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Advance Data Sheet

BCM43143

Single-Chip IEEE 802.11b/g/n MAC/PHY/Radio with USB/SDIO Host Interface

GENERAL DESCRIPTION

The BCM43143 is a single-band, single-stream, IEEE 802.11n compliant, MAC/PHY/Radio system-on-a-chip with internal 2.4 GHz Power Amplifier (PA) and integrated T/R switch. The BCM43143 supports internal RX diversity by providing two antenna ports. The device enables development of USB or SDIO 802.11n WLAN clients that can take advantage of the high throughput and extended range of Broadcom's second-generation solution. The BCM43143 maintains compatibility with legacy IEEE 802.11b/g devices.

State-of-the-art security is provided by industry standard support for WPA, WPA2 (802.11i), and hardware-accelerated AES encryption/decryption, coupled with TKIP, IEEE 802.1X support, and a WLAN Authentication and Privacy Infrastructure (WAPI) hardware engine.

Embedded hardware acceleration enables increased system performance and reduced host-CPU utilization in both client and access point configurations. The BCM43143 also supports Broadcom's widely accepted and deployed WPS to easily secure WLAN networks.

- SDIO and USB wireless client modules for digital TVs, Blu-ray Disc® players, set-top boxes, game consoles, and printers.
- Supports the I^2S digital audio interface.
- Stand-alone wireless USB dongles and multimedia streaming boxes.

FEATURES

- Supports 3.3V ±10% power supply input with high efficiency Power Management Unit (PMU).
- Programmable dynamic power management.
- Eight GPIOs with multiplexed JTAG interface.
- Complies with USB 2.0 specification and link power management.
- Supports standard SDIO v2.0 (50 MHz, 4-bit and 1-bit) and USB host interfaces.
- 20 MHz reference clock.

FEATURES

- Supports USB 2.0, standard SDIO v2.0 (50 MHz, 4-bit and 1-bit) host interfaces.
- Supports the I^2S audio interface.
- Greenfield, mixed mode, and legacy mode support.
- 802.11n MPDU/MSDU aggregation support for high throughput.
- Full IEEE 802.11b/g legacy compatibility with enhanced performance.
- Supports Broadcom's OneDriver™ software.
- Supports drivers for Windows®, Linux®, and Android™ operating systems.
- Comprehensive wireless network security support that includes WPA, WPA2, and AES encryption/decryption, coupled with TKIP, IEEE 802.1X support, and a WAPI encryption/decryption engine.
- Single stream IEEE 802.11n support for 20 MHz and 40 MHz channels provides PHY layer rates up to 150 Mbps for typical upper-layer throughput in excess of 90 Mbps.
- Supports the IEEE 802.11n RX space-time block coding (STBC) and low-density parity check (LDPC) options for improved range and power efficiency.
- Supports an IEEE 802.15.2 external coexistence interface to optimize bandwidth utilization with other colocated wireless technologies such as GPS, WiMAX, LTE, Bluetooth, and UWB.
- Integrated ARM Cortex-M3 processor and on-chip memory for complete WLAN subsystem functionality, minimizing the need to wake up the applications processor for standard WLAN functions. This allows for further minimization of power consumption while maintaining the ability to field upgrade with future features. On-chip memory includes 448 KB SRAM and 256 KB ROM.
- USB 2.0 with Link Power Management (LPM) for low power standby application.
- SDIO out of band low power application.
- Integrated One Time Programmable (OTP) memory to save configuration settings.

43143-DS104-R

5300 California Avenue • Irvine, CA 92617 • Phone: 949-926-5000 • Fax: 949-926-5203

November 14, 2014

FEATURES

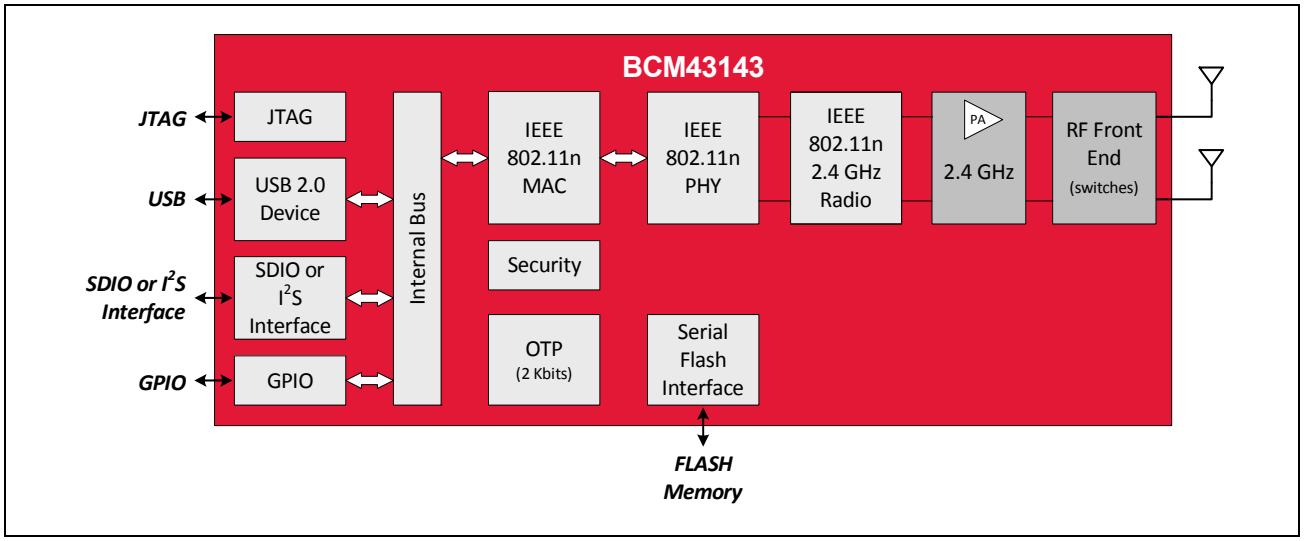
IEEE 802.11x Key Features:

- IEEE 802.11n compliant.
- 2.4 GHz internal PA.
- Internal T/R and RX diversity switches.
- Supports MCS 0–7 coding rates.
- Support for Short Guard Interval (SGI).
- Single stream IEEE 802.11n support for 20 MHz and 40 MHz channels provides PHY layer rates up to 150 Mbps for typical upper-layer throughput in excess of 90 Mbps.
- Supports the IEEE 802.11n RX space-time block coding (STBC) and low-density parity check (LDPC) options for improved range and power efficiency.

Package options:

- 7 mm × 7 mm, 56-pin QFN package.

Figure 1: BCM43143 High-Level Block Diagram



Revision History

Revision	Date	Change Description
43143-DS104-R	11/14/14	**Updated:** • Table 7: “Guaranteed Operating Conditions and DC Characteristics,” on page 32. • Table 8: “WLAN Current Consumption in SDIO Mode using SR_VDDBAT5V,” on page 33. • Table 9: “WLAN Current Consumption in USB mode using VDD33,” on page 34.
43143-DS103-R	02/24/14	**Updated:** • “Reset and Low-Power Off Mode” on page 12 • Table 6: “Absolute Maximum Ratings,” on page 30 • Table 8: “WLAN Current Consumption in SDIO Mode using SR_VDDBAT5V,” on page 32 • Table 9: “WLAN Current Consumption in USB mode using VDD33,” on page 33 • Table 16: “2.4 GHz Band Transmitter RF Specifications,” on page 40 • Section 14: “Thermal Information,” on page 53
43143-DS102-R	06/25/13	**Updated:** • Table 7 on page 34.
43143-DS101-R	06/03/13	**Added:** • Various features on cover, reorganized feature lists. • “Link Power Management (LPM) Support” on page 16. • “I2S Interface” on page 17. • “Serial Flash Timing” on page 47. • “I2S Slave Mode Tx Timing” on page 48. **Updated:** • Figure 1 on page 2. • Figure 3 on page 11. • Figure 4 on page 13. • Note in “Crystal Oscillator” on page 15. • Figure 9 on page 24. • Table 2 on page 25. • Table 3 on page 26. • Table 4 on page 28. • Table 5 on page 32. • Table 6 on page 33. • Table 7 on page 34. • Table 9 on page 36. • Table 10 on page 37. • Table 11 on page 39. • Note in Section 14: “Thermal Information,” on page 56. • Table 24 on page 56
43143-DS100-R	04/26/12	Initial release.

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About This Document

Purpose and Audience

This document provides details of the functional, operational, and electrical characteristics of the Broadcom® BCM43143. It is intended for hardware design, application, and OEM engineers.

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 Broadcom documents, go to: http://www.broadcom.com/press/glossary.php.

Document Conventions

The following conventions may be used in this document:

Convention	*Description*
Bold	User input and actions: for example, type **exit**, click **OK,** press **Alt+C**
`Monospace`	Code: `#include <iostream>` HTML: `<td rowspan = 3>` Command line commands and parameters: `wl [-l] <command>`
< >	Placeholders for *required* elements: enter your <username> or `wl <command>`
[ ]	Indicates *optional* command-line parameters: `wl [-l]` Indicates bit and byte ranges (inclusive): [0:3] or [7:0]

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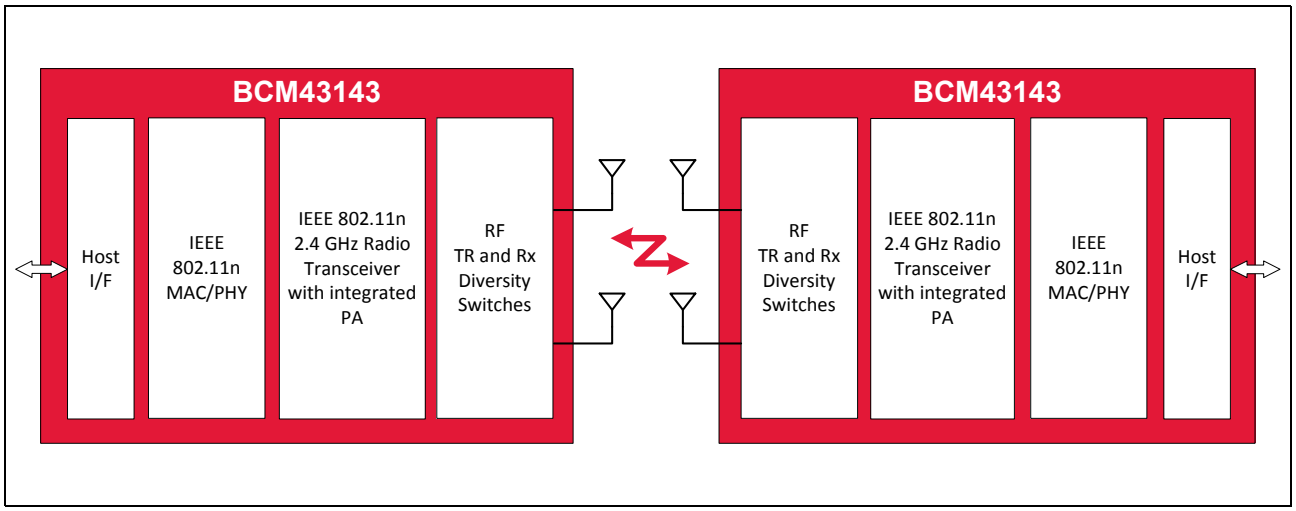
In addition, Broadcom provides other product support through its Downloads & Support site (http://www.broadcom.com/support/).

Section 1: Introduction

The Broadcom® BCM43143 single-chip device provides the highest level of integration for wireless systems with integrated IEEE 802.11b/g/n (MAC/PHY/radio). It provides a small form-factor solution with minimal external components to drive down the cost for mass volumes and allows for wireless media client flexibility in size, form, and function.

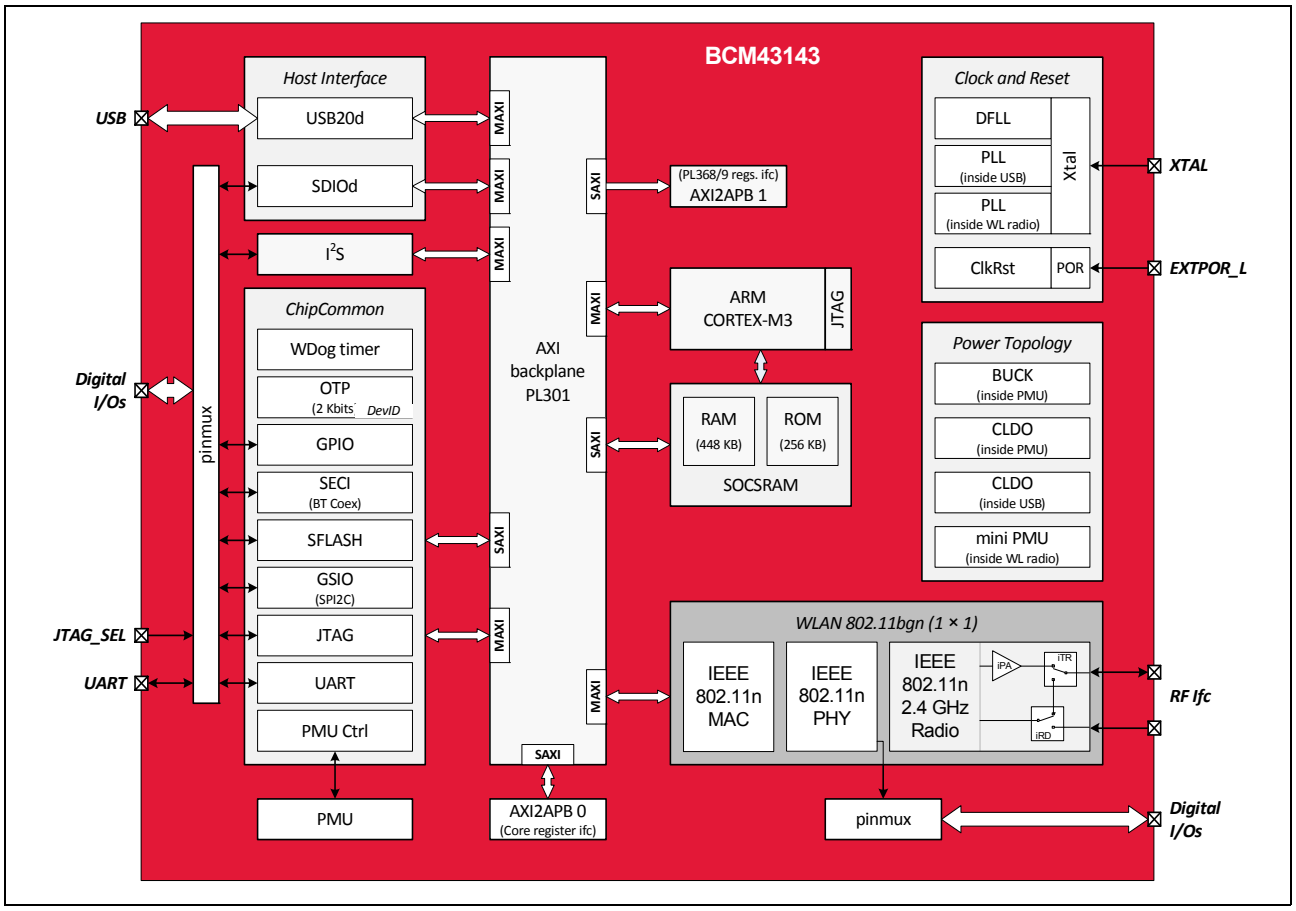
Figure 2: BCM43143 System Diagram Showing Two Antennas and a Single Stream



Employing a native 32-bit bus with a Direct Memory Access (DMA) architecture, the BCM43143 offers significant performance improvements in both transfer rates and CPU utilization. Flexible support for a variety of system bus interfaces is provided, including USB and SDIO devices.

