AN214788

Headless Mode and Power Conservation for Bluetooth Device and Host

Associated Part Family: CYW20705

This application note provides details on the headless mode and power conservation for the CYW20705 Bluetooth device and host. Headless mode in this context is a system configuration wherein the display device, mouse, or keyboard is absent. The device configuration thus operates without a graphical user interface (GUI) or a controlling screen running on the front end.

1 Introduction

The CYW20705 is the optimal solution for voice and data applications that require a Bluetooth SIG standard host controller interface (HCI) via USB. The CYW20705 radio transceiver's enhanced radio performance meets the most stringent industrial temperature application requirements for compact integration into mobile handset and portable devices.

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
BCM20705	CYW20705

1.2 Acronyms and Abbreviations

In most cases, acronyms and abbreviations are defined on first use.

For a comprehensive list of acronyms and other terms used in Cypress documents, go to: http://www.cypress.com/glossary.

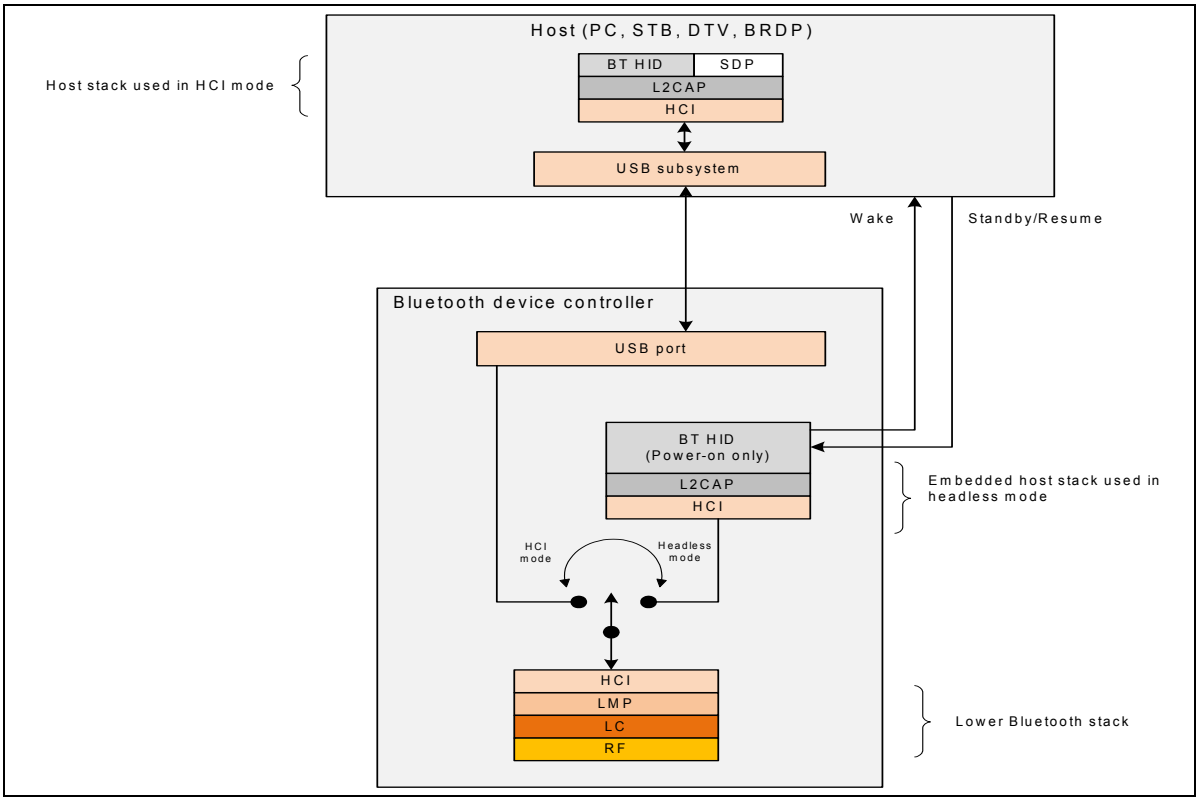
2 IoT Resources

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 Headless Mode Operation

Headless mode is a power conservation mode for Bluetooth (BT) devices and hosts. Figure 1 shows the human interface device (HID) block diagram and the HCI mode and the headless mode within the Bluetooth device controller, the host stack layers in HCI mode, embedded host stack layers in headless mode, and the lower Bluetooth stack layers. The HCI enables the USB to communicate with the host controller driver via software.

