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PRELIMINARY

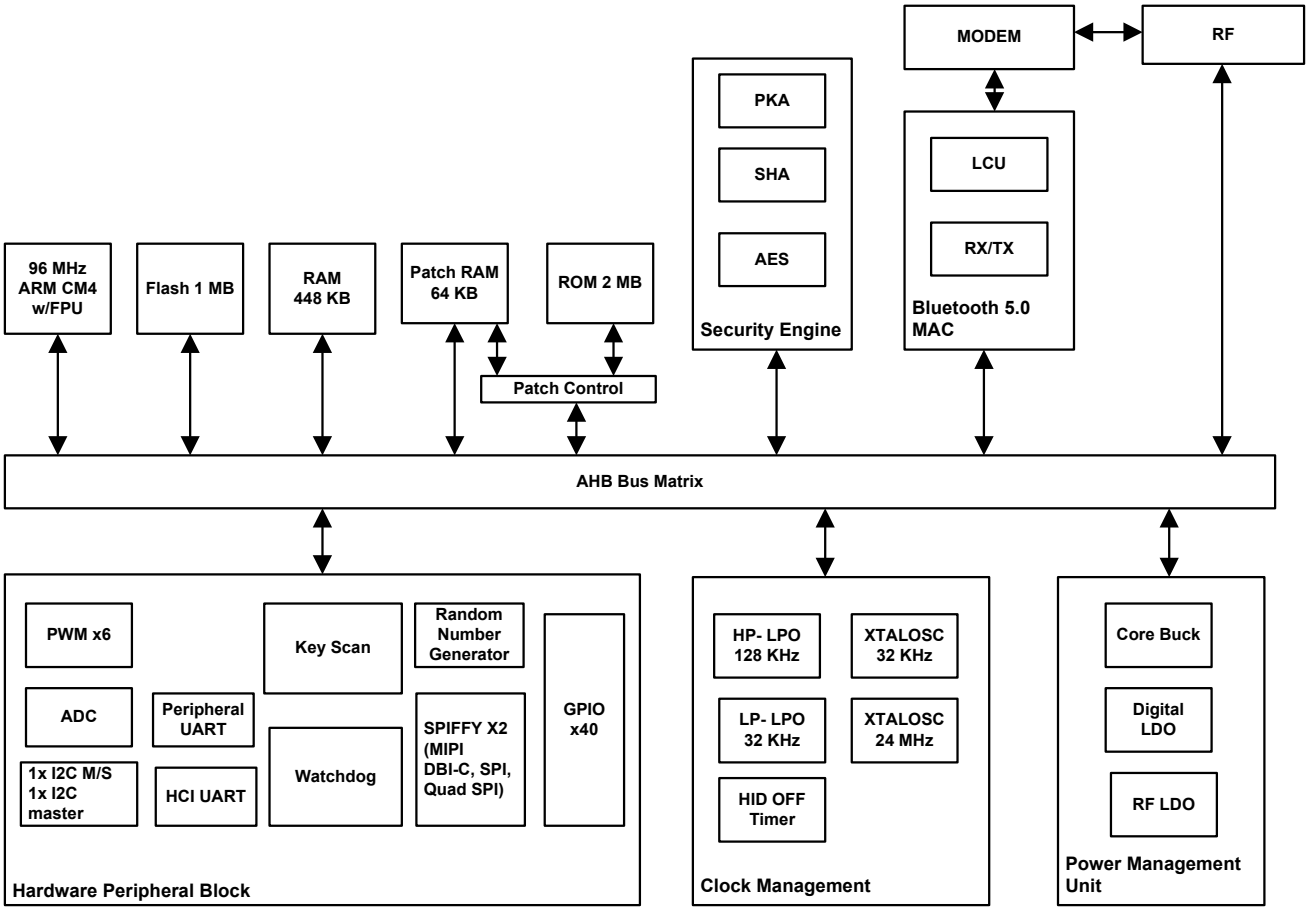
CYW20719

Enhanced Low Power, BR/EDR/BLE Bluetooth 5.0 SOC

The CYW20719 is a BT 5.0 compliant, stand-alone baseband processor with an integrated 2.4 GHz transceiver with BLE, EDR and BR. The device is intended for use in audio, IoT, sensors (medical, home, security, and so forth) and human interface device (HID) applications. Manufactured using an advanced 40nm CMOS low-power fabrication process, the CYW20719 employs high level of integration to reduce external components, thereby minimizing application footprint and costs.

This datasheet provides details of the functional, operational, and electrical characteristics of the CYW20719 device. It is intended for hardware, design, application, and OEM engineers.

Figure 1. Functional Block Diagram



Features

Bluetooth Subsystem

- Complies with Bluetooth Core Specification v5.0 with LE 2 Mbps
- Supports Basic Rate (BR), Enhanced Data Rate (EDR) 2&3 Mbps, Bluetooth Low Energy (BLE)
- Supports Adaptive Frequency Hopping (AFH)
- TX power 4 dBm
- RX sensitivity -95.5 dBm (BLE)
- Ultra-low-power radio
  - RX current 5.9 mA (BLE)
  - TX current 5.6 mA @ 0 dBm (BLE)

Coexistence Support

- Support for Global Coexistence Interface for easy coexistence implementation with select Cypress Wi-Fi devices

MCU Subsystem

- 96-MHz Arm Cortex-M4 microcontroller unit (MCU) with floating point unit (FPU)
- Supports serial wire debug (SWD)
- Runs Bluetooth stack and application
- Option to execute from on-chip flash or RAM

Memory Subsystem

- 1 MB flash
- 512 KB RAM
- 2 MB ROM that stores Bluetooth stack and driver and offloads flash for user applications

Audio features and interfaces

- 1x I^2S with master and slave modes
- 1x PCM
- PDM[2]
- Analog front end for analog microphone[1]

Clocks

- On-chip 32 kHz oscillator (LP-LPO)
- On-chip 128 kHz oscillator (HP-LPO)
- 32 kHz crystal oscillator (Optional if low power modes not required)
- 24 MHz crystal oscillator
- 48-bit real time clock (RTC)

Peripherals and communication

- 6x 16-bit PWMs
- Programmable key-scan matrix interface, up to 8x20 key-scanning matrix [1,2]
- Quadrature decoder[2]
- Watchdog timer (WDT)
- 1x peripheral UART, 1x UART for programming and HCI
- 2x SPI (master/slave mode) Blocks (SPI, Quad SPI, and MIPI DBI-C)
- 1x I2C master/slave and 1x I2C master
- 1x 28-channel ADC (10-ENOB for DC measurement and 12-ENOB for Audio measurement)
- Hardware security engine[2]

General Purpose Input Output (GPIO)

- 16 GPIOs on QFN package
- 40 GPIOs on WLCSP package
- Support up to 3.63 V operation
- Four GPIOs support 16 mA and 8 mA sink at 3.3 V and 1.8 V respectively

Operating voltage and low-power support

- Wide operating voltage range: 1.90 V to 3.63 V
- 5 power modes to implement ultra-low power application – managed by real time operating system
- 0.4 uA current in HID-OFF mode (wake from GPIO).

Packages

- 5 mm x 5 mm 40-pin quad flat no-lead (QFN)
- 3.2 mm x 3.1 mm 134-ball Wafer Level Chip Scale Package (WLCSP)

Software Support

- WICED Studio

Applications

- Wearables and Fitness bands
- Headsets, earbuds, and other audio solutions
- Home automation
- Blood pressure monitors and other medical applications
- Proximity sensors
- Key Fobs
- Thermostats and thermometers
- Toys

1. Available only in WLCSP Package
2. Subjected to driver support in WICED® Studio

Contents

1. Bluetooth Baseband Core

The Bluetooth Baseband Core (BBC) implements all time-critical functions required for high-performance Bluetooth operation. The BBC manages the buffering, segmentation, and routing of data for all connections. It prioritizes and schedules all RX/TX activities including adv, paging, scanning, and servicing of connections. In addition to these functions, it independently handles the host controller interface (HCI) including all commands, events, and data flowing over HCI. The core also handles symbol timing, forward error correction (FEC), header error control (HEC), cyclic redundancy check (CRC), authentication, data encryption/decryption, and data whitening/dewhitening.

