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Continuity of document content

The fact that Infineon offers the following product as part of the Infineon product portfolio does not lead to any changes to this document. Future revisions will occur when appropriate, and any changes will be set out on the document history page.

Continuity of ordering part numbers

Infineon continues to support existing part numbers. Please continue to use the ordering part numbers listed in the datasheet for ordering.

CY7C652148

USB-SPI Single Channel Bridge Controller

Features

- USB 2.0-compliant, Full-Speed (12 Mbps)
  - Supports communication driver class (CDC), personal health care device class (PHDC), and vendor-device class
  - Battery charger detection (BCD) compliant with USB Battery Charging Specification, Rev. 1.2 (Peripheral Detect only)
  - Integrated USB termination resistors
- Single-channel configurable SPI interface
  - Data rate up to 3 MHz for SPI master and 1 MHz for SPI slave
  - Data width: 4 bits to 16 bits
  - 256 bytes for each transmit and receive buffer
  - Supports Motorola, TI, and National SPI modes
- General-purpose input/output (GPIO) pins: 6
- 512-byte flash for storing configuration parameters
- Configuration utility (Windows) to configure the following:
  - Vendor ID (VID), Product ID (PID), and Product and Manufacturer descriptors
  - SPI
  - Charger detection
  - GPIO
- Driver support for VCOM and DLL
  - Windows 10: 32- and 64-bit versions
  - Windows 8.1: 32- and 64-bit versions
  - Windows 8: 32- and 64-bit versions
  - Windows 7: 32- and 64-bit versions
  - Windows Vista: 32- and 64-bit versions
  - Windows XP: 32- and 64-bit versions
  - Mac OS-X: 10.6, 10.7
  - Linux: Kernel version 2.6.35 onwards.
- Clocking: Integrated 48-MHz clock oscillator
- Supports bus-/self-powered configurations
- USB Suspend mode for low power
- Operating voltage: 1.71 to 5.5 V
- Operating temperature
  - Commercial: 0 °C to 70 °C
  - Industrial: –40 °C to 85 °C
- ESD protection: 2.2-kV HBM
- RoHS-compliant package
  - 24-pin QFN (4.0 mm × 4.0 mm, 0.55 mm, 0.5 mm pitch)
- Ordering part number
  - CY7C652148-24LTXI
  - CY7C652148-24LTXIT

Applications

- Medical/healthcare devices
- Point-of-Sale (POS) terminals
- Test and measurement system
- Gaming systems
- Set-top box PC-USB interface
- Industrial
- Networking
- Enabling USB connectivity in legacy peripherals

Functional Description

For a complete list of related resources, click here.

USB-Compliant

The USB-SPI Single Channel Bridge Controller is fully compliant with the USB 2.0 Specification and Battery Charging Specification v1.2.

USB Serial Bridge Controller Family

USB Serial bridge Controllers are a family of configurable products for most common applications requiring no firmware changes.

Configuration utility is provided to Configure USB-VID, USB-PID, USB Product and Manufacturer Descriptors. The same configuration utility can be used to configure UART, I²C, SPI, Battery Charger Detection, GPIOs, Power mode, and so on.

