

Automotive Grade Bluetooth Low Energy System on a Chip

The Cypress CYW89035 is an AECQ100 Automotive Grade, Bluetooth 4.2-compliant, stand-alone baseband processor with an integrated 2.4 GHz transceiver. Manufactured in ISO/TS16949 Automotive Qualified Facilities using the industry's most advanced 40 nm CMOS low-power process, the CYW89035 employs the highest level of integration to eliminate all critical external components, thereby minimizing the device footprint and the automotive qualification costs associated with implementing Bluetooth solutions.

The CYW89035 is the optimal solution for automotive connectivity and body control applications including keyless entry, wireless seat and lighting controls, tire pressure monitoring, and other sensor connections.

Built-in firmware adheres to the Bluetooth Low Energy (BLE) profile and the BLE Human Interface Device (HID) profile.

Cypress Part Numbering Scheme

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

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

Broadcom Part Number	Cypress Part Number
BCM89035	CYW89035
BCM89035CWMLG	CYW89035CWMLG

Acronyms and Abbreviations

In most cases, acronyms and abbreviations are defined on first use. Acronyms and abbreviations in this document are also defined in [Acronyms and Abbreviations on page 42](#).

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

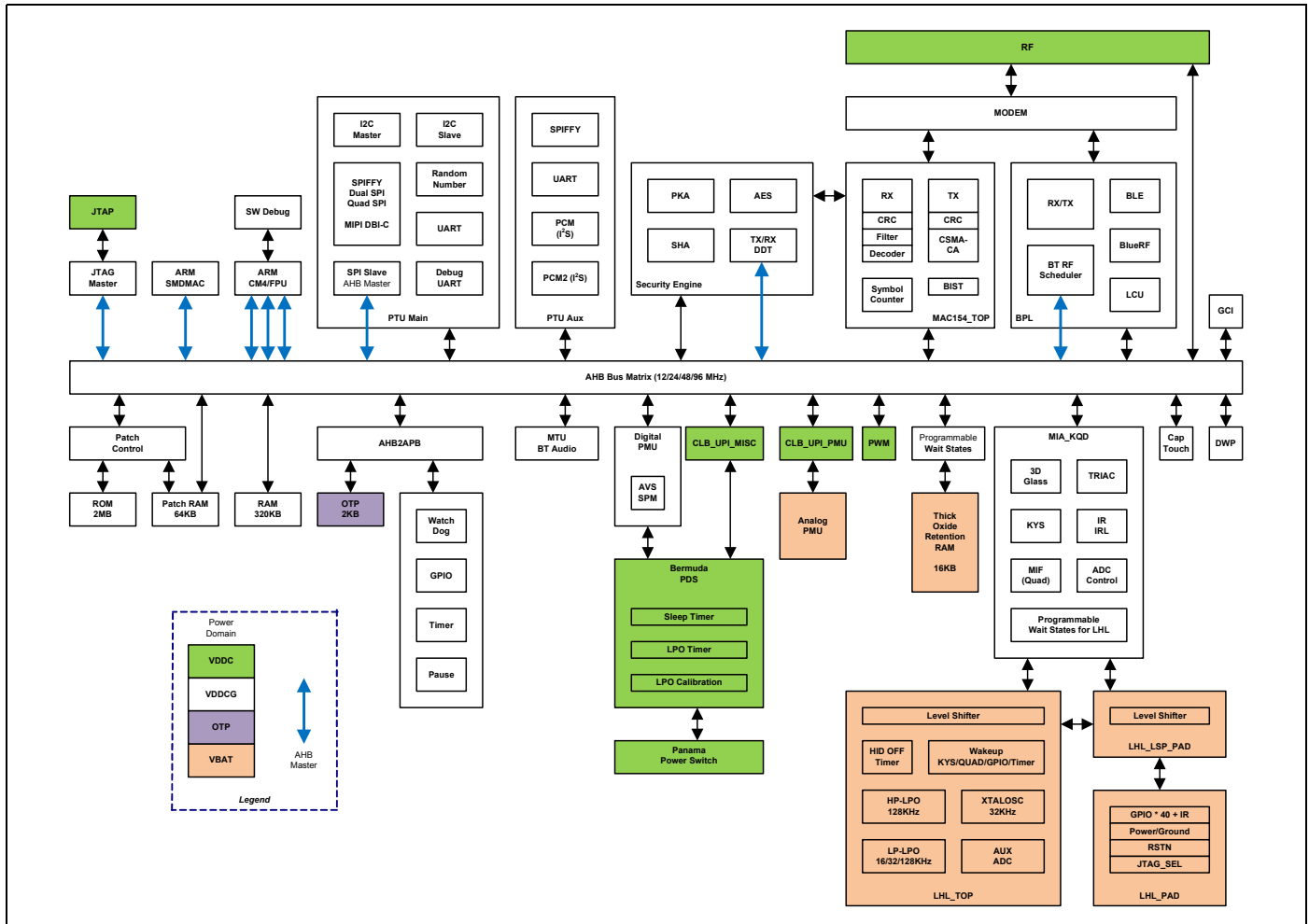
Applications

- Key entry and remote start
- Tire pressure monitoring
- Environmental controls
- Seat and lighting controls
- Sensors and actuators
- Passenger wearables
- Lighting controls

Features

- Complies with Bluetooth Core Specification version 4.2 including Basic Rate (BR) BR/LE
- Supports Cypress proprietary LE data rate up to 2 Mbps
- BLE HID profile version 1.00 compliant
- Bluetooth Device ID profile version 1.3 compliant
- Supports Generic Access Profile (GAP)
- Supports Adaptive Frequency Hopping (AFH)
- Excellent receiver sensitivity
- Programmable output power control
- Integrated ARM Cortex-M4 microprocessor core floating point unit (FPU)
- On-chip power-on reset (POR)
- Support for serial flash interfaces
- Integrated buck and low dropout (LDO) regulators
- On-chip software controlled power management unit
- Programmable key scan matrix interface, up to 8 × 20 key-scanning matrix
- Three-axis quadrature signal decoder
- Infrared modulator
- IR learning
- Auxiliary ADC with up to 28 analog channels
- On-chip support for serial peripheral interface (SPI) (master and slave modes)
- Broadcom Serial Communications (BSC) interface (compatible with NXP I²C slaves)
- LE package extension
- Timed wakeup
- Wireless charging interface
- Automotive grade package:
 - 60-pin wettable flanks quad flat no-lead (QFN)
 - RoHS compliant

Figure 1. Functional Block Diagram



IoT Resources

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

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1. Functional Description

1.1 Bluetooth Baseband Core

The Bluetooth Baseband Core (BBC) implements all of the time-critical functions required for high-performance Bluetooth operation. The BBC manages the buffering, segmentation, and routing of data for all connections. It also buffers data that passes through it, handles data flow control, schedules SCO/ACL and TX/RX transactions, monitors Bluetooth slot usage, optimally segments and packages data into baseband packets, manages connection status indicators, and composes and decodes HCI packets. In addition to these functions, it independently handles HCI event types, and HCI command types.

The following transmit and receive functions are also implemented in the BBC hardware to increase reliability and security of the TX/RX data before sending over the air:

- Symbol timing recovery, data deframing, forward error correction (FEC), header error control (HEC), cyclic redundancy check (CRC), data decryption, and data dewatering in the receiver.
- Data framing, FEC generation, HEC generation, CRC generation, key generation, data encryption, and data whitening in the transmitter.

1.1.1 Bluetooth 4.2 Features

The CYW89035 supports the following Bluetooth v4.2 features:

- LE data packet length extension
- LE secure connections
- Link layer privacy

1.1.2 Bluetooth 4.1 Features

The CYW89035 supports the following Bluetooth v4.1 features:

- Secure connections for BR
- Fast advertising interval
- Piconet clock adjust
- Connectionless broadcast
- LE privacy v1.1
- Low duty cycle directed advertising
- LE dual mode topology

1.1.3 Bluetooth 4.0 Features

The BBC supports all Bluetooth 4.0 features, with the following benefits:

- Dual-mode Bluetooth low energy (BT and BLE operation)
- Extended inquiry response (EIR): Shortens the time to retrieve the device name, specific profile, and operating mode.
- Encryption pause resume (EPR): Enables the use of Bluetooth technology in a much more secure environment.
- Sniff subrating (SSR): Optimizes power consumption for low duty cycle asymmetric data flow, which subsequently extends battery life.
- Secure simple pairing (SSP): Reduces the number of steps for connecting two devices, with minimal or no user interaction required.
- Link supervision time out (LSTO): Additional commands added to HCI and Link Management Protocol (LMP) for improved link time-out supervision.
- Quality of service (QoS) enhancements: Changes to data traffic control, which results in better link performance. Audio, human interface device (HID), bulk traffic, SCO, and enhanced SCO (eSCO) are improved with the erroneous data (ED) and packet boundary flag (PBF) enhancements.

1.1.4 Link Control Layer

The link control layer is part of the Bluetooth link control functions that are implemented in dedicated logic in the link control unit (LCU). This layer consists of the command controller that takes commands from the software, and other controllers that are activated or configured by the command controller, to perform the link control tasks. Each task is performed in a different state or substate in the Bluetooth Link Controller.

- BLE states:
 - Advertising
 - Scanning
 - Connection
- Major states:
 - Standby
 - Connection
- Substates:
 - Page
 - Page Scan
 - Inquiry
 - Inquiry Scan
 - Sniff

1.1.5 Test Mode Support

The CYW89035 fully supports Bluetooth Test mode as described in Part I:1 of the Specification of the Bluetooth System Version 3.0. This includes the transmitter tests, normal and delayed loopback tests, and reduced hopping sequence.

In addition to the standard Bluetooth Test Mode, the CYW89035 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

1.1.6 Frequency Hopping Generator

The frequency hopping sequence generator selects the correct hopping channel number based on the link controller state, Bluetooth clock, and device address.

1.2 Microprocessor Unit

The CYW89035 microprocessor unit runs software from the link control (LC) layer up to the host controller interface (HCI). The microprocessor is a Cortex-M4 32-bit RISC processor with embedded ICE-RT debug and serial wire debug (SWD) interface units. The microprocessor also includes 2 MB of ROM memory for program storage and 384 KB of RAM for data scratch-pad.

The internal ROM provides flexibility during power-on reset to enable the same device to be used in various configurations. At power-up, the lower-layer protocol stack is executed from internal ROM.

External patches can be applied to the ROM-based firmware to provide flexibility for bug fixes and feature additions. The device also supports the integration of user applications and profiles.

1.2.1 Floating Point Unit

CYW89035 includes the CM4 single precision IEEE-754 compliant floating point unit. For details see the Cortex-M4 manual.

1.2.2 OTP Memory

The CYW89035 includes 2 KB of one-time programmable memory that can be used by the factory to store product-specific information.

Note: Use of OTP requires that a 3V supply to be present at all times.