Table 1. Bluetooth Features

Bluetooth 1.0	Bluetooth 1.2	Bluetooth 2.0
Basic Rate	Interlaced Scans	EDR 2 Mbps and 3 Mbp
SCO	Adaptive Frequency Hopping	–
Paging and Inquiry	eSCO	–
Page and Inquiry Scan	–	–
Sniff	–	–
Bluetooth 2.1	**Bluetooth 3.0**	**Bluetooth 4.0**
Secure Simple Pairing	Unicast Connectionless Data	Bluetooth Low Energy
Enhanced Inquiry Response	Enhanced Power Control	–
Sniff Subrating	eSCO	–
Bluetooth 4.1	**Bluetooth 4.2**	**Bluetooth 5.0**
Low Duty Cycle Advertising	Data Packet Length Extension	LE 2 Mbps
Dual Mode	LE Secure Connection	Slot Availability Mask
LE Link Layer Topology	Link Layer Privacy	High Duty Cycle Advertising

1.1 BQB and Regulatory Testing Support

The CYW20719 fully supports Bluetooth Test mode as described in Part 1:1 of the Specification of the Bluetooth System v3.0. This includes the transmitter tests, normal and delayed loop back tests, and reduced hopping sequence.

In addition to the standard Bluetooth Test Mode, the CYW20719 also supports enhanced testing features to simplify RF debugging and qualification and type-approval testing. These features include:

- Fixed frequency carrier wave (unmodulated) transmission
  - Simplifies some type-approval measurements (Japan)
  - Aids in transmitter performance analysis
- Fixed frequency constant receiver mode
  - Receiver output directed to I/O pin
  - Allows for direct BER measurements using standard RF test equipment
  - Facilitates spurious emissions testing for receive mode
- Fixed frequency constant transmission
  - 8-bit fixed pattern or PRBS-9
  - Enables modulated signal measurements with standard RF test equipment

2. MCU

The CYW20719 includes a Cortex M4 processor with 2 MB of ROM, 448 KB of data RAM, 64 KB of patch RAM, and 1 MB of on-chip flash. The CM4 has a maximum speed of 96 MHz. CYW20719 supports execution from on-chip flash (OCF).

The CM4 also includes a single precision IEEE 754 compliant floating point unit (FPU).

The CM4 runs all the BT layers as well as application code. The ROM includes LM, HCI, L2CAP, GATT, as well as other stack layers freeing up the flash for application usage. A standard SWD Interface provides debugging support.

3. External Reset

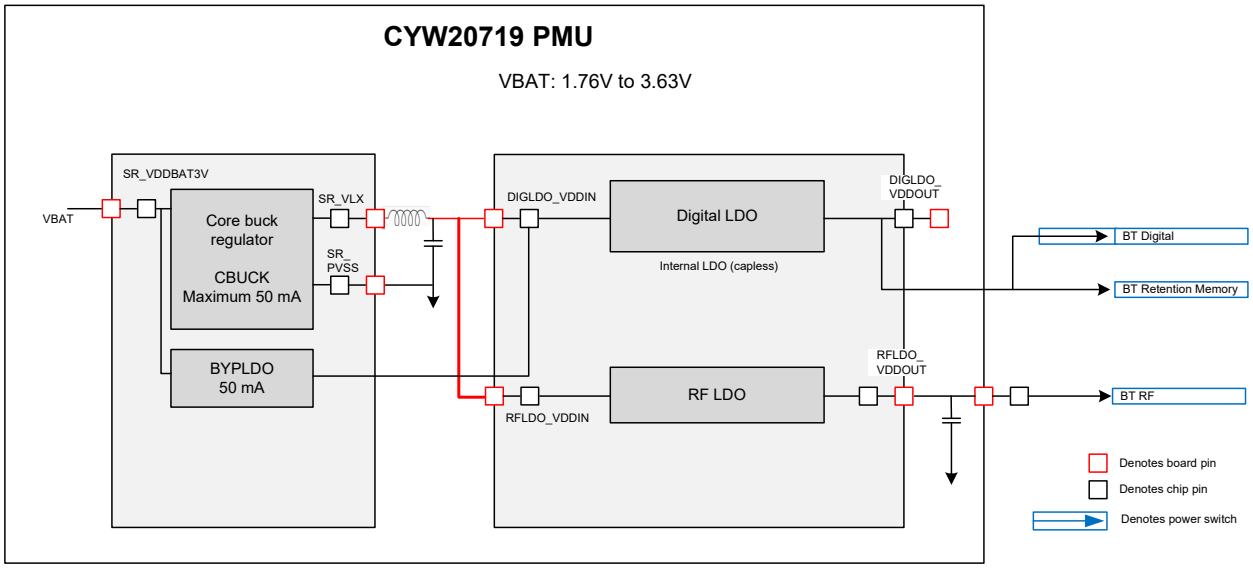
An external active-low reset signal, RESET_N, can be used to put the CYW20719 in the reset state. The RESET_N should be released only after the VDDO supply voltage level has been stabilized for at least 35 ms.

4. Power Management Unit (PMU)

Figure 2 shows the CYW20719 PMU block diagram. The CYW20719 includes an integrated buck regulator, a bypass LDO, a capless LDO for digital circuits and a separate LDO for RF. The bypass LDO automatically takes over from the buck once V_{bat} supply falls below 2.1 V.

The voltage levels shown in this figure are the default settings; the firmware may change voltage levels based on operating conditions.

Figure 2. Default Usage Mode



5. Integrated Radio Transceiver

The CYW20719 has an integrated radio transceiver that has been designed to provide low power operation in the globally available 2.4 GHz unlicensed ISM band. It is fully compliant with the Bluetooth Radio Specification and exceeds the requirements to provide the highest communication link quality of service.

5.1 Transmitter Path

The CYW20719 features a fully integrated transmitter. The baseband transmit data is GFSK modulated in the 2.4 GHz ISM band.

Digital Modulator

The digital modulator performs the data modulation and filtering required for the GFSK signal. The fully digital modulator minimizes any frequency drift or anomalies in the modulation characteristics of the transmitted signal.

Power Amplifier

The CYW20719 has an integrated power amplifier (PA) that can transmit up to +4 dBm for class 2 operation.

5.2 Receiver Path

The receiver path uses a low IF scheme to down-convert the received signal for demodulation in the digital demodulator and bit synchronizer. The receiver path provides a high degree of linearity, and an extended dynamic range to ensure reliable operation in the noisy 2.4 GHz ISM band. The front-end topology, which has built-in out-of-band attenuation, enables the CYW20719 to be used in most applications without off-chip filtering.

Digital Demodulator and Bit Synchronizer

The digital demodulator and bit synchronizer take the low-IF received signal and perform an optimal frequency tracking and bit synchronization algorithm.

Receiver Signal Strength Indicator

The radio portion of the CYW20719 provides a receiver signal strength indicator (RSSI) to the baseband. This enables the controller to take part in a Bluetooth power-controlled link by providing a metric of its own receiver signal strength to determine whether the transmitter should increase or decrease its output power.

5.3 Local Oscillator (LO)

LO provides fast frequency hopping (1600 hops/second) across the 79 maximum available channels for BR/EDR functionality. The CYW20719 uses an internal loop filter.

6. Peripheral and Communication Interfaces

6.1 I²C Compatible Master

The CYW20719 provides a 2-pin I²C compatible Master interface to communicate with I²C compatible peripherals. The I²C compatible master supports the following clock speeds:

- 100 kHz
- 400 kHz
- 800 kHz (Not a standard I²C-compatible speed.)
- 1 MHz (Compatibility with high-speed I²C-compatible devices is not guaranteed.)

SCL and SDA lines can be routed to any of the P0-P39 GPIOs allowing for flexible system configuration. When used as SCL/SDA the GPIOs go into open drain mode and require an external pull-up for proper operation. I²C block does not support multi master capability by either master/slave devices.

I²C1 is Master Only; I²C2 is Master/Slave. The Slave support is subject to driver support in WICED® Studio.