Figure 3 shows a block diagram of the device.

Figure 3: BCM43143 Functional Block Diagram



Section 2: Power Management and Resets

Power Management

The BCM43143 includes an internal Power Management Unit (PMU). The PMU takes care of powering up the chip, and also enables and disables clocks based on clock requests sent from BCM43143 internal blocks.

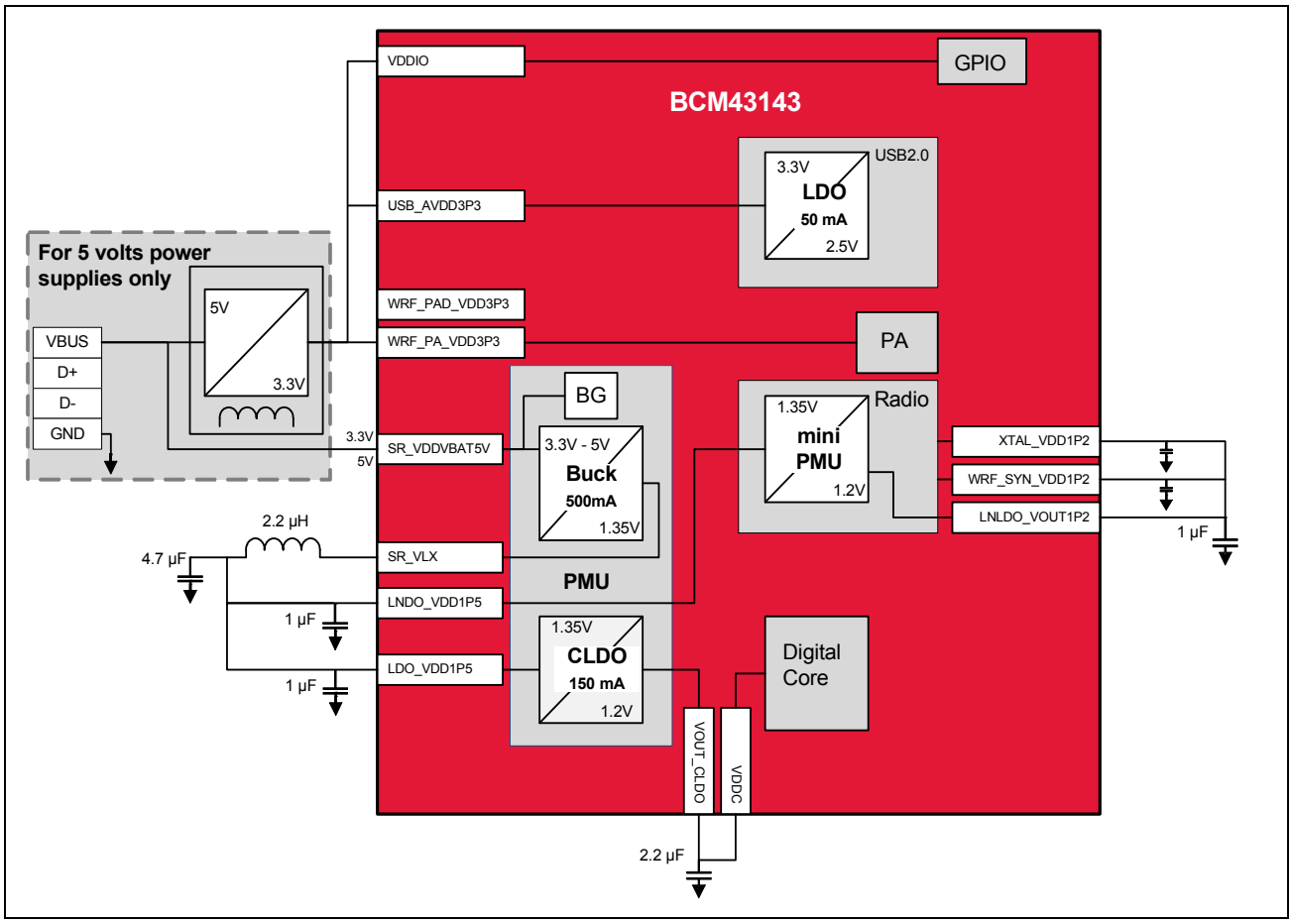
Power Topology

The BCM43143 contains a high-efficiency power topology to convert input supply voltages to the supply voltages required by the device's internal blocks. A CBUCK switching regulator is used to convert the input supply to 1.35V. Internal LDOs perform a low-noise conversion from 1.35V to 1.2V. As shown in Figure 4 on page 13, the BCM43143 supports two power supply configurations:

- A 3.3V power supply, connected to SR_VDDBAT5V, WRF_PA_VDD3P3, and WRF_PAD_VDD3P3.
- A 5V power supply connected to SR_VDDBAT5V, WRF_PA_VDD3P3, and WRF_PAD_VDD3P3 connected to 3.3V. The latter can be obtained through a DC-DC conversion as shown in Figure 4 on page 13.

The default VDDIO supply of the BCM43143 is 3.3V. In SDIO mode, the BCM43143 supports an SDIO interface specific voltage range of 1.8V to 3.3V. Refer to pin 46 description in Table 4 on page 26. All VDDIO pins other than pin 46 remain at 3.3V as described in Table 4 on page 26.

Figure 4: Power Topology with the VDD33 (3.3V) Main Supply



Reset and Low-Power Off Mode

Full-chip reset is achieved by switching off the 3.3V VDDIO voltage to pins 1, 25, 37, and 53. This puts the chip in reset and low-power off mode; in this mode the internal CBUCK switcher is shut down, bringing the total typical current consumption down to less than 100 µA. The device must be kept in reset/low-power off mode for at least 25 ms.

Section 3: WLAN Global Functions

GPIO Interface

There are 19 General-Purpose I/O (GPIO) pins provided on the BCM43143. GPIOs 0–18 are multiplexed with the JTAG, SDIO, I^2S, SFlash, and Serial Enhanced Coexistence Interface (SECI) functions. These pins can be used to interface to various external devices. Upon power-up and reset, these pins become tristated. Subsequently, they can be programmed to be either input or output pins via the GPIO control register. A programmable internal pull-up/pull-down resistor is included on each GPIO. If a GPIO output enable is not asserted, and the corresponding GPIO signal is not being driven externally, the GPIO state is determined by its programmable resistor.

OTP

The BCM43143 has 2 Kbits of on-chip One-Time Programmable (OTP) memory that can be used for non-volatile storage of WLAN information such as a MAC address and other hardware-specific board and interface configuration parameters.

JTAG Interface

The BCM43143 supports the IEEE 1149.1 JTAG boundary-scan standard for testing a packaged device on a manufactured board. The JTAG interface is enabled by driving the JTAG_SEL pin high.

Crystal Oscillator

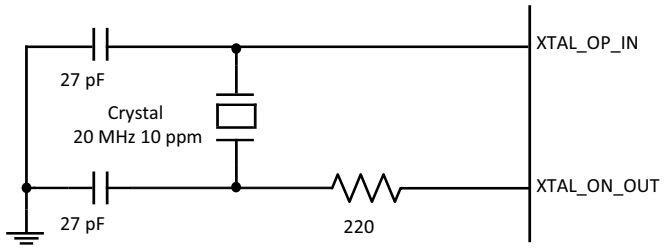
Table 1 lists the requirements for the crystal oscillator.

Table 1: Crystal Oscillator Requirements

Parameter	*Value*
Frequency	20 MHz
Mode	AT cut, fundamental
Load capacitance	16 pF
ESR	50Ω maximum
Frequency stability	±10 ppm at 25°C
	±10 ppm at 0°C to +85°C
Aging	±3 ppm/year maximum the first year, ±1 ppm thereafter
Drive level	300 µW maximum
Q-factor	40,000 minimum
Shunt capacitance	< 5 pF

Figure 5 shows the recommended oscillator configuration.

Figure 5: Recommended Oscillator Configuration



Note: Refer to reference schematics for design-specific details.

Note: The component values referenced in Figure 5 are only recommended values and the correct values will have to be characterized on a per board basis. Please see the reference board schematic for the correct characterized values.

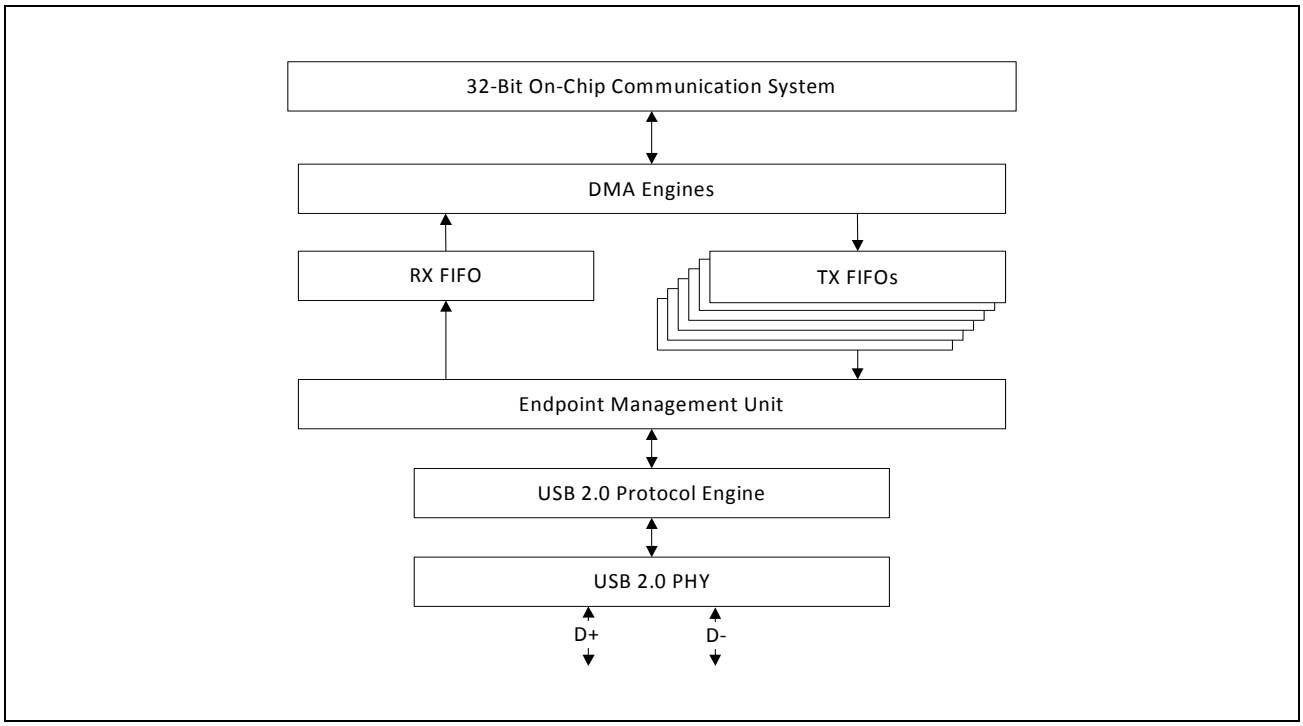
Section 4: WLAN USB 2.0 Host Interface

The BCM43143 USB interface can be set to operate as a USB 2.0 port. Features include the following:

- A USB 2.0 protocol engine that supports the following:
  - A Parallel Interface Engine (PIE) between packet buffers and USB transceiver
  - Up to nine endpoints, including Configurable Control Endpoint 0
- Separate endpoint packet buffers with a 512-byte FIFO buffer each
- Host-to-device communication for bulk, control, and interrupt transfers
- Configuration and status registers

Figure 6 shows the blocks in the device core.

Figure 6: WLAN USB 2.0 Host Interface Block Diagram



The USB 2.0 PHY handles the USB protocol and the serial signaling interface between the host and device. It is primarily responsible for data transmission and recovery. On the transmit side, data is encoded, along with a clock, using the NRZI scheme with bit stuffing to ensure that the receiver detects a transition in the data stream. A SYNC field that precedes each packet enables the receiver to synchronize the data and clock recovery circuits. On the receive side, the serial data is deserialized, unstuffed, and checked for errors. The recovered data and clock are then shifted to the clock domain that is compatible with the internal bus logic.

The endpoint management unit contains the PIE control logic and the endpoint logic. The PIE interfaces between the packet buffers and the USB transceiver. It handles packet identification (PID), USB packets, and transactions.