1.2.3 NVRAM Configuration Data and Storage

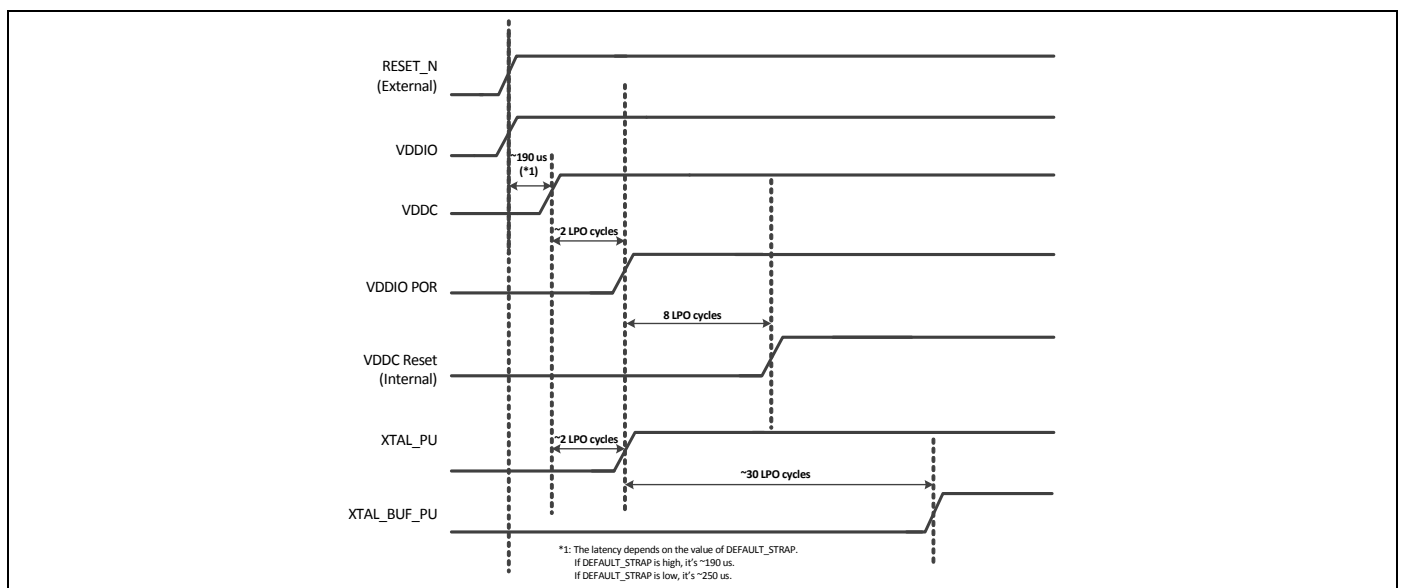
NVRAM contains configuration information about the customer application, including the following:

- Fractional-N information
- BD_ADDR
- UART baud rate
- SDP service record
- File system information used for code, code patches, or data. The CYW89035 uses SPI flash for NVRAM storage.

1.2.4 External Reset

An external active-low reset signal, RESET_N, can be used to put the CYW89035 in the reset state. An external voltage detector reset IC with 50 ms delay is needed on the RESET_N. The RESET_N should be released only after the VDDO supply voltage level has been stabilized for 50 ms.

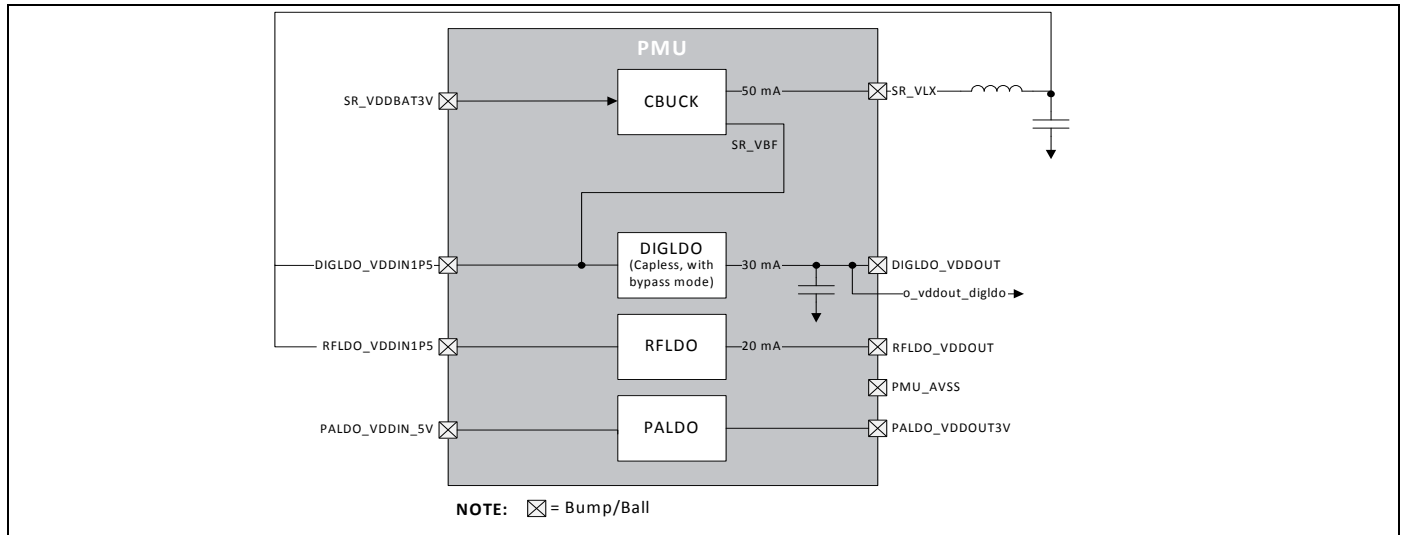
Figure 2. Reset Timing



1.3 Power Management Unit

Figure 3 shows the CYW89035 power management unit (PMU) block diagram. The CYW89035 includes an integrated buck regulator, a capless LDO, PALDO and an additional 1.2V LDO for RF.

Figure 3. Power Management Unit



1.4 Integrated Radio Transceiver

The CYW89035 has an integrated radio transceiver that has been optimized for use in 2.4 GHz Bluetooth wireless systems. It has been designed to provide low-power, low-cost, robust communications for applications operating in the globally available 2.4 GHz unlicensed ISM band. The CYW89035 is fully compliant with the Bluetooth Radio Specification and meets or exceeds the requirements to provide the highest communication link quality of service.

1.4.1 Transmit Path

The CYW89035 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 CYW89035 has an integrated power amplifier (PA) that can transmit up to +10 dBm for class 1 operations.

1.4.2 Receiver Path

The receiver path uses a low-IF scheme to downconvert the received signal for demodulation in the digital demodulator and bit synchronizer. The receiver path provides a high degree of linearity, an extended dynamic range to ensure reliable operation in the noisy 2.4 GHz ISM band. The front-end topology, with built-in out-of-band attenuation, enables the CYW89035 to be used in most applications with minimal off-chip filtering.

Digital Demodulator and Bit Synchronizer

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

Receiver Signal Strength Indicator

The radio portion of the CYW89035 provides a receiver signal strength indicator (RSSI) signal to the baseband, so that the controller can 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.

1.4.3 Local Oscillator

A local oscillator (LO) generation provides fast frequency hopping (1600 hops/second) across the 79 maximum available channels. The CYW89035 uses an internal loop filter.

1.4.4 Calibration

The CYW89035 radio transceiver features a self-contained automated calibration scheme. No user interaction is required during normal operation or during manufacturing to provide optimal performance. Calibration compensates for filter, matching network, and amplifier gain and phase characteristics to yield radio performance within 2% of what is optimal. Calibration takes process and temperature variations into account, and it occurs transparently during normal operation and hop setting times.

1.5 Peripheral Transport Unit

1.5.1 Broadcom Serial Communications Interface

The CYW89035 provides a 2-pin master BSC to communicate with peripherals such as track-ball or touch-pad modules, and motion tracking ICs used in mouse devices. The BSC interface is compatible with I²C slave devices. BSC does not support multimaster capability or flexible wait-state insertion by either master or slave devices.

The following transfer clock rates are supported by BSC:

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

The following transfer types are supported by BSC:

- Read (Up to 8 bytes can be read.)
- Write (Up to 8 bytes can be written.)
- Read-then-Write (Up to 8 bytes can be read and up to 8 bytes can be written.)
- Write-then-Read (Up to 8 bytes can be written and up to 8 bytes can be read.)

Hardware controls the transfers, requiring minimal firmware setup and supervision.

The clock pin (SCL) and data pin (SDA) are both open-drain I/O pins. Pull-up resistors external to the CYW89035 are required on both the SCL and SDA pins for proper operation.

1.6 UART Interface

The CYW89035 includes a UART interface for factory programming and 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 57600 bps to 6 Mbps. During initial boot, UART speeds may be limited to 750 kbps. The baud rate may be selected via a vendor-specific UART HCI command. The CYW89035 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.

The UART clock default setting is 24 MHz, and can be configured to run as high as 48 MHz to support up to 6 Mbps. The baud rate of the CYW89035 UART is controlled by two values. The first is a UART clock divisor (set in the DLBR register) that divides the UART clock by an integer multiple of 16. The second is a baud rate adjustment (set in the DHBR register) that is used to specify a number of UART clock cycles to stuff in the first or second half of each bit time. Up to eight UART cycles can be inserted into the first half of each bit time, and up to eight UART clock cycles can be inserted into the end of each bit time.

Table 2 contains example values to generate common baud rates with a 24 MHz UART clock.

Table 2. Common Baud Rate Examples, 24 MHz Clock

Baud Rate (bps)	Baud Rate Adjustment		Mode	Error (%)
	High Nibble	Low Nibble		
3M	0xFF	0xF8	High rate	0.00
2M	0xFF	0xF4	High rate	0.00
1M	0x44	0xFF	Normal	0.00
921600	0x05	0x05	Normal	0.16
460800	0x02	0x02	Normal	0.16
230400	0x04	0x04	Normal	0.16
115200	0x00	0x00	Normal	0.16
57600	0x00	0x00	Normal	0.16

Table 3 contains example values to generate common baud rates with a 48 MHz UART clock.

Table 3. Common Baud Rate Examples, 48 MHz Clock

Baud Rate (bps)	High Rate	Low Rate	Mode	Error (%)
6M	0xFF	0xF8	High rate	0
4M	0xFF	0xF4	High rate	0
3M	0x0	0xFF	Normal	0
2M	0x44	0xFF	Normal	0
1.5M	0x0	0xFE	Normal	0
1M	0x0	0xFD	Normal	0
921600	0x22	0xFD	Normal	0.16
230400	0x0	0xF3	Normal	0.16
115200	0x1	0xE6	Normal	-0.08
57600	0x1	0xCC	Normal	0.04

Support for changing the baud rate during normal HCI UART operation is included through a vendor-specific command that allows the host to adjust the contents of the baud rate registers.

The CYW89035 UART operates correctly with the host UART as long as the combined baud rate error of the two devices is within $\pm 5\%$.

1.7 Peripheral UART Interface

The CYW89035 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 CYW89035 can map the peripheral UART to any LHL GPIO. The peripheral UART clock is fixed at 24 MHz. Both TX and RX have a 256-byte FIFO (see Table 2 on page 9).

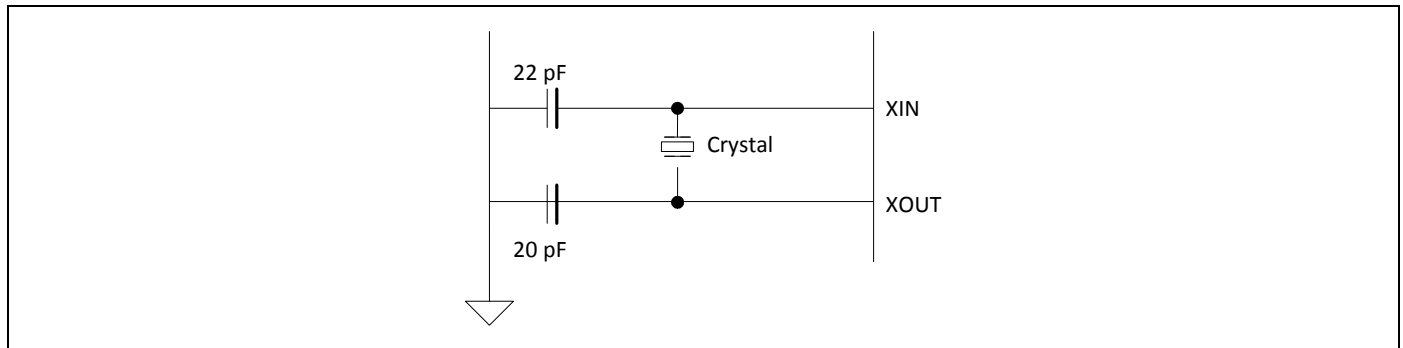
1.8 Clock Frequencies

The CYW89035 uses a 24 MHz crystal oscillator (XTAL).