6.2 HCI UART Interface

The CYW20719 includes a UART interface for factory programming as well as when operating as a BT HCI device in a system with an external host. The UART physical interface is a standard, 4-wire interface (RX, TX, RTS, and CTS) with adjustable baud rates from 115200 bps to 1.5 Mbps. Typical rates are 115200, 921600, 1500000 bps although intermediate speeds are also available. Support for changing the baud rate during normal HCI UART operation is included through a vendor-specific command. The CYW20719 UART operates correctly with the host UART as long as the combined baud rate error of the two devices is within ±5%. The UART interface has a 1040-byte receive FIFO and a 1040-byte transmit FIFO to support enhanced data rates. The interface supports the Bluetooth UART HCI (H4) specification. The default baud rate for H4 is 115.2 kbaud.

During HCI mode the DEV_WAKE signal can be programmed to wake up the CYW20719 or allow the CYW20719 to sleep when radio activities permit. The CYW20719 can also wake up the host as needed or allow the host to sleep via the HOST_WAKE signal. The combined two signals allow the host and the CYW20719 to optimize system power consumption by allowing independent control of low power modes. DEV_WAKE and HOST_WAKE signals can be enabled via a vendor specific command.

6.3 Peripheral UART Interface

The CYW20719 has a second UART that may be used to interface to peripherals. This peripheral UART is accessed through the optional I/O ports, which can be configured individually and separately for each functional pin. The CYW20719 can map the peripheral UART to any GPIO (P0-P39). The Peripheral UART is functionally the same as HCI UART but with a 256 byte transmit and receive FIFO.

6.4 Crystal Oscillators

6.4.1 24-MHz Crystal Oscillator

The CYW20719 uses a 24 MHz crystal oscillator (XTAL). The XTAL must have an accuracy of ±20 ppm as defined by the Bluetooth specification. Two external load capacitors are required to work with the crystal oscillator. The selection of the load capacitors is XTAL-dependent (see Figure 3).

Figure 3. Recommended 24 MHz Oscillator Configuration

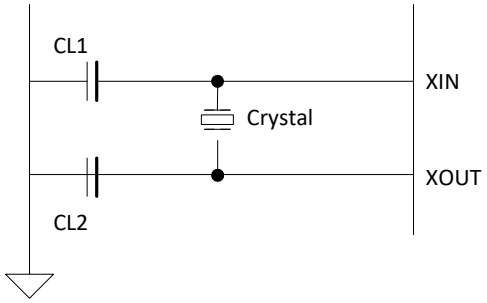


Table 2. Reference Crystal Electrical Specifications

Parameter	Conditions	Minimum	Typical	Maximum	Unit
Nominal frequency	–	–	24.000	–	MHz
Oscillation mode	–		Fundamental		–
Frequency Accuracy	Includes operating temperature range and aging	–	–	± 20	ppm
Equivalent series resistance	–	–	–	60	ohm
Load capacitance	–	–	8	–	pF
Drive level	–	–	–	200	µW
Shunt capacitance	–	–	–	2	pF

6.4.2 32 kHz Crystal Oscillator

The CYW20719 includes a 32 KHz oscillator to provide accurate timing during low power operations. Figure 4 shows the 32 kHz XTAL oscillator with external components and Table 3 lists the oscillator's characteristics. This oscillator can be operated with 32.768 kHz crystal oscillator or be driven with a clock input at similar frequency. The default component values are: R1 = 10 MΩ and C1 = C2 = ~6 pF. The values of C1 and C2 are used to fine-tune the oscillator.

Figure 4. Recommended 32 kHz Oscillator Electrical Specification

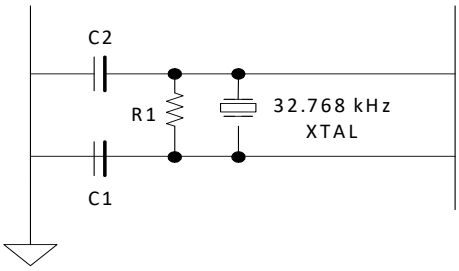


Table 3. Reference 32 kHz Oscillator Electrical Specification

Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Unit
Output frequency	F_{oscout}	–	–	32.768	–	kHz
Frequency tolerance	–	Crystal-dependent	–	100	–	ppm
Start-up time	$T_{startup}$	–	–	500	–	ms
XTAL drive level	P_{drv}	For crystal selection	–	–	0.5	µW
XTAL series resistance	R_{series}	For crystal selection	–	–	70	kΩ
XTAL shunt capacitance	C_{shunt}	For crystal selection	–	–	2.2	pF
External AC Input Amplitude	V_{IN} (AC)	C_{couple} = 100 pF; R_{bias}= 10 Mohm	400	–	–	mVpp

6.5 GPIO Ports

The CYW20719 has 40 GPIOs labeled P0-P39 on WLCSP package and 16 GPIOs on QFN package. All GPIOs support the following:

- programmable pull-up/down of approx 45K Ohms.
- input disable, allowing pins to be left floating or analog signals connected without risk of leakage.
- source/sink 8 mA at 3.3 V and 4 mA at 1.8 V.
- P15 is Bonded to the same pin as XTALI_32K on the QFN package (Pin 32). If External 32.768KHz crystal is not used, then this pin can be used as GPIO P15.
- P26/P27/P28/P29 (some of these pins are not available on QFN package) sink/source 16 mA at 3.3 V and 8 mA at 1.8 V.

Most peripheral functions can be assigned to any GPIO. For details, refer to Table 4 and Table 5.

For more details on Supermux configuration and control, refer to "Supermux Wizard for CYW20719" user guide.

6.6 Keyboard Scanner (Available only on WLCSP Package)

The CYW20719 includes a HW keyscanner that supports a maximum matrix size of 20x8. The scanner has 8 inputs (also referred to as rows) and 20 outputs (also referred to as columns). Keys are detected by driving the columns down sequentially and sampling the rows. The HW scanner includes support for ghost key detection and debouncing. The scanner can also operate in sleep and PDS mode allowing low power operation while continuing to detect/store all key strokes, up or down. In other low power modes, the scanner can continue to monitor the matrix and initiate exit to active mode upon detecting a change of state.

Note: Subject to the driver support in WICED® Studio.

6.7 Mouse Quadrature Signal Decoder

The CYW20719 includes one double-axis and one single axis quadrature decoders. There are two input lines for each axis and a programmable control signal that can be active high or low. The application can access the quadrature interface via the driver included in the firmware.

Note: Subject to the driver support in WICED® Studio.

6.8 ADC

CYW20719 includes is a Σ-Δ ADC designed for audio (13 bits) and DC (10 bits) measurements. The ADC can measure the voltage on 28 GPIO. When used for analog inputs, the GPIOs must be placed in digital input disable mode to disconnect the digital circuit from the pin and avoid leakage. The internal band gap reference has ±5% accuracy without calibration. Calibration and digital correction schemes can be applied to reduce ADC absolute error and improve measurement accuracy in DC mode.

- P0, P1, P8-P18, P21-23, P28-P38 can be used as ADC inputs.