Figure 1. USB Serial Bridge Controller Family

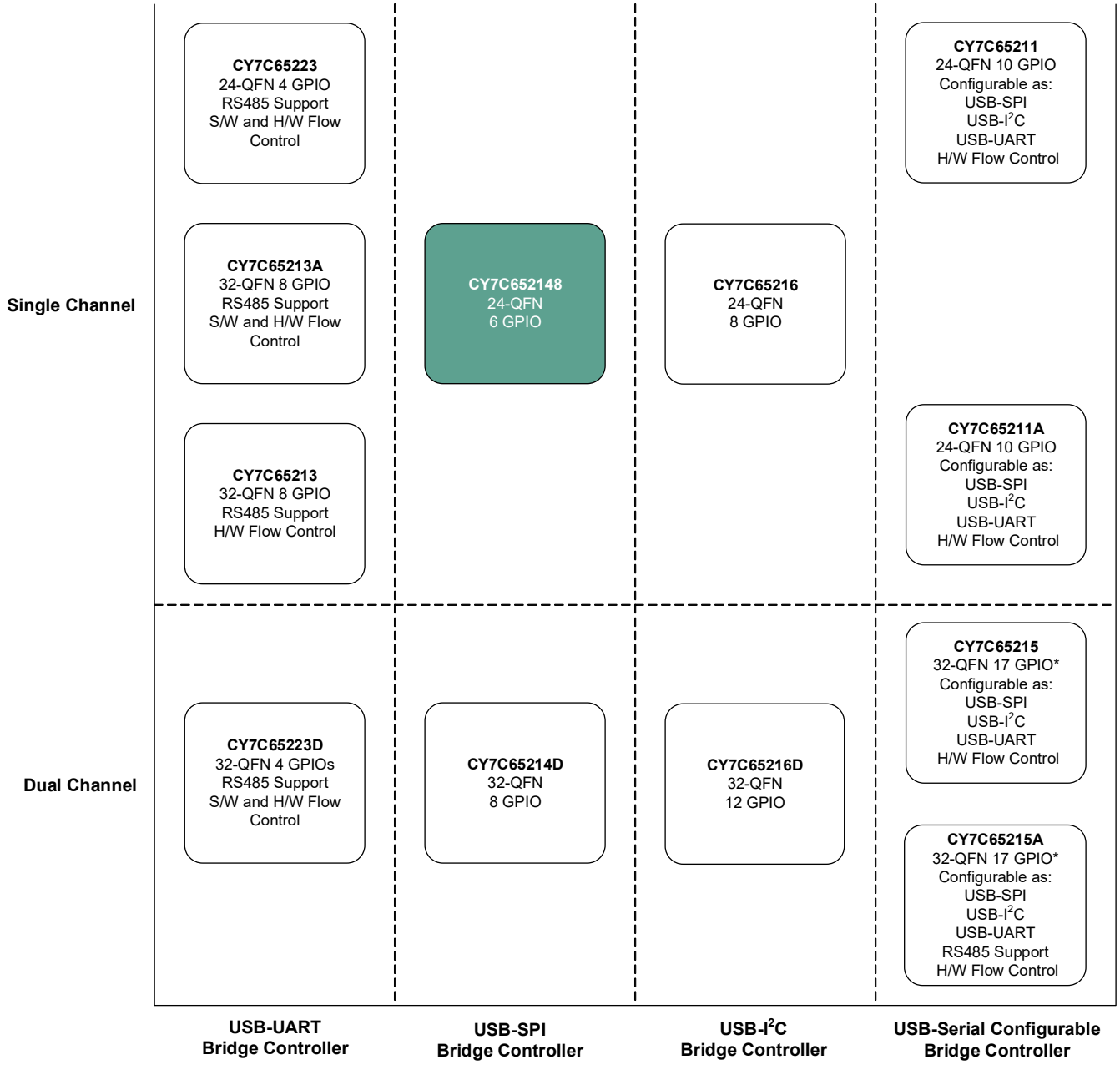


Table 1. USB Serial Family Feature Comparison

MPN	# of Channels	GPIO	USB-UART				USB-SPI		USB-I²C
			RS485 Support	Software Flow Control	Hardware Flow Control	UART Pins**	SPI Serial Data Width (bit)	SPI Master/ Slave	I²C Master/ Slave
CY7C65213	1	8	N	N	Y	8	–	–	–
CY7C65213A	1	8	Y	N	Y	8	–	–	–
CY7C65223	1	4	Y	Y	Y	2 / 4 / 6	–	–	–
CY7C65223D	2	4	Y	Y	Y	2 / 4 / 6 / 8	–	–	–
CY7C652148	**1**	**6**	**–**	**–**	**–**	**–**	**4-16 bits**	**Master/Slave**	**–**
CY7C65214D	2	8	–	–	–	–	4-16 bits	Master/Slave	–
CY7C65216	1	8	–	–	–	–	–	–	Master/Slave
CY7C65216D	2	12	–	–	–	–	–	–	Master/Slave
CY7C65211	1	10*	N	N	Y	2 / 4 / 6	4-16 bits	Master/Slave	Master/Slave
CY7C65211A	1	10*	Y	N	Y	2 / 4 / 6	4-16 bits	Master/Slave	Master/Slave
CY7C65215	2	17*	N	N	Y	2 / 4 / 6	4-16 bits	Master/Slave	Master/Slave
CY7C65215A	2	17*	Y	N	Y	2 / 4 / 6 / 8	4-16 bits	Master/Slave	Master/Slave

Legend

* Represents the total GPIO count offered by the part. This count can dynamically change based on UART / SPI / I²C pin configuration.
** UART Pins

**UART Pins	UART Signal
2	RxD and TxD
4	RxD, TxD, RTS#, CTS#
6	RxD, TxD, RTS#, CTS#, DTR#, DSR#
8	RxD, TxD, RTS#, CTS#, DTR#, DSR#, DCD#, RI#

Table 2. Default Serial Channel Configuration

MPN	# of Channels	GPIO	USB Protocol	USB- UART		USB-SPI	USB-I²C
				Is RS485 Enabled	UART Pins	SPI Master/ Slave	I²C Master/ Slave
CY7C65213	1	4	CDC**	N	8	–	–
CY7C65213A	1	4	CDC**	N	8	–	–
CY7C65223	1	4	CDC**	Y	4	–	–
CY7C65223D	2	4	CDC**	Y	4	–	–
CY7C652148	**1**	**6**	**Vendor*** **	**–**	**–**	**Master**	**–**
CY7C65214D	2	8	Vendor***	–	–	Master	–
CY7C65216	1	8	Vendor***	–	–	–	Slave
CY7C65216D	2	12	Vendor***	–	–	–	Master
CY7C65211	1	3	CDC**	N	6	–	–
CY7C65211A	1	3	CDC**	N	6	–	–
CY7C65215	2	4	CDC**	N	6	–	–
CY7C65215A	2	4	CDC**	N	6	–	–

** USB CDC Protocol allows the USB host Operating System to detect the device as Virtual COM Port Device.
*** USB Vendor Protocol allows the USB host operating system to detect the device as general USB device. This device is accessible using Cypress Application Library.

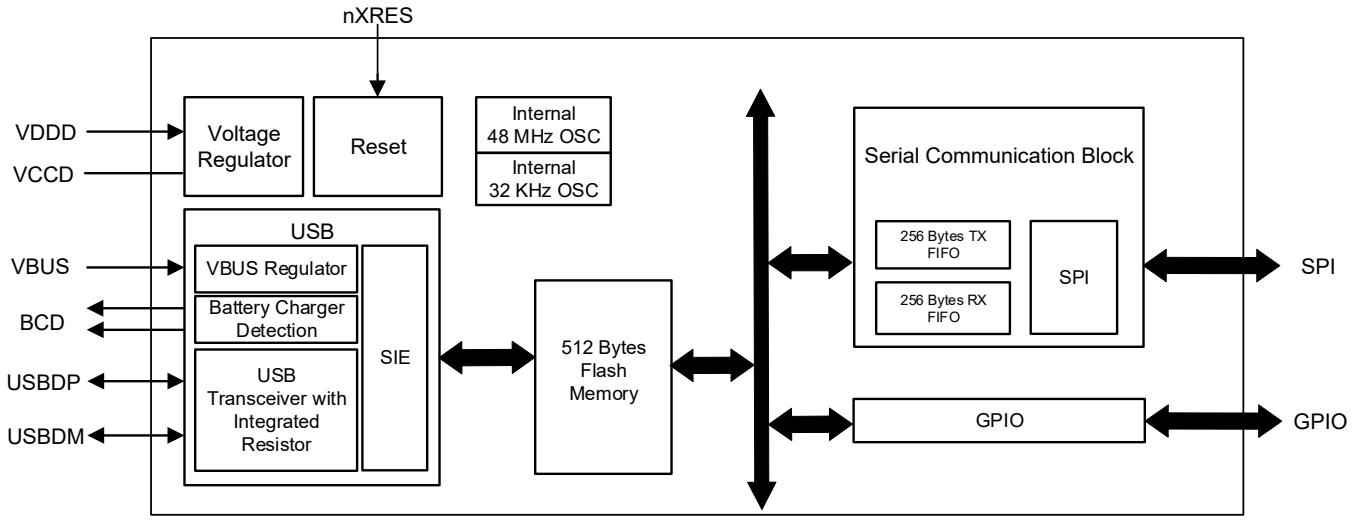
More Information

Cypress provides a wealth of data at www.cypress.com to help you to select the right device for your design, and to help you to quickly and effectively integrate the device into your design. For a comprehensive list of resources, see the document USB-Serial Bridge Controller Product Overview.