1.8.1 Crystal Oscillator

The XTAL must have an accuracy of ± 20 ppm as defined by the Bluetooth specification. Two external load capacitors in the range of 5 pF to 30 pF are required to work with the crystal oscillator. The selection of the load capacitors is XTAL-dependent (see [Figure 4](#)).

Figure 4. Recommended Oscillator Configuration—12 pF Load Crystal



[Table 4](#) shows the recommended crystal specifications.

Table 4. Reference Crystal Electrical Specifications

Parameter	Conditions	Minimum	Typical	Maximum	Unit
Nominal frequency	—	—	24.000	—	MHz
Oscillation mode	—	Fundamental			—
Frequency tolerance	@25°C	—	± 10	—	ppm
Tolerance stability over temp	@0°C to +70°C	—	± 10	—	ppm
Equivalent series resistance	—	—	—	60	Ω
Load capacitance	—	—	10	—	pF
Operating temperature range	—	0	—	+70	°C
Storage temperature range	—	−40	—	+125	°C
Drive level	—	—	—	200	μ W
Aging	—	—	± 3	± 10	ppm/year
Shunt capacitance	—	—	—	2	pF

HID Peripheral Block

The peripheral blocks of the CYW89035 all run from a single 128 kHz low-power RC oscillator. The oscillator can be turned on at the request of any of the peripherals. If the peripheral is not enabled, it shall not assert its clock request line.

The keyboard scanner is a special case, in that it may drop its clock request line even when enabled, and then reassert the clock request line if a keypress is detected.

32 kHz Crystal Oscillator

Figure 5 shows the 32 kHz XTAL oscillator with external components and Table 5 on page 11 lists the oscillator's characteristics. It is a standard Pierce oscillator using a comparator with hysteresis on the output to create a single-ended digital output. The hysteresis was added to eliminate any chatter when the input is around the threshold of the comparator and is ~100 mV. This circuit can be operated with a 32 kHz or 32.768 kHz crystal oscillator or be driven with a clock input at similar frequency. The default component values are: $R1 = 10\text{ M}\Omega$ and $C1 = C2 = \sim 10\text{ pF}$. The values of $C1$ and $C2$ are used to fine-tune the oscillator.

Figure 5. 32 kHz Oscillator Block Diagram

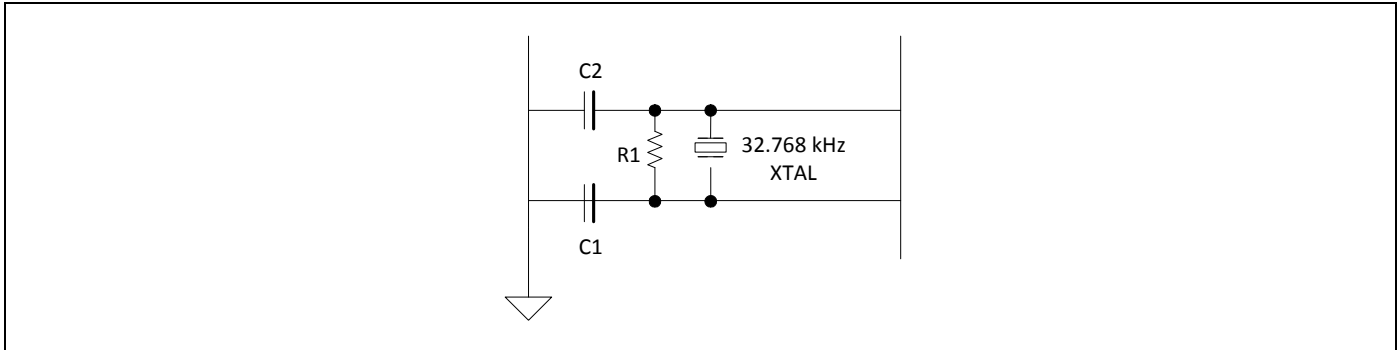


Table 5. XTAL Oscillator Characteristics

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	$\text{k}\Omega$
XTAL shunt capacitance	C_{shunt}	For crystal selection	—	—	1.3	pF

1.9 GPIO Ports

1.9.1 60-Pin QFN Package

The 60-pin QFN package GPIO ports are shown in Table 7 on page 19.

1.10 Keyboard Scanner

The keyboard scanner is designed to autonomously sample keys and store them into buffer registers without the need for the host microcontroller to intervene. The scanner has the following features:

- Ability to turn off its clock if no keys are pressed.
- Sequential scanning of up to 160 keys in an 8 × 20 matrix.
- Programmable number of columns from 1 to 20.
- Programmable number of rows from 1 to 8.
- 16-byte key-code buffer (can be augmented by firmware).
- 128 kHz clock that allows scanning of full 160-key matrix in about 1.2 ms.
- N-key rollover with selective 2-key lockout if ghost is detected.
- Keys are buffered until host microcontroller has a chance to read it, or until overflow occurs.
- Hardware debouncing and noise/glitch filtering.
- Low-power consumption. Single-digit μ A-level sleep current.

1.10.1 Theory of Operation

The key scan block is controlled by a state machine with the following states:

Idle

The state machine begins in the idle state. In this state, all column outputs are driven high. If any key is pressed, a transition occurs on one of the row inputs. This transition causes the 128 kHz clock to be enabled (if it is not already enabled by another peripheral) and the state machine to enter the scan state. Also in this state, an 8-bit row-hit register and an 8-bit key-index counter is reset to 0.

Scan

In the scan state, a row counter counts from 0 up to a programmable number of rows minus 1. After the last row is reached, the row counter is reset and the column counter is incremented. This cycle repeats until the row and column counters are both at their respective terminal count values. At that point, the state machine moves into the Scan-End state.

As the keys are being scanned, the key-index counter is incremented. This counter value is compared to the modifier key codes stored in RAM, or in the key-code buffer if the key is not a modifier key. It can be used by the microprocessor as an index into a lookup table of usage codes.

Also, as the n th row is scanned, the row-hit register is ORed with the current 8-bit row input values if the current column contains two or more row hits. During the scan of any column, if a key is detected at the current row, and the row-hit register indicates that a hit was detected in that same row on a previous column, then a ghost condition may have occurred, and a bit in the status register is set to indicate this.

Scan End

This state determines whether any keys were detected while in the scan state. If yes, the state machine returns to the scan state. If no, the state machine returns to the idle state, and the 128 kHz clock request signal is made inactive.

Note: The microcontroller can poll the key status register.

1.11 Mouse Quadrature Signal Decoder

The mouse signal decoder is designed to autonomously sample two quadrature signals commonly generated by an optomechanical mouse. The decoder has the following features:

- Three pairs of inputs for X, Y, and Z (typical scroll wheel) axis signals. Each axis has two options:
 - For the X axis, choose P2 or P32 as X0 and P3 or P33 as X1.
 - For the Y axis, choose P4 or P34 as Y0 and P5 or P35 as Y1.
 - For the Z axis, choose P6 or P36 as Z0 and P7 or P37 as Z1.
- Control of up to four external high-current GPIOs to power external optoelectronics:
 - Turn-on and turn-off time can be staggered for each HC-GPIO to avoid simultaneous switching of high currents and having multiple high-current devices on at the same time.
 - Sample time can be staggered for each axis.
 - Sense of the control signal can be active high or active low.
 - Control signal can be tristated for off condition or driven high or low, as appropriate.

1.11.1 Theory of Operation

The mouse decoder block has four 10-bit PWMs for controlling external quadrature devices and sampling the quadrature inputs at its core.

The GPIO signals may be used to control such items as LEDs, external ICs that may emulate quadrature signals, photodiodes, and photodetectors.

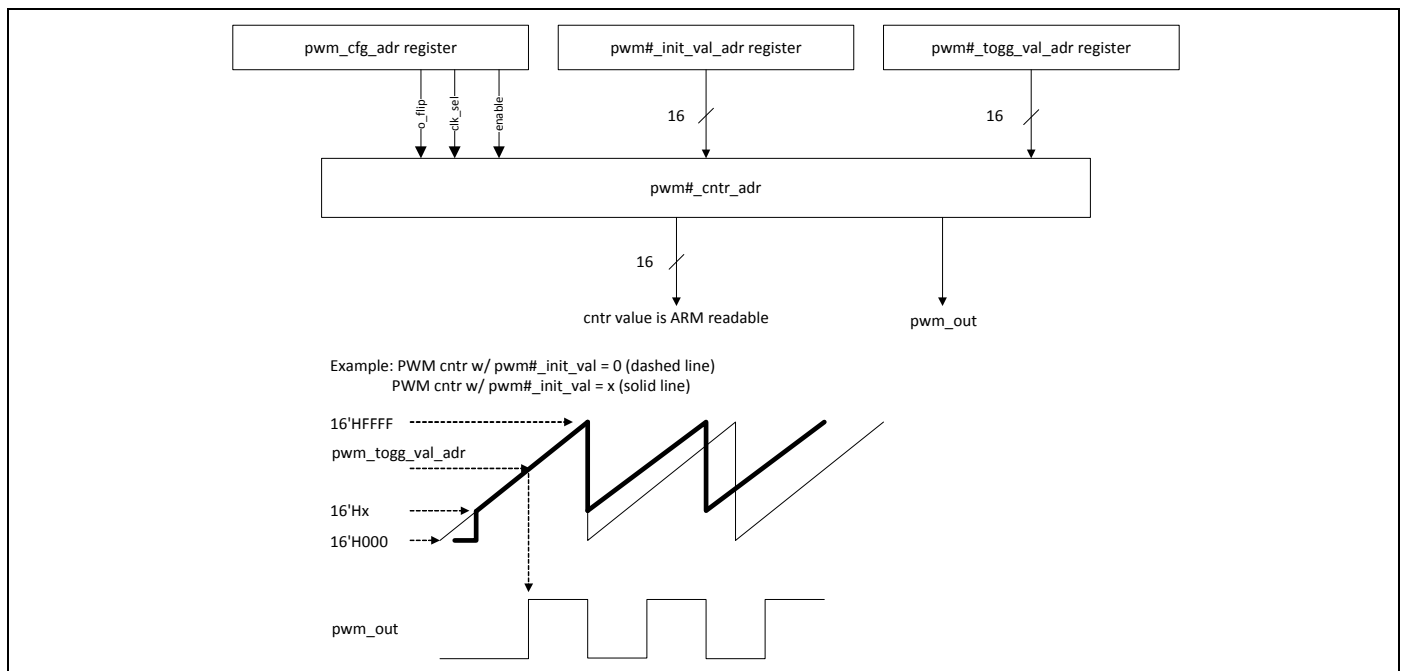
1.12 PWM

The CYW89035 has six internal PWMs. The PWM module consists of the following:

- 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 shared among PWM0–5 (read/write). This 18-bit register is used:
 - To configure each PWM channel
 - To select the clock of each PWM channel
 - To change the phase of each PWM channel

Figure 6 shows the structure of one PWM.

Figure 6. PWM Block Diagram



1.13 Triac Control

The CYW89035 includes hardware support for zero-crossing detection and trigger control for up to four triacs. The CYW89035 detects zero-crossing on the AC zero detection line and uses that to provide a pulse that is offset from the zero crossing. This allows the CYW89035 to be used in dimmer applications, as well as any other applications that require a control signal that is offset from an input event.

The zero-crossing hardware includes an option to suppress glitches.

1.14 Serial Peripheral Interface

The CYW89035 has two independent SPI interfaces, Both of which support single, dual, and quad mode SPI operations.

