In and 17 for SECI_Out

7 3-Wire Coexistence Interface

7.1 ZigBee 3-Wire Coexistence Interface

The 3-wire coexistence will be the standard offering from Cypress for supporting third-party ZigBee chips, such as the IEEE 15.4 ZigBee device. Three GPIO signals are used for this interface and the signals functions and definitions are described below:

From ZigBee to WLAN Third-party chips.

Only three signals are used between the ZigBee/WLAN for handshaking.

1. The RF_ACTIVE indicates ZigBee's request to use medium.

2. Status indicates both ZigBee's priority and Tx/Rx slots.

3. TX_CONF allows/denies ZigBee's transmission.

4. Packet Traffic Arbitrator (PTA) is the decision maker on coexistence.

5. ZigBee asserts RF_ACTIVE to request antenna access before its transaction (default is active high).

6. PTA readout Status pin, check the ZigBee's priority.

7. High-priority ZigBee requests are generally granted.

8. If PTA grants ZigBee antenna access, it asserts TX_CONFX (default is active low); otherwise it deasserts TX_CONFX.

9. Once granted, ZigBee uses the antenna.

10.When the ZigBee transaction completes, it is expected to dessert RF_ACTIVE.

The CYW43XXX will always operate as a master device.

Figure 2. ZigBee 3-Wire Coexistence Interface

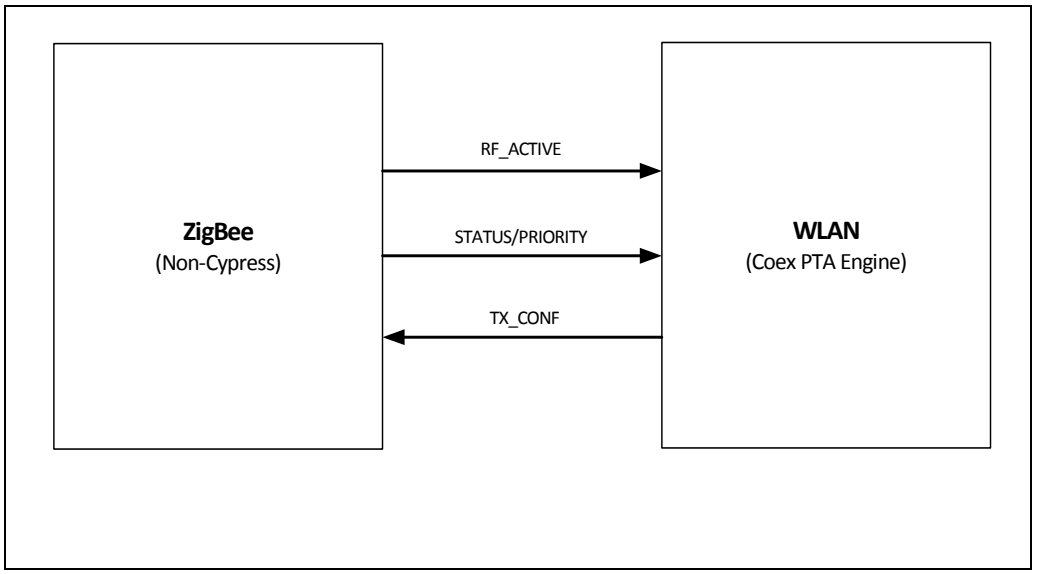


Table 3 summarizes available GPIO pins, which can be used for a 3-wire coexistence interface. Unless otherwise specified, the GPIO pins are programmable for any signaling.

Note: WL_GPIO_0 is normally reserved for WLAN_HOST_WAKE or interrupt events, and therefore is not recommended for coexistence hardware interface.

Table 3. Combo chips and Its GPIOs which are used for 3-wire coex interface

Chips	Signal Name	Available I/Os	Purpose/Comments
CYW4343W	WL_GPIO_x	1, 2, 4	Need the below NVRAM parameters to enable ZB coex on 4343W card. boardflags=0x1 zbcxpadnum=0x040201 zbcxfnsel=0x233 zbcxgcigpio=0x132"

8 NVRAM Parameters

NVRAM Variables for GPIO Configuration and Interface selection for ZBCoex.