The endpoint logic contains nine uniquely addressable endpoints. These endpoints are the source or sink of communication flow between the host and the device. Endpoint zero is used as a default control port for both the input and output directions. The USB system software uses this default control method to initialize and configure the device information and allows USB status and control access. Endpoint zero is always accessible after a device is attached, powered, and reset.

Endpoints are supported by 512-byte FIFO buffers, one for each IN endpoint and one shared by all OUT endpoints. Both TX and RX data transfers support a DMA burst of 4, which guarantees low latency and maximum throughput performance. The RX FIFO can never overflow by design. The maximum USB packet size cannot be more than 512 bytes.

Link Power Management (LPM) Support

The USB 2.0 host interface supports a power management feature called Link Power Management (LPM) which is similar to the existing suspend/resume, but has transitional latencies of tens of microseconds between power states (instead of three to greater than 20 millisecond latencies of the USB 2.0 suspend/resume). LPM simply adds a new feature and bus state that co-exists with the USB 2.0 defined suspend/resume.

I^2S Interface

The I^2S interface for audio supports slave mode transmit 2.1 or 5.1 channel operation. The I^2S signals are:

- I^2S bit clock: I2S_BITCLK
- I^2S Word Select: I2S_WS
- I^2S Data Out: I2S_SDOUT

I2S_BITCLK and I2S_WS are inputs, while I2S_SDOUT is an output. Channel word lengths of 16 bits, 20 bits, 24 bits, and 32 bits are supported, and the data is justified so that the MSB of the left-channel data is aligned with the MSB of the I^2S bus, per the I^2S specification. The MSB of each data word is transmitted one bit clock cycle after the I2S_WS transition, synchronous with the falling edge of bit clock. Left-channel data is transmitted when I2S_WS is low, and right-channel data is transmitted when I2S_WS is high. An embedded 128 x 32 bits single port SRAM for data processing enhances the performance of the interface.

The bit depth of I^2S is 16, 20, 24, and 32.

Variable sampling rates are also supported:

- 8k, 12k, 16k, 24k, 32k, 48k, 96k with a 12.288 MHz master clock used by the external master receiver and/or controller
- 22.05k, 44.1k, 88.2k with a 11.2896 MHz master clock used by the external master receiver and/or controller
- 96k with a 24.567 MHz master clock used by the external master receiver and/or controller

The BCM43143 needs an external clock source input on the slave clock pin for the I^2S interface. The slave clock frequency is dependent upon the audio sample rate and the external I^2S codec.

Section 5: SDIO Interface

The SDIO interface is enabled by a strapping option (see Table 5 on page 30 for details). The BCM43143 supports all of the SDIO version 2.0 modes:

- 1-bit SDIO-SPI mode (25 Mbps)
- 1-bit SDIO-SD mode (25 Mbps)
- 4-bit SDIO-SD default speed mode (100 Mbps)
- 4-bit SDIO-SD high speed mode (200 Mbps).

The SDIO interface supports the full clock range from 0 to 50 MHz. The chip has the ability to stop the SDIO clock between transactions to reduce power consumption. As an option, the GPIO_4 or the GPIO_16 pin can be mapped to provide an SDIO Interrupt signal. This out-of-band interrupt is hardware generated and is always valid (unlike the SDIO in-band interrupt, which is signalled only when data is not driven on SDIO lines). The ability to force control of the gated clocks from within the WLAN chip is also provided. Three functions are supported:

- Function 0 standard SDIO function. Maximum BlockSize/ByteCount = 32 bytes.
- Function 1 backplane function to access the internal System-on-a-Chip (SoC) address space. Maximum BlockSize/ ByteCount = 64 bytes.
- Function 2 WLAN function for efficient WLAN packet transfer through DMA. Maximum BlockSize/ ByteCount = 512 bytes.

Section 6: Wireless LAN MAC and PHY

IEEE 802.11n MAC Description

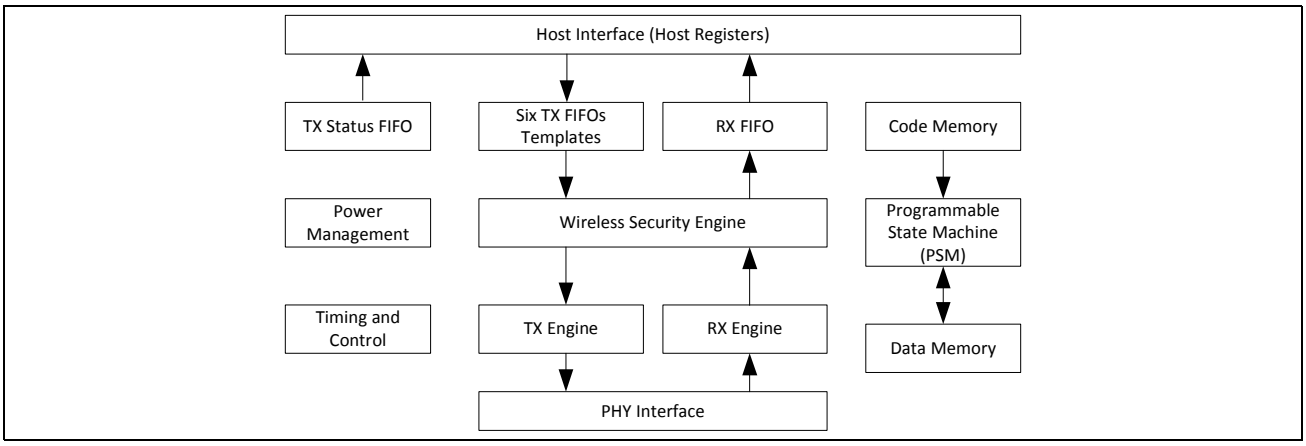
The IEEE 802.11n MAC features include:

- Enhanced MAC for supporting 802.11n features
- Programmable Access Point (AP) or Station (STA) functionality
- Programmable mode selection as Independent Basic Service Set (IBSS) or infrastructure
- Aggregated MAC Protocol Data Unit (MPDU) support for High Throughput (HT)
- Passive scanning
- Network Allocation Vector (NAV), Interframe Space (IFS), and Timing Synchronization Function (TSF) functionality
- RTS/CTS procedure support
- Transmission of response frames (ACK/CTS)
- Address filtering of receive frames as specified by IBSS rules
- Multirate support
- Programmable Target Beacon Transmission Time (TBTT), beacon transmission/cancellation, and Announcement Traffic Indication Message (ATIM) window
- Coordination Function (CF) conformance: Setting a NAV for neighborhood Point Coordination Function (PCF) operation
- Security through a variety of encryption schemes including WEP, TKIP, AES, WPA, WAP2, and IEEE 802.1X
- Power management
- Statistics counters for MIB support

The MAC core supports the transmission and reception of packet sequences, together with related timing, without any packet-by-packet driver interaction. Time-critical tasks requiring response times of only a few milliseconds are handled in the MAC core. This achieves the required medium timing while minimizing driver complexity. Also, the MAC driver processes incoming packets that have been buffered in the MAC core in bursts, enabling high bandwidth performance.

The MAC driver interacts with the MAC core to prepare transmit packet queues and to analyze and forward received packets to upper software layers. The internal blocks of the MAC core are connected to a Programmable State Machine (PSM) through the host interface that connects to the internal bus (see Figure 7 on page 20).

Figure 7: Enhanced MAC Block Diagram



The host interface consists of registers for controlling and monitoring the status of the MAC core and interfacing with the TX/RX FIFOs. For transmission, 32 KB of FIFO buffering is available that can be dynamically allocated to six transmit queues plus template space for beacons, ACKs, and probe responses. Whenever the host has a frame to transmit, the host queues the frame into one of the transmit FIFOs with a TX descriptor containing TX control information. The PSM schedules the transmission on the medium depending on the frame type, transmission rules in the IEEE 802.11™ protocol, and the current medium occupancy scenario. After the transmission completes, a TX status is returned to the host, informing the host of the transmission.

The MAC contains a 10 KB RX FIFO. Received frames are sent to the host along with RX descriptors that contain additional frame reception information.

The power management block maintains power management state information of the core (and of the associated STAs in the case of an AP) to help with dynamic frame transmission decisions by the core.

The wireless security engine performs the required encryption/decryption on the TX/RX frames. This block supports separate transmit and receive keys with four shared keys and 50 link-specific keys. The link-specific keys are used to establish a secure link between any two network nodes. The wireless security engine supports the following encryption schemes that can be selected on a per-destination basis:

- None: The wireless security engine acts as a pass-through
- WEP: 40-bit secure key and 24-bit IV as defined in IEEE Std. 802.11-2007
- WEP128: 104-bit secure key and 24-bit IV
- TKIP: IEEE Std. 802.11-2007
- AES: IEEE Std. 802.11-2007

The transmit engine is responsible for the byte flow from the TX FIFO to the PHY interface through the encryption engine and the addition of a CRC-32 Frame Check Sequence (FCS) as required by IEEE 802.11-2007. Similarly, the receive engine is responsible for byte flow from the PHY interface to the RX FIFO through the decryption engine and for detection of errors in the RX frame.

The timing block performs the TSF, NAV, and IFS functionality as described in IEEE Std. 802.11-2007.

The Programmable State Machine (PSM) coordinates the operation of different hardware blocks required for both transmission and reception. The PSM also maintains the statistics counters required for MIB support.

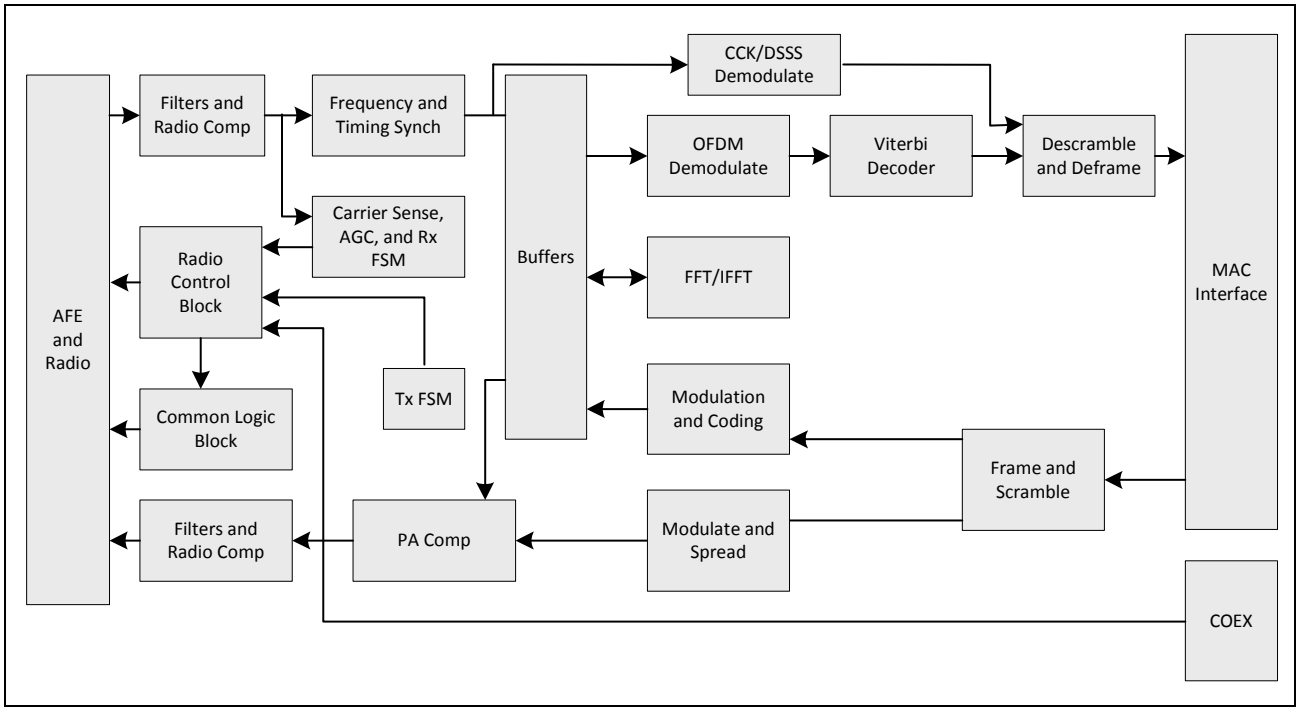
IEEE 802.11n PHY Description

The PHY supports:

- Programmable data rates from MCS 0–7 in 20 MHz and 40 MHz channels, as specified in 802.11n.
- Short Guard Interval (SGI) and optional reception of two space-time block encoded streams.
- All scrambling, encoding, forward error correction, and modulation in the transmit direction, and inverse operations in the receive direction.
- Advanced digital signal processing technology for best-in-class receive sensitivity.
- Both mixed-mode and optional greenfield preamble of 802.11n.
- Both long and optional short IEEE 802.11b preambles.
- Closed-Loop transmit power control.
- Per-packet receive antenna diversity.
- Automatic Gain Control (AGC).
- Available per-packet channel quality and signal strength measurements.

The BCM43143 PHY provides baseband processing at all mandatory 802.11n data rates up to 150 Mbps, and the legacy rates specified in IEEE 802.11b/g, including 1, 2, 5.5, 6, 9, 11, 12, 18, 24, 36, 48, and 54 Mbps. This core acts as an intermediary between the MAC and the 2.4 GHz radio, converting back and forth between packets and baseband waveforms.

Figure 8: PHY Block Diagram



Single-Band Radio Transceiver

The BCM43143 has a 2.4 GHz radio transceiver that ensures low power consumption and robust communication in 20 MHz and 40 MHz channel bandwidths as specified in IEEE 802.11n.

Receiver Path

The BCM43143 has a wide dynamic range, direct conversion receiver. It employs high-order, on-chip channel filtering to ensure reliable operation in the noisy 2.4 GHz ISM band. The excellent noise figure of the receiver makes an external LNA unnecessary.