6.9 PWM

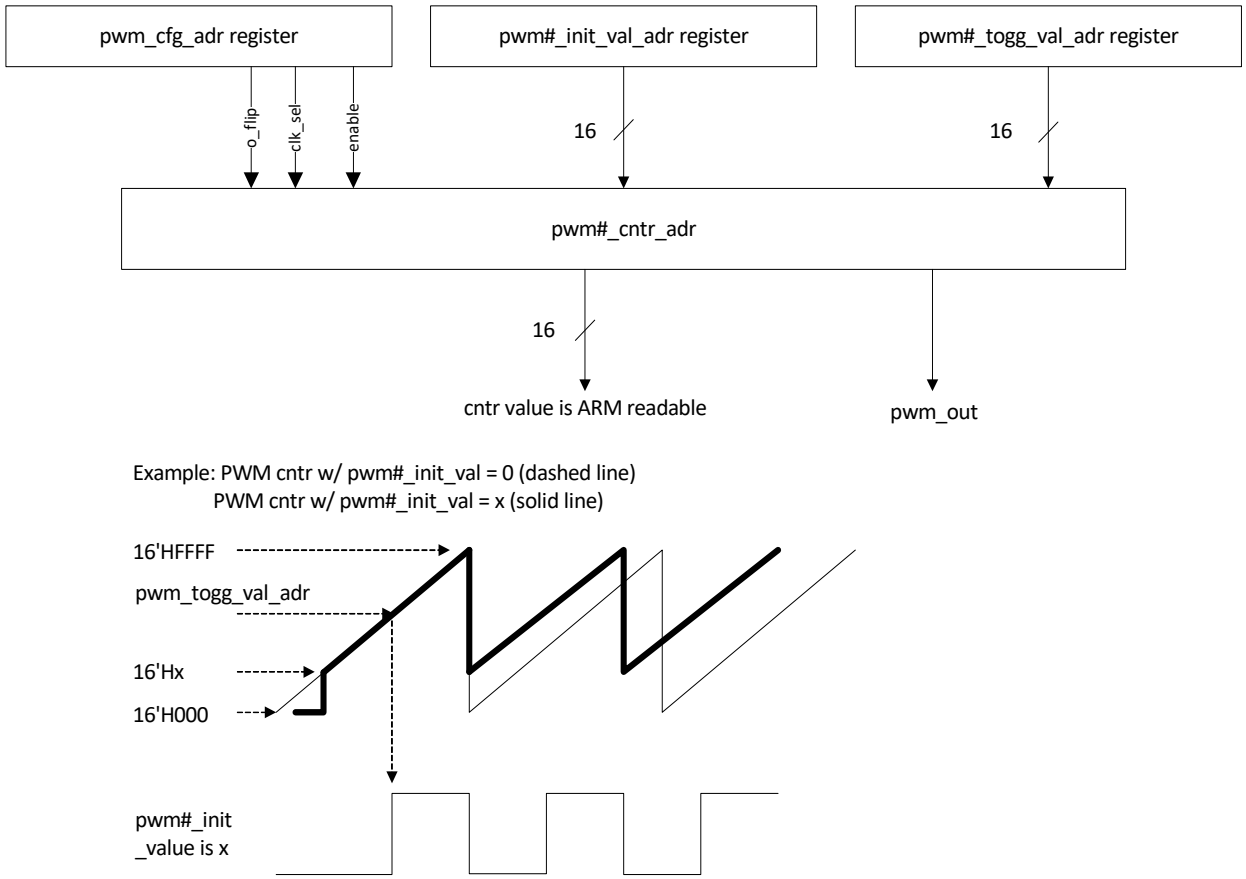
The CYW20719 has six internal PWMs, labeled PWM0-5

- Each of the six PWM channels contains the following registers:
  - 16-bit initial value register (read/write)
  - 16-bit toggle register (read/write)
  - 16-bit PWM counter value register (read)
- PWM configuration register is shared among PWM0–5 (read/write). This 6-bit register is used:
  - To enable/disable each PWM channel
  - To select the clock of each PWM channel
  - To invert the output phase of each PWM channel

The application can access the PWM module through the FW driver.

Figure 5 shows the structure of one PWM channel.

Figure 5. PWM Block Diagram



6.10 Serial Peripheral Interface block

The CYW20719 has two independent SPI interfaces. Both interfaces support Single, Dual, and Quad mode SPI operations as well as MIPI DBI-C Interface.Either of the interface can be a master/slave. SPI2 can support only one Slave. SPI1 has a 1024 byte transmit and receive buffers which is shared with the host UART interface. SPI2 has a dedicated 256 byte transmit and receive buffers. To support more flexibility for user applications, the CYW20719 has optional I/O ports that can be configured individually and separately for each functional pin. SPI I/O voltage depends on VDDO.

6.10.1 MIPI interface

There are three options in DBI type-C corresponding to 9-bit, 16-bit, and 8-bit modes. The CYW20719 plays the role of host, and only the 9-bit and 8-bit modes (option 1 and option 3 in DBI-C spec) are supported. In the 9-bit mode, the SCL, CS, MOSI, and MISO pins are used. In the 8-bit mode, an additional pin DCX, indicating whether the current outgoing bit stream is a command or data byte is required.

6.11 Pulse Density Modulation (PDM) Microphone

The CYW20719 accepts a ΣΔ-based one-bit PDM input stream and outputs filtered samples at either 8 kHz or 16 kHz sampling rates. The PDM signal derives from an external kit that can process analog microphone signals and generate digital signals. The PDM input shares the filter path with the aux ADC. Two types of data rates can be supported:

- 8 kHz
- 16 kHz

The external digital microphone takes in a 2.4 MHz clock generated by the CYW20719 and outputs a PDM signal which is registered by the PDM interface with either the rising or falling edge of the 2.4 MHz clock selectable through a programmable control bit. The design can accommodate two simultaneous PDM input channels, so stereo voice is possible.

Note: Subject to the driver support in WICED Studio.

6.12 I²S Interface

The CYW20719 supports a single I²S digital audio port in both master and slave modes. The I²S signals are:

- I²S Clock: I²S SCK
- I²S Word Select: I²S WS
- I²S Data Out: I²S DO
- I²S Data In: I²S DI

I²S SCK and I²S WS become outputs in master mode and inputs in slave mode, while I²S DO always stays as an output and I²S DI stays as input. The channel word length is fixed to 16 bits (frame length of 32 bits) and the data is justified so that the MSB of the left-channel data is aligned with the MSB of the I²S bus, as per I²S Specifications. 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. Data bits sent by the CYW20719 are synchronized with the falling edge of I²S SCK and should be sampled by the receiver on the rising edge of the I²S SCK.

The I²S port is primarily used to transfer audio samples while using the A2DP profile[1]. The A2DP controller is half duplex and the direction of the audio samples depend on the A2DP role (sink/source). The I2S clock in the master mode can either be

- 44.1 KHz x 32 bits per frame = 1411.2 KHz
- 48 KHz x 32 bits per frame = 1536 KHz

In the slave mode, any clock rate is supported up to a maximum of 3.072 MHz.

Note: PCM interface shares HW with the I²S interface which means that both voice and audio cannot be routed at the same time.

1. The I²S port cannot be used at the application level for purposes other than routing A2DP audio samples.

6.13 PCM Interface

The CYW20719 includes a PCM interface that can connect to linear PCM codec devices in master or slave mode. In master mode, the CYW20719 generates the PCM_CLK and PCM_SYNC signals. In slave mode, these signals are provided by another device on the PCM interface and are inputs to the CYW20719. Some of the parameters of the PCM interface may be configured by the host.

The PCM interface is used for full-duplex bi-directional transfer of 8K or 16K voice samples from and to a SCO or eSCO connection[2]. By default, the PCM interface runs in an I^2S compatible mode, which allows the CYW20719 to transfer voice samples to I^2S devices.

Note: PCM interface shares HW with the I^2S interface which means that both voice and audio cannot be routed simultaneously.

6.13.1 Slot Mapping

The CYW20719 supports up to three simultaneous full-duplex SCO or eSCO channels through the PCM Interface. These three channels are time-multiplexed onto the single PCM interface by using a time-slotting scheme where the 8 kHz or 16 kHz voice sample interval is divided into as many as 16 slots. The number of slots is dependent on the selected interface rate (128 kHz, 256kHz, 512 kHz, 1024 kHz or 2048 kHz). The corresponding number of slots for these interface rate is 1, 2, 4, 8, and 16, respectively. Transmit and receive PCM data from an SCO channel is always mapped to the same slot. The PCM data output driver tristates its output on unused slots to allow other devices to share the same PCM interface signals. The data output driver tristates its output after the falling edge of the PCM clock during the last bit of the slot.

6.13.2 Frame Synchronization

The CYW20719 supports both short and long-frame synchronization in both master and slave modes and can be configured from the host. In short frame synchronization mode, the frame synchronization signal is an active-high pulse at the audio frame rate that is a single-bit period in width and is synchronized to the rising edge of the bit clock. The PCM slave looks for a high on the falling edge of the bit clock and expects the first bit of the first slot to start at the next rising edge of the clock. In long-frame synchronization mode, the frame synchronization signal is again an active-high pulse at the audio frame rate; however, the duration is three bit periods and the pulse starts coincident with the first bit of the first slot.