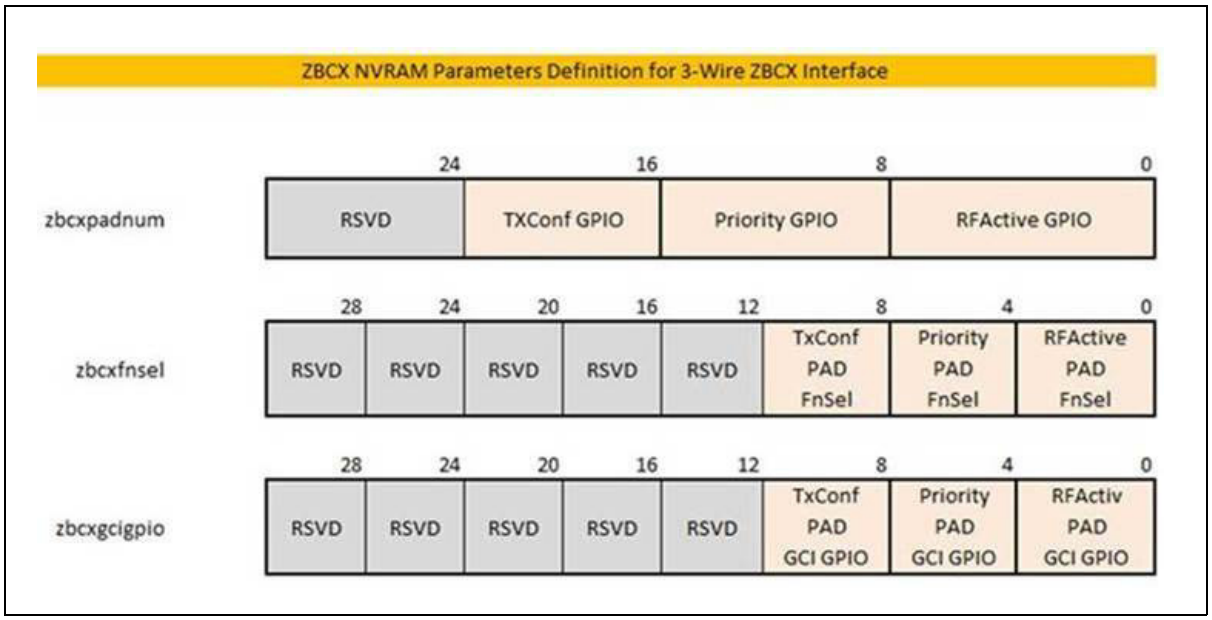
We need to add the below NVRAM parameters to enable ZBCoex .

boardflags=0x1

zbcxpadnum=0xAABBCC

zbcxfnsel=0xabc

zbcxgcigpio=0x123



It is WICED or Linux we use NVRAM file to enable / disable SECI and 3-wire coex.

Boardflags = 0x00000001 /* SECI coex */

Boardflags2=0x00000080 /* Board support legacy 3/4 wire */

9 Table of Valid Pair of Cypress WLAN and BT Discrete Chips

WLAN Chip	BT Chip
43907	20706
43364	20707
43364	20719

Document History Page

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Rev.	**ECN No.**	**Orig. of Change**	**Submission Date**	**Description of Change**
**	-	-	05/02/2016	43XX-AN2500-R Initial Release
*A	5473612	UTSV	10/13/2016	Added Cypress Part Numbering Scheme. Updated to Cypress template
*B	5725334	AESATMP9	05/03/2017	Updated logo and copyright.
*C	5862726	UTSV	01/29/2018	Removed section “7.1 Bluetooth 3-Wire Coexistence Interface” and New Sections added (Section 8 and 9).

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Cypress Semiconductor
198 Champion Court
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