Figure 1. HID Block Diagram



The following terms and processes are applicable to Figure 1 on page 2.

- Service Discovery Protocol (SDP): Allows a device to discover services offered by other devices, and reconciles associated parameters.
- Logical Link Control and Adaptation Protocol (L2CAP): Multiplexes multiple logical connections between two devices using different higher level protocols and provides segmentation and reassembly of on-air packets.
- Link Management Protocol (LMP) enables set-up and control of the radio link between two devices and is implemented within the controller.
- Link Control (LC): A core Bluetooth system protocol.
- Radio Frequency (RF): A core Bluetooth system protocol.

3.1 Configuration Options

Headless mode can be entered via:

- A hardware line command using BT_WAKE_DEV and BT_WAKE_HOST.
  - Host to Bluetooth module: BT_WAKE_DEV.
  - Bluetooth module to host: BT_WAKE_HOST. A USB interface enables a Bluetooth module to enter a standard interlaced R1 scan mode. The USB interface detaches from the host to conserve power.
- A software-driven HCI vendor specific command (VSC)

In both cases, when the device enters and operates in headless mode, the required USB disconnection occurs only if BT_WAKE_DEV is set to a level indicating that BT_WAKE_DEV should be in headless mode (usually low). Thus, to disconnect the USB port, the host typically issues the command to enable headless mode and then it sets BT_WAKE_DEV to the headless mode level before it turns off.

3.1.1 Entering Headless Mode via Hardware

Headless mode configuration via hardware is initiated when the Bluetooth controller runs a *lite* HID stack that searches only for HID reports containing the **Power On** usage code.

- If any other usages are received, the embedded HID stack disconnects with the reason code **Power Off**.
- If the **Power On** usage code is detected, the *lite* HID stack toggles a GPIO to wake the host device. A host device can include the following types of devices:
  - PC
  - Set top box (STB)
  - Digital TV (DTV)
  - Blu-ray Disc® (BD)

3.1.2 Entering Headless Mode via Software

Headless mode via software occurs when the application on the host device sends a vendor-specific HCI command to the Bluetooth controller. This command causes the Bluetooth controller to:

- Detach from the USB bus.
- Prepare for the USB power to be removed:
  - The host device should power-down VDDUSB for lowest power.
- Enter standard interlaced R1 page scan mode (interval: 1.28s, window: 18 slots):
  - Listen on each of two frequencies for 11.25 ms each every 1.28s.

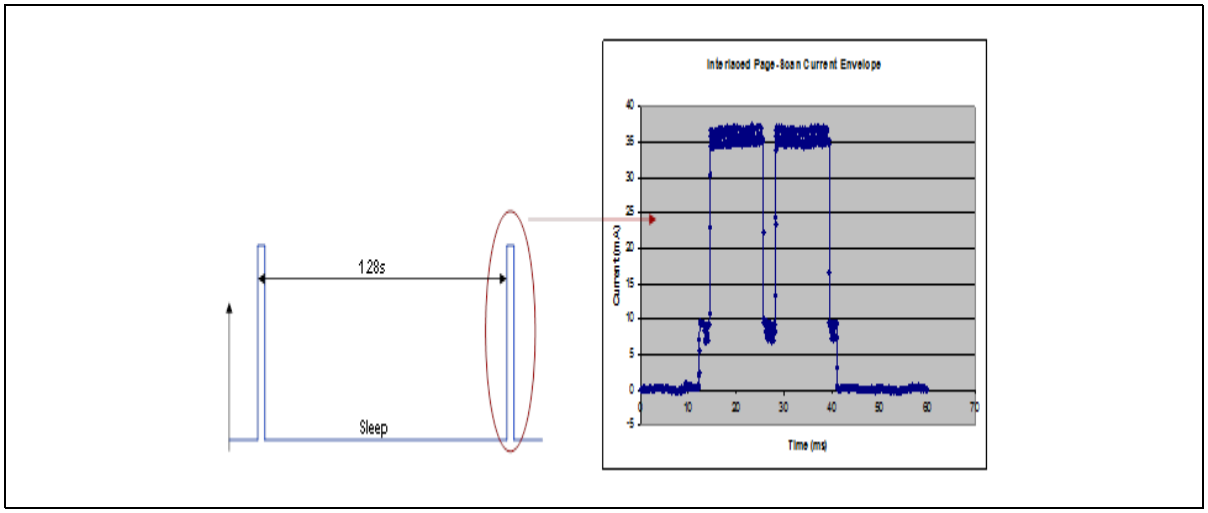
The HCI provides a command interface to the baseband controller and link manager, and access to configuration parameters. This interface provides a uniform method for accessing the Bluetooth baseband capabilities.