6.13.3 Data Formatting

The CYW20719 may be configured to generate or accept several different data formats. For conventional narrow band speech mode, the CYW20719 always uses 13 of the 16 bits in each PCM frame. The location and order of these 13 bits can be configured to support various data formats on the PCM interface. The remaining three bits are ignored on the input and may be filled with 0s, 1s, a sign bit, or a programmed value on the output. The default format is 13-bit 2's complement data, left justified, filled with 0's and clocked MSB first.

6.13.4 Burst PCM Mode

In this mode of operation, the PCM bus runs at a significantly higher rate of operation to allow the host to duty cycle its operation and save current. In this mode of operation, the PCM bus can operate at a rate of up to 24 MHz. This mode of operation is initiated with an HCI command from the host.

6.14 Security Engine

The CYW20719 includes a hardware security accelerator which greatly decreases the time required to perform typical security operations.This security engine includes:

- Public key acceleration (PKA) cryptography
- AES-CTR/CBC-MAC/CCM acceleration
- SHA2 message hash and HMAC acceleration
- RSA encryption and decryption of modulus sizes up to 2048 bits
- Elliptic curve Diffie-Hellman in prime field GF(p)

Note: Security engine is used only by Bluetooth stack to reduce CPU overhead. It is not available for application use

6.14.1 Random Number Generator

This hardware block is used for key generation for Bluetooth.

Note: Availability for use by the application is subject to the support in WICED® Studio.

2. The PCM interface cannot be used as a generic serial interface at the application level. It can only be used for routing SCO or eSCO voice samples.

6.15 Power Modes

The CYW20719 supports the following HW power modes:

- Active mode - Normal operating mode in which all peripherals are available and the CPU is active.
- Idle mode- In this mode, the CPU is in “Wait for Interrupt” (WFI) and the HCLK, which is the high frequency clock derived from the main crystal oscillator is running at a lower clock speed. Other clocks are active and the state of the entire chip is retained.
- Sleep mode - In this mode, CPU is in WFI and the HCLK is not running. The PMU determines if the other clocks can be turned off and does accordingly. State of the entire chip is retained, the internal LDOs run at a lower voltage (voltage is managed by the PMU), and SRAM is retained.
- Power Down Sleep (PDS) mode -This mode is an extension of the PMU Sleep wherein most of the peripherals such as UART and SPI are turned off. The entire memory is retained, and on wakeup the execution resumes from where it paused.
- Shut Down Sleep (SDS) mode -Everything is turned off except I/O Power Domain, RTC, and LPO. The device can come out of this mode either due to BT activity or by an external interrupt. Before going into this mode, the application can store some bytes of data into “Always On RAM” (AON). When the device comes out of this mode, the data from AON is restored. After waking from SDS, the application will start from the beginning (warmboot) and has to restore its state based on information stored in AON. In the SDS mode, a single BT task with no data activity, such as an ACL connection, BLE connection, or BLE advertisement can be performed.
- HID-OFF (Timed-Wake) mode -The device can enter this mode asynchronously, that is, the application can force the device into this mode at any time. I/O Power Domain, RTC, and LPO are the only active blocks. A timer that runs off the LPO is used to wake the device up after a predetermined fixed time.
- HID-OFF (External Interrupt-Waked) mode - This mode is similar to Timed-Wake, but in HID-OFF mode even the LPO and RTC are turned off. So, the only wakeup source is an external interrupt.

Transition between power modes is handled by the on-chip firmware with host/application involvement. Please see Firmware Section for details.

7. Firmware

The CYW20719 ROM firmware runs on a real time operating system and handles the programming and configuration of all on-chip hardware functions as well as the BT/LE baseband, Link Manager (LM), HCI, Generic Attribute Profile (GATT), Attribute Protocol (ATT), Logical Link Control and Adaptation Protocol (L2CAP) and Service Discovery Protocol (SDP) layers. The ROM also includes drivers for on-chip peripherals as well as handling on-chip power management functions including transitions between different power modes.

The CYW20719 is fully supported by the Cypress WICED® Studio platform. WICED releases provide latest ROM patches, drivers, and sample applications allowing customized applications using the CYW20719 to be built quickly and efficiently.

Please refer to WICED Technical Brief and CYW20719 Product Guide for details on the firmware architecture, driver documentation, power modes and how to write applications/profiles using the CYW20719.

8. Pin Assignments and GPIOs

This section addresses both QFN and WLCSP pin assignments and GPIOs for the CYW20719 device.

8.1 40-Pin QFN and WLCSP Pin Assignments

Table 4. 40-Pin QFN and WLCSP Pin Assignments

Pin Name	Pin Number		I/O	Power Domain	Description
	QFN-40	WLCSP			
Microphone					
ADC_avddBAT	–	5	I	VDDIO	VDDIO
ADC_AVDDC	–	3	I	–	No Connect
Mic_avdd	–	19	I	MIC_AVDD	Microphone supply
Micbias	–	32	I	MIC_AVDD	Microphone Bias Supply
Micn	–	4	I	MIC_AVDD	Microphone negative input
Micp	–	18	I	MIC_AVDD	Microphone positive input
ADC_AVSS	–	34	I	AVSS	Analog ground
ADC_AVSSC	–	17	I	AVSS	Analog ground
ADC_REFGND	–	33	I	AVSS	Analog reference ground
Mic_avss	–	47	I	AVSS	Microphone analog ground
Baseband Supply					
BT_VDDO	25	1,8,9,11,14,26,29,42,56,66,91	I	VDDO	I/O Pad Power supply
BT_VDDC	–	2,43,58,74, 99	I/O	VDDC	Baseband core power supply
VDDO	39	-	I	VDDO	LHL PAD power supply. Can be tied to BT_VDDO.
RF Power Supply					
BT_PAVDD	17	116	I	PAVDD	PA supply
BT_PLLVDD1p2	21	106	I	PLLVDD1P2	RFPLL and crystal oscillator supply
BT_VCOVDD1p2	20	125	I	VCOVDD1P2	VCO supply
BT_IFVDD1P2	19	110	I	IFVDD1P2	IFPLL Power Supply
Onboard LDO's					
DIGLDO_VDDIN	16	127	I		Internal Digital LDO input
DIGLDO_VDDOUT	–	126	O		Internal Digital LDO output
RFLDO_VDDIN	15	111	I	–	RF LDO Input
RFLDO_VDDOUT	14	128	O	–	RF LDO Output
SR_VDDBAT3V	13	129	I	–	Core Buck Input
VDDBAT3V	–	120	I	–	Core Buck Input
SR_VLX	12	121	O	–	Core Buck Output
Ground Pins					
BT_PAVSS	–	123	I	VSS	Ground
BT_PLLVSS	–	107	I	VSS	Ground
BT_VCOVSS	–	119	I	VSS	Ground
BT_IFVSS	–	115	I	VSS	Ground
BT_VSSC	–	30, 57, 75, 87, 117, 118, 124, 133, 134	I	VSS	Ground

Table 4. 40-Pin QFN and WLCSP Pin Assignments (Cont.)