- Overview: USB Portfolio, USB Roadmap
- USB 2.0 Product Selectors: USB-Serial Bridge Controller, USB to UART Controller (Gen I)
- Knowledge Base Articles: Cypress offers a large number of USB knowledge base articles covering a broad range of topics, from basic to advanced level. Recommended knowledge base articles for getting started with USB-Serial Bridge Controller are:
  - KBA85909 – Key Features of the Cypress® USB-Serial Bridge Controller
  - KBA85920 – USB-UART and USB-Serial
  - KBA85921 – Replacing FT232R with CY7C65213 USB-UART LP Bridge Controller
  - KBA85913 – Voltage supply range for USB-Serial
  - KBA89355 – USB Serial Cypress Default VID and PID
  - KBA92641 – USB-Serial Bridge Controller Managing I/Os using API
  - KBA92442 – Non-Standard Baud Rates in USB-Serial Bridge Controllers
  - KBA91366 – Binding a USB-Serial Device to a Microsoft® CDC Driver
  - KBA92551 – Testing a USB-Serial Bridge Controller Configured as USB-UART with Linux®
  - KBA91299 – Interfacing an External I^2C Device with the CYUSBS234/236 DVK

  For complete list of knowledge base articles, click here.
- Code Examples: USB Full-Speed
- Development Kits:
  - CYUSBS232, Cypress USB-UART LP Reference Design Kit
  - CYUSBS234, Cypress USB-Serial (Single Channel) Development Kit
  - CYUSBS236, Cypress USB-Serial (Dual Channel) Development Kit
- Models: IBIS

Block Diagram



Contents

Functional Overview

The CY7C652148 is a Full-Speed USB controller that enables seamless PC connectivity for peripherals with serial interface. CY7C652148 is BCD compliant with the USB Battery Charging Specification, Rev. 1.2. It integrates a voltage regulator, an oscillator, and flash memory for storing configuration parameters, offering a cost-effective solution. CY7C652148 supports bus-powered and self-powered modes and enables efficient system power management with suspend and remote wake-up signals. It is available in a 24-pin QFN package.

USB and Charger Detect

USB

CY7C652148 has a built-in USB 2.0 Full-Speed transceiver. The transceiver incorporates the internal USB series termination resistors on the USB data lines and a 1.5-kΩ pull-up resistor on USBDP.

Charger Detection

CY7C652148 supports BCD for Peripheral Detect only and complies with the USB Battery Charging Specification, Rev. 1.2. It supports the following charging ports:

- Standard Downstream Port (SDP): Allows the system to draw up to 500 mA current from the host
- Charging Downstream Port (CDP): Allows the system to draw up to 1.5 A current from the host
- Dedicated Charging Port (DCP): Allows the system to draw up to 1.5 A of current from the wall charger

Serial Communication

CY7C652148 has a serial communication block (SCB). Each SCB can implement SPI interface. A 256-byte buffer is available in both the TX and RX lines.

SPI Interface

The SPI interface supports an SPI Master and SPI Slave. This interface supports the Motorola, TI, and National Microwire protocols. The maximum frequency of operation is 3 MHz in SPI master mode and 1 MHz in SPI slave mode. It can support transaction sizes ranging from 4 bits to 16 bits in length, SPI slave supports 4 bits to 8 bits and 12 bits to 16 bits data width at 1 MHz operation. Whereas, it supports 9 bits,10 bits and 11 bits data width operation at 500 kHz operation. (refer to USB to SPI Bridge on page 24 for more details).

GPIO Interface

CY7C652148 has six GPIOs. The configuration utility allows configuration of the GPIO pins. The configurable options are as follows:

- TRISTATE: GPIO can be tristated through Config Utility
- DRIVE 1: Output static 1
- DRIVE 0: Output static 0
- POWER#: Power control for bus power designs
- TXLED#: Drives LED during USB transmit
- RXLED#: Drives LED during USB receive
- TX or RX LED#: Drives LED during USB transmit or receive GPIO can be configured to drive LED at 8-mA drive strength.
- BCD0/BCD1: Two-pin output to indicate the type of USB charger
- BUSDETECT: Connects the VBUS pin for USB host detection

Default Configuration

SPI Master is the default configuration of CY7C652148. CY7C652148 can be configured as USB to SPI slave bridge using configuration utility.

Memory

CY7C652148 has a 512-byte flash. Flash is used to store USB parameters, such as VID/PID, serial number, product and manufacturer descriptors, which can be programmed by the configuration utility.

System Resources

Power System

CY7C652148 supports the USB Suspend mode to control power usage. CY7C652148 operates in bus-powered or self-powered modes over a range of 3.15 to 5.5 V.

Clock System

CY7C652148 has a fully integrated clock with no external components required. The clock system is responsible for providing clocks to all subsystems.

Internal 48-MHz Oscillator

The internal 48-MHz oscillator is the primary source of internal clocking in CY7C652148.

Internal 32-kHz Oscillator

The internal 32-kHz oscillator is primarily used to generate clocks for peripheral operation in the USB Suspend mode.

Reset

The reset block ensures reliable power-on reset and brings the device back to the default known state. The nXRES (active low) pin can be used by the external devices to reset the CY7C652148.

Suspend and Resume

The CY7C652148 device asserts the SUSPEND pin when the USB bus enters the suspend state. This helps in meeting the stringent suspend current requirement of the USB 2.0 specification, while using the device in bus-powered mode. The device resumes from the suspend state under either of the two following conditions:

1. Any activity is detected on the USB bus
2. The WAKEUP pin is asserted to generate remote wakeup to the host

WAKEUP

The WAKEUP pin is used to generate the remote wakeup signal on the USB bus. The remote wakeup signal is sent only if the host enables this feature through the SET_FEATURE request. The device communicates support for the remote wakeup to the host through the configuration descriptor during the USB enumeration process. The CY7C652148 device allows enabling/disabling and polarity of the remote wakeup feature through the configuration utility.

Software

Cypress delivers a complete set of software drivers and a configuration utility to enable configuration of the product during system development.

Drivers for Linux Operating Systems

Cypress provides a User Mode USB driver library (*libcyusbserial.so*) that abstracts vendor commands for the SPI interface and provides a simplified API interface for user applications. This library uses the standard open-source libUSB library to enable USB communication. The Cypress serial library supports the USB plug-and-play feature using the Linux 'udev' mechanism.

CY7C652148 binds to Linux USB Inbox driver.

Drivers for Mac OSx

Cypress delivers a dynamically linked shared library (*CyUSBSerial.dylib*) based on libUSB, which enables communication to the CY7C652148 device.

In addition, CY7C652148 binds to Mac OSx native driver.

Drivers for Windows Operating Systems

For Windows operating systems (XP, Vista, Win 7, Win 8, Win 8.1, and Windows 10), Cypress delivers a user-mode dynamically linked library–CyUSBSerial DLL–that abstracts a vendor-specific interface of the CY7C652148 devices and provides convenient APIs to the user. It provides interface APIs for vendor-specific SPI and class-specific APIs for PHDC.

USB-SPI Bridge Controller works with Cypress provided USB vendor class driver. The Cypress Windows drivers are MS logo certified drivers.

These drivers are bound to device through WU (Windows Update) services.

Cypress drivers also support Windows plug-and-play and power management and USB Remote Wake-up.

Device Configuration Utility (Windows only)

A Windows-based configuration utility is available to configure device initialization parameters. This graphical user application provides an interactive interface to define the boot parameters stored in the device flash.

This utility allows the user to save a user-selected configuration to text or xml formats. It also allows users to load a selected configuration from text or xml formats. The configuration utility allows the following operations:

- View current device configuration
- Select and configure SPI, battery charging, and GPIOs
- Configure USB VID, PID, and string descriptors
- Save or Load configuration

You can download the free configuration utility and drivers at www.cypress.com.