Either interface can be a master or a slave. Each interface has a 64-byte transmit buffer and a 64-byte receive buffer. To support more flexibility for user applications, the CYW89035 has optional I/O ports that can be configured individually and separately for each functional pin. The CYW89035 acts as an SPI master device that supports 1.8V or 3.3V SPI slaves. The CYW89035 can also act as an SPI slave device that supports a 1.8V or 3.3V SPI master.

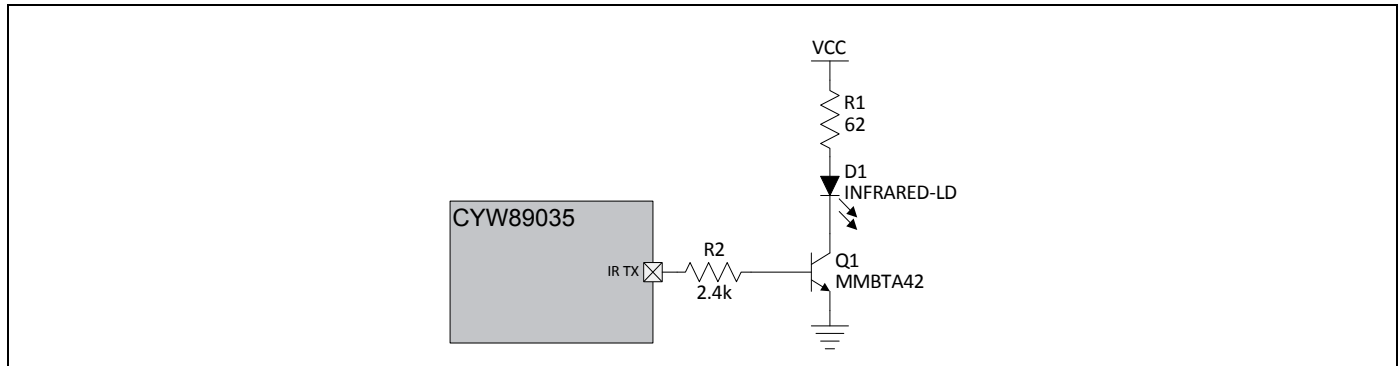
Note: SPI voltage depends on VDDO/VDDM; therefore, it defines the type of devices that can be supported.

1.15 Infrared Modulator

The CYW89035 includes hardware support for infrared TX. The hardware can transmit both modulated and unmodulated waveforms. For modulated waveforms, hardware inserts the desired carrier frequency into all IR transmissions. IR TX can be sourced from firmware-supplied descriptors, a programmable bit, or the peripheral UART transmitter.

If descriptors are used, they include IR on/off state and the duration between 1–32767 μ sec. The CYW89035 IR TX firmware driver inserts this information in a hardware FIFO and makes sure that all descriptors are played out without a glitch due to underrun (see Figure 7).

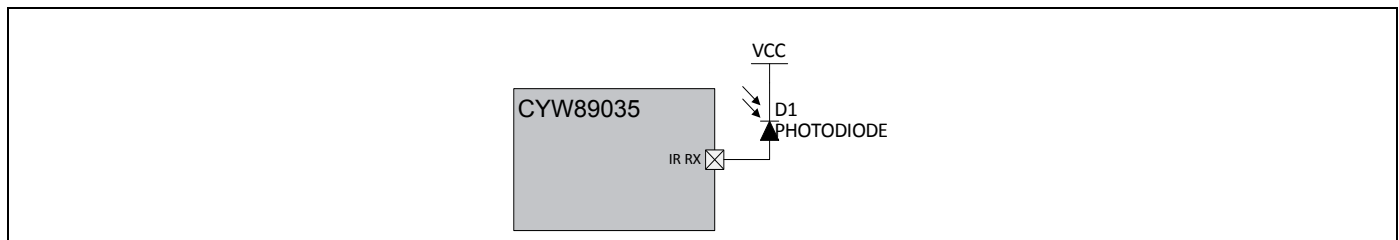
Figure 7. Infrared TX



1.16 Infrared Learning

The CYW89035 includes hardware support for infrared learning. The hardware can detect both modulated and unmodulated signals. For modulated signals, the CYW89035 can detect carrier frequencies between 10 kHz and 500 kHz, and the duration that the signal is present or absent. The CYW89035 firmware driver supports further analysis and compression of the learned signal. The learned signal can then be played back through the CYW89035 IR TX subsystem (see Figure 8).

Figure 8. Infrared RX



1.17 Security Engine

The CYW89035 includes a hardware security accelerator that greatly decreases the time required to perform typical security operations. These functions include:

- 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)
- Generic modular math functions

1.18 Power Management Unit

The Power Management Unit (PMU) provides power management features that can be invoked by software through power management registers or packet-handling in the baseband core.

1.18.1 RF Power Management

The BBC generates power-down control signals for the transmit path, receive path, PLL, and power amplifier to the 2.4 GHz transceiver, which then processes the power-down functions accordingly.

1.18.2 Host Controller Power Management

Power is automatically managed by the firmware based on input device activity. As a power-saving task, the firmware controls the disabling of the on-chip regulator when in HIDOFF (deep sleep) mode.

1.18.3 BBC Power Management

There are several low-power operations for the BBC:

- Physical layer packet handling turns RF on and off dynamically within packet TX and RX.
- Bluetooth-specified low-power connection mode. While in these low-power connection modes, the CYW89035 runs on the Low Power Oscillator and wakes up after a predefined time period.

The CYW89035 automatically adjusts its power dissipation based on user activity. The following power modes are supported:

- Active mode
- Idle mode
- Sleep mode
- HIDOFF (deep sleep) mode

The CYW89035 transitions to the next lower state after a programmable period of user inactivity. When user activity resumes, the CYW89035 immediately enters Active mode.

In HIDOFF mode, the CYW89035 baseband and core are powered off by disabling power to VDDC_OUT and PAVDD. The VDDO domain remains powered up and will turn the remainder of the chip on when it detects user events. This mode minimizes chip power consumption and is used for longer periods of inactivity.

2. Pin Assignments and GPIOs

2.1 Pin Assignments

Table 6. Pin Assignments

Pin Name	QFN Pin	I/O	Power Domain	Description
Microphone				
MIC_AVDD	48	I	MIC_AVDD	Microphone supply
MICBIAS	45	I	MIC_AVDD	Microphone bias supply
MICN	47	I	MIC_AVDD	Microphone negative input
MICP	46	I	MIC_AVDD	Microphone positive input
Baseband Supply				
BT_VDDO	36	I	VDDO	I/O pad power supply
BT_VDDC	37	I	VDDC	Baseband core power supply
LHL_VDDO	60	I	VDDO	LHL PAD power supply: can be tied to BT_VDDO
RF Power Supply				
BT_PAVDD2P5	26	I	PAVDD2P5	PA supply
BT_PLLVDD1P2	31	I	PLLVD1P2	RFPLL and crystal oscillator supply
BT_VCOVDD1P2	29	I	VCOVDD1P2	VCO supply
BT_IFVDD1P2	28	I	IFVDD1P2	IFPLL power supply
Onboard LDOs				
DIGLDO_VDDIN1P5	25	I	–	Internal digital LDO input and feedback pin of switching regulator (CLOCK).
RFLDO_VDDIN1P5	24	I	–	RF LDO input
RFLDO_VDDOUT	23	O	–	RF LDO output
PALDO_VDDIN_5V	19	I	–	PA LDO input
PALDO_VDDOUT3V	20	O	–	PA LDO output
SR_VDDBAT3V	22	I	–	Core buck input
SR_VLX	21	O	–	Core buck output
Ground Pins				
HS-VSS	H	I	VSS	Digital ground
UART				
UART_CTS_N	44	I, PU	VDDO	CTS for HCI UART interface: NC if unused.
UART_RTS_N	43	O, PU	VDDO	RTS for HCI UART interface. NC if unused.
UART_RXD	41	I	VDDO	UART serial input. Serial data input for the HCI UART interface.
UART_TXD	42	O, PU	VDDO	UART serial input. Serial data input for the HCI UART interface.
Serial Peripheral Interface				
SPI_MISO	40	I	VDDO	SPI Master In Slave Out
SPI_MOSI	39	O	VDDO	SPI Master Out Slave In
SPI_CSN	38	O	VDDO	SPI Chip Select
SPI_CLK	35	O	VDDO	SPI Clock

Table 6. Pin Assignments (Cont.)

Pin Name	QFN Pin	I/O	Power Domain	Description
Crystal				
BT_XTALI	32	I	PLLVD1P2	Crystal oscillator input: see “Crystal Oscillator” on page 10 for options
BT_XTALO	33	O	PLLVD1P2	Crystal oscillator output
XTALI_32K	50	I	VDDO	Low-power oscillator input
XTALO_32K	49	O	VDDO	Low-power oscillator output
Others				
DEFAULT_STRAP	18	I	VDDO	Connect to VDDO
BT_HOST_WAKE	34	O	VDDO	Host wake-up. This is a signal from the Bluetooth device to the host indicating that the Bluetooth device requires attention. <ul style="list-style-type: none"> ■ Asserted: Host device must wake up or remain awake. ■ Deasserted: Host device may sleep when sleep criteria is met. The polarity of this signal is software configurable and can be asserted high or low.
BT_RF	27	I/O	PAVDD2P5	RF antenna port
JTAG_SEL	17	–	–	ARM JTAG debug mode control: connect to GND for all applications
RST_N	16	I	VDDO	Active-low system reset with open-drain output and internal pull-up resistor
NC	30			Leave floating

2.2 GPIO Pin Descriptions

Table 7. GPIO Pin Descriptions^{ab}

Pin Number	Pin Name	Default Direction	POR State	Power Domain	Default Alternate Function Description
8	P0	Input	Floating	VDDO	<ul style="list-style-type: none"> ■ GPIO: P0 ■ Keyboard scan input (row): KSI0 ■ A/D converter input 29 ■ Peripheral UART: puart_tx ■ SPI_1: MOSI (master and slave) ■ IR_RX ■ 60Hz_main <p>Note: Not available during TM1 = 1.</p>
9	P1	Input	Floating	VDDO	<ul style="list-style-type: none"> ■ GPIO: P1 ■ Keyboard scan input (row): KSI1 ■ A/D converter input 28 ■ Peripheral UART: puart_rts ■ SPI_1: MISO (master and slave) ■ IR_TX
52	P2	Input	Floating	VDDO	<ul style="list-style-type: none"> ■ GPIO: P2 ■ Keyboard scan input (row): KSI2 ■ Quadrature: QDX0 ■ Peripheral UART: puart_rx ■ SPI_1: SPI_CS (slave only) ■ SPI_1: MOSI (master only)
53	P3	Input	Floating	VDDO	<ul style="list-style-type: none"> ■ GPIO: P3 ■ Keyboard scan input (row): KSI3 ■ Quadrature: QDX1 ■ Peripheral UART: puart_cts ■ SPI_1: SPI_CLK (master and slave)

Table 7. GPIO Pin Descriptions^{ab} (Cont.)

Pin Number	Pin Name	Default Direction	POR State	Power Domain	Default Alternate Function Description
54	P4	Input	Floating	VDDO	<ul style="list-style-type: none"> ■ GPIO: P4 ■ Keyboard scan input (row): KSI4 ■ Quadrature: QDY0 ■ Peripheral UART: puart_rx ■ SPI_1: MOSI (master and slave) ■ IR_TX
55	P5	Input	Floating	VDDO	<ul style="list-style-type: none"> ■ GPIO: P5 ■ Keyboard scan input (row): KSI5 ■ Quadrature: QDY1 ■ Peripheral UART: puart_tx ■ SPI_1: MISO (master and slave) ■ BSC: SDA
56	P6	Input	Floating	VDDO	<ul style="list-style-type: none"> ■ GPIO: P6 ■ Keyboard scan input (row): KSI6 ■ Quadrature: QDZ0 ■ Peripheral UART: puart_rts ■ SPI_1: SPI_CS (slave only) ■ 60Hz_main
57	P7	Input	Floating	VDDO	<ul style="list-style-type: none"> ■ GPIO: P7 ■ Keyboard scan input (row): KSI7 ■ Quadrature: QDZ1 ■ Peripheral UART: puart_cts ■ SPI_1: SPI_CLK (master and slave) ■ BSC: SCL

Table 7. GPIO Pin Descriptions^{ab} (Cont.)