Pin Name	Pin Number		I/O	Power Domain	Description
	QFN-40	WLCSP			
VSSC	–	112	I	VSS	Ground
VSSO_0	–	10,13, 25, 28,72, 96,101	I	VSS	Ground
SR_PVSS	–	130	I	VSS	Ground
xtal_avss	–	35	I	XTAL_AVSS	Crystal ground
PMU_AVSS	–	113	I	PMU_AVSS	PMU ground
UART					
BT_UART_CTS_N	30	15	I, PU	VDDO	Clear to send (CTS) for HCI UART interface. Leave unconnected if not used.
BT_UART_RTS_N	29	31	O, PU	VDDO	Request to send (RTS) for HCI UART interface. Leave unconnected if not used.
BT_UART_RXD	27	45	I	VDDO	UART serial input. Serial data input for the HCI UART interface.
BT_UART_TXD	28	46	O, PU	VDDO	UART serial output. Serial data output for the HCI UART interface.
Crystal					
BT_XTALI	22	105	I	PLLVDD1P2	Crystal oscillator input. See “The XTAL must have an accuracy of ±20 ppm as defined by the Bluetooth specification. Two external load capacitors are required to work with the crystal oscillator. The selection of the load capacitors is XTAL-dependent (see Figure 3)” for options.
BT_XTALO	23	104	O	PLLVDD1P2	Crystal oscillator output.
XTALI_32K	32	6	I	VDDO	Low-power oscillator input.
XTALO_32K	31	20	O	VDDO	Low-power oscillator output.
BT_RF	18	132	–	–	RF Antenna Port
BT_CLK_REQ	–	68	O	N/A	Used for shared-clock application.
JTAG_SEL	11	102	–	–	Reserved ARM JTAG debug mode control. Connect to GND for all applications.
RST_N	10	103	I	VDDO	Active-low system reset with internal pull-up resistor.
Reserved Pins					
Reserved	26	21, 36, 49, 61, 77, 84, 85, 108	N/A	N/A	Reserved. Leave unconnected.
Reserved, Connect to GND	–	16, 92	N/A	N/A	Reserved, connect to GND

8.2 40-Pin QFN and WLCSP GPIOs

Table 5. 40-Pin QFN and WLCSP GPIOs

Pin Name	Pin Number		I/O	Power Domain	Description
	QFN-40	WLCSP			
BT_DEV_WAKE	–	86	I	VDDO	A signal from the host to the CYW20719 indicating that the host requires attention.
BT_HOST_WAKE	24	76	O	VDDO	A signal from the CYW20719 device to the host indicating that the Bluetooth device requires attention.
BT_GPIO_2	–	44	I/O	VDDO	GPIO: Can also be configured as a GCI Pin
BT_GPIO_3	–	59	I/O	VDDO	GPIO: Can also be configured as a GCI Pin
BT_GPIO_4	–	79	I/O	VDDO	GPIO: Can also be configured as a GCI Pin
BT_GPIO_5	–	78	I/O	VDDO	GPIO: Can also be configured as a GCI Pin
P0	3	93	I/O	VDDO	■ GPIO: P0 ■ Keyboard scan input (row): KSI0 ■ A/D converter input 29 ■ Supermux I/O functions as defined in Table 6.
P1	4	54	I/O	VDDO	■ GPIO: P1 ■ Keyboard scan input (row): KSI1 ■ A/D converter input 28 ■ Supermux I/O functions as defined in Table 6
P2	34	60	I/O	VDDO	■ GPIO: P2 ■ Keyboard scan input (row): KSI2 ■ Supermux I/O functions as defined in Table 6
P3	–	22	I/O	VDDO	■ GPIO: P3 ■ Keyboard scan input (row): KSI3 ■ Supermux I/O functions as defined in Table 6
P4	35	23	I/O	VDDO	■ GPIO: P4 ■ Keyboard scan input (row): KSI4 ■ Supermux I/O functions as defined in Table 6
P5	–	37	I/O	VDDO	■ GPIO: P5 ■ Keyboard scan input (row): KSI5 ■ Supermux I/O functions as defined in Table 6
P6	36	50	I/O	VDDO	■ GPIO: P6 ■ Keyboard scan input (row): KSI6 ■ Supermux I/O functions as defined in Table 6
P7	37	62	I/O	VDDO	■ GPIO: P7 ■ Keyboard scan input (row): KSI7 ■ Supermux I/O functions as defined in Table 6
P8	–	69	I/O	VDDO	■ GPIO: P8 ■ A/D converter input 27 ■ Supermux I/O functions as defined in Table 6
P9	–	52	I/O	VDDO	■ GPIO: P9 ■ A/D converter input 26 ■ External T/R switch control: tx_pd ■ Supermux I/O functions as defined in Table 6

Table 5. 40-Pin QFN and WLCSP GPIOs (Cont.)

Pin Name	Pin Number		I/O	Power Domain	Description
	QFN-40	WLCSP			
P10	40	63	I/O	VDDO	■ GPIO: P10 ■ Keyboard scan output (column): KSO2 ■ A/D converter input 25 ■ Supermux I/O functions as defined in Table 6
P11	40	70	I/O	VDDO	■ GPIO: P11 ■ A/D converter input 24 ■ Supermux I/O functions as defined in Table 6
P12	–	40	I/O	VDDO	■ GPIO: P12 ■ A/D converter input 23 ■ Supermux I/O functions as defined in Table 6
P13	1	71	I/O	VDDO	■ GPIO: P13 ■ A/D converter input 22 ■ Supermux I/O functions as defined in Table 6
P14	–	24	I/O	VDDO	■ GPIO: P14 ■ A/D converter input 21 ■ Supermux I/O functions as defined in Table 6
P15[C]	32	7	I/O	VDDO	■ GPIO: P15 ■ A/D converter input 20 ■ Supermux I/O functions as defined in Table 12
P16	33	48	I/O	VDDO	■ GPIO: P16 ■ A/D converter input 19 ■ Supermux I/O functions as defined in Table 6
P17	38	38	I/O	VDDO	■ GPIO: P17 ■ A/D converter input 18 ■ Supermux I/O functions as defined in Table 6
P18	–	51	I/O	VDDO	■ GPIO: P18 ■ A/D converter input 17 ■ Supermux I/O functions as defined in Table 6
P19	–	39	I/O	VDDO	■ Reserved for system use. Leave unconnected.
P20	–	12	I/O	VDDO	■ Reserved for system use. Leave unconnected.
P21	–	53	I/O	VDDO	■ GPIO: P21 ■ A/D converter input 14 ■ Supermux I/O functions as defined in Table 6
P22	–	27	I/O	VDDO	■ GPIO: P22 ■ A/D converter input 13 ■ Supermux I/O functions as defined in Table 6
P23	1	64	I/O	VDDO	■ GPIO: P23 ■ A/D converter input 12 ■ Supermux I/O functions as defined in Table 6
P24	–	90	I/O	VDDO	■ GPIO: P24 ■ Supermux I/O functions as defined in Table 6
P25	8	97	I/O	VDDO	■ GPIO: P25 ■ Supermux I/O functions as defined in Table 6
P26	7	83	I/O	VDDO	■ GPIO: P26 ■ Current: 16 mA sink ■ Supermux I/O functions as defined in Table 6

Table 5. 40-Pin QFN and WLCSP GPIOs (Cont.)

Pin Name	Pin Number		I/O	Power Domain	Description
	QFN-40	WLCSP			
P27	–	94	I/O	VDDO	■ GPIO: P27 ■ Current: 16 mA sink ■ Supermux I/O functions as defined in Table 6
P28	1	41	I/O	VDDO	■ GPIO: P28 ■ A/D converter input 11 ■ Current: 16 mA sink ■ Supermux I/O functions as defined in Table 6
P29	2	80	I/O	VDDO	■ GPIO: P29 ■ Optical control output: QOC3 ■ A/D converter input 10 ■ Current: 16 mA sink ■ Supermux I/O functions as defined in Table 6
P30	–	95	I/O	VDDO	■ GPIO: P30 ■ A/D converter input 9 ■ Supermux I/O functions as defined in Table 6
P31	–	73	I/O	VDDO	■ GPIO: P31 ■ A/D converter input 8 ■ Supermux I/O functions as defined in Table 6
P32	–	98	I/O	VDDO	■ GPIO: P32 ■ A/D converter input 7 ■ Supermux I/O functions as defined in Table 6
P33	9	100	I/O	VDDO	■ GPIO: P33 ■ A/D converter input 6 ■ Supermux I/O functions as defined in Table 6
P34	5	81	I/O	VDDO	■ GPIO: P34 ■ A/D converter input 5 ■ Supermux I/O functions as defined in Table 6
P35	5	65	I/O	VDDO	■ GPIO: P35 ■ A/D converter input 4 ■ Supermux I/O functions as defined in Table 6
P36	5	55	I/O	VDDO	■ GPIO: P36 ■ A/D converter input 3 ■ Supermux I/O functions as defined in Table 6
P37[c]	–	88	I/O	VDDO	■ GPIO: P37 ■ A/D converter input 2 ■ Supermux I/O functions as defined in Table 6
P38	6	89	I/O	VDDO	■ GPIO: P38 ■ A/D converter input 1 ■ Supermux I/O functions as defined in Table 6
P39	–	82	I/O	VDDO	■ Reserved for system use. Leave unconnected.
Strapping Pins					
BT_TM1	–	67	I	–	Device test mode control. Connect to GND for all applications.
PMU_DISABLE	–	109	I	VDDO	PMU Enable/Disable. Connected to ground.

a. All GPIOs are super mux. All GPIOs can be programmed for any alternative functions as listed in Table 6 and Table 7.

b. During power-on reset, all inputs are disabled.
c. P15 and P37 should not be driven high externally while the part is held in reset (they can be floating or driven low). Failure to do so may cause some current to flow through these pins until the part comes out of reset.