Internal Flash Configuration

The internal flash memory can be used to store the configuration parameters shown in the following table. A free configuration utility is provided to configure the parameters listed in the table to meet application-specific requirements over the USB interface. The configuration utility can be downloaded at www.cypress.com/usbserial.

Table 3. Internal Flash Configuration for CY7C652148

Parameter	Default Value	Description
USB Configuration		
USB Vendor ID (VID)	0x04B4	Default Cypress VID. Can be configured to customer VID.
USB Product ID (PID)	0x0004	Default Cypress PID. Can be configured to customer PID.
Manufacturer string	Cypress	Can be configured with any string up-to 64 characters
Product string	USB-Serial (Single Channel)	Can be configured with any string up-to 64 characters
Serial string		Can be configured with any string up-to 64 characters
Power mode	Bus powered	Can be configured to bus-powered or self-powered mode
Max current draw	100 mA	Can be configured to any value from 0 to 500 mA. The configuration descriptor will be updated based on this.
Remote wakeup	Enabled	Can be disabled. Remote wakeup is initiated by asserting the WAKEUP pin.
USB interface protocol	Vendor	Can be configured to function in CDC, PHDC, or Cypress vendor class
BCD	Disabled	Charger detect is disabled by default. When BCD is enabled, three of the GPIOs must be configured for BCD.

Electrical Specifications

Absolute Maximum Ratings

Exceeding maximum ratings[1] may shorten the useful life of the device.

Storage temperature ..... –55 °C to +100 °C

Ambient temperature with power supplied (Industrial) ..... –40 °C to +85 °C

Supply voltage to ground potential

V_{DDD} ..... 6.0 V

V_{BUS} ..... 6.0 V

V_{CCD} ..... 1.95 V

V_{GPIO} ..... V_{DDD} + 0.5 V

Static discharge voltage ESD protection levels:

■ 2.2-KV HBM per JESD22-A114

Latch-up current ..... 140 mA

Current per GPIO ..... 25 mA

Operating Conditions

T_A (ambient temperature under bias)

Industrial .....–40 °C to +85 °C

V_{BUS} supply voltage .... 3.15 V to 5.25 V

V_{DDD} supply voltage .... 1.71 V to 5.50 V

V_{CCD} supply voltage .... 1.71 V to 1.89 V

Device-Level Specifications

All specifications are valid for –40 °C ≤ T_A ≤ 85 °C, T_J ≤ 100 °C, and 1.71 V to 5.50 V, except where noted.

Table 4. DC Specifications

Parameter	Description	Min	Typ	Max	Units	Details/Conditions
V_{BUS}	V_{BUS} supply voltage	3.15	3.30	3.45	V	Set and configure the correct voltage range using a configuration utility for V_{BUS}. Default 5 V.
		4.35	5.00	5.25	V	
V_{DDD}	V_{DDD} supply voltage	1.71	1.80	1.89	V	Used to set I/O and core voltage. Set and configure the correct voltage range using a configuration utility for V_{DDD}. Default 3.3 V.
		2.0	3.3	5.5	V	
V_{CCD}	Output voltage (for core logic)	–	1.80	–	V	Do not use this supply to drive the external device. • 1.71 V ≤ V_{DDD} ≤ 1.89 V: Short the V_{CCD} pin with the V_{DDD} pin • V_{DDD} > 2 V – connect a 1-µF capacitor (Cefc) between the V_{CCD} pin and ground
Cefc	External regulator voltage bypass	1.00	1.30	1.60	µF	X5R ceramic or better
I_{DD1}	Operating supply current	–	20	–	mA	USB 2.0 FS, no GPIO switching.
I_{DD2}	USB Suspend supply current	–	5	–	µA	Does not include current through a pull-up resistor on USBDP. In USB suspend mode, the D+ voltage can go up to a maximum of 3.8 V.

Table 5. AC Specifications

Parameter	Description	Min	Typ	Max	Units	Details/Conditions
Zout	USB driver output impedance	28	–	44	Ω	–
Twakeup	Wakeup from USB Suspend mode	–	25	–	µs	–

Note

1. Usage above the Absolute Maximum conditions may cause permanent damage to the device. Exposure to Absolute Maximum conditions for extended periods of time may affect device reliability. When used below Absolute Maximum conditions but above normal operating conditions, the device may not operate to specification.

GPIO

Table 6. GPIO DC Specifications

Parameter	Description	Min	Typ	Max	Units	Details/Conditions
V_{IH}[2]	Input voltage high threshold	0.7 × V_{DDD}	–	–	V	CMOS Input
V_{IL}	Input voltage low threshold	–	–	0.3 × V_{DDD}	V	CMOS Input
V_{IH}[2]	LVTTL input, V_{DDD}< 2.7 V	0.7 × V_{DDD}	–	–	V	–
V_{IL}	LVTTL input, V_{DDD} < 2.7V	–	–	0.3 × V_{DDD}	V	–
V_{IH}[2]	LVTTL input, V_{DDD} ≥ 2.7V	2	–	–	V	–
V_{IL}	LVTTL input, V_{DDD} ≥ 2.7V	–	–	0.8	V	–
V_{OH}	CMOS output voltage high level	V_{DDD} – 0.4	–	–	V	I_{OH} = 4 mA, V_{DDD} = 5 V +/- 10%
V_{OH}	CMOS output voltage high level	V_{DDD} – 0.6	–	–	V	I_{OH} = 4 mA, V_{DDD} = 3.3 V +/- 10%
V_{OH}	CMOS output voltage high level	V_{DDD} – 0.5	–	–	V	I_{OH} = 1 mA, V_{DDD} = 1.8 V +/- 5%
V_{OL}	CMOS output voltage low level	–	–	0.4	V	I_{OL} = 8 mA, V_{DDD} = 5 V +/- 10%
V_{OL}	CMOS output voltage low level	–	–	0.6	V	I_{OL} = 8 mA, V_{DDD} = 3.3 V +/- 10%
V_{OL}	CMOS output voltage low level	–	–	0.6	V	I_{OL} = 4 mA, V_{DDD} = 1.8 V +/- 5%
Rpullup	Pull-up resistor	3.5	5.6	8.5	kΩ	–
Rpulldown	Pull-down resistor	3.5	5.6	8.5	kΩ	–
I_{IL}	Input leakage current (absolute value)	–	–	2	nA	25 °C, V_{DDD} = 3.0 V
C_{IN}	Input capacitance	–	–	7	pF	–
Vhysttl	Input hysteresis LVTTL; V_{DDD} > 2.7 V	25	40	C	mV	–
Vhyscmos	Input hysteresis CMOS	0.05 × V_{DDD}	–	–	mV	–