Transmitter Path

Baseband data is modulated and upconverted to the 2.4 GHz ISM band. Linear on-chip power amplifiers are included, which are capable of delivering a nominal output power exceeding +15 dBm while meeting the IEEE 802.11n specification. The TX gain has 128 steps of 0.25 dB per step.

Calibration

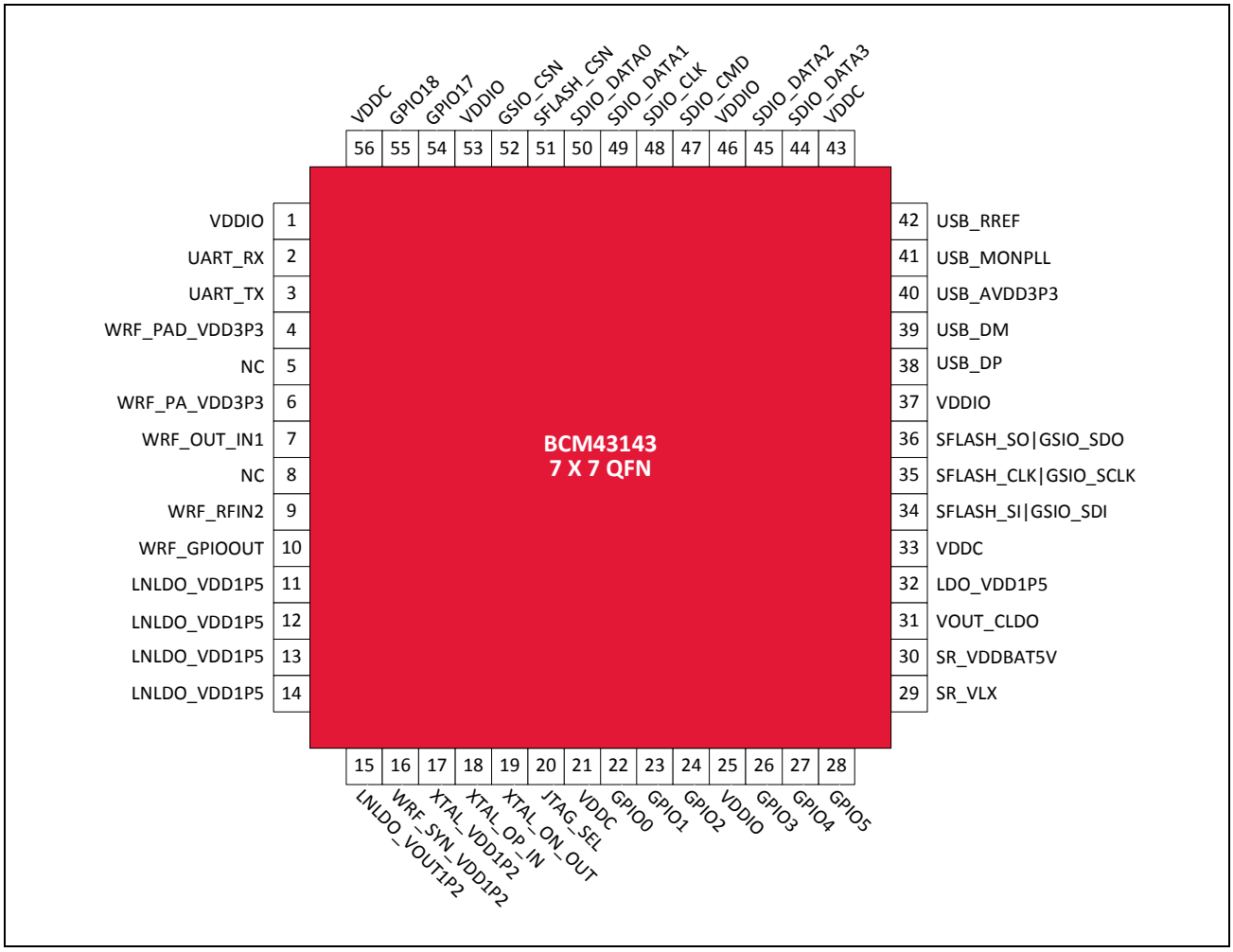
The BCM43143 features dynamic on-chip calibration, eliminating process variation across components. This enables the device to be used in high-volume applications because calibration routines are not required during manufacturing. These calibration routines are performed periodically in the course of normal radio operation.

Section 7: Pin Assignments

56-Pin QFN Assignments

The 56-pin QFN package pin assignments are shown in Figure 9.

Figure 9: BCM43143 56-Pin QFN Package



56-Pin QFN Signals

Pin Assignments by Pin Number

Table 2: Pin Assignments by Pin Number

Pin	Signal Name	Pin	Signal Name
1	VDDIO	29	SR_VLX
2	UART_RX	30	SR_VDDBAT5V
3	UART_TX	31	VOUT_CLDO
4	WRF_PAD_VDD3P3	32	LDO_VDD1P5
5	GND	33	VDDC
6	WRF_PA_VDD3P3	34	SFLASH_SI|GSIO_SDI
7	WRF_OUT_IN1	35	SFLASH_CLK|GSIO_SCLK
8	GND	36	SFLASH_SO|GSIO_SDO
9	WRF_RFIN2	37	VDDIO
10	WRF_GPIOOUT	38	USB_DP
11	LNLDO_VDD1P5	39	USB_DM
12	LNLDO_VDD1P5	40	USB_AVDD3P3
13	LNLDO_VDD1P5	41	USB_MONPLL
14	LNLDO_VDD1P5	42	USB_RREF
15	LNLDO_VOUT1P2	43	VDDC
16	WRF_SYN_VDD1P2	44	SDIO_DATA3
17	XTAL_VDD1P2	45	SDIO_DATA2
18	XTAL_OP_IN	46	VDDIO
19	XTAL_ON_OUT	47	SDIO_CMD
20	JTAG_SEL	48	SDIO_CLK
21	VDDC	49	SDIO_DATA1
22	GPIO0	50	SDIO_DATA0
23	GPIO1	51	SFLASH_CSN
24	GPIO2	52	GSIO_CSN
25	VDDIO	53	VDDIO
26	GPIO3	54	GPIO17
27	GPIO4	55	GPIO18
28	GPIO5	56	VDDC

Pin Assignments by Pin Name

Table 3: Pin Assignments by Signal Name

Signal Name	*Pin*
GPIO0	22
GPIO1	23
GPIO2	24
GPIO3	26
GPIO4	27
GPIO5	28
GPIO17	54
GPIO18	55
GSIO_CSN	52
JTAG_SEL	20
LDO_VDD1P5	32
LNLDO_VDD1P5	11
LNLDO_VDD1P5	12
LNLDO_VDD1P5	13
LNLDO_VDD1P5	14
LNLDO_VOUT1P2	15
GND	5
GND	8
SDIO_CLK	48
SDIO_CMD	47
SDIO_DATA0	50
SDIO_DATA1	49
SDIO_DATA2	45
SDIO_DATA3	44
SFLASH_CLK|GSIO_SCLK	35
SFLASH_CSN	51
SFLASH_SI|GSIO_SDI	34
SFLASH_SO|GSIO_SDO	36
SR_VDDBAT5V	30

Signal Name	*Pin*
SR_VLX	29
UART_RX	2
UART_TX	3
USB_AVDD3P3	40
USB_DM	39
USB_DP	38
USB_MONPLL	41
USB_RREF	42
VDDC	21
VDDC	33
VDDC	43
VDDC	56
VDDIO	1
VDDIO	25
VDDIO	37
VDDIO	46
VDDIO	53
VOUT_CLDO	31
WRF_GPIOOUT	10
WRF_OUT_IN1	7
WRF_PA_VDD3P3	6
WRF_PAD_VDD3P3	4
WRF_RFIN2	9
WRF_SYN_VDD1P2	16
XTAL_ON_OUT	19
XTAL_OP_IN	18
XTAL_VDD1P2	17

Section 8: Signal and Pin Descriptions

Package Signal Descriptions

The signal name, type, and description of each pin in the BCM43143 56-pin QFN package is listed in Table 4. The symbols shown in the Type column indicate pin directions (I/O = bidirectional, I = input, O = output, and OD = open drain output) and the internal pull-up/pull-down characteristics (PU = weak internal pull-up resistor and PD = weak internal pull-down resistor), if any. Resistor strapping options are defined in Table 5 on page 30.

Table 4: BCM43143 Signal Descriptions

Pin	Signal	Type	Description
SDIO Bus Interface			
48	SDIO_CLK	I/O	SDIO clock When not used as SDIO this is a general purpose GPIO pin (GPIO12) or an I^2S Audio Interface signal (I2S_WS)
47	SDIO_CMD	I/O	SDIO bus command line When not used as SDIO this is a general purpose GPIO pin (GPIO11) or an I^2S Audio Interface signal (I2S_BITCLK)
50	SDIO_DATA0	I/O	SDIO data line 0 When not used as SDIO this is a general purpose GPIO pin (GPIO14)
49	SDIO_DATA1	I/O	SDIO data line 1 When not used as SDIO this is a general purpose GPIO pin (GPIO13) or an I^2S Audio Interface signal (I2S_SDOUT)
45	SDIO_DATA2	I/O	SDIO data line 2 When not used as SDIO this is a general purpose GPIO pin (GPIO10)
44	SDIO_DATA3	I/O	SDIO data line 3 When not used as SDIO this is a general purpose GPIO pin (GPIO9)
USB Interface			
39	USB_DM	I/O	USB data negative
38	USB_DP	I/O	USB data positive
41	USB_MONPLL	–	USB reserved pin for Diagnostic purposes only
42	USB_RREF	–	USB bandgap reference resistor/capacitor, tie this pin in parallel through a 100 pF capacitor and a 4 kΩ resistor to ground
WLAN RF Signal Interface			
7	WRF_OUT_IN1	I/O	2.4 GHz RF output, 2.4 GHz RF input 1
9	WRF_RFIN2	I	2.4 GHz RF input 2
10	WRF_GPIOOUT	O	WLAN reference output. Connect to ground through a 15 kΩ, 1% resistor.

Table 4: BCM43143 Signal Descriptions (Cont.)

Pin	Signal	Type	Description
I^2S Audio Interface			
47	I2S_BITCLK	I/O	I^2S serial bit clock, only available when no SDIO I/F
48	I2S_WS	I/O	I^2S word select, only available when no SDIO I/F
49	I2S_SDOUT	I/O	I^2S serial data out, only available when no SDIO I/F
Serial Flash Interface and SPI/BSC Interface			
51	SFLASH_CSN	I/O	Serial flash chip select. When not used as SFLASH, this is a general purpose GPIO pin (GPIO15)
34	SFLASH_SI GSIO_SDI	I/O	This pin is muxed with: • Serial flash data in • SPI/BSC data in When not used as SFLASH or GSIO this is a general purpose GPIO pin (GPIO6)
36	SFLASH_SO GSIO_SDO	I/O	This pin is muxed with: • Serial flash data out • SPI/BSC data out When not used as SFLASH or GSIO this is a general purpose GPIO pin (GPIO8)
35	SFLASH_CLK GSIO_SCLK	I/O	This pin is muxed with: • Serial flash clock • SPI/BSC clock When not used as SFLASH or GSIO this is a general purpose GPIO pin (GPIO7)
52	GSIO_CSN	I/O	SPI/BSC chip select. When not used as GSIO this is a general purpose GPIO pin (GPIO16).

Table 4: BCM43143 Signal Descriptions (Cont.)

Pin	Signal	Type	Description
GPIO Pins			
22	GPIO0 TDI BTCX_RF_ACTIVE SECI_IN0	I/O	This pin is muxed with: • GPIO0, a general purpose I/O pin • JTAG test data in • Legacy BT coexistence RF Active • SECI in0
23	GPIO1 TDO BTCX_TX_CONF SECI_OUT	I/O	This pin is muxed with: • GPIO1, a general purpose I/O pin • JTAG test data out • Legacy BT coexistence TX Conf • SECI out
24	GPIO2 TCK BTCX_STATUS SECI_AUX0	I/O	This pin is muxed with: • GPIO2, a general purpose I/O pin • JTAG test clock • Legacy BT coexistence Status • SECI aux0
26	GPIO3 TRST-L BTCX_PRISEL SECI_IN1	I/O	This pin is muxed with: • GPIO3, a general purpose I/O pin • JTAG test reset low • Legacy BT coexistence Priority Select • SECI in1
27	GPIO4 TMS BTCX_FREQ	I/O	This pin is muxed with: • GPIO4, a general purpose I/O pin • JTAG test mode select • Legacy BT coexistence FREQ
28	GPIO5 EXTPOR_L	I/O (PU)	This pin is muxed with: • GPIO5, a general purpose I/O pin • External power-on reset low, when JTAG_SEL high
54	GPIO17	I/O (PD)	General purpose I/O pin
55	GPIO18	I/O (PD)	General purpose I/O pin
UART Interface			
2	UART_RX	I/O (PD)	UART receive data (SW debug)
3	UART_TX	I/O (PU)	UART transmit data (SW debug)
Crystal Oscillator			
19	XTAL_ON_OUT	O	XTAL oscillator output. Connect a 20 MHz, 10 ppm crystal between the XTAL_ON_OUT and XTAL_OP_IN pins
18	XTAL_OP_IN	I	XTAL oscillator input

Table 4: BCM43143 Signal Descriptions (Cont.)