Table 6. GPIO Supermux Input Functions

Input	Description
SWDCK	Serial Wire Debugger Clock
SWDIO	Serial Wire Debugger I/O
spiffy1_clk[s]	SPIFFY 1 Clock (Slave)
spiffy1_cs[s]	SPIFFY 1 Chip Select (Slave)
spiffy1_mosi[s]	SPIFFY 1 MOSI (Slave)
spiffy1_miso[m]	SPIFFY 1 MISO (Master)
spiffy1_io2	SPIFFY 1 I/O 2 (Quad SPI)
spiffy1_io3	SPIFFY 1 I/O 3 (Quad SPI)
spiffy1_int[s]	SPIFFY 1 Interrupt (Slave)
spiffy2_clk[s]	SPIFFY 2 Clock (Slave)
spiffy2_cs[s]	SPIFFY 2 Chip Select (Slave)
spiffy2_mosi[s]	SPIFFY 2 MOSI (Slave)
spiffy2_miso[m]	SPIFFY 2 MISO (Master)
spiffy2_io2	SPIFFY 2 I/O 2
spiffy2_io3	SPIFFY 2 I/O 3

Table 6. GPIO Supermux Input Functions (Cont.)

Input	Description
spiffy2_int[s]	SPIFFY 2 Interrupt (Slave)
puart_rx	Peripheral UART RX
puart_cts_n	Peripheral UART CTS
SCL	I2C Clock
SDA	I2C Data
SCL2	I2C2 Clock
SDA2	I2C2 Data
PCM_IN	PCM Input
PCM_CLK	PCM Clock
PCM_SYNC	PCM Sync
I2S_DI	I2S Data Input
I2S_WS	I2S Word Select
I2S_CLK	I2S Clock
PDM_IN_Ch_1	PDM Input Channel 1
PDM_IN_Ch 2	PDM Input Channel 2

Table 7. GPIO Supermux Output Functions

Output	Description
do_P# (data out of GPIO. For example: 0)	
kso0	Key Scan output 0
kso1	Key Scan output 1
kso2	Key Scan output 2
kso3	Key Scan output 3
kso4	Key Scan output 4
kso5	Key Scan output 5
kso6	Key Scan output 6
kso7	Key Scan output 7
kso8	Key Scan output 8
kso9	Key Scan output 9
kso10	Key Scan output 10
kso11	Key Scan output 11
kso12	Key Scan output 12
kso13	Key Scan output 13
kso14	Key Scan output 14
kso15	Key Scan output 15
kso16	Key Scan output 16
kso17	Key Scan output 17
kso18	Key Scan output 18
kso19	Key Scan output 19
do_P# ^ pwm0	PWM Channel 0
do_P# ^ pwm1	PWM Channel 1
do_P# ^ pwm2	PWM Channel 2
do_P# ^ pwm3	PWM Channel 3
do_P# ^ pwm4	PWM Channel 4
do_P# ^ pwm5	PWM Channel 5
aclk0	Auxiliary clock Output 0
aclk1	Auxiliary clock Output 1
HID_OFF	HID-OFF Indicator
pa_ramp	External PA ramp
tx_pu	External PA Control Signal

Table 7. GPIO Supermux Output Functions (Cont.)

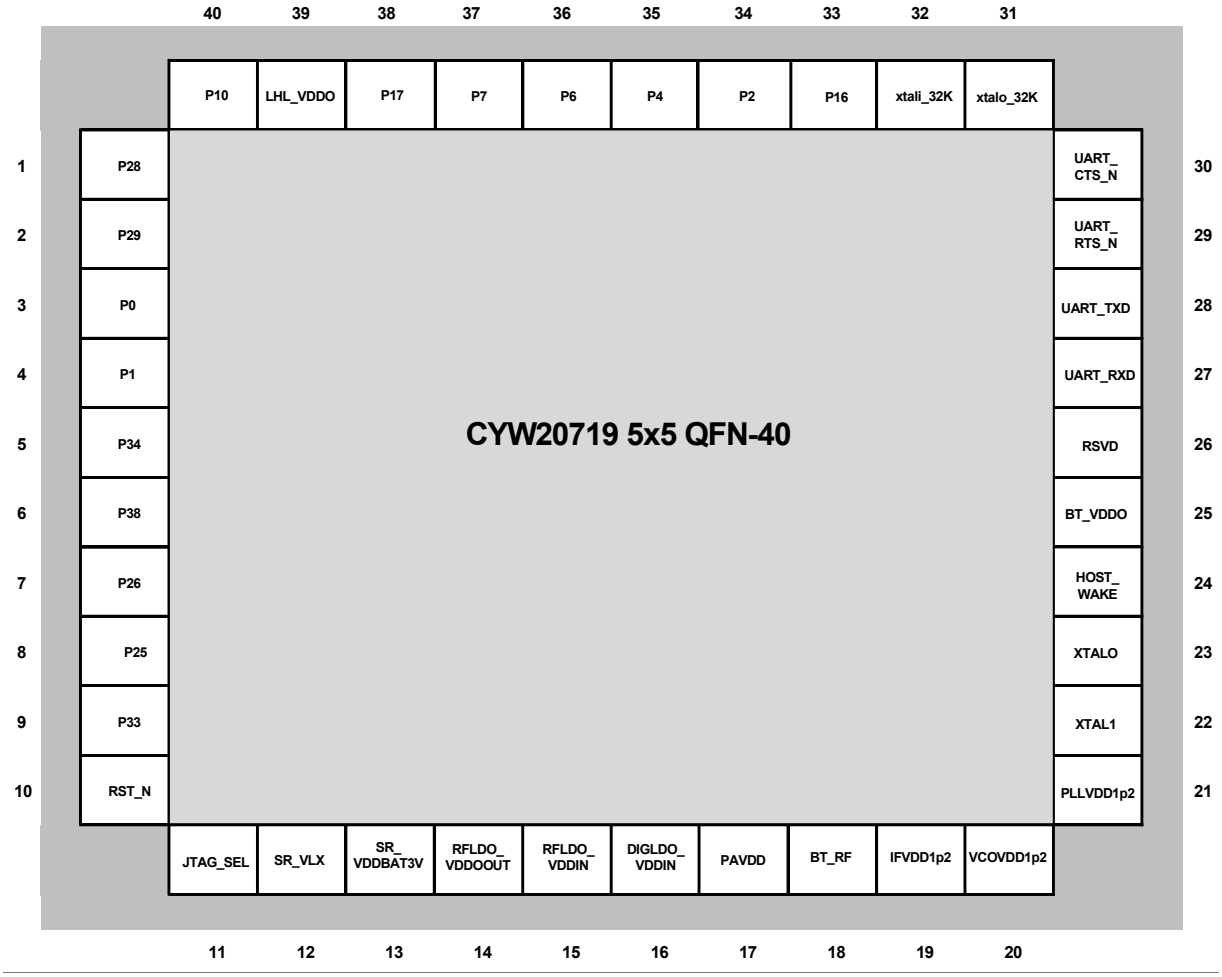
Output	Description
rx_pu	External PA Control Signal
SWDIO	Serial Wire Debugger Input/ Output
SDA2	I2C 2 Data
SCL2	I2C 2 Clock
puart_tx (uart2_tx)	Peripheral UART TX
puart_rts_n (uart2_rts_n)	Peripheral UART RTS
spiffy1_CLK	SPIFFY 1 Clock
spiffy1_CS	SPIFFY 1 Chip Select
spiffy1_MOSI	SPIFFY 1 MOSI
spiffy1_MISO	SPIFFY 1 MISO
spiffy1_IO2	SPIFFY I/O 2
spiffy1_IO3	SPIFFY I/O 3
spiffy1_INT	SPIFFY Interrupt
spiffy1_DCX	MIPI-DBI Data/Command Indicator
spiffy2_CLK	SPIFFY 2 Clock
spiffy2_CS	SPIFFY 2 Chip Select
spiffy2_MOSI	SPIFFY 2 MOSI
spiffy2_MISO	SPIFFY 2 MISO
spiffy2_IO2	SPIFFY 2 I/O 2
spiffy2_IO3	SPIFFY 2 I/O 3
spiffy2_INT	SPIFFY 2 Interrupt
spiffy2_DCX	MIPI-DBI Data/Command Indicator
pcm_in_o	PCM IN
pcm_out_o	PCM Out
pcm_bclk_o	PCM Bit Clock
pcm_sync_o	PCM Sync Output
i2s_ssd	I2S Slave Serial Data
i2s_sws	I2S Slave Word Select
i2s_sck	I2S Slave Clock
i2s_msd	I2S Master Serial Data
i2s_mws	I2S Master Word Select
i2s_mck	I2S Master Clock