Table 7. GPIO AC Specifications

Parameter	Description	Min	Typ	Max	Units	Details/Conditions
$T_{RiseFast1}$	Rise Time in Fast mode	2	–	12	ns	V_{DDD} = 3.3 V/ 5.5 V, Cload = 25 pF
$T_{FallFast1}$	Fall Time in Fast mode	2	–	12	ns	V_{DDD} = 3.3 V/ 5.5 V, Cload = 25 pF
$T_{RiseSlow1}$	Rise Time in Slow mode	10	–	60	ns	V_{DDD} = 3.3 V/ 5.5 V, Cload = 25 pF
$T_{FallSlow1}$	Fall Time in Slow mode	10	–	60	ns	V_{DDD} = 3.3 V/ 5.5 V, Cload = 25 pF
$T_{RiseFast2}$	Rise Time in Fast mode	2	–	20	ns	V_{DDD} = 1.8 V, Cload = 25 pF
$T_{FallFast2}$	Fall Time in Fast mode	20	–	100	ns	V_{DDD} = 1.8 V, Cload = 25 pF
$T_{RiseSlow2}$	Rise Time in Slow mode	2	–	20	ns	V_{DDD} = 1.8 V, Cload = 25 pF
$T_{FallSlow2}$	Fall Time in Slow mode	20	–	100	ns	V_{DDD} = 1.8 V, Cload = 25 pF

Note
2. V_{IH} must not exceed V_{DDD} + 0.2 V.

nXRES

Table 8. nXRES DC Specifications

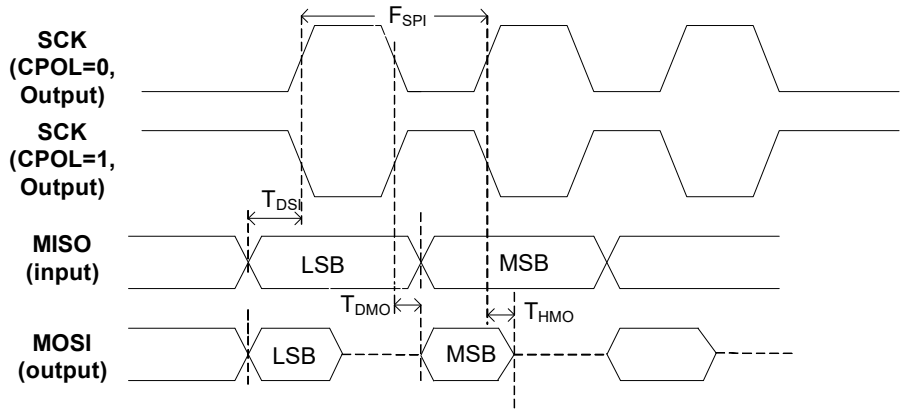
Parameter	Description	Min	Typ	Max	Units	Details/Conditions
V_{IH}	Input voltage high threshold	0.7 × V_{DDD}	–	–	V	–
V_{IL}	Input voltage low threshold	–	–	0.3 × V_{DDD}	V	–
Rpullup	Pull-up resistor	3.5	5.6	8.5	kΩ	–
C_{IN}	Input capacitance	–	5	–	pF	–
Vhysxres	Input voltage hysteresis	–	100	–	mV	–

Table 9. nXRES AC Specifications

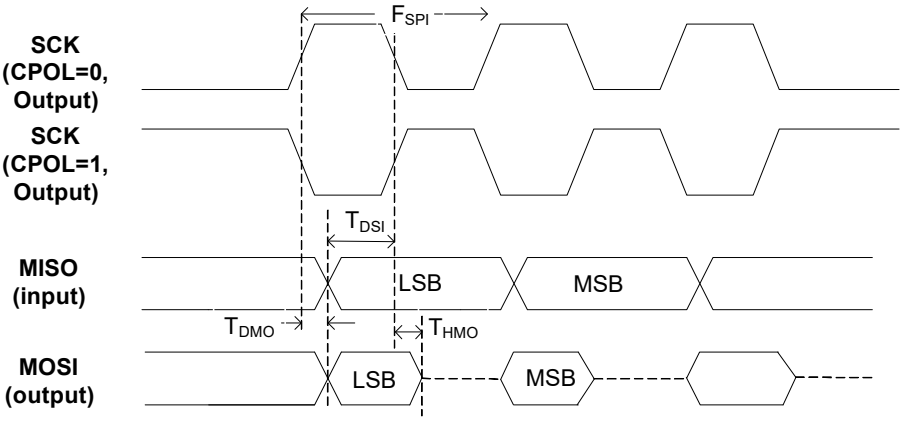
Parameter	Description	Min	Typ	Max	Units	Details/Conditions
Tresetwidth	Reset pulse width	1	–	–	µs	–

SPI Specifications

Figure 2. SPI Master Timing

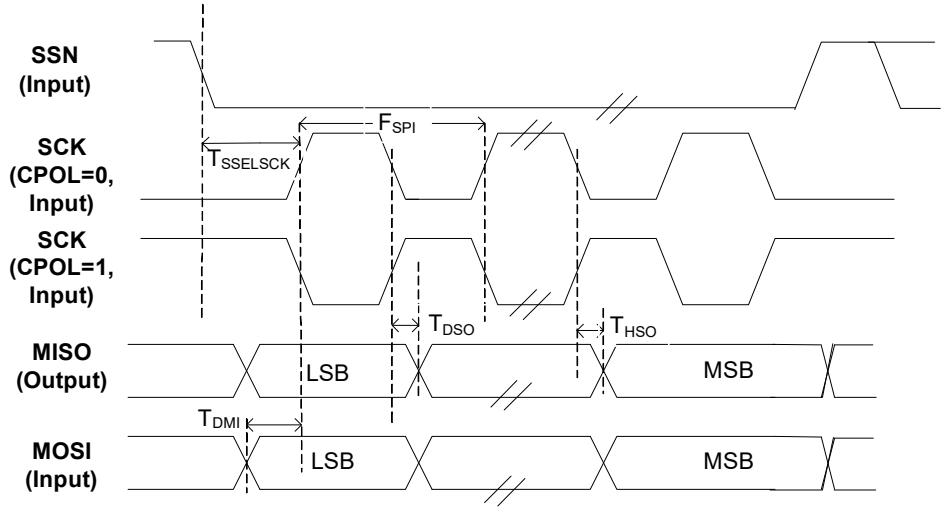


SPI Master Timing for CPHA = 0 (Refer to Table 10)