Pin	Signal	Type	Description
Test Pins			
20	JTAG_SEL	I (PD)	JTAG select
Strap Pins			
2	UART_RX	I/O (PD)	Strap RemapToROM[1]
3	UART_TX	I/O (PU)	Strap RemapToROM[0]
34	SFLASH_SI	I/O (PD)	Strap SDIOHighDrive
54	GPIO17	I/O (PD)	Strap SDIOEnabled
55	GPIO18	I/O (PD)	Strap SDIOIso
Integrated Voltage Regulators			
11, 12, 13, 14	LNLDO_VDD1P5	PWR	LNLDO 1.5V input
15	LNLDO_VOUT1P2	PWR	LNLDO 1.2V output
30	SR_VDDBAT5V	PWR	VBAT power input
29	SR_VLX	PWR	CBUCK switching regulator output
31	VOUT_CLDO	PWR	Output of core LDO
32	LDO_VDD1P5	PWR	Input of core LDO
WLAN Power Supplies			
40	USB_AVDD3P3	PWR	USB 3.3V input
16	WRF_SYN_VDD1P2	PWR	RF synthesizer VDD 1.2V input
6	WRF_PA_VDD3P3	PWR	WLAN PA 3.3V supply
4	WRF_PAD_VDD3P3	PWR	WLAN PA driver 3.3V supply
17	XTAL_VDD1P2	PWR	XTAL oscillator 1.2V supply
Miscellaneous Power Supplies and Ground			
21, 33, 43, 56	VDDC	PWR	Core supply for WLAN
1, 25, 37, 53	VDDIO	PWR	I/O supply for pads (3.3V)
46	VDDIO	PWR	I/O supply for SDIO pads (1.8V to 3.3V). Can only be 3.3V when USB is used.
H	GND_SLUG	GND	Ground
5, 8	GND	GND	Ground

Strapping Options

The pins listed in Table 5 are sampled at Power-On Reset (POR) to determine the various operating modes. Sampling occurs within a few milliseconds following internal POR or deassertion of external POR. After POR, each pin assumes the function specified in the signal descriptions table. Each pin has an internal pull-up (PU) or pull-down (PD) resistor that determines the default mode. To change the mode, connect an external PU resistor to VDDIO or a PD resistor to GND (use 10 kΩ or less)[1].

Table 5: Strapping Options

Signal Name	*Mode*	*Default*	*Description*
[UART_RX, UART_TX]	RemapToROM[1:0]	[PD,PU]	00 = Boot from SRAM, ARMCM3 in reset, no SFLASH connected 01 = Boot from ROM, no SFLASH connected (default) 10 = Boot from SFLASH 11 = Invalid
GPIO17	SDIOEnabled	PD	0 = USB Enabled, SDIO pins can be GPIO or I^2S (default) 1 = SDIO Enabled
GPIO18	SDIOIso	PD	0 = SDIO pads are not in Isolation mode (default) 1 = Keep SDIO pads in Isolation mode
SFLASH_SI	SDIOHighDrive	PD	0 = SDIO pins drive strength set by SDIOd core or PMU Chip Control (= default) 1 = SDIO pins drive strength set by SDIOd core to either 12 mA or 16 mA

1. BCM43143 reference board schematics can be obtained through your Broadcom representative.

Section 9: Electrical Characteristics

Note: Values in this data sheet are design goals and are subject to change based on the results of device characterization.

Absolute Maximum Ratings

Caution! These specifications indicate levels where permanent damage to the device can occur. Functional operation is not guaranteed under these conditions. Operation at absolute maximum conditions for extended periods can adversely affect the long-term reliability of the device.

Table 6: Absolute Maximum Ratings

Rating	*Symbol*	*Minimum*	*Maximum*	*Unit*
DC supply for CBUCK switching regulator	SR_VDDBAT5V	–0.5	5.5	V
DC supply voltage for the WL PA/PA driver	WRF_PA_VDD3P3, WRF_PAD_VDD3P3	–0.5	3.8	V
DC supply voltage for I/O	VDDIO	–0.5	3.8	V
DC supply voltage for the BCM43143 core	VDDC	–0.5	1.32	V
DC supply voltage for BCM43143 RF blocks	WRF_SYN_VDD1P2, XTAL_VDD1P2	–0.5	1.32	V
DC input supply voltage for CLDO and LNLDO	LDO_VDD1P5, LNLDO_VDD1P5	–0.5	2.1	V
Maximum junction temperature	T_{J_MAX}	–	125	°C
Operating humidity	–	–	85	%
Ambient operating temperature	–	–	65[a]	°C
Storage temperature	T_{STG}	–40	125	°C
Storage humidity	–	–	60	%
ESD protection (HBM)	V_{ESD}	–	2000	V

a. On a 1s1P JEDEC board, not exceeding T_{J_MAX}, see Section 14: “Thermal Information,” on page 54.

Recommended Operating Conditions and DC Characteristics

Table 7: Guaranteed Operating Conditions and DC Characteristics

		Value			
Element	***Parameter***	***Minimum***	***Typical***	***Maximum***	***Unit***
DC supply for CBUCK switching regulator	SR_VDDBAT5V	2.3	3.6	5.25	V
DC supply voltage for WL PA/PA driver	WRF_PA_VDD3P3, WRF_PAD_VDD3P3	2.97	3.3	3.63	V
DC supply voltage for core	VDDC	1.14	1.2	1.26	V
DC supply voltage for RF blocks in chip	VDDRF	1.14	1.2	1.26	V
SDIO Interface I/O Pins[a]					
Input high voltage	VIH	0.625 × VDDIO	–	–	V
Input low voltage	VIL	–	–	0.25 × VDDIO	V
Output high voltage @ 2 mA	VOH	0.75 × VDDIO	–	–	V
Output low voltage @ 2 mA	VOL	–	–	0.125 × VDDIO	V
Other Digital I/O Pins					
Input low voltage	VIL	–	–	0.8	V
Input high voltage	VIH	2.0	–	–	V
Output low voltage @ 2 mA	VOL	–	–	0.4	V
Output high voltage @ 2 mA	VOH	VDDIO – 0.4V	–	–	V
RF Switch Control I/O Pins					
Input low voltage	VIL	–	–	0.8	V
Input high voltage	VIH	2.0	–	–	V
Output low voltage @ 2 mA	VOL	–	–	0.4	V
Output high voltage @ 2 mA	VOH	VDDIO – 0.4V	–	–	V
Input capacitance	Cin	–	–	5	pf

a. VDDIO voltage tolerance is ±10%; for SDIO 1.8V levels (VDDIO at pin 46 = 1.8V ±10%), the maximum SDIO clock frequency should be limited to 25 MHz in high-speed mode only.

WLAN Current Consumption

The WLAN current consumption measurements are shown in Table 8 through Table 9 on page 34.

Table 8: WLAN Current Consumption in SDIO Mode using SR_VDDBAT5V[a]

	VDDIO	SR_VDDBAT5V	WRF_PA_VDD3P3	WRF_PAD_VDD3P3	USB_AVDD3P3	I_Total	P_Total
Host Interface SDIO	**mA**						**mW**
OFF (Low power off mode: VDDIO switched off)	0	0.07	0	0	0	0.07	0.2
Sleep[b]	1	2	0	1	1	< 5	< 17
Power save[c]	1	3	0	1	1	< 6	< 20
RX (Listen), 2.4 GHz HT 20[d]	1	40	0	1	0	42	139
RX (Active), 2.4 GHz HT 20[e,f]	2	65	0	1	0	68	224
TX CCK (20 dBm @ Chip port, 2.4 GHz HT 20)[g]	1	56	329	30	0	416	1373
TX OFDM, 54 Mbps (–20 dBm @ Chip port, 2.4 GHz HT 20)[g]	2	58	295	30	0	385	1265
TX MCS7 (18 dBm @ Chip port, 2.4 GHz HT20)[g]	2	72	249	24	0	347	1145
TX MCS7 (18 dBm @ Chip port, 2.4 GHz HT40)[g]	2	78	272	25	0	377	1244

a. Typical numbers, measured at 3.3V, 25°C.
b. Inter-beacon sleep.
c. Beacon interval = 102.4 ms, DTIM = 3, Beacon duration = 1 ms @ 1 Mbps. Integrated sleep + wake up + Beacon RX current over 3 DTIM intervals.
d. Carrier sense (CCA) when no carrier present.
e. Carrier sense (CS) detect/packet RX.
f. Applicable to all supported rates.
g. Duty cycle is 100%.

Table 9: WLAN Current Consumption in USB mode using VDD33[a]

	VDDIO	SR_VDDBAT5V	WRF_PA_VDD3P3	WRF_PAD_VDD3P3	USB_AVDD3P3	I_Total	P_Total
Host Interface USB	**mA**						**mW**
OFF (Low power off mode: VDDIO switched off)	0	0.07	0	0	0	0.07	0.2
Sleep[b]	0.4	2	0	1	5.6	< 9	< 30
Power save[c]	0.4	3	0	1	5.6	< 10	< 33
RX (Listen), 2.4 GHz HT 20[d]	0.4	45	0	1	22	68	226
RX (Active), 2.4 GHz HT 20[e,f]	0.4	70	0	1	23	94	312
TX CCK (20 dBm @ Chip port, 2.4 GHz HT 20)[g]	0.5	55	320	30	21	427	1407
TX OFDM, 54 Mbps (–20 dBm @ Chip port, 2.4 GHz HT 20)[g]	0.4	59	265	30	21	376	1239
TX MCS7 (18 dBm @ Chip port, 2.4 GHz HT20)[g]	0.6	74	248	24	21	368	1213
TX MCS7 (18 dBm @ Chip port, 2.4 GHz HT40)[g]	1.6	80	272	25	21	400	1319

a. Typical numbers, measured at 3.3V, 25°C.
b. Inter-beacon sleep.
c. Beacon interval = 102.4 ms, DTIM = 3, Beacon duration = 1 ms @ 1 Mbps. Integrated sleep + wake up + Beacon RX current over 3 DTIM intervals.
d. Carrier sense (CCA) when no carrier present.
e. Carrier sense (CS) detect/packet RX.
f. Applicable to all supported rates.
g. Duty cycle is 100%.

Section 10: Regulator Electrical Specifications

Note: Values in this data sheet are design goals and are subject to change based on the results of device characterization.

Functional operation is not guaranteed outside of the specification limits provided in this section.

Core Buck Switching Regulator

Table 10: Core Buck Switching Regulator (CBUCK) Specifications

Specification	Notes	Min	Typ	Max	Units
Input supply voltage (DC)	DC voltage range inclusive of disturbances.	2.3	3.6	5.25	V
Input supply voltage (spikes)	Up to 10 seconds cumulative duration over 7 years lifetime. 10 ms maximum pulse width.	–	–	5.5	V
PWM mode switching frequency	CCM: Load > 100 mA SR_VDDBAT5V = 3.6V	2	4	6	MHz
PWM output current	–	–	–	500[a]	mA
Output current limit	–	–	1390	–	mA
Output voltage range	Programmable, 30 mV steps Default = 1.35V	1.2	1.35	1.5	V
PWM output voltage DC accuracy	Includes load and line regulation. Forced PWM mode	–4	–	4	%
PWM ripple voltage, static	Measure with 20 MHz bandwidth limit.	–	7	20	mVpp
PWM mode peak efficiency	Peak Efficiency at 200 mA load	78	84	–	%
PFM mode efficiency	5 mA load current	–	65	–	%
Low Power Operating mode (LPOM) efficiency	5 mA load current	–	80	–	%
Start-up time from power down	VDDIO already ON and steady. Time from REG_ON rising edge to CLDO reaching 1.2V	–	–	850	µs
External inductor	0603 size, ±30%, 0.26 ±25% ohms	1.2	2.2	3.3	µH
External output capacitor	Ceramic, X5R, 0402, ESR <30mΩ at 4 MHz, ±20%, 6.3V	2.53[b]	4.7	10	µF

Table 10: Core Buck Switching Regulator (CBUCK) Specifications (Cont.)

Specification	*Notes*	*Min*	*Typ*	*Max*	*Units*
External input capacitor	For SR_VDDBATP5V pin, Ceramic, X5R, 0603, ESR < 30 mΩ at 4 MHz, ± 20%, 6.3V, 4.7 µF	0.76[b]	4.7	–	µF
Operating junction temperature	–	–40	50	125	°C
Input supply voltage ramp-up time	0 to 4.3V	40	–	–	µs

a. 500 mA TT junction temp 110°C. Derate to 372 mA for T_j > 125°C.
b. Minimum capacitor value refers to the residual capacitor value after taking into account the part-to-part tolerance, DC-bias, temperature, and aging.

CLDO

Table 11: CLDO Specifications

Specification	Notes	Min	Typ	Max	Units
Input supply voltage (V_{in})	Min = 1.2 + 0.1V = 1.3V Dropout voltage requirement must be met under maximum load.	1.2	1.35	1.5	V
Output current[a]	–	–	–	150	mA
Output voltage (V_o)	Programmable in 25 mV steps. Default = 1.2V	1.1	1.2	1.275	V
Dropout voltage	At max load	–	–	100	mV
Output voltage DC accuracy	Includes line/load regulation	–4	–	+4	%
Quiescent current	No load	–	10	–	µA
Line regulation	V_{in} from (V_o + 0.1V) to 1.5V, maximum load	–	–	+1.1	$\%V_o/V$
Load regulation	Load from 1 mA to 150 mA	–	–	0.02	$\%V_o/mA$
Leakage current[b]	Power-down	–	–	10	µA
Power supply rejection ratio (PSRR)	@1 kHz Vin ≥ 1.35V C_o = 2.2 µF	20	–	–	dB
PMU start-up time	SR_VDDBAT5V up and stable. Time from the VDDIO rising edge to the CLDO reaching 1.2V.	–	–	850	µs
LDO turn-on time	LDO turn-on time when rest of the chip is up	–	–	180	µs
In-rush current during turn-on	Measured when the output capacitor is fully discharged.	–	–	150	mA
External output capacitor, C_o	Total ESR: 30–200 mΩ	1.67[c]	1	–	µF
External input capacitor	Only use an external input capacitor at the VDD_LDO pin if it is not supplied from CBUCK output. Total ESR (trace/capacitor): 30 mΩ–200 mΩ	–	1	2.2	µF
Operating temperature	Junction temperature	–40	50	125	°C

a. Output current is measured at 125°C junction temperature.
b. Leakage current is measured by 85°C junction temperature.
c. Minimum capacitor value refers to the residual capacitor value after taking into account the part-to-part tolerance, DC-bias, temperature, and aging.