Pin Number	Pin Name	Default Direction	POR State	Power Domain	Default Alternate Function Description
58	P8	Input	Floating	VDDO	<ul style="list-style-type: none"> ■ GPIO: P8 ■ Keyboard scan output (column): KSO0 ■ A/D converter input 27 ■ External T/R switch control: ~tx_pd
1	P9	Input	Floating	VDDO	<ul style="list-style-type: none"> ■ GPIO: P9 ■ Keyboard scan output (column): KSO1 ■ A/D converter input 26 ■ External T/R switch control: tx_pd
2	P10	Input	Floating	VDDO	<ul style="list-style-type: none"> ■ GPIO: P10 ■ Keyboard scan output (column): KSO2 ■ A/D converter input 25 ■ External PA ramp control: ~PA_Ramp
3	P11	Input	Floating	VDDO	<ul style="list-style-type: none"> ■ GPIO: P11 ■ Keyboard scan output (column): KSO3 ■ A/D converter input 24
4	P12	Input	Floating	VDDO	<ul style="list-style-type: none"> ■ GPIO: P12 ■ Keyboard scan output (column): KSO4 ■ A/D converter input 23
5	P13	Input	Floating	VDDO	<ul style="list-style-type: none"> ■ GPIO: P13 ■ Keyboard scan output (column): KSO5 ■ A/D converter input 22 ■ PWM3 ■ Triac control 3

Table 7. GPIO Pin Descriptions^{ab} (Cont.)

Pin Number	Pin Name	Default Direction	POR State	Power Domain	Default Alternate Function Description
59	P14	Input	Floating	VDDO	<ul style="list-style-type: none"> ■ GPIO: P14 ■ Keyboard scan output (column): KSO6 ■ A/D converter input 21 ■ PWM2 ■ Triac control 4
50	P15	Input	Floating	VDDO	<ul style="list-style-type: none"> ■ GPIO: P15 ■ Keyboard scan output (column): KSO7 ■ A/D converter input 20 ■ IR_RX ■ 60Hz_main
51	P16	Input	Floating	VDDO	<ul style="list-style-type: none"> ■ GPIO: P16 ■ Keyboard scan output (column): KSO8 ■ A/D converter input 19
13	P26 PWM0	Input	Floating	VDDO	<ul style="list-style-type: none"> ■ GPIO: P26 ■ Keyboard scan output (column): KSO18 ■ SPI_1: SPI_CS (slave only) ■ Optical control output: QOC0 ■ Triac control 1 Current: 16 mA sink
14	P27 PWM1	Input	Floating	VDDO	<ul style="list-style-type: none"> ■ GPIO: P27 ■ Keyboard scan output (column): KSO19 ■ SPI_1: MOSI (master and slave) ■ Optical control output: QOC1 ■ Triac control 2 Current: 16 mA sink

Table 7. GPIO Pin Descriptions^{ab} (Cont.)

Pin Number	Pin Name	Default Direction	POR State	Power Domain	Default Alternate Function Description
6	P28 PWM2	Input	Floating	VDDO	<ul style="list-style-type: none"> ■ GPIO: P28 ■ Optical control output: QOC2 ■ A/D converter input 11 ■ LED1 Current: 16 mA sink
7	P29 PWM3	Input	Floating	VDDO	<ul style="list-style-type: none"> ■ GPIO: P29 ■ Optical control output: QOC3 ■ A/D converter input 10 ■ LED2 Current: 16 mA sink
15	P32	Input	Floating	VDDO	<ul style="list-style-type: none"> ■ GPIO: P32 ■ A/D converter input 7 ■ Quadrature: QDX0 ■ SPI_1: SPI_CS (slave only) ■ Auxiliary clock output: ACLK0 ■ Peripheral UART: puart_tx
10	P34	Input	Floating	VDDO	<ul style="list-style-type: none"> ■ GPIO: P34 ■ A/D converter input 5 ■ Quadrature: QDY0 ■ Peripheral UART: puart_rx ■ External T/R switch control: tx_pd
11	P38	Input	Floating	VDDO	<ul style="list-style-type: none"> ■ GPIO: P38 ■ A/D converter input 1 ■ SPI_1: MOSI (master and slave) ■ IR_TX

Table 7. GPIO Pin Descriptions^{ab} (Cont.)

Pin Number	Pin Name	Default Direction	POR State	Power Domain	Default Alternate Function Description
12	P39	Input	Floating	VDDO	<ul style="list-style-type: none"> ■ GPIO: P39 ■ SPI_1: SPI_CS (slave only) ■ External PA ramp control: PA_Ramp ■ 60Hz_main

- a. All GPIOs are supermux. All GPIOs can be programmed for any alternative functions. For example, key scan, SPI, I²C, IR_TX, quadrature, peripheral UART, ADC, etc.
b. During power-on reset, all inputs are disabled.

Table 8. GPIO Supermux Input/Output Function List

Function	Function	Function	Function
SPI_1: CLK	SPI_1: CS	SPI_1: MOSI	SPI_1: MISO
SPI_1: INT	SPI_2: CLK	SPI_2: CS	SPI_2: MOSI
SPI_2: MISO	SPI_2: INT	SPI_3: CLK	SPI_3: CS
SPI_3: MOSI	SPI_3: MISO	SPI_3: INT	UART_RX
UART_CTS	UART_TX	UART_RTS	PUART_RX
PUART_CTS	PUART_TX	PUART_RTS	SCL
SDA	SCL2	SDA2	PCM_IN
PCM_OUT	PCM_CLK	PCM_SYNC	I2S_DO
I2S_DI	I2S_WS	I2S_CLK	IR_TX
kso0	kso1	kso2	kso3
kso4	kso5	kso6	kso7
kso8	kso9	kso10	kso11
kso12	kso13	kso14	kso15
kso16	kso17	kso18	kso19
PWM0	PWM1	PWM2	PWM3
PWM4	PWM5	ack0	ack1
pa_ramp	tx_pd	~tx_pd	–

2.3 Ball Map

The 60-pin QFN package is shown in Figure 9.

Figure 9. CYW89035 60-Pin QFN Package

		LHL_VDDO	P14	P8	P7	P6	P5	P4	P3	P2	P16	P15/XTALI_32K	XTALO_32K	MIC_AVDD	MICN	MICP		
1	P9	<div><div>H</div><div>HS-VSS</div></div>														45	MICBIAS	
2	P10															44	UART_CTS_N	
3	P11															43	UART_RTS_N	
4	P12															42	UART_TXD	
5	P13															41	UART_RXD	
6	P28															40	SPI_MISO	
7	P29															39	SPI_MOSI	
8	P0															38	SPI_CSN	
9	P1															37	BT_VDDC	
10	P34															36	BT_VDDO	
11	P38															35	SPI_CLK	
12	P39															34	BT_HOST_WAKE	
13	P26															33	BT_XTALO	
14	P27															32	BT_XTALI	
15	P32															31	BT_PLLVDD1P2	
		RST_N	JTAG_SEL	DEFAULT_STRAP	PALDO_VDDIN_5V	PALDO_VDDOUT3V	SR_VLX	SR_VDDBAT3V	RFLDO_VDDOUT	RFLDO_VDDIN1P5	DIGLDO_VDDIN1P5	BT_PAVDD2P5	BT_RF	BT_IFVDD1P2	BT_VCOVDD1P2	---		
		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30		

Note: Pin H is a ground pin that is used for the signal name HS-VSS.

3. Specifications

3.1 Electrical Characteristics

Table 9 shows the maximum electrical rating for voltages referenced to VDD pin.

Table 9. Absolute Maximum Voltages

Requirement Parameter	Specification			Unit
	Min.	Nom.	Max.	
Ambient Temperature of Operation	–	25		°C
Storage temperature	–40	–	150	°C
ESD Tolerance HBM	–2000	–	2000	V
ESD Tolerance MM	–100	–	100	V
ESD Tolerance CDM	–500	–	500	V
Latch-up	–	200	–	mA
VDD IO	1.62	3.3	3.6	V
VDD RF	1.14	1.2	1.26	V
VDDBAT3V	1.62	3.0	3.63	V
DIGLDO_VDDIN1P5	1.2	1.35	1.5	V
RFLDO_VDDIN1P5	1.3	1.35	1.5	V
PALDO_VDDIN_5V	2.5	3.0	3.63	V

3.1.1 Core Buck Regulator

Table 10. Core Buck Regulator

Parameter	Conditions	Min.	Typ.	Max.	Unit
Input supply voltage DC, VBAT	DC voltage range	1.62	3.0	3.63	V
CBUCK output current	–	–	–	65	mA
Output voltage range	Programmable, 30mV/step default = 1.35V (bits = 0000)	1.2	1.35	1.5	V
Output voltage DC accuracy	Includes load and line regulation: Before trimming	–4	–	+4	%
	After trimming	–2	–	+2	%
LPOM ripple voltage, static	Measured with 20 MHz bandwidth limit, static load. Max ripple based on VBAT = 3V, Vout = 1.35V Inductor: 0806 inch-size, Tmax = 1 mm, 2.2 μ H $\pm$ 25%, DCR = 114 m Ω $\pm$ 20%, ACR<1 Ω (for frequency <1 MHz) Capacitor: 1 μ F $\pm$ 10%, 6.3V, 0603 inch, X5R, MLCC capacitor + board total-ESR < 20 m Ω	–	–	30	mVpp
Efficiency (high load)	10–50 mA load current, Vout = 1.35V, Vbat = 3V @25°C Inductor: 0806 inch-size, Tmax = 1 mm, 2.2 μ H $\pm$ 25%, DCR = 114 m Ω $\pm$ 20%, ACR<1 Ω (for frequency<1 MHz) Capacitor: 1 μ F $\pm$ 10%, 6.3V, 0603 inch, X5R, MLCC capacitor +board total-ESR < 20 m Ω	–	85	–	%
Efficiency (low load)	1–5 mA load current, Vout = 1.35V, Vbat = 3V @25°C Inductor: 0806 inch-size, Tmax = 1 mm, 2.2 μ H $\pm$ 25%, DCR = 114 m Ω $\pm$ 20%, ACR<1 Ω (for frequency<1 MHz) Capacitor: 1 μ F $\pm$ 10%, 6.3V, 0603 inch, X5R, MLCC capacitor +board total-ESR < 20 m Ω	–	80	–	%
Startup time	See Table 11 on page 29 .	–	–	–	–
External inductor L	2.2 μ H $\pm$ 25%, DCR = 114 m Ω $\pm$ 20%, ACR<1 Ω (for frequency<1 MHz)	–	2.2	–	μ H
External output capacitor, Cout	1 μ F $\pm$ 10%, 6.3V, 0603 inch, X5R, MLCC capacitor +board total-ESR < 20 m Ω	0.7	1	1.1	μ F
External input capacitor, Cin	For SR_VDDBAT 3V pin Ceramic, X5R, 0402, ESR<30 m Ω at 4 MHz, $\pm$ 20%, 6.3V, 4.7 μ F	0.7	4.7	5.64	μ F
Input supply voltage ramp-up time	0 to 3.3V	40	–	–	μ s

- Minimum capacitor value refers to residual capacitor value after taking into account part-to-part tolerance, DC-bias, temperature, and aging.
- Maximum capacitor value refers to the total capacitance seen at a node where the capacitor is connected. This also includes any decoupling capacitors connected at the load side, if any.