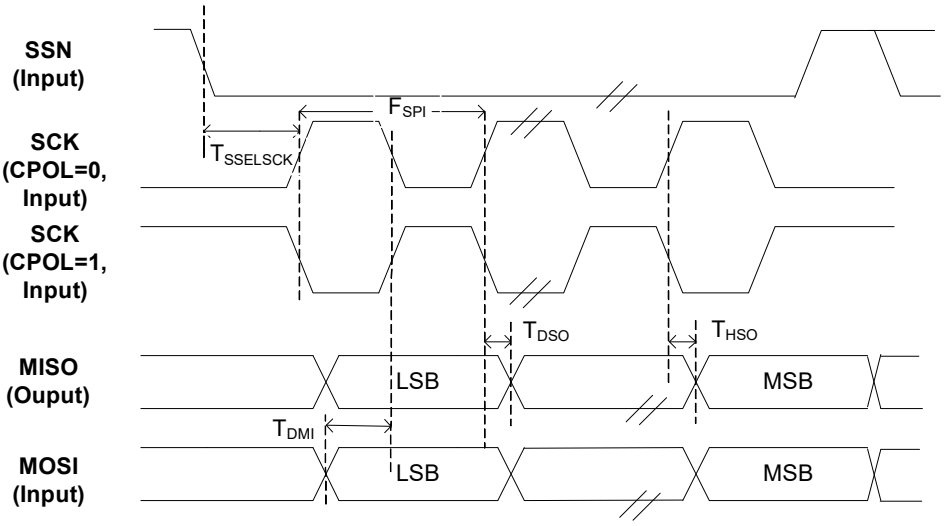


SPI Master Timing for CPHA = 1 (Refer to Table 10)

Figure 3. SPI Slave Timing



SPI Slave Timing for CPHA = 0 (Refer to Table 10)



SPI Slave Timing for CPHA = 1 (Refer to Table 10)

Table 10. SPI AC Specifications

Parameter	Description	Min	Typ	Max	Units	Details/Conditions
F_{SPI}	SPI operating frequency (Master/Slave)	–	–	3	MHz	–
WL_{SPI}	SPI word length	4	–	16	bits	–
SPI Master Mode						–
T_{DMO}	MOSI valid after SClock driving edge	–	–	15	ns	–
T_{DSI}	MISO valid before SClock capturing edge	20	–	–	ns	–
T_{HMO}	Previous MOSI data hold time with respect to capturing edge at slave	0	–	–	ns	–
SPI Slave Mode						–
T_{DMI}	MOSI valid before Sclock Capturing edge	40	–	–	ns	–
T_{DSO}	MISO valid after Sclock driving edge	–	–	104.4	ns	–
T_{HSO}	Previous MISO data hold time	0	–	–	ns	–
$T_{SSELSCK}$	SSEL valid to first SCK Valid edge	100	–	–	ns	–

Flash Memory Specifications

Table 11. Flash Memory Specifications

Parameter	Description	Min	Typ	Max	Units	Details/Conditions
Fend	Flash endurance	100K	–	–	cycles	–
Fret	Flash retention. $T_A \leq 85$ °C, 10 K program/erase cycles	10	–	–	years	–

Pin Description

Pin[3]	Type	Name	Default	Description
1	GPIO	GPIO_6	GPIO IN	GPIO Input Pin (see Table 13)
2	GPIO	GPIO_7	GPIO IN	GPIO Input Pin (see Table 13)
3	Power	VSSD		Digital Ground
4	GPIO	GPIO_8	GPIO IN	GPIO Input Pin (see Table 13)
5	GPIO	GPIO_9	GPIO OUT	GPIO Output Pin (see Table 13)
6	GPIO	GPIO_10	GPIO OUT	GPIO Output Pin (see Table 13)
7	Output	POWER#		Signal to external logic to indicate USB Unconfigured state and USB Suspend
8	Output	Suspend		Asserted when the part enters Low Power mode
9	Input	Wakeup		Wakeup device from suspend mode. Can be configured as active high/low using configuration utility.
10	USBIO	USBDP		USB D+
11	USBIO	USBDM		USB D-
12	Power	VCCD		VCCD (Internal LDO Output)
13	Power	VSSD		Digital Ground
14	Reset	nXRES		Chip Reset active, low. Can be left unconnected or have a pull up resistor connected when not in use.
15	Power	VBUS		USB VBUS
16	Power	VSSD (VBUS)		Digital Ground
17	Power	VSSA		Analog Ground
18	GPIO	TX_RX_LED		Notification LED for SPI Tx/Rx Data
19	GPIO	GPIO_1	GPIO IN	GPIO Input Pin (see Table 13)
20	SCB/GPIO	SSEL_OUT		Slave Select
21	SCB/GPIO	MISO		SPI Master IN Slave OUT
22	SCB/GPIO	MOSI		SPI Master Out Slave IN
23	SCB/GPIO	SCLK		SPI Clock
24	Power	VDDD		VDDD Core

Note
3. Any pin acting as an Input pin should not be left unconnected.

Figure 4. 24-pin QFN Pinout

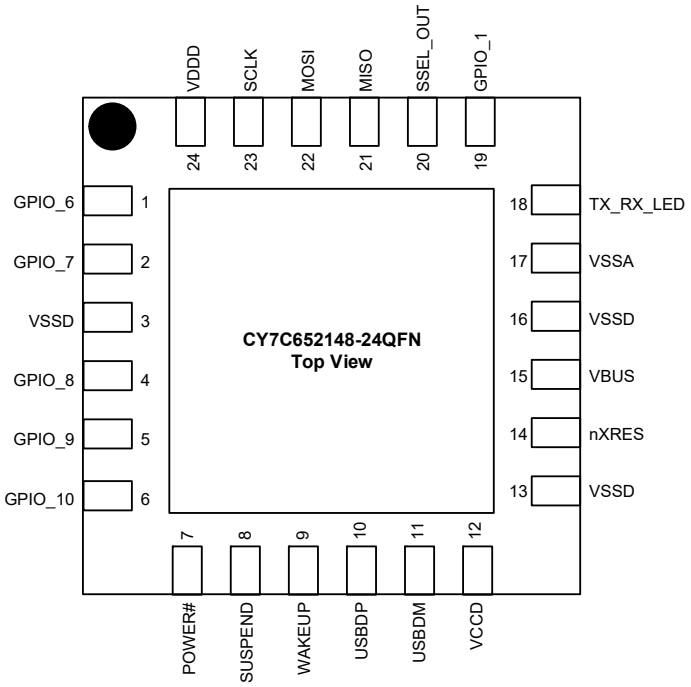


Table 12. Serial Communication Block Configurations

Pin	Serial Port	Mode 0[4]	Mode 1
		SPI Master	SPI Slave
1	SCB_0	GPIO_6	GPIO_6
20	SCB_1	SSEL_OUT	SSEL_IN
21	SCB_2	MISO_IN	MISO_OUT
22	SCB_3	MOSI_OUT	MOSI_IN
23	SCB_4	SCLK_OUT	SCLK_IN
2	SCB_5	GPIO_7	GPIO_7

Note
4. The device is configured in Mode 0 as the default. Other modes can be configured using the configuration utility provided by Cypress.