The average current is <1 mA. This assumes that:

- VDDUSB is powered down.
- The D+ pull-up is powered down (via VDDUSB).
- The controller sleeps between scans.

Figure 2 shows a standard R1 interlaced page scan of a current envelope.

Figure 2. Interlaced R1 Page Scan of a Current Envelope



3.1.3 Exiting Headless Mode

The following provides information on exiting the headless mode.

- The host device can wake up using either of two methods:
  - The user may press the **Power button** on the remote device. The causes the **power on** HID message to be sent to the host device.
  - Optionally, the user may press the **Power button** on the host device.
- After waking, the host device should signal the Bluetooth controller via the **Standby/Resume** signal.
  - This signal may be issued by the VDDUSB power rail.
- The Bluetooth controller then reinitializes the USB, switches to the HCI mode, and re-enumerates on the bus.
- The host stack then resumes control of all Bluetooth functions.

3.2 Out-of-Box Scenario

The following provides information on getting the system up and running “out of the box.”

- Both the TV and Remote Control are marked as in **new mode** at factory. The **new mode** condition is indicated by a flag in the EEPROM.
- When first plugged in, the TV Bluetooth controller automatically enters into **headless mode** and does the following:
  - Performs a Page Scan and Inquiry Scan.
  - Provides an Extended Inquiry Response (EIR) tag that can be inserted to indicate that the TV is in **new mode**. The EIR is a standard feature that was introduced with Bluetooth v2.1 + enhanced data rate (EDR).
- The user inserts batteries into the remote control and then pushes the **Power button**. If the remote is in **new mode**, once the **Power button** is pressed, the remote does the following:
  - Performs a system inquiry.
  - If the remote identifies a TV that is in **new mode** (as determined by the EIR response), then the remote connects to and pairs with that TV.
  - The TV powers on.

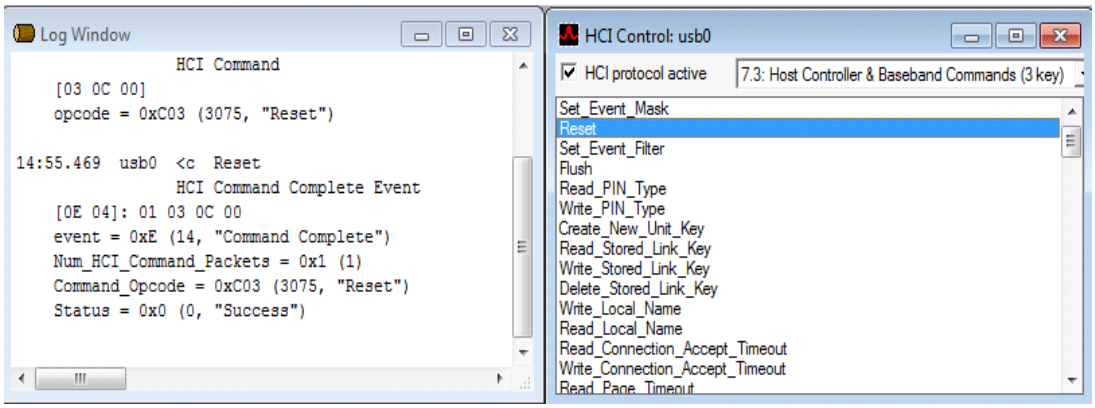
4 Testing Headless Mode

This section provides a basic sequence of select steps for configuring headless mode using HCI commands. For more extensive BlueTool configuration information, see the Bluetooth MWS Coexistence 2–wire Transport Interface Specification at www.bluetooth.com. The following screens illustrate a typical sequence.