LNLDO

Table 12: LNLDO Specifications

Specification	*Notes*	*Min*	*Typ*	*Max*	*Units*
Input supply voltage (V_{in})	Min = $1.2V_o$ + 0.1V = 1.3V Dropout voltage requirement must be met under maximum load.	1.3	1.35	1.5	V
Output Current	–	–	–	100	mA
Output voltage (V_o)	Programmable in 25 mV steps. Default = 1.2V	1.1	1.2	1.275	V
Dropout Voltage	At maximum load	–	–	100	mV
Output voltage DC accuracy	includes line/load regulation	–4	–	+4	%
Quiescent current	No load	–	44	–	µA
Line regulation	V_{in} from (V_o + 0.1V) to 1.5V, maximum load	–0.3	–	+0.3	$\%V_o/V$
Load regulation	Load from 1 mA to 300 mA	–	0.02	0.05	$\%V_o$/mA
Transient undershoot	–	–	–	TBD	mV
Transient overshoot	–	–	–	TBD	mV
Leakage current	Power-down	–	–	10	µA
Output noise	@30 kHz, 60 mA load C_o = 1 µF @100 kHz, 60 mA load C_o = 1 µF	–	–	60 30	nV/rt Hz nV/rt Hz
PSRR	@ 1kHz, Input > 1.3V, C_o= 1 µF, V_o = 1.2V	20	–	–	dB
PMU start-up time	From power-down	–	–	850	µs
LDO Turn-on Time	LDO turn-on time when rest of chip is up	–	–	180	µs
In-rush current during turn-on	Measured when the output capacitor is fully discharged.	–	–	150	mA
External output capacitor (C_o)	Total ESR (trace/capacitor): 30 mΩ–200 mΩ	0.74[a]	1	2.2	µF
External input capacitor	Only use an external input capacitor at the VDD_LDO pin if it is not supplied from CBUCK output. Total ESR (trace/capacitor): 30 mΩ–200 mΩ	–	1	2.2	µF
Operating temperature	Junction temperature	–40	50	125	°C

a. Minimum capacitor value refers to the residual capacitor value after taking into account the part-to-part tolerance, DC-bias, temperature, and aging.

Section 11: WLAN Specifications

Note: Values in this data sheet are design goals and are subject to change based on the results of device characterization.

2.4 GHz Band General RF Specifications

Table 13: 2.4 GHz Band General RF Specifications

Item	Condition	Minimum	Typical	Maximum	Unit
TX/RX switch time	Including TX ramp down	–	5	10	µs
RX/TX switch time	Including TX ramp up	–	5	5	µs

2.4 GHz Band Receiver RF Specifications

The receiver specifications including sensitivity are shown in Table 14 and Table 15 on page 40.

Table 14: 2.4 GHz Band Receiver RF Specifications

Characteristic	Condition	Minimum	Typical	Maximum	Unit
Cascaded noise figure	–	–	4	–	dB
Maximum receive level[a]	@ 1, 2 Mbps	–4	–	–	dBm
	@ 5.5, 11 Mbps	–10	–	–	dBm
	@ 54 Mbps	–10	–	–	dBm
Adjacent channel power rejection • DSSS at 11 Mbps[b]	RX = –70 dBm	35	–	–	dB
Return loss	Zo = 50Ω, across dynamic range	TBD	TBD	TBD	dB
Maximum receiver gain	–	–	>90	–	dB

a. When using a suitable external RF switch.
b. Difference between interfering and desired signal (>25 MHz apart) at 8% PER for 1024-octet Physical-Layer Service Data Units (PSDUs) with desired signal level as specified.

Table 15: 2.4 GHz Receiver Sensitivity

Rate/Modulation	*Typical Receive Sensitivity[a] [b](dBm)*
1 Mbps DSSS	–97
2 Mbps DSSS	–95
5.5 Mbps CCK	–91
11 Mbps CCK	–89
6 Mbps OFDM	–91
9 Mbps OFDM	–90
12 Mbps OFDM	–88
18 Mbps OFDM	–86
24 Mbps OFDM	–84
36 Mbps OFDM	–81
48 Mbps OFDM	–78
54 Mbps OFDM	–76
MCS0 (20 MHz channel)	–91
MCS1 (20 MHz channel)	–88
MCS2 (20 MHz channel)	–86
MCS3 (20 MHz channel)	–83
MCS4 (20 MHz channel)	–81
MCS5 (20 MHz channel)	–77
MCS6 (20 MHz channel)	–75
MCS7 (20 MHz channel)	–73
MCS0 (40 MHz channel)	–90
MCS1 (40 MHz channel)	–86
MCS2 (40 MHz channel)	–84
MCS3 (40 MHz channel)	–82
MCS4 (40 MHz channel)	–78
MCS5 (40 MHz channel)	–74
MCS6 (40 MHz channel)	–72
MCS7 (40 MHz channel)	–70

a. Values are measured at the input of the BCM43143. Thus, they include insertion losses from the integrated baluns and integrated T/R switches, but exclude losses from the external circuits. For the 1, 2, 5.5, and 11 Mbps rates, sensitivity is defined as an 8% packet error rate (PER) for 1000-octet PSDUs. For 11g rates (6 Mbps OFDM up to 54 MBps OFDM), sensitivity is defined as a 10% packet error rate (PER) for 1000-octet PSDUs. For 11n rates (MCS0 to MCS7), sensitivity numbers are provide for 10% PER and 4000byte packets.
b. Sensitivity levels at Vcc=3.3V±6%; at Vcc=3.3 ±10%, sensitivity levels may be degraded.

2.4 GHz Band Transmitter RF Specifications

Table 16: 2.4 GHz Band Transmitter RF Specifications

Characteristic	*Condition*		*Min.*	*Typ.*	*Max.*	*Unit*
RF output frequency range	–		2400	–	2500	MHz
Chip output power[a] (EVM and ACPR compliant, Vcc=3.3V ±6%[b])	20 MHz channel	DSSS/CCK rates 1, 2, 5.5, and 11 Mbit/s	–	–	21.0	dBm
		802.11g rates 6, 9, 12, 18, 24, and 36 Mpps	–	–	20.0	
		802.11g rate 48 Mbps	–	–	19.0	
		802.11g rate 56 Mbps	–	–	18.0	
		OFDM rates MCS0-MCS5	–	–	20.0	
		OFDM rate MCS6	–	–	19.0	
		OFDM rate MCS7	–	–	18.0	
	40 MHz channel	OFDM rates MCS0- MCS4	–	–	19.5	
		OFDM rate MCS5	–	–	19.0	
		OFDM rate MCS6	–	–	18.0	
		OFDM rate MCS7	–	–	17.0	
Gain flatness	Maximum gain		–	–	2	dB
Output IP3	Maximum gain		–	37	–	dBm
Output P1dB	–		–	27	–	dBm
Carrier suppression	–		15	–	–	dBr
CCK TX spectrum mask @ maximum gain	fc –22 MHz < f < fc –11 MHz		–	–	–30	dBr
	fc +11 MHz < f< fc +22 MHz		–	–	–30	dBr
	f < fc –22 MHz; and f > fc +22 MHz		–	–	–50	dBr
OFDM TX spectrum mask (chip output power = 16 dBm)	f < fc –11 MHz and f > fc +11 MHz		–	–	–26	dBc
	f < fc –20 MHz and f > fc +20 MHz		–	–	–35	dBr
	f < fc –30 MHz and f > fc +30 MHz		–	–	–40	dBr
TX modulation accuracy (i.e. EVM) at maximum gain	IEEE 802.11b mode		–	–	35%	–
	IEEE 802.11g mode QAM64 54 Mbps		–	–	5%	–
Gain control step size	–		–	0.25	–	dB/ step
Amplitude balance[c]	DC input		–1	–	1	dB
Phase balance	DC input		–1.5	–	1.5	°
Baseband differential input voltage	Shaped pulse		–	0.6	–	Vpp
TX power ramp up	90% of final power		–	–	2	µsec
TX power ramp down	10% of final power		–	–	2	µsec

a. Power control will back off output power by 1.5 dB ensuring EVM and ACPR limits are always met.
b. Linear output power at 3.3V ±10% supply voltage may be degraded and EVM/ACPR compliant output power may be lower than listed.
c. At a 3 MHz offset from the carrier frequency.

2.4 GHz Band Local Oscillator Specifications

Table 17: 2.4 GHz Band Local Oscillator Specifications

Characteristic	*Condition*	*Minimum*	*Typical*	*Maximum*	*Unit*
VCO frequency range	–	2412	–	2484	MHz
Reference input frequency range	–	–	Various[a]	–	MHz
Reference spurs	–	–	–	–34	dBc
Local oscillator phase noise, single-sided from 1–300 kHz offset	–	–	–	–86.5	dBc/Hz
Clock frequency tolerance	–	–	–	±20	ppm

a. Reference supported frequencies range from 12 MHz to 52 MHz.

Section 12: Antenna Specifications

Voltage Standing Wave Ratio

The Voltage Standing Wave Ratio (VSWR) into the antenna should be less than 2.5:1.

Section 13: Timing Characteristics

Power Sequence Timing

The recommended power-up sequence is to bring up the power supplies in the order of the rated voltage. This power-up sequence minimizes the possibility of a latchup condition.

In the case of a 3.3V supply (see Figure 10), the 3.3V supplied to SR_VDDBAT5V, WRF_PA_VDD3P3, WRF_PAD_VDD3P3, USB_AVDD3P3, and VDDIO can ramp at the same time.

In the case of a 5V supply (see Figure 11 on page 45), the 5V first ramps on SR_VDDBAT5V, followed by bring-up of the 3.3V supply to WRF_PA_VDD3P3, WRF_PAD_VDD3P3, USB_AVDD3P3, and VDDIO. The power-up timing parameters for both configurations are shown in Table 18 on page 45.

Figure 10: Power-Up Sequence Timing—3V Supply

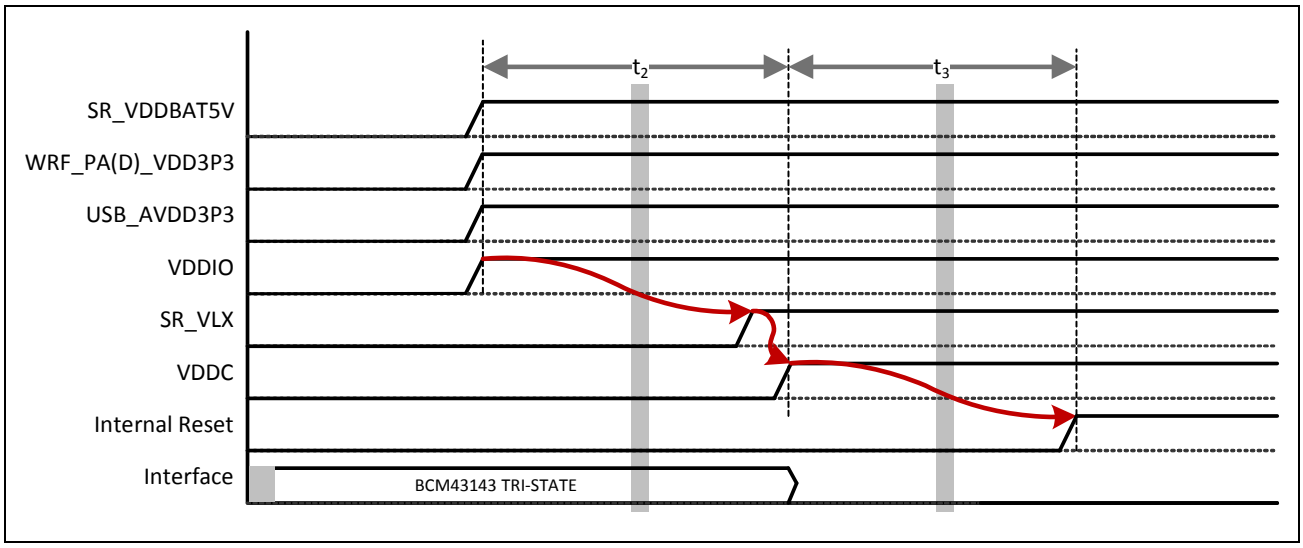


Figure 11: Power-Up Sequence Timing—5V Supply with External DC-DC Conversion

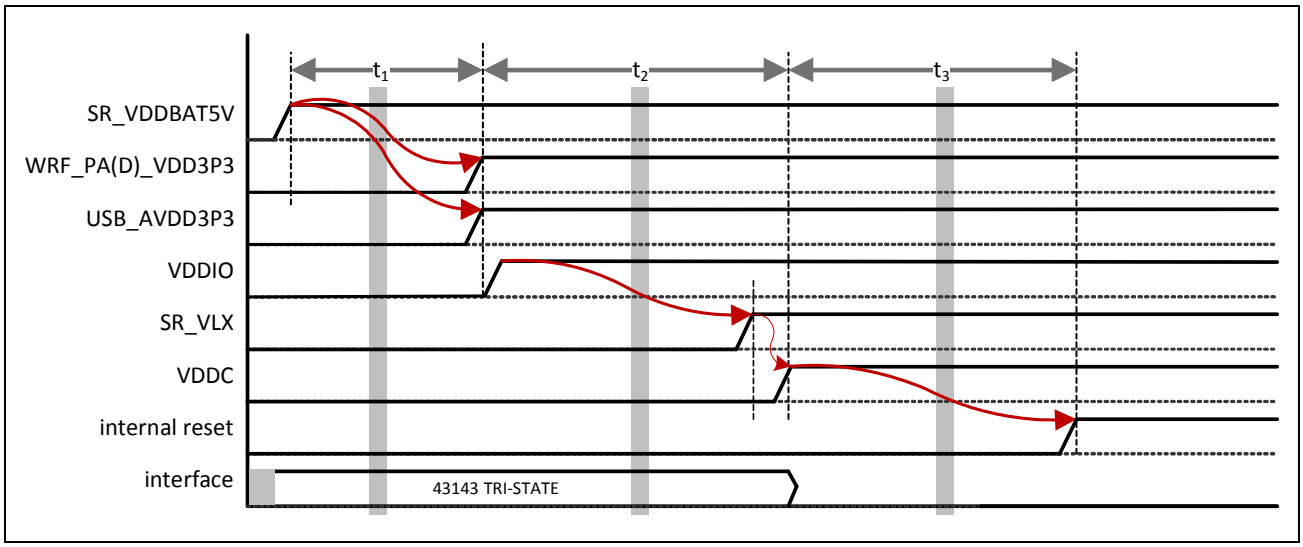


Table 18: Power-Up Timing Parameters

Symbol	Description	Minimum	Typical	Maximum	Unit
t_1	SR_VDDBAT5V to 3P3 active	0[a]	50[b]	–	µs
t_2	Time from VDDIO rising edge to VDDC reaching 1.2V	–	–	850	µs
t_3	Time from VDDC reaching 1.2V to internal reset deactivation	30	35	50	ms

a. In the case of the 3.3V power supply, t1 = 0 for SR_VDDBAT5V, WRF_PA_VDD3P3, and WRF_PAD_VDD3P3.
b. In the case of the 5V power supply, SR_VDD_BAT5V is directly connected to 5V, but the connection to WRF_PA_VDD3P3, WRF_PAD_VDD3P3, and VDDIO must be made through a DC-DC converter chip to convert 5V to 3V3. Since the converter chip introduces a delay in the ramp-up time, t1 = 50 µs (nominal). The actual value of t1 will vary slightly based on the particular DC-DC converter chip used in the design.