9. Pin/Ball Maps

9.1 40-Pin QFN Pin Map

The CYW20719 40-pin QFN package is shown in Figure 6.

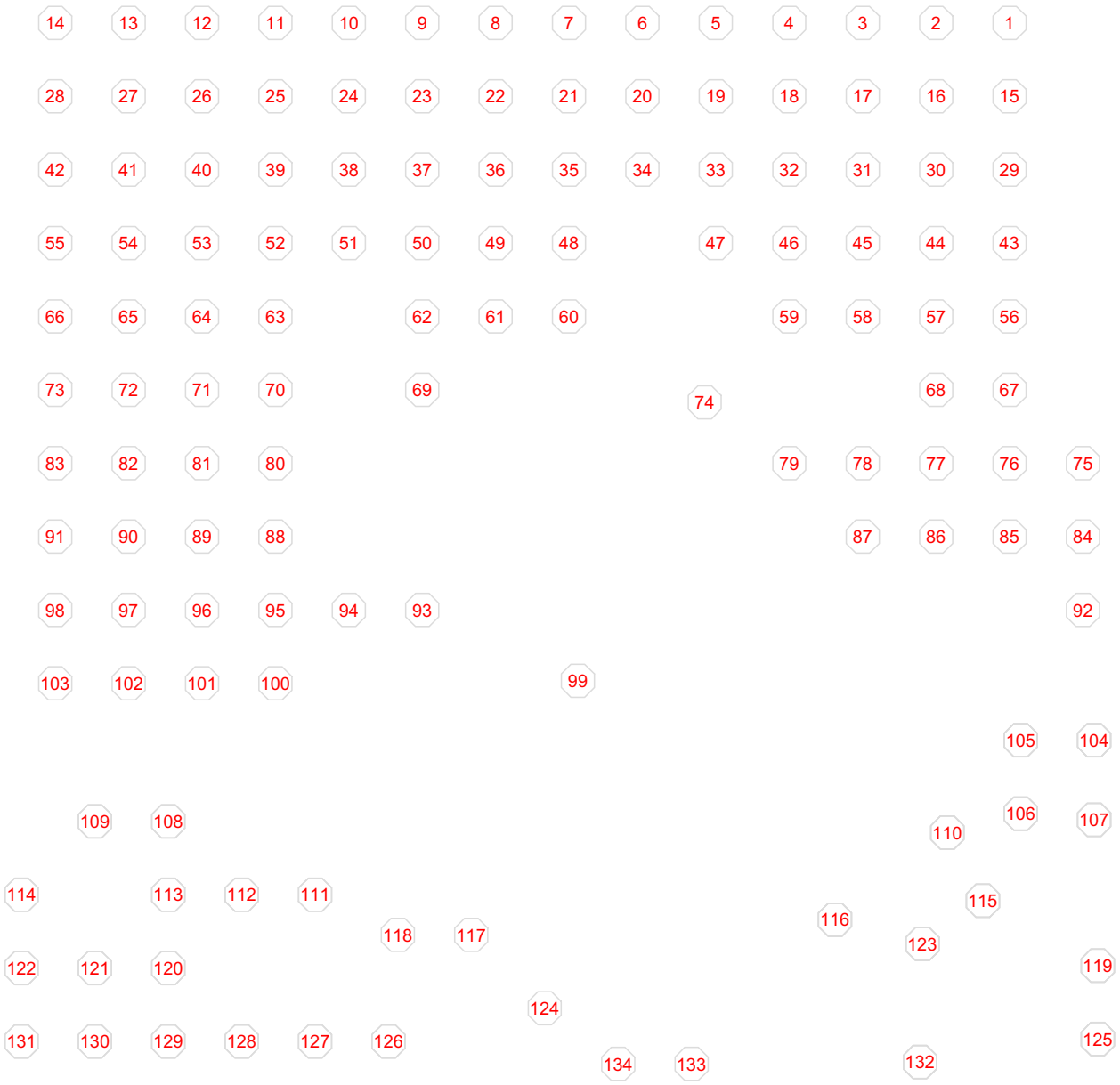
Figure 6. 40-Pin QFN Pin Map



9.2 WLCSP Ball Map

The CYW20719 WLCSP package is shown in Figure 7.

Figure 7. WLCSP Ball Map



Notes:

- Figure 7 shows the bottom view of the WLCSP package (Bumps facing up).
- See Table 4 and Table 9 and for additional WLCSP information.
- Table 9 shows the package view from the bottom (bumps facing up).
- Coordinate origin (0, 0) is at the center of the WLCSP package with the bumps facing up.

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Table 8. CYW20719 WLCSP Bump Coordinates

Bump#	NET_NAME	X-COORD (µm)	Y-COORD (µm)
1	BT_VDDO	1232.28	1356.88
2	BT_VDDC	1032.28	1356.88
3	Reserved - Do not connect	832.28	1356.88
4	Micn	632.28	1356.88
5	ADC_avddBAT	432.28	1356.88
6	xtali_32K	232.29	1356.88
7	P15	32.29	1356.88
8	VDDO_0	-167.7	1356.88
9	VDDO_0	-367.7	1356.88
10	VSSO_0	-567.7	1356.88
11	VDDO_0	-767.7	1356.88
12	P20	-967.69	1356.88
13	VSSO_0	-1167.69	1356.88
14	VDDO_0	-1367.69	1356.88
15	BT_UART_CTS_N	1232.28	1156.88
16	Reserved, Connect to GND	1032.28	1156.88
17	ADC_AVSSC	832.28	1156.88
18	Micp	632.28	1156.88
19	Mic_avdd	432.28	1156.88
20	xtalo_32K	232.29	1156.88
21	Reserved	32.29	1156.88
22	P3	-167.7	1156.88
23	P4	-367.7	1156.88
24	P14	-567.7	1156.88
25	VSSO_0	-767.7	1156.88
26	VDDO_0	-967.69	1156.88
27	P22	-1167.69	1156.88
28	VSSO_0	-1367.69	1156.88
29	BT_VDDO	1232.28	956.88
30	BT_VSSC	1032.28	956.88
31	BT_UART_RTS_N	832.28	956.88
32	Micbias	632.28	956.88
33	ADC_REFGND	432.28	956.88
34	ADC_AVSS	232.29	956.88
35	xtal_avss	32.29	956.88
36	Reserved	-167.7	956.88
37	P5	-367.7	956.88
38	P17	-567.7	956.88
39	P19	-767.7	956.88
40	P12	-967.69	956.88
41	P28	-1167.69	956.88
42	VDDO_0	-1367.69	956.88