4.1 Configuration Using BlueTool™

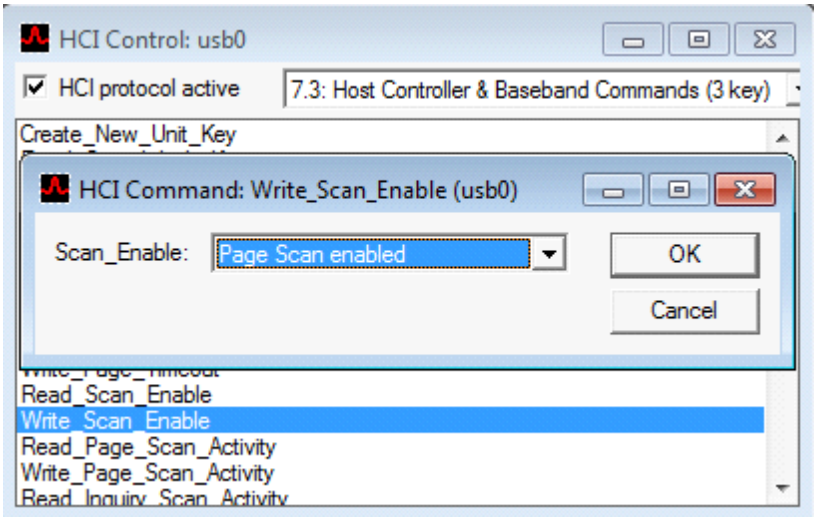
4.1.1 HCI Reset

1. Select **Reset**.
2. Click **OK**.



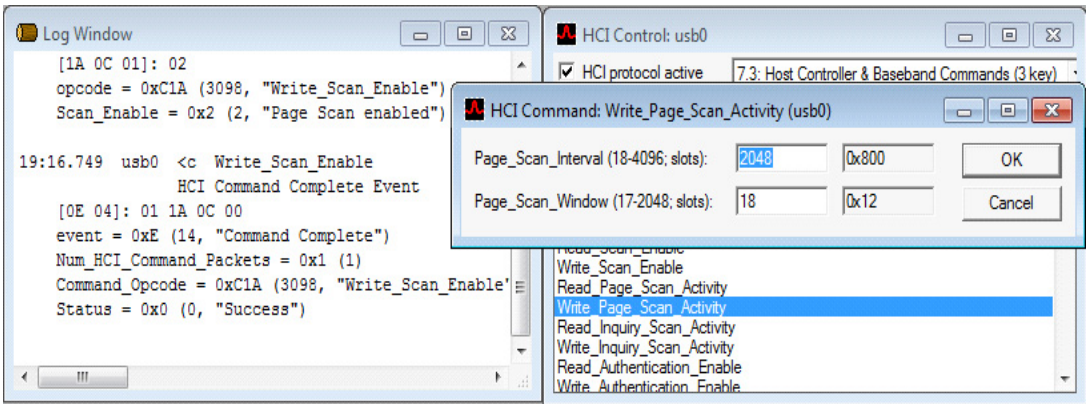
4.1.2 HCI Write Scan Enable

1. Select **Page Scan enabled** from the Scan_Enable menu.
2. Click **OK**.



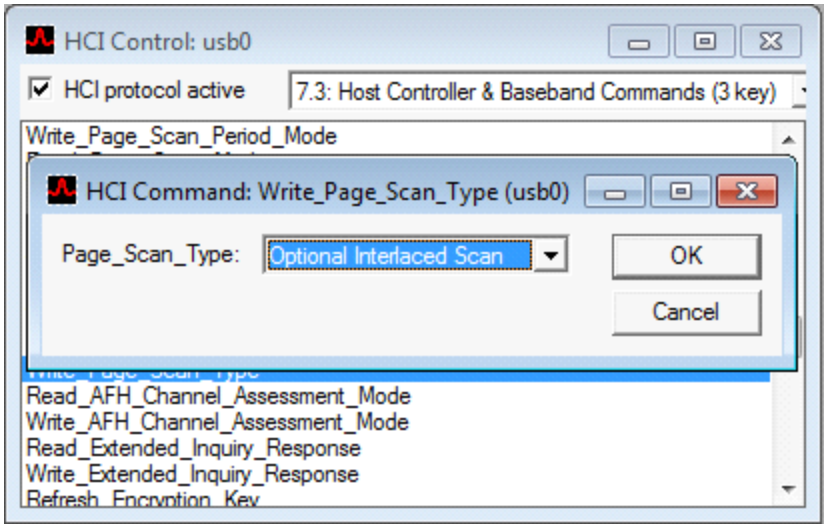
4.1.3 Write Page Scan Activity

1. Type in a representative page scan interval as shown in following screen.
2. Click **OK**.



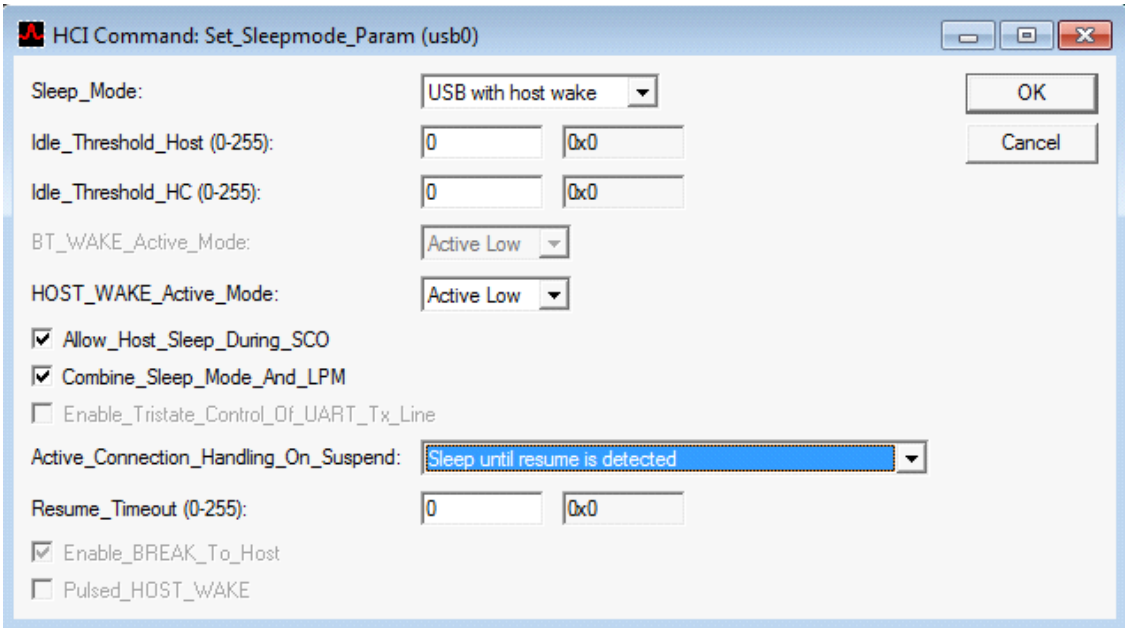
4.1.4 Write Page Scan Type

1. From the Page_Scan_Type menu, select **Optional Interlaced Scan**.
2. Click **OK**.



4.1.5 Set Sleep Mode Parameter

1. From the HCI Command: Set_Sleepmode_param menu, enter the settings as shown in the following screen. The places the PC in sleep/hibernate mode. The device should now be in headless mode also, with the USB detached from the PC.
2. Click **OK**.



4.2 Alternate Headless Mode Testing

The following provides information on an alternative method for testing the headless mode.