Legend

GPIO
SCB

Table 13. GPIO Configuration[5]

GPIO Configuration Option	Description
TRISTATE	I/O tristated
DRIVE 1	Output static 1
DRIVE 0	Output static 0
POWER#	This output is used to control power to an external logic through a switch to cut power off during an unconfigured USB device and USB suspend. 0 - USB device in Configured state 1 - USB device in Unconfigured state or during USB suspend mode
TXLED#	Drives LED during USB transmit
RXLED#	Drives LED during USB receive
TX or RX LED#	Drives LED during USB transmit or receive
BCD0 BCD1	Configurable battery charger detect pins to indicate the type of USB charger (SDP, CDP, or DCP) Configuration example: 00 - Draw up to 100 mA (unconfigured state) 01 - SDP (up to 500 mA) 10 - CDP/DCP (up to 1.5 A) 11 - Suspend (up to 2.5 mA) This truth table can be configured using a configuration utility
BUSDETECT	VBUS detection. Connect the VBUS to this pin through a resistor network for VBUS detection when using the BCD feature (refer to Figure 9, Figure 10, and Figure 11).

Note
5. These signal options can be configured on any of the available GPIO pins using the configuration utility provided by Cypress.

USB Power Configurations

The following section describes possible USB power configurations for the CY7C652148. Refer to the Pin Description on page 16 for signal details.

USB Bus-Powered Configuration

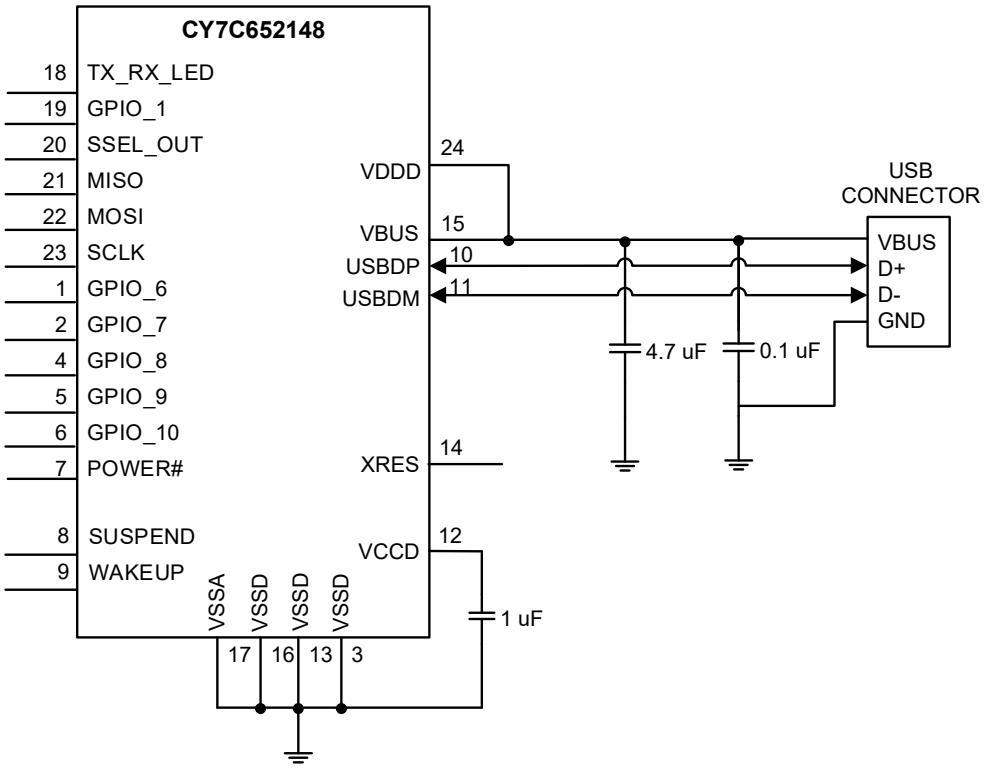
Figure 5 shows an example of the CY7C652148 in a bus-powered design. The VBUS is connected directly to the CY7C652148 because it has an internal regulator.

The USB bus-powered system must comply with the following requirements:

1. The system should not draw more than 100 mA prior to USB enumeration (Unconfigured state).
2. The system should not draw more than 2.5 mA during the USB Suspend mode.
3. A high-power bus-powered system (can draw more than 100 mA when operational) must use POWER# (configured over GPIO) to keep the current consumption below 100 mA prior to USB enumeration, and 2.5 mA during USB Suspend state.
4. The system should not draw more than 500 mA from the USB host.

The configuration descriptor in the CY7C652148 flash should be updated to indicate bus power and the maximum current required by the system using the configuration utility.

Figure 5. Bus-Powered Configuration



Self-Powered Configuration

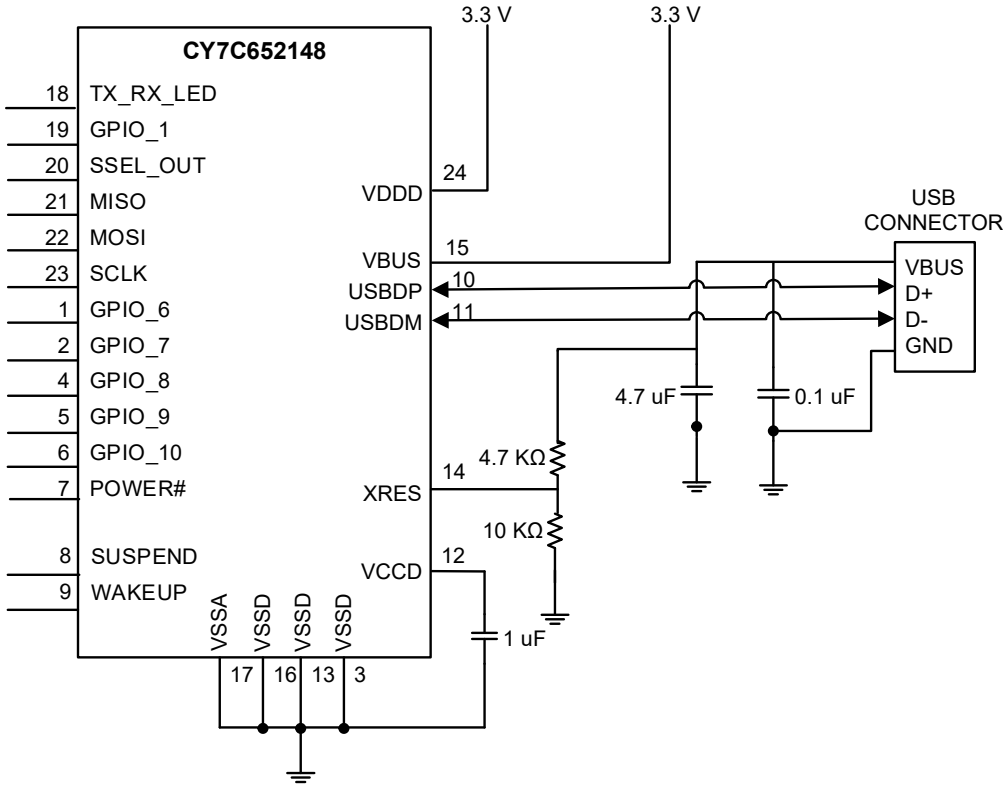
Figure 6 shows an example of CY7C652148 in a self-powered design. A self-powered system does not use the VBUS from the host to power the system, but it has its own power supply. A self-powered system has no restriction on current consumption because it does not draw any current from the VBUS.