3.1.2 Digital LDO

Table 11. Digital LDO

Parameter	Conditions	Min.	Typ.	Max.	Unit
Input supply voltage, V_{in}	Minimum $V_{in} = V_o + 0.12V$ requirement must be met under maximum load.	1.2	1.35	1.6	V
Nominal output voltage, V_o	Internal default bit setting	–	1.1	–	V
Output voltage programmability	Range	0.9	–	1.25	V
	Step size	–	10	–	mV
	Accuracy at any step (including line/load regulation) before trimming	–4	–	+4	%
	Accuracy at any step (including line/load regulation) after trimming	–2	–	+2	%
Dropout voltage	At maximum load	–	–	120	mV
Output current	DC load	0.2 ^a	–	40	mA
Output loading capacitor	Internal, including the decoupling capacitor to be placed next to the load and the equivalent loading capacitor by the core.	4	–	10	nF
Quiescent current	At no load, excluding main bandgap I_q	–	90	120	μA
Line regulation	V_{in} from ($V_o + 0.12V$) to 1.5V; 40 mA load	–	–	5	mV/V
Load regulation	Load from 1 mA to 25 mA; V_{in} ($V_o + 0.12V$)	–	0.025	0.045	mV/mA
Leakage current	In full power-down mode or bypass mode:	–	0.05	0.2	μA
	Junction temperature: 25°C Junction temperature: 125°C	–	1.1	5.0	μA
PSRR	@1 kHz, V_{in} , $V_o + 0.12V$ Output cap of 4 nF~10 nF	40	–	–	dB
LDO turn-on time	LDO turn-on time when balance of chip is up	–	–	22	μs
External input capacitor	Only use an external input capacitor at VDD_DIGLDO1P5 pin if it is not supplied from CBUCK output.	–	1	2.2	μF

a. By default, an internal loading of ~0.2 mA resides inside the LDO. This is to ensure the LDO is stable with zero loading from the core. After the core is up, digital logic can disable this internal loading by setting `i_ldo_cntl[8:7]` to 00.

3.1.3 PA LDO

Table 12. PA LDO

Specification	Notes	Min.	Typ.	Max.	Units
Input supply voltage	Min = $3.0 + 0.1V = 3.1V$ Dropout voltage requirement must be met under max load for performance specs	2.5	3.3	3.63	V
Output current	Junction temperature 125°C	–	–	50	mA
Output voltage (Vo)	Default = 3.0V	2.4	3.0	3.4	V
Dropout voltage	At max. load	–	–	100	mV
Output voltage DC accuracy	Include line/load regulation	–5		+5	%
Quiescent current	No load	–	8	–	μA
Line regulation	Vin from (Vo + 0.1V) to 4.8V, max load	–0.2		+0.2	%Vo/V
Load regulation	Load from 1 mA to 50 mA		0.02	0.05	%Vo/mA
Leakage current	In Power-Down mode at 25°C junction temp	–	0.3	–	μA
PSRR	Vbat 3.6V, Vo = 2.5V, Co = 1 μF, max load, 100 Hz to 100 kHz	20	–		dB
LDO turn-on time	LDO turn-on time when the rest of the chip is up	–	–	100	μs
In-rush current during turn-on	From its output cap in the fully-discharged state	–	–	70	mA
External output capacitor (Co)	Ceramic, X5R, 0402, (ESR: 30m–200 mΩ), ±10%, 6.3V	0.44	1	–	μF
External input capacitor	For PALDO_VDDIN_5V pin Ceramic, X5R, 0402, (ESR: 30m-200 mΩ), ±10%, 6.3V	–	1	–	μF
Operating temperature	Junction temperature	–40	50	125	°C

3.1.4 RFLDO

Table 13. RF LDO

Parameter	Conditions	Min.	Typ.	Max.	Unit
Input supply voltage, V_{in}	Min $V_{in} = V_o + 0.15V = 1.35V$ (for $V_o = 1.2V$) Dropout voltage requirement must be met under maximum load.	1.2	1.35	1.5	V
Nominal output voltage, V_o	Internal default bit setting 000	–	1.2	–	V
Output voltage programmability	Range	1.1	–	1.275	V
	Step size	–	25	–	mV
	Accuracy at any step (including line/load regulation)	–4	–	+4	%
	Accuracy at any step (including line/load regulation) after trimming	–2	–	+2	%
Dropout voltage	At maximum load	–	–	150	mV
Output current	TBD	0.1	–	25	mA
Quiescent current	No load	–	44	–	μA
	Maximum load	–	200	–	μA
Line regulation	V_{in} from ($V_o+0.15V$) to 1.5V; 25 mA load	–	–	5.5	mV/V
Load regulation	Load from 1 mA to 25 mA; $V_{in} \geq (V_o+0.15V)$	–	0.025	0.045	mV/mA
Load step error	Load step from 1 mA–25 mA in 1 μs and 25 mA–1 mA in 1 μs; $V_{in}(V_o+0.15V)$; $C_o = 2.2 \mu F$	–	–	35	mV
Leakage current	Power-down junction temperature: 85°C	–	–	10	μA
Output noise	@30 kHz, 25 mA load, $C_o = 2.2 \mu F$	–	–	60	nV/√Hz
	@100 kHz, 25 mA load, $C_o = 2.2 \mu F$	–	–	35	nV/√Hz
PSRR	@1kHz, Input > 1.35V, $C_o = 2.2 \mu F$, $V_o = 1.2V$	20	–	–	dB
LDO turn-on time	LDO turn-on time when balance of chip is up	–	140	180	μs
In-rush current	$V_{in} = V_o+0.15V$ to 1.5V, $C_o = 2.2 \mu F$, no load	–	–	100	mA
External output capacitor, C_o	Total ESR (trace/cap): 5 m–240 mΩ	0.5	2.2	4.7	μF
External input capacitor	Only use an external input capacitor at RFLDO ₋ VDDIN1P5 pin if it is not supplied from CBUCK output.	–	1	2.2	μF

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

3.1.5 Digital I/O Characteristics

Table 14. Digital I/O Characteristics

Characteristics	Symbol	Minimum	Typical	Maximum	Unit
Input low voltage (VDDO = 3.3V)	V_{IL}	–	–	0.8	V
Input high voltage (VDDO = 3.3V)	V_{IH}	2.0	–	–	V
Input low voltage (VDDO = 1.8V)	V_{IL}	–	–	0.6	V
Input high voltage (VDDO = 1.8V)	V_{IH}	1.1	–	–	V
Output low voltage	V_{OL}	–	–	0.4	V
Output high voltage	V_{OH}	VDDO – 0.4V	–	–	V
Input low current	I_{IL}	–	–	1.0	μA
Input high current	I_{IH}	–	–	1.0	μA
Output low current (VDDO = 3.3V, V_{OL} = 0.4V)	I_{OL}	–	–	2.0	mA
Output high current (VDDO = 3.3V, V_{OH} = 2.9V)	I_{OH}	–	–	4.0	mA
Output high current (VDDO = 1.8V, V_{OH} = 1.4V)	I_{OH}	–	–	2.0	mA
Input capacitance	C_{IN}	–	–	0.4	pF

3.1.6 Current Consumption

In [Table 15](#), current consumption measurements are taken at VBAT with the assumption that VBAT is connected to VDDIO and LDOIN.

Table 15. BLE Current Consumption

Operational Mode	Conditions	Typical	Max.	Unit
Receiving	Receiver and baseband are both operating, 100% ON.	8	–	mA
Transmitting	Transmitter and baseband are both operating, 100% ON.	18	–	mA
Advertising	1.28s direct advertising in low power idle mode	30	–	μA
Connecting	1-second connection interval in low power idle mode	25	–	μA
HIDOFF (Deep Sleep)	–	1	–	μA

3.2 RF Specifications

Note:

■ Table 16 and Table 17 on page 34 apply to single-ended industrial temperatures. Unused inputs are left open.

Table 16. Receiver RF Specifications

Parameter	Conditions	Minimum	Typical ^a	Maximum	Unit
General					
Frequency range	–	2402	–	2480	MHz
RX sensitivity ^b	–	–	–91.5	–	–
Maximum input	GFSK, 1 Mbps	–	–	–20	dBm
Interference Performance					
TBD					
Out-of-Band Blocking Performance (CW)^c					
30 MHz–2000 MHz	0.1% BER	–	–10.0	–	dBm
2000–2399 MHz	0.1% BER	–	–27	–	dBm
2498–3000 MHz	0.1% BER	–	–27	–	dBm
3000 MHz–12.75 GHz	0.1% BER	–	–10.0	–	dBm
Intermodulation Performance^d					
BT, Df = 4 MHz	–	–39.0	–	–	dBm
Spurious Emissions^e					
30 MHz to 1 GHz	–	–	–	–62	dBm
1 GHz to 12.75 GHz	–	–	–	–47	dBm
65 MHz to 108 MHz	FM RX	–	–147	–	dBm/Hz
746 MHz to 764 MHz	CDMA	–	–147	–	dBm/Hz
851–894 MHz	CDMA	–	–147	–	dBm/Hz
925–960 MHz	EDGE/GSM	–	–147	–	dBm/Hz
1805–1880 MHz	EDGE/GSM	–	–147	–	dBm/Hz
1930–1990 MHz	PCS	–	–147	–	dBm/Hz
2110–2170 MHz	WCDMA	–	–147	–	dBm/Hz

a. Typical operating conditions are 1.22V operating voltage and 25°C ambient temperature.

b. The receiver sensitivity is measured at BER of 0.1% on the device interface.

c. Meets this specification using front-end band pass filter.

d. $f_0 = -64$ dBm Bluetooth-modulated signal, $f_1 = -39$ dBm sine wave, $f_2 = -39$ dBm Bluetooth-modulated signal, $f_0 = 2f_1 - f_2$, and $|f_2 - f_1| = n \cdot 1$ MHz, where n is 3, 4, or 5. For the typical case, $n = 4$.

e. Includes baseband radiated emissions.

Table 17. Transmitter RF Specifications (TBD)

Parameter	Conditions	Minimum	Typical	Maximum	Unit
General					
Frequency range	–	2402	–	2480	MHz
Class 1: GFSK TX power	–	–	10	–	dBm
Power control step	–	2	4	8	dB
Out-of-Band Spurious Emissions					
30 MHz to 1 GHz	–	–	–	–36.0 ^a	dBm
1 GHz to 12.75 GHz	–	–	–	–30.0 ^{a, b}	dBm
1.8 GHz to 1.9 GHz	–	–	–	–47.0	dBm
5.15 GHz to 5.3 GHz	–	–	–	–47.0	dBm

a. Maximum value is the value required for Bluetooth qualification.

b. Meets this spec using a front-end band-pass filter.

Table 18. BLE RF Specifications

Parameter	Conditions	Minimum	Typical	Maximum	Unit
Frequency range	N/A	2402	–	2480	MHz
RX sense ^a	GFSK, 0.1% BER, 1 Mbps	–	–94.5	–	dBm
TX power ^b	N/A	–	9	–	dBm
Mod Char: Delta F1 average	N/A	225	255	275	kHz
Mod Char: Delta F2 max ^c	N/A	99.9	–	–	%
Mod Char: Ratio	N/A	0.8	0.95	–	%

a. Dirty TX is Off.

b. The BLE TX power can be increased to compensate for front-end losses such as BPF, diplexer, switch, etc. The output is capped at 12 dBm out. The BLE TX power at the antenna port cannot exceed the 10 dBm EIRP specification limit.

c. At least 99.9% of all delta F2 max frequency values recorded over 10 packets must be greater than 185 kHz.