To enter headless mode:

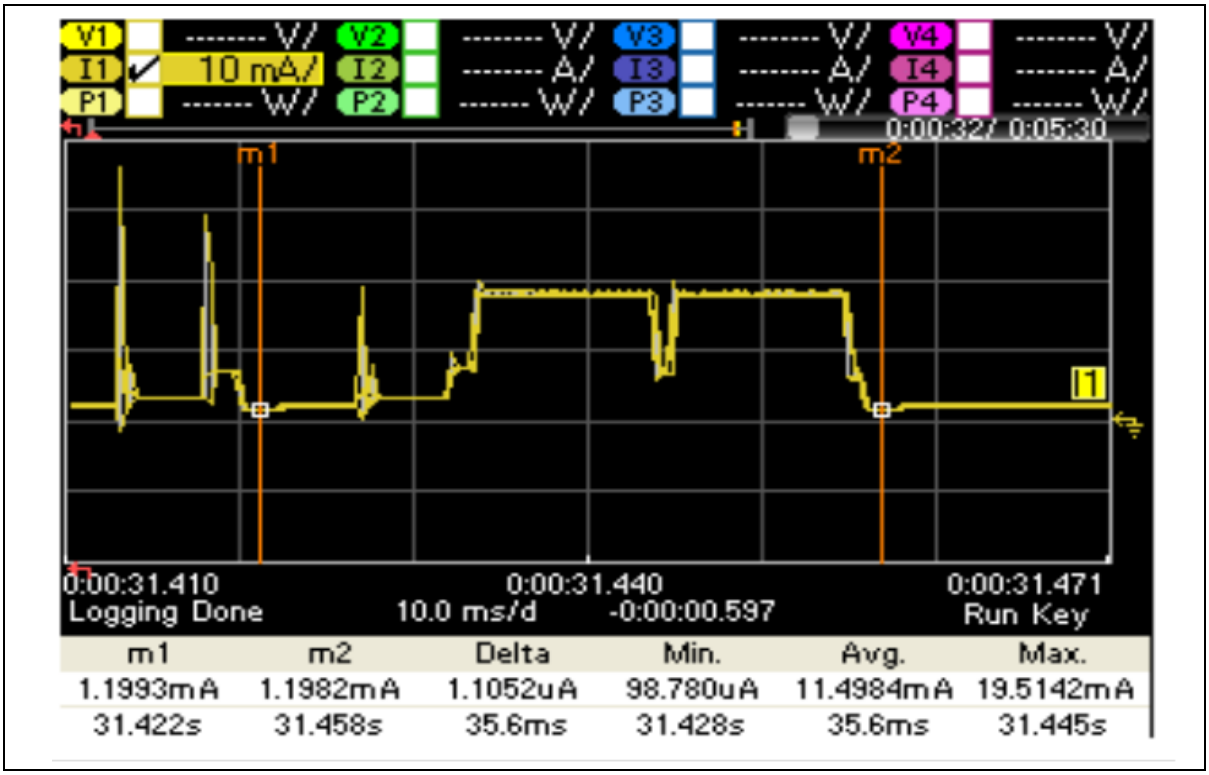
1. Toggle BT_WAKE_BT pin J1 low to trigger headless mode.
2. Assert BT_HL_MODE_GPIO_2 pin M5 to low.
   a. This sets WLAN_REG_ON to low.
   b. This sets WLAN into reset and disconnects VDDUSB3_3 from VDD3_3.

To exit headless mode:

1. Toggle BT_Wake_BT pin J1 high to exit headless mode.
2. Set BT_HL_MODE_GPIO_2 pin M5 to high.
   a. This sets WLAN_REG_ON to high.
   b. This turns on regulators and the WLAN is out of reset.

Figure 3 shows the resulting headless mode current measurement.

Figure 3. Headless Mode Current Measurement



5 References

The references in this section may be used in conjunction with this document.

Note: Cypress provides customer access to technical documentation and software through its Customer Support Portal (CSP) and Downloads and Support site (see IoT Resources on page 1).

For Broadcom documents, replace the “xx” in the document number with the largest number available in the repository to ensure that you have the most current version of the document.

Document (or Item) Name	Broadcom Number	Cypress Number	Source
Items			
[1] Single-Chip Bluetooth Transceiver and Baseband Processor	20705-DS10x-R	002-15410	community.cypress.com
Other Items			
[2] Bluetooth MWS Coexistence 2–wire Transport Interface Specification	–	–	www.bluetooth.com

Document History

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Rev.	**ECN No.**	**Orig. of Change**	**Submission Date**	**Description of Change**
**	–	–	06/23/2014	20705-AN100-R: Initial release
*A	5466506	UTSV	10/07/2016	Updated to Cypress template
*B	5877736	AESATMP9	09/08/2017	Updated logo and copyright.

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