Serial Flash Timing

Figure 12: Serial Flash Timing Diagram (STMicroelectronics-Compatible)

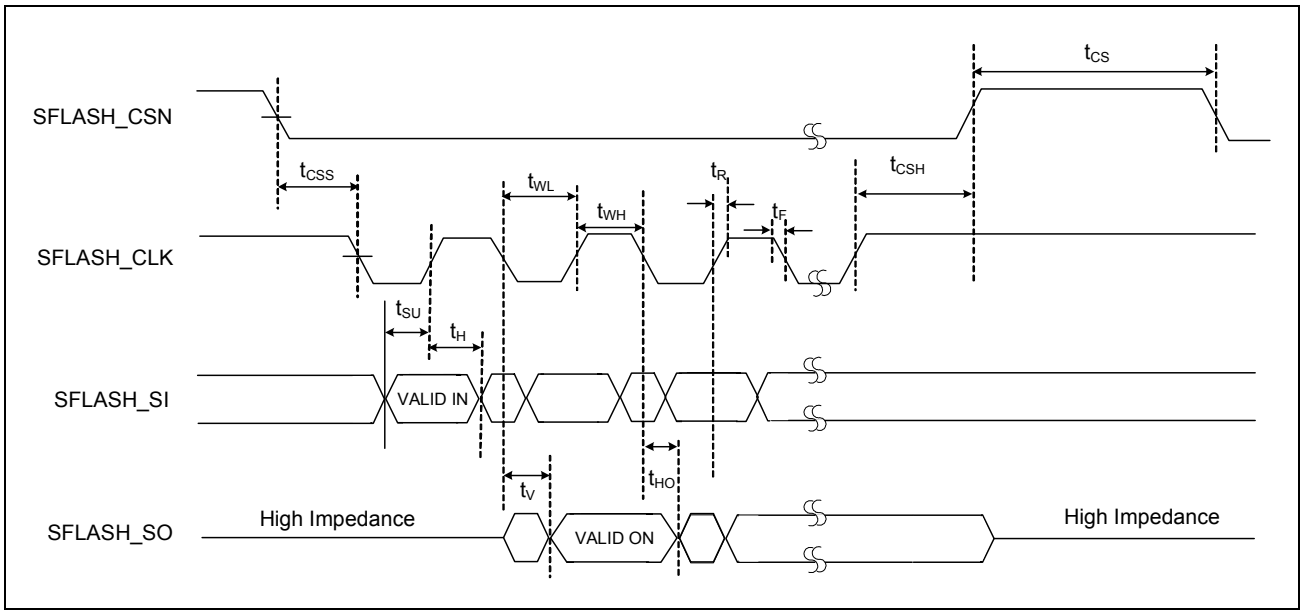


Table 19: Serial Flash Timing

Parameter	*Descriptions*	*Minimum*	*Typical*	*Maximum*	*Units*
f_{SCK}	Serial flash clock frequency	–	12.5	49.2	MHz
t_{WH}	Serial flash clock high time	9	–	–	ns
t_{WL}	Serial flash clock low time	9	–	–	ns
t_R, t_F[a]	Clock rise and fall times[b]	TBD	–	–	V/ns
t_{CSS}	Chip select active setup time	5	–	–	ns
t_{CS}	Chip select deselect time	100	–	–	ns
t_{CSH}	Chip select hold time	5	–	–	ns
t_{SU}	Data input setup time	2	–	–	ns
t_H	Data input hold time	5	–	–	ns
t_{HO}	Data output hold time	0	–	–	ns
t_V	Clock low to output valid	–	–	8	ns

a. t_R and t_F are expressed as a slew-rate.
b. Peak-to-peak

I2S Slave Mode Tx Timing

In I2S slave mode, the serial clock (I2S_BITCLK) input speed can vary up to a maximum of 12.288 MHz.

I2S Slave mode timing is illustrated in Figure 13.

Figure 13: I2S Slave Mode Timing

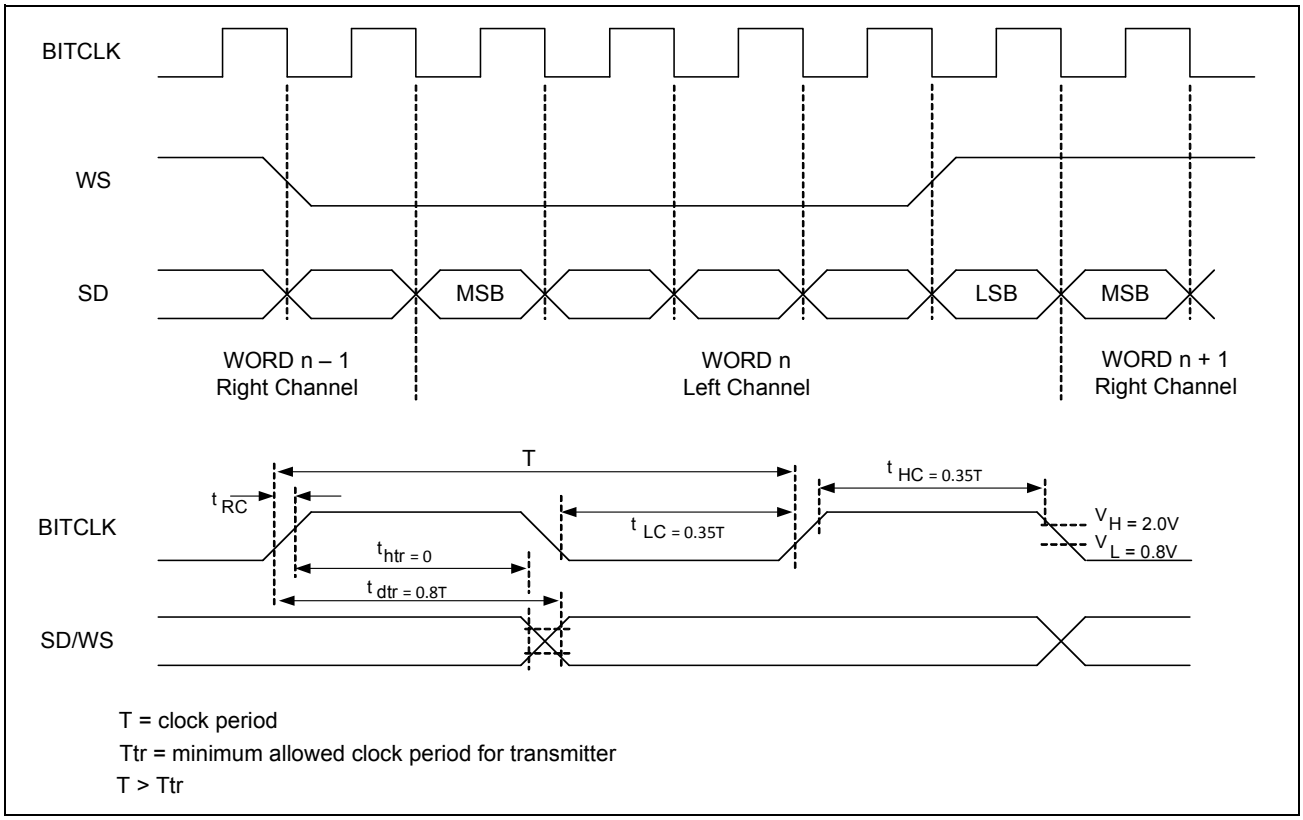


Table 20: Timing for I2S Transmitters and Receivers

	Transmitter				Receiver	
	Lower Limit		Upper Limit		Lower Limit	
Parameter	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
Clock period T	T_{tr}				T_{tr}	
Slave Mode:						
Clock accepted by transmitter or receiver:						
HIGH t_{HC}		0.35 T_r				0.35 T_r
LOW t_{LC}		0.35 T_r				0.35 T_r
rise time t_{RC}			0.15 T_{tr}			

Table 20: Timing for I2S Transmitters and Receivers

	Transmitter				Receiver	
	Lower Limit		Upper Limit		Lower Limit	
Parameter	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
Transmitter:						
delay t_{dtr}				0.8 T		
hold time t_{htr}	0					
Receiver:						
setup time t_{sr}						0.2 T_r
hold time t_{hr}						0

SDIO Default Mode Timing

SDIO default mode timing is shown by the combination of Figure 14 and Table 21.

Figure 14: SDIO Bus Timing (Default Mode)

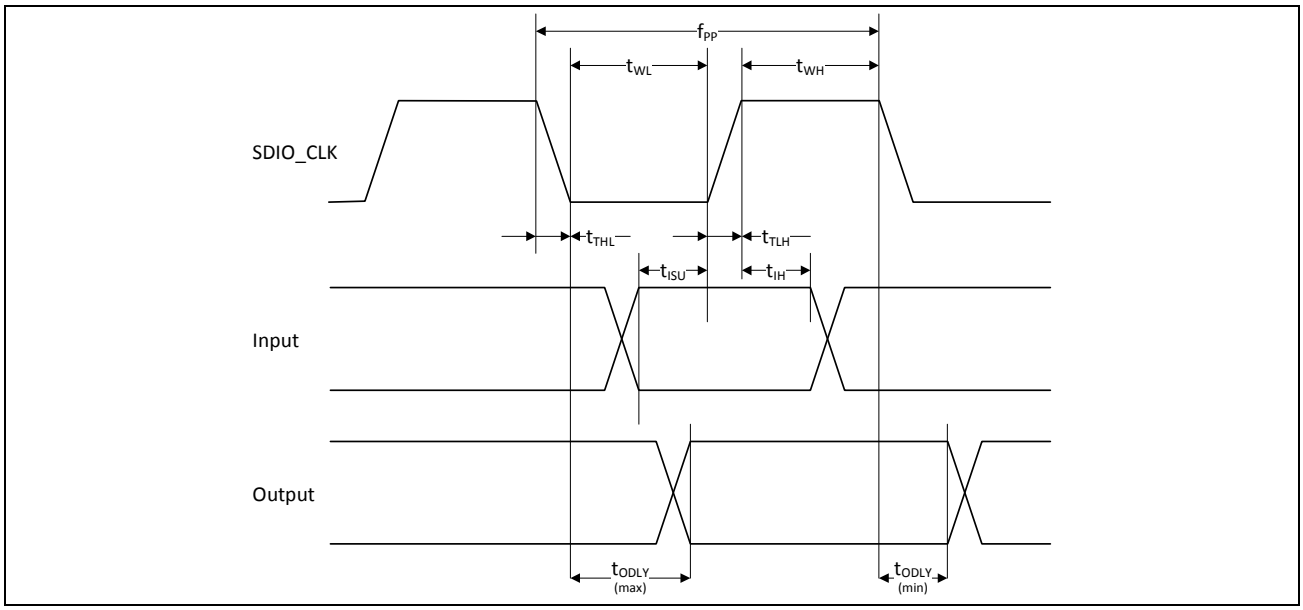


Table 21: SDIO Bus Timing[a] Parameters (Default Mode)

Parameter	Symbol	Minimum	Typical	Maximum	Unit
SDIO CLK (All values are referred to minimum VIH and maximum VIL[b])					
Frequency – data transfer mode	fPP	0	–	25	MHz
Frequency – identification mode	fOD	0	–	400	kHz
Clock low time	tWL	10	–	–	ns
Clock high time	tWH	10	–	–	ns
Clock rise time	tTLH	–	–	10	ns
Clock low time	tTHL	–	–	10	ns
Inputs: CMD, DAT (referenced to CLK)					
Input setup time	tISU	5	–	–	ns
Input hold time	tIH	5	–	–	ns
Outputs: CMD, DAT (referenced to CLK)					
Output delay time – data transfer mode	tODLY	0	–	14	ns
Output delay time – identification mode	tODLY	0	–	50	ns

a. Timing is based on CL ≤40 pF load on CMD and data.
b. min(Vih) = 0.7 × VDDIO_SD and max(Vil) = 0.2 × VDDIO_SD.

SDIO High Speed Mode Timing

SDIO high-speed mode timing is shown by the combination of Figure 15 and Table 22 on page 51.