3.3 Timing and AC Characteristics

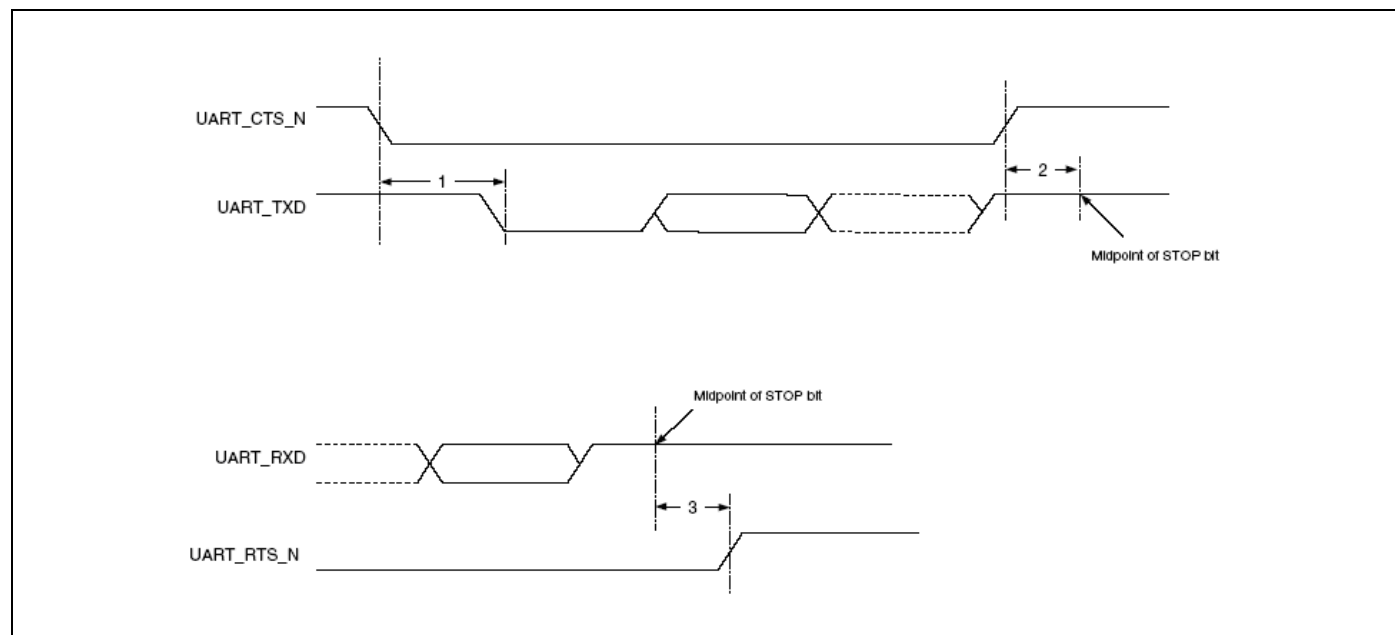
In this section, use the numbers listed in the Reference column of each table to interpret the following timing diagrams.

3.3.1 UART Timing

Table 19. UART Timing Specifications

Reference	Characteristics	Min.	Max.	Unit
1	Delay time, UART_CTS_N low to UART_TXD valid	–	24	Baud out cycles
2	Setup time, UART_CTS_N high before midpoint of stop bit	–	10	ns
3	Delay time, midpoint of stop bit to UART_RTS_N high	–	2	Baud out cycles

Figure 10. UART Timing



3.3.2 SPI Timing

The SPI interface can be clocked up to 12 MHz.

Table 20 and Figure 11 show the timing requirements when operating in SPI Mode 0 and 2.

Table 20. SPI Mode 0 and 2

Reference	Characteristics	Min.	Max.	Unit
1	Time from master assert SPI_CSN to first clock edge	45	–	ns
2	Hold time for MOSI data lines	12	$\frac{1}{2}$ SCK	ns
3	Time from last sample on MOSI/MISO to slave deassert SPI_INT	0	100	ns
4	Time from slave deassert SPI_INT to master deassert SPI_CSN	0	–	ns
5	Idle time between subsequent SPI transactions	1 SCK	–	ns

Figure 11. SPI Timing, Mode 0 and 2

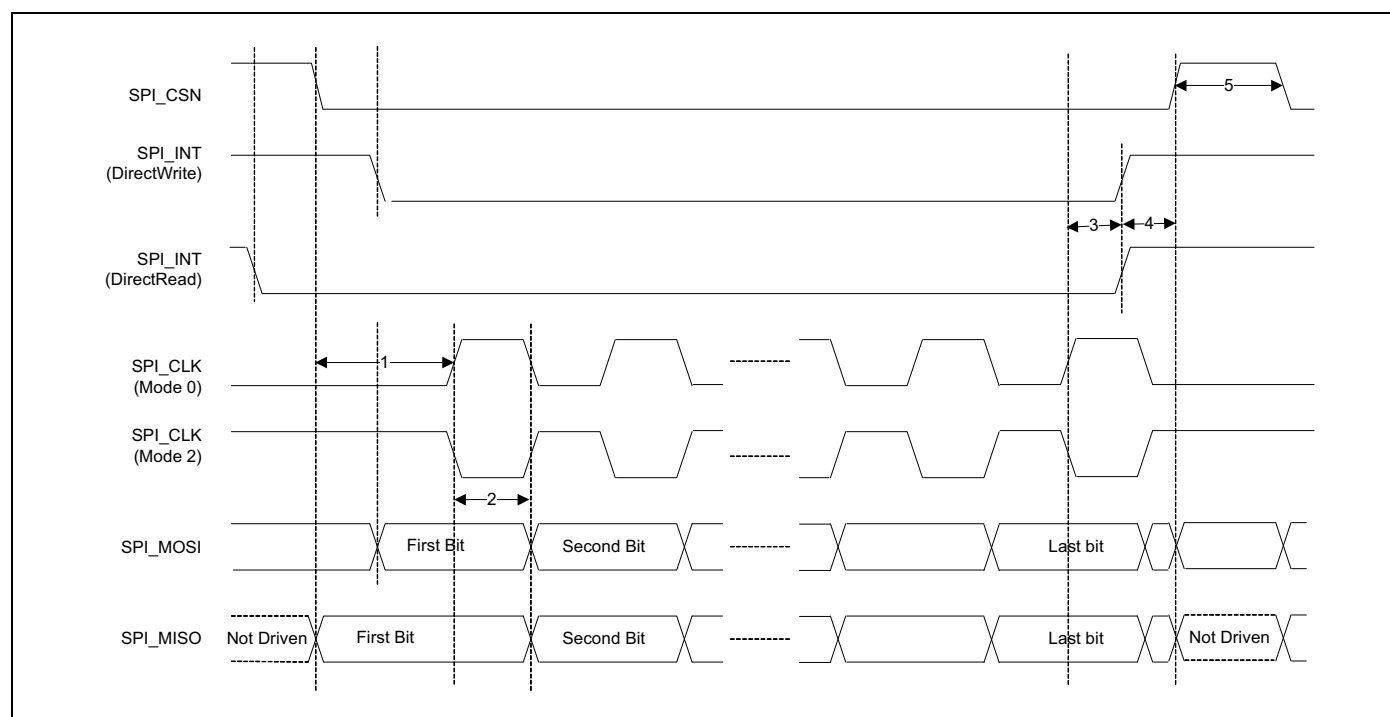
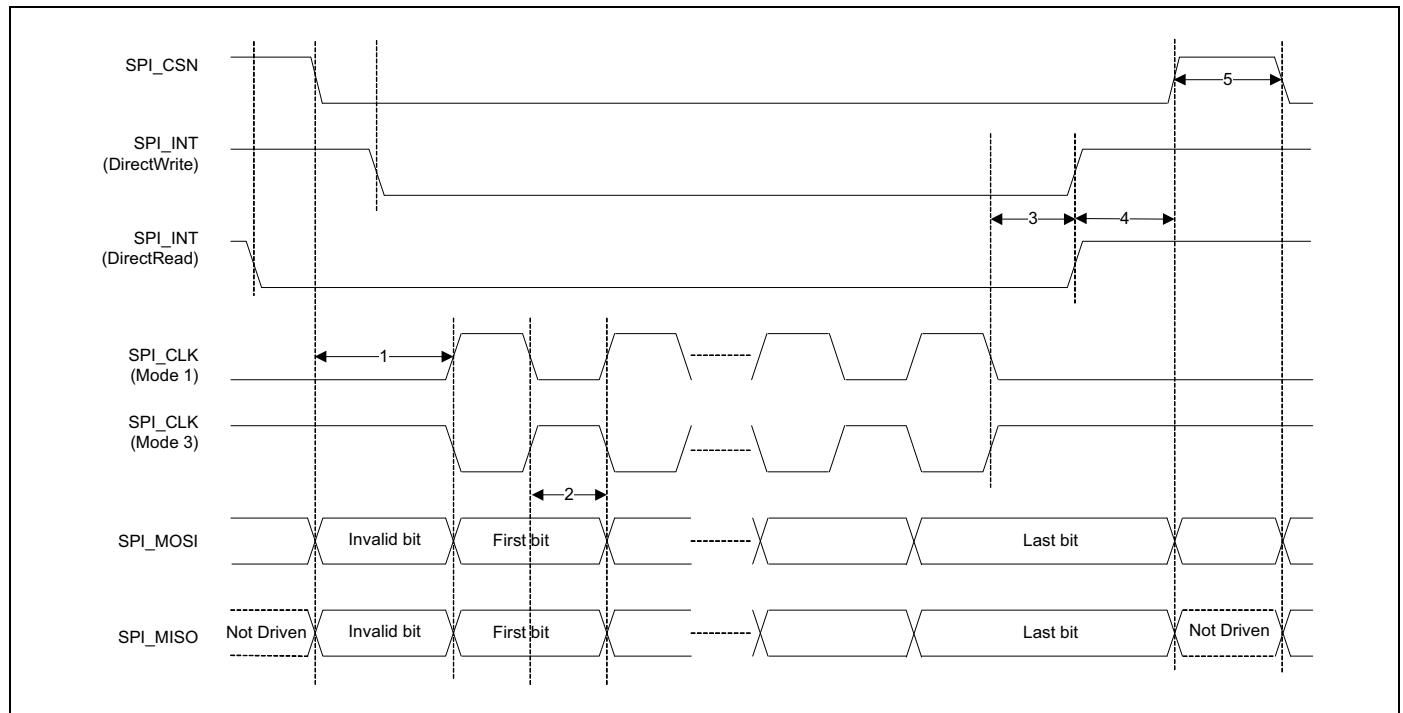


Table 21 and Figure 12 show the timing requirements when operating in SPI Mode 1 and 3.

Table 21. SPI Mode 1 and 3

Reference	Characteristics	Min.	Max.	Unit
1	Time from master assert SPI_CSN to first clock edge	45	–	ns
2	Hold time for MOSI data lines	12	$\frac{1}{2}$ SCK	ns
3	Time from last sample on MOSI/MISO to slave deassert SPI_INT	0	100	ns
4	Time from slave deassert SPI_INT to master deassert SPI_CSN	0	–	ns
5	Idle time between subsequent SPI transactions	1 SCK	–	ns

Figure 12. SPI Timing, Mode 1 and 3



3.3.3 BSC Interface Timing

The specifications in [Table 22](#) references [Figure 13](#).