Figure 15: SDIO Bus Timing (High-Speed Mode)

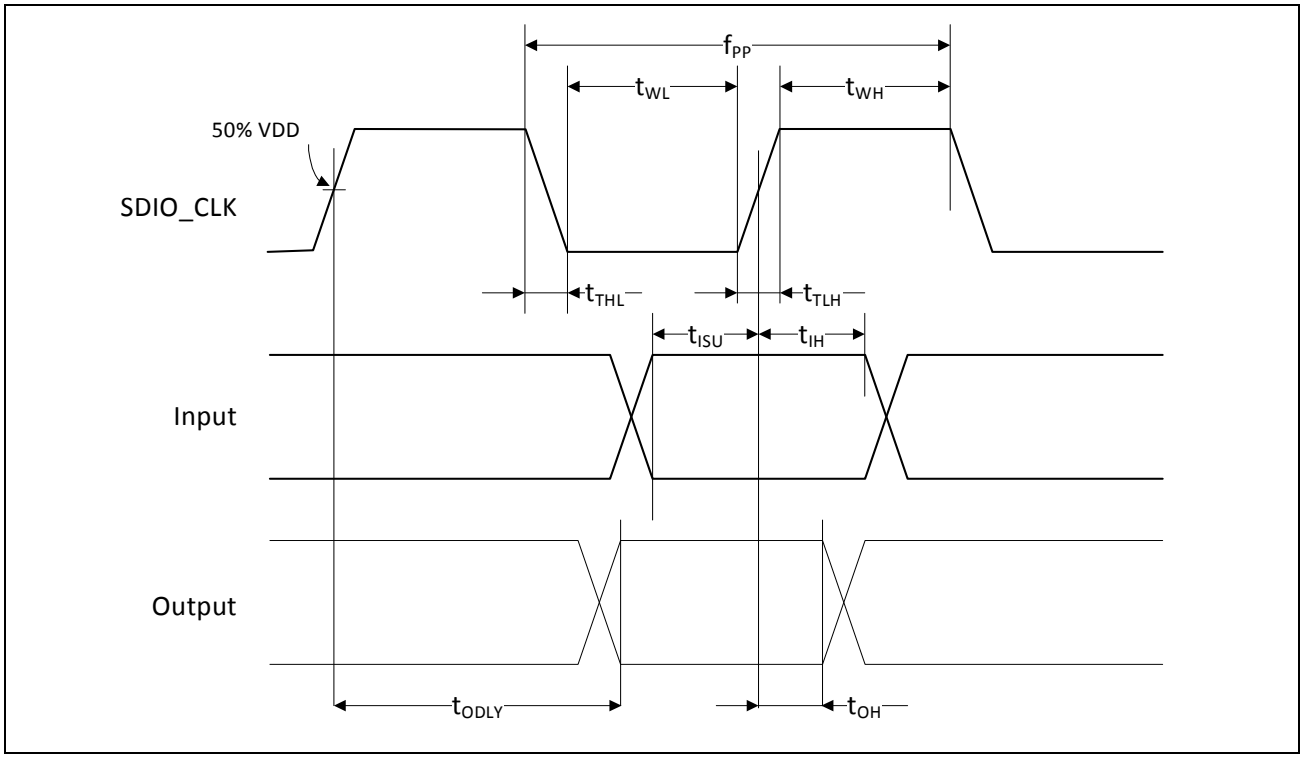


Table 22: SDIO Bus Timing[a] Parameters (High-Speed Mode)

Parameter	Symbol	Minimum	Typical	Maximum	Unit
SDIO CLK (all values are referred to minimum VIH and maximum VIL[b])					
Frequency – data transfer mode	fPP	0	–	50[c]	MHz
Frequency – identification mode	fOD	0	–	400	kHz
Clock low time	tWL	7	–	–	ns
Clock high time	tWH	7	–	–	ns
Clock rise time	tTLH	–	–	3	ns
Clock low time	tTHL	–	–	3	ns
Inputs: CMD, DAT (referenced to CLK)					
Input setup time	tISU	6	–	–	ns
Input hold time	tIH	2	–	–	ns
Outputs: CMD, DAT (referenced to CLK)					
Output delay time – data transfer mode	tODLY	–	–	14	ns
Output hold time	tOH	2.5	–	–	ns
Total system capacitance (each line)	CL	–	–	40	pF

a. Timing is based on CL ≤40 pF load on CMD and data.
b. min(Vih) = 0.7 × VDDIO_SD and max(Vil) = 0.2 × VDDIO_SD.
c. 0 - 46 MHz when running at 1.8V.

USB Parameters

Table 23: USB Parameters

Parameter	*Symbol*	*Comments*	*Minimum*	*Typical*	*Maximum*	*Unit*
General						
Baud rate	BPS	–	–	2.5	–	Gbaud
Reference frequency	Fref	From crystal oscillator	–	100	–	MHz
Reference clock amplitude	Vref	LVPECL, AC coupled	1	–	–	V
Receiver						
Differential termination	ZRX-DIFF-DC	Differential termination	80	100	120	Ω
DC impedance	ZRX-DC	DC common-mode impedance	40	50	60	Ω
Powered down termination	ZRX-HIGH-IMP-DC	Power-down high impedance (singled ended to ground)	200k	–	–	Ω
Input voltage	VRX-DIFFp-p	AC coupled, differential p-p	175	–	1200	mV
Jitter tolerance	TRX-EYE	Minimum receiver eye width	0.4	–	–	UI
Differential return loss	RLRX-DIFF	Differential return loss	12	–	–	dB
Common-mode return loss	RLRX-CM	Common-mode return loss	11	–	–	dB
Unexpected electrical idle enter detect threshold integration time	TRX-IDEL-DET-DIFF-ENTERTIME	An unexpected electrical idle must be recognized no longer than this time to signal an unexpected idle condition.	–	–	10	ms
Signal detect threshold	VRX-IDLE-DET-DIFFp-p	Electrical idle detect threshold	65	–	175	mV
Transmitter						
Output voltage	VTX-DIFFp-p	Differential p-p, programmable in 16 steps	0	–	1200	mV
Output voltage rise time	VTX-RISE	20% to 80%	0.125	–	–	UI
Output voltage fall time	VTX-FALL	80% to 20%	0.125	–	–	UI
De-emphasis (a1)	VTX-DE-RATIO	Programmable in 16 steps	0	–	40	%
RX detection voltage swing	VTX-RCV-DETECT	The amount of voltage change allowed during receiver detection.	–	–	600	mV

Table 23: USB Parameters (Cont.)

Parameter	*Symbol*	*Comments*	*Minimum*	*Typical*	*Maximum*	*Unit*
AC peak common-mode voltage	VTX-CM-Acp	AC peak common-mode ripple	–	–	20	mV
Absolute delta of DC common-mode voltage during L0 and electrical idle	VTX-CM-DC-ACTIVE-IDLE-DELTA	Absolute delta of DC common-mode voltage during L0 and electrical idle.	0	–	100	mV
Absolute delta of DC common-model voltage between D+ and D-	VTX-CM-DC-LINE-DELTA	DC offset between D+ and D–	0	–	25	mV
Electrical idle differential peak output voltage	VTX-IDLE-DIFFp	Peak-to-peak voltage	0	–	20	mV
TX short circuit current	ITX-SHORT	Current limit when TX output is shorted to ground.	–	–	90	mA
Differential termination	ZTX-DIFF-DC	Differential termination	80	100	120	Ω
Differential return loss	RLTX-DIFF	Differential return loss	8	–	–	dB
Common-mode return loss	RLTX-CM	Common-mode return loss	8	–	–	dB
TX eye width	TTX-EYE	Minimum TX eye width	0.7	–	–	UI

Section 14: Thermal Information

Table 24: 56-pin QFN Thermal Characteristics[a]

Air Velocity m/s	*Power W*	T_{J_MAX} *°C*	T_t *°C*	θJA, *°C/W*	Ψ_{JT} *°C/W*
0	1.166	110.3	105.2	37.95	4.37

a. 1s1P JEDEC board, package only, no heat sink, TA = 65°C. P = 1.061W (PA on).

Note:

- Ambient air temperature is 1 mm above the heat shield on top of the chip.
- Ambient air temperature: TA = 65°C, subject to absolute junction maximum temperature at 125°C.
- The BCM43143 is designed and rated for operation at a maximum junction temperature not to exceed 125°C.

Junction Temperature Estimation and PSI_{JT} Versus $Theta_{JC}$

Package thermal characterization parameter Psi-J_T (Ψ_{JT}) yields a better estimation of actual junction temperature (T_J) versus using the junction-to-case thermal resistance parameter Theta-J_C (θ_{JC}). The reason for this is θ_{JC} assumes that all the power is dissipated through the top surface of the package case. In actual applications, some of the power is dissipated through the bottom and sides of the package. Ψ_{JT} takes into account power dissipated through the top, bottom, and sides of the package. The equation for calculating the device junction temperature is as follows:

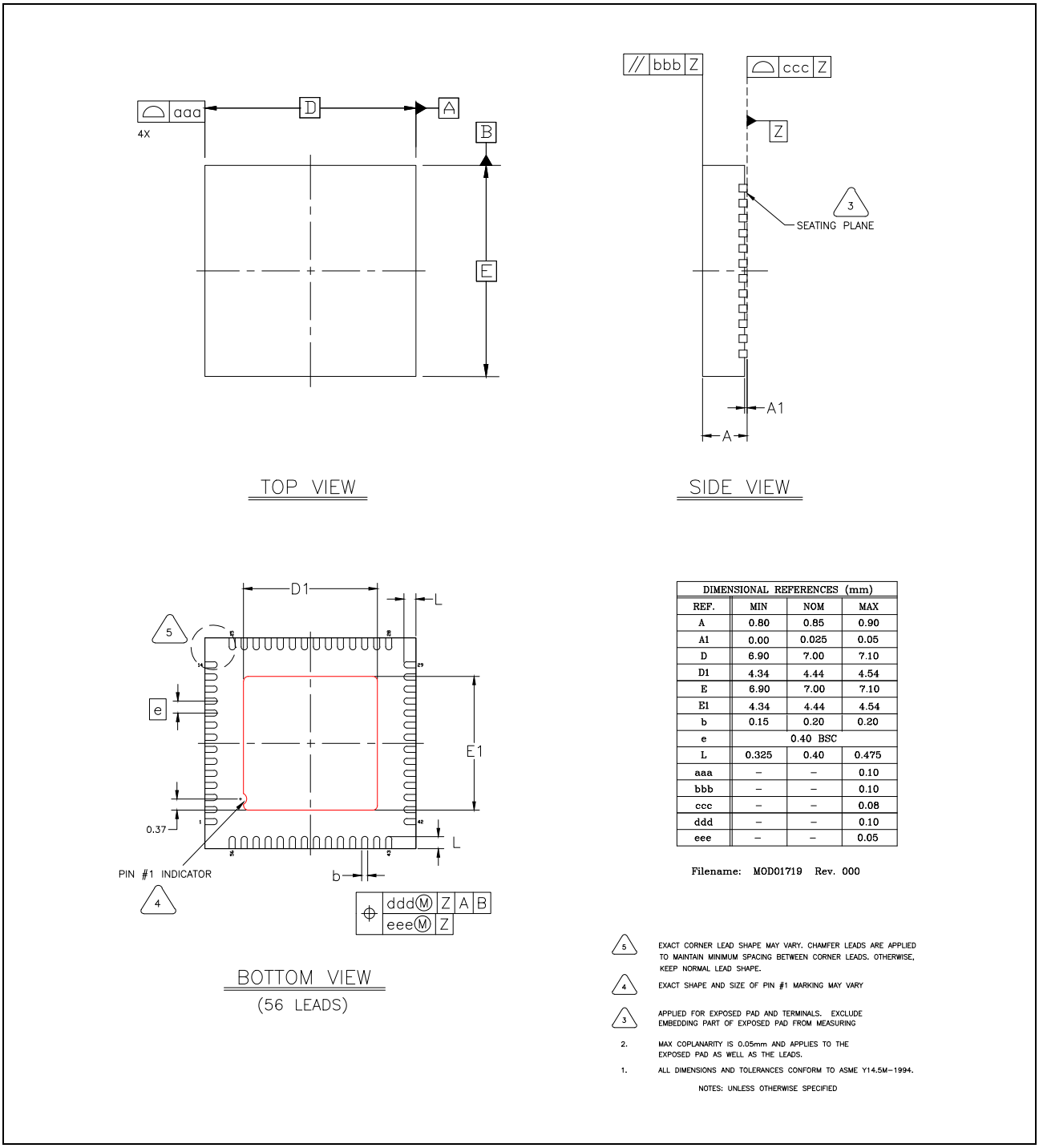
$$T_J = T_T + P \times \Psi_{JT}$$

Where:

- T_J = junction temperature at steady-state condition, °C
- T_T = package case top center temperature at steady-state condition, °C
- P = device power dissipation, Watts
- Ψ_{JT} = package thermal characteristics (no airflow), °C/W

Section 15: Package Information

Figure 16: 7 mm × 7 mm, 56-pin QFN package



DIMENSIONAL REFERENCES (mm)			
REF.	MIN	NOM	MAX
A	0.80	0.85	0.90
A1	0.00	0.025	0.05
D	6.90	7.00	7.10
D1	4.34	4.44	4.54
E	6.90	7.00	7.10
E1	4.34	4.44	4.54
b	0.15	0.20	0.20
e		0.40 BSC	
L	0.325	0.40	0.475
aaa	–	–	0.10
bbb	–	–	0.10
ccc	–	–	0.08
ddd	–	–	0.10
eee	–	–	0.05

Filename: MOD01719 Rev. 000

5 EXACT CORNER LEAD SHAPE MAY VARY. CHAMFER LEADS ARE APPLIED TO MAINTAIN MINIMUM SPACING BETWEEN CORNER LEADS. OTHERWISE, KEEP NORMAL LEAD SHAPE.

4 EXACT SHAPE AND SIZE OF PIN #1 MARKING MAY VARY

3 APPLIED FOR EXPOSED PAD AND TERMINALS. EXCLUDE EMBEDDING PART OF EXPOSED PAD FROM MEASURING

2. MAX COPLANARITY IS 0.05mm AND APPLIES TO THE EXPOSED PAD AS WELL AS THE LEADS.

1. ALL DIMENSIONS AND TOLERANCES CONFORM TO ASME Y14.5M–1994.

NOTES: UNLESS OTHERWISE SPECIFIED

Section 16: Ordering Information

Table 25: Ordering Information

Part Number	*Package*	*Ambient Temperature*
BCM43143KMLG	7 mm × 7 mm, 56-pin QFN (RoHs compliant)	0 to 65°C (32 to 149°F)

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