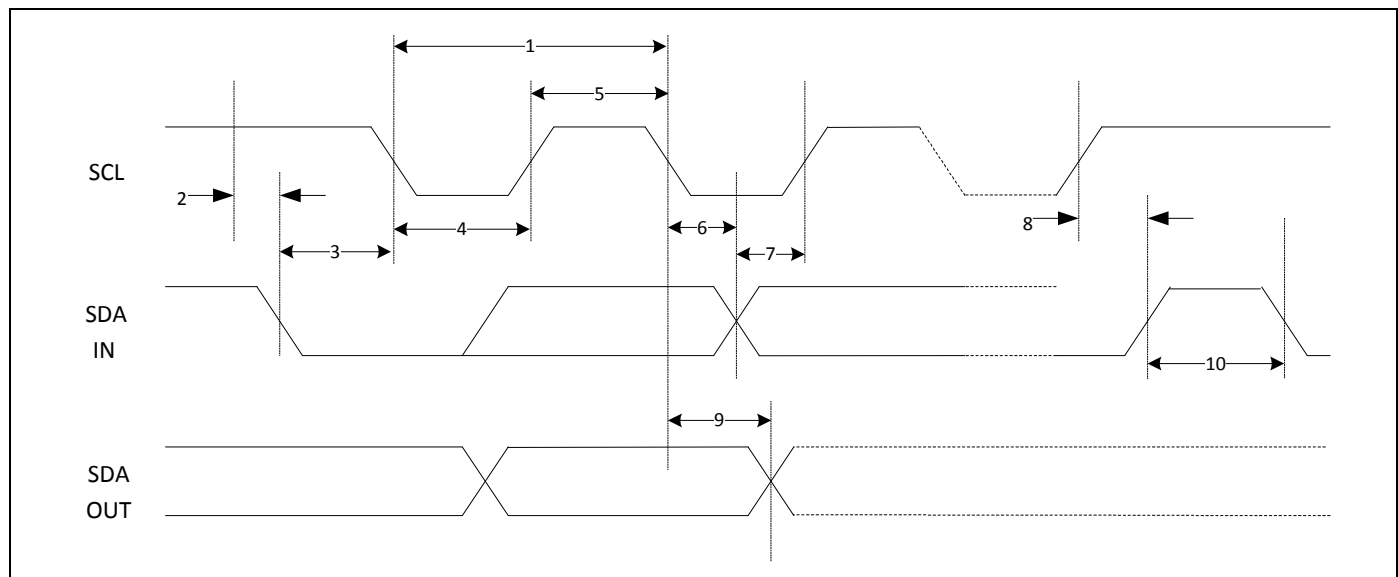
Table 22. BSC Interface Timing Specifications (up to 1 MHz)

Reference	Characteristics	Minimum	Maximum	Unit
1	Clock frequency	–	100	kHz
			400	
			800	
			1000	
2	START condition setup time	650	–	ns
3	START condition hold time	280	–	ns
4	Clock low time	650	–	ns
5	Clock high time	280	–	ns
6	Data input hold time ^a	0	–	ns
7	Data input setup time	100	–	ns
8	STOP condition setup time	280	–	ns
9	Output valid from clock	–	400	ns
10	Bus free time ^b	650	–	ns

a. As a transmitter, 125 ns of delay is provided to bridge the undefined region of the falling edge of SCL to avoid unintended generation of START or STOP conditions.

b. Time that the CBUS must be free before a new transaction can start.

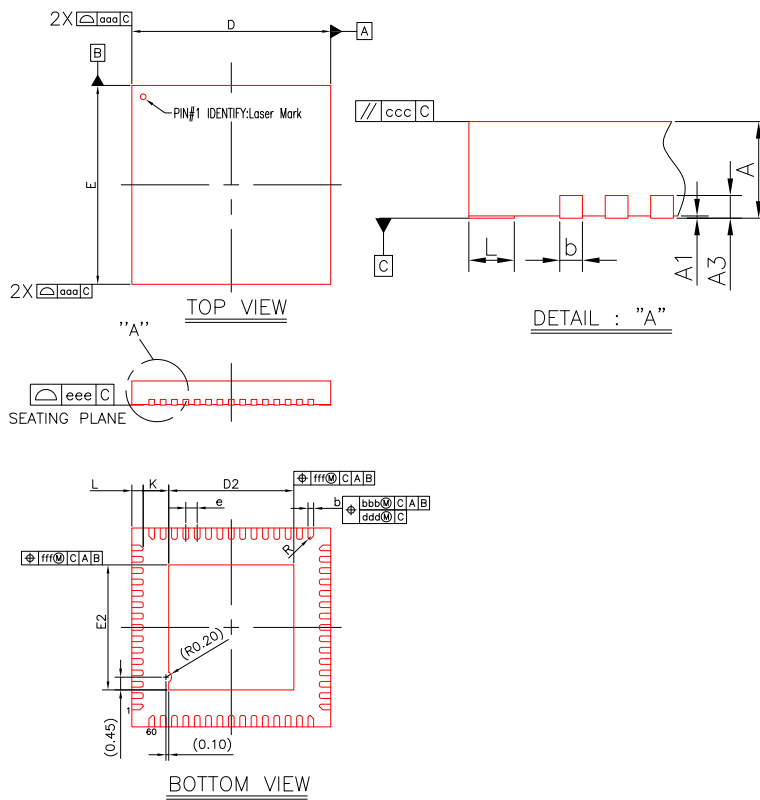
Figure 13. BSC Interface Timing Diagram



4. Mechanical Information

4.1 Package Diagram

Figure 14. CYW89035 7 mm × 7 mm 60-Pin QFN Package



Symbol	Dimension in mm			Dimension in inch		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.80	0.85	0.90	0.031	0.033	0.035
A1	0.00	0.02	0.05	0.000	0.001	0.002
A3	0.20 REF			0.008 REF		
b	0.15	0.20	0.25	0.006	0.008	0.010
D	6.90	7.00	7.10	0.272	0.276	0.280
E	6.90	7.00	7.10	0.272	0.276	0.280
D2	4.30	4.40	4.50	0.169	0.173	0.177
E2	4.30	4.40	4.50	0.169	0.173	0.177
e	0.40 BSC			0.016 BSC		
L	0.30	0.40	0.50	0.012	0.016	0.020
K	0.60	---	---	0.024	---	---
R	0.075	---	0.125	0.003	---	0.005
aaa	0.10			0.004		
bbb	0.07			0.003		
ccc	0.10			0.004		
ddd	0.05			0.002		
eee	0.08			0.003		
fff	0.10			0.004		

NOTE:

1. CONTROLLING DIMENSION : MILLIMETER
2. REFERENCE DOCUMENT: JEDEC MO-220.

4.2 Tray Packaging Specification

The CYW89035 QFN package and tray dimensions are annotated in Figure 15 and defined in Table 23 and Table 24 on page 40.

Figure 15. QFN Package and Tray Dimensions

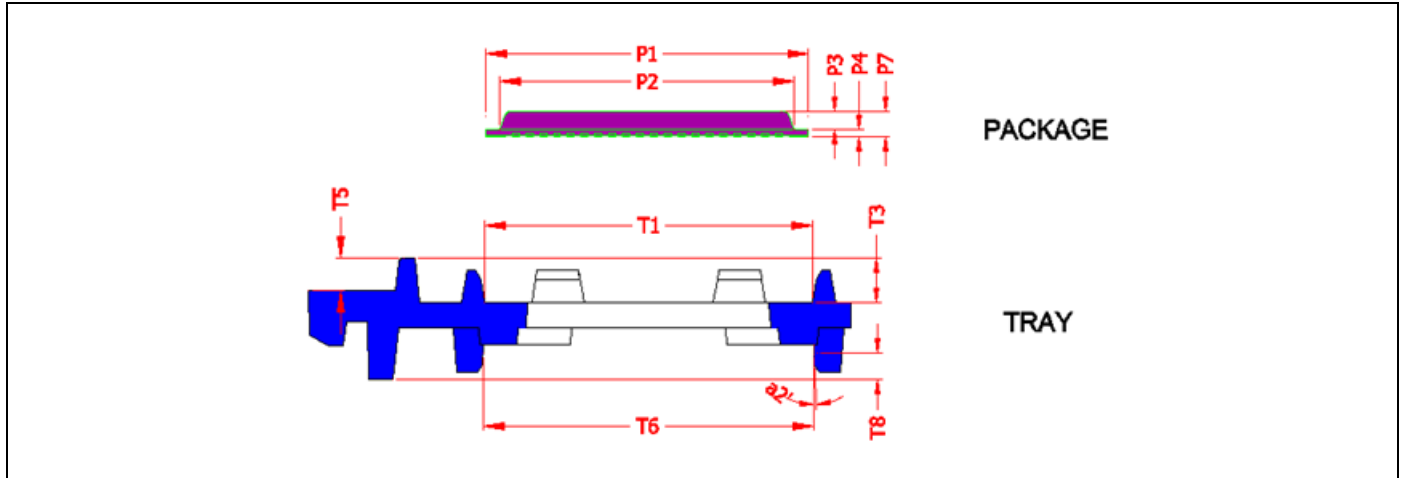


Table 23. QFN Package Dimensions and Tolerances

Parameter	Description	Nom.	Min.	Max.	± Tol.	Unit
P1	Package size	7	6.9	7.1	0.1	mm
P2	Top hat width	0	0	0	–	mm
P3	Top hat height	0	0	0	–	mm
P4	Substrate thickness	0.85	0.8	0.9	0.05	mm
P7	Total thickness (P3 + P4)	0.85	0.8	0.9	0.05	mm

Table 24. QFN Tray Dimensions and Tolerances

Parameter	Description	Nom.	Min.	Max.	± Tol.	Unit
T1	Top pocket size	7.25	7.17	7.33	0.08	mm
T3	Top pocket depth	1.75	1.5	2	0.25	mm
T5	Stacking height	2	1.87	2.13	0.13	mm
T6	Bottom pocket size	7.25	7.17	7.33	0.08	mm
T8	Bottom pocket depth	1.650	1.52	1.78	0.13	mm
a2	Bottom pocket relief wall draft angle	5	5	5	0	Degrees
T10	Packing value between two stacking trays	0.2	0.07	0.33	0.13	mm

5. Ordering Information

Table 25. Ordering Information

Part Number	Package	Ambient Operating Temperature
CYW89035CWMLG	60-pin QFN	–40°C to 105°C

A. Appendix: Acronyms and Abbreviations

The following list of acronyms and abbreviations may appear in this document.

Term	Description
ADC	analog-to-digital converter
AFH	adaptive frequency hopping
AHB	advanced high-performance bus
APB	advanced peripheral bus
APU	audio processing unit
ARM7TDMI-S™	Acorn RISC Machine 7 Thumb instruction, Debugger, Multiplier, Ice, Synthesizable
BSC	Broadcom Serial Control
BTC	Bluetooth controller
COEX	coexistence
DFU	device firmware update
DMA	direct memory access
EBI	external bus interface
HCI	Host Control Interface
HV	high voltage
IDC	initial digital calibration
IF	intermediate frequency
IRQ	interrupt request
JTAG	Joint Test Action Group
LCU	link control unit
LDO	low drop-out
LHL	lean high land
LPO	low power oscillator
LV	LogicVision™
MIA	multiple interface agent
PDM	pulse density modulation
PLL	phase locked loop
PMU	power management unit
POR	power-on reset
PWM	pulse width modulation
QD	quadrature decoder
RAM	random access memory
RC oscillator	A resistor-capacitor oscillator is a circuit composed of an amplifier, which provides the output signal, and a resistor-capacitor network, which controls the frequency of the signal.
RF	radio frequency
ROM	read-only memory
RX/TX	receive, transmit
SPI	serial peripheral interface
SW	software

Term	Description
SWD	serial wire debug
UART	universal asynchronous receiver/transmitter
UPI	μ-processor interface
WD	watchdog

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Revision	ECN	Orig. of Change	Submission Date	Description of Change
**	—	—	04/22/2015	89035-DS100-R: Initial release
*A	—	—	11/06/2015	89035-DS101-R: Updated: • Table 15 on page 32
*B	5474879	UTSV	10/14/2016	Updated to Cypress template

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