When the VBUS is present, CY7C652148 enables an internal, 1.5-kΩ pull-up resistor on USBDP. When the VBUS is absent (USB host is powered down), CY7C652148 removes the 1.5-kΩ pull-up resistor on USBDP. This ensures that no current flows from the USBDP to the USB host through a 1.5-kΩ pull-up resistor, to comply with the USB 2.0 specification.

When reset is asserted to CY7C652148, all the I/O pins are tristated.

The configuration descriptor in the CY7C652148 flash should be updated to indicate self-power using the configuration utility.

Figure 6. Self-Powered Configuration



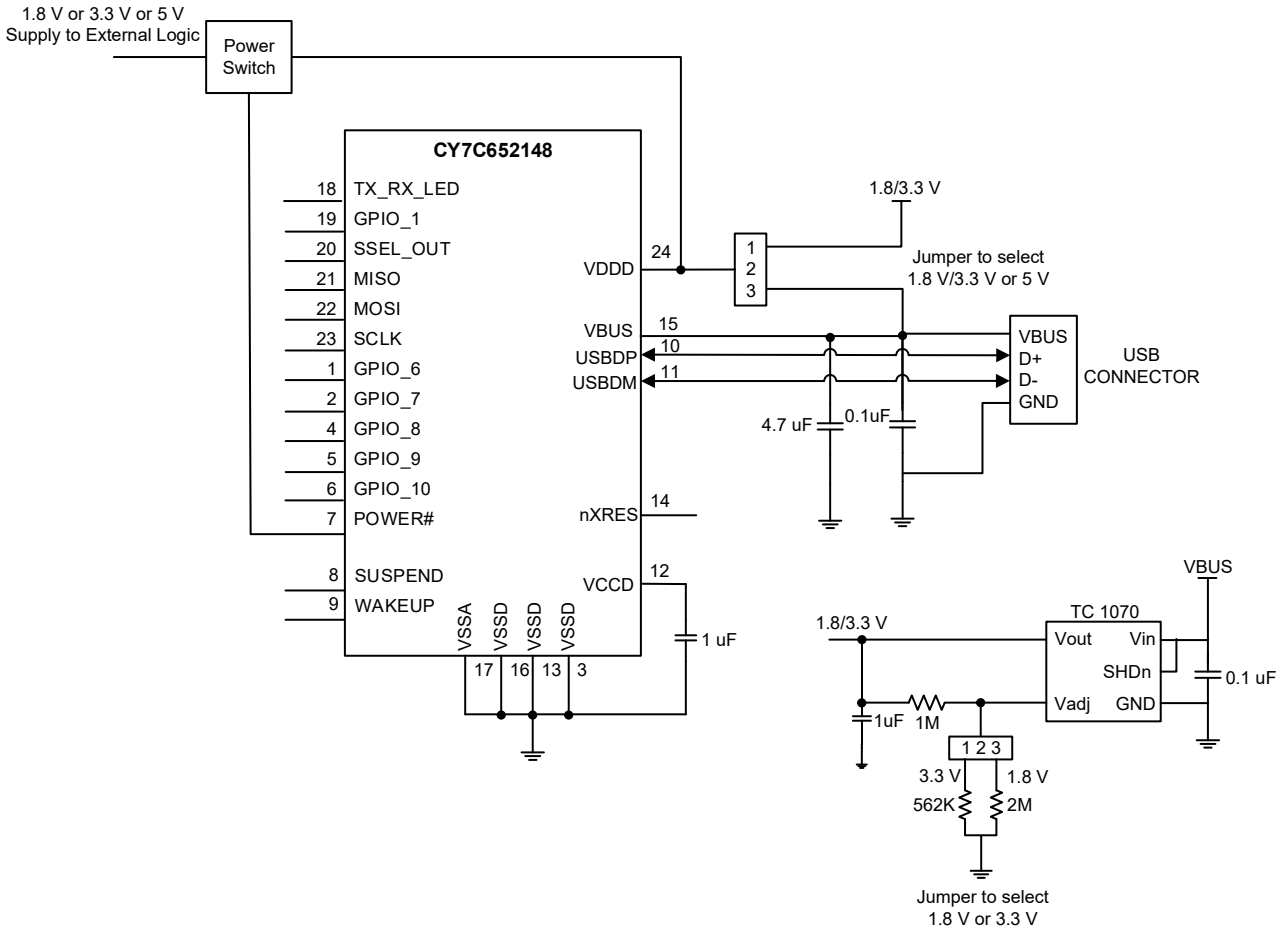
USB Bus-Powered with Variable I/O Voltage

Figure 7 shows CY7C652148 in a bus-powered system with variable I/O voltage. A low dropout (LDO) regulator is used to supply 1.8 V or 3.3 V, using a jumper switch the input of which is 5 V from the VBUS. Another jumper switch is used to select 1.8/3.3 V or 5 V from the VBUS for the VDDD pin of CY7C652148. This allows I/O voltage and supply to external logic to be selected among 1.8 V, 3.3 V, or 5 V.

The USB bus-powered system must comply with the following conditions:

- The system should not draw more than 100 mA prior to USB enumeration (unconfigured state)
- The system should not draw more than 2.5 mA during USB Suspend mode
- A high-power bus-powered system (can draw more than 100 mA when operational) must use POWER# (configured over GPIO) to keep the current consumption below 100 mA prior to USB enumeration and 2.5 mA during the USB Suspend state

Figure 7. USB Bus-Powered with 1.8-V, 3.3-V, or 5-V Variable I/O Voltage[6]



Note

6. 1.71 V ≤ VDDD ≤ 1.89 V - Short VCCD pin with VDDD pin; VDDD > 2 V - connect a 1-µF decoupling capacitor to the VCCD pin.

Application Examples

The following section provides CY7C652148 application examples.

Battery-Operated, Bus-Powered USB to MCU with Battery Charge Detection

Figure 8 illustrates CY7C652148 as a USB-to-microcontroller interface. The TXD and RXD lines are used for data transfer, and the RTS# and CTS# lines are used for handshaking. The SUSPEND pin indicates to the MCU if the device is in USB Suspend, and the WAKEUP pin is used to wake up CY7C652148, which in turn issues a remote wakeup to the USB host.

This application illustrates a battery-operated system, which is bus-powered. CY7C652148 implements the battery charger detection functionality based on the USB Battery Charging Specification, Rev. 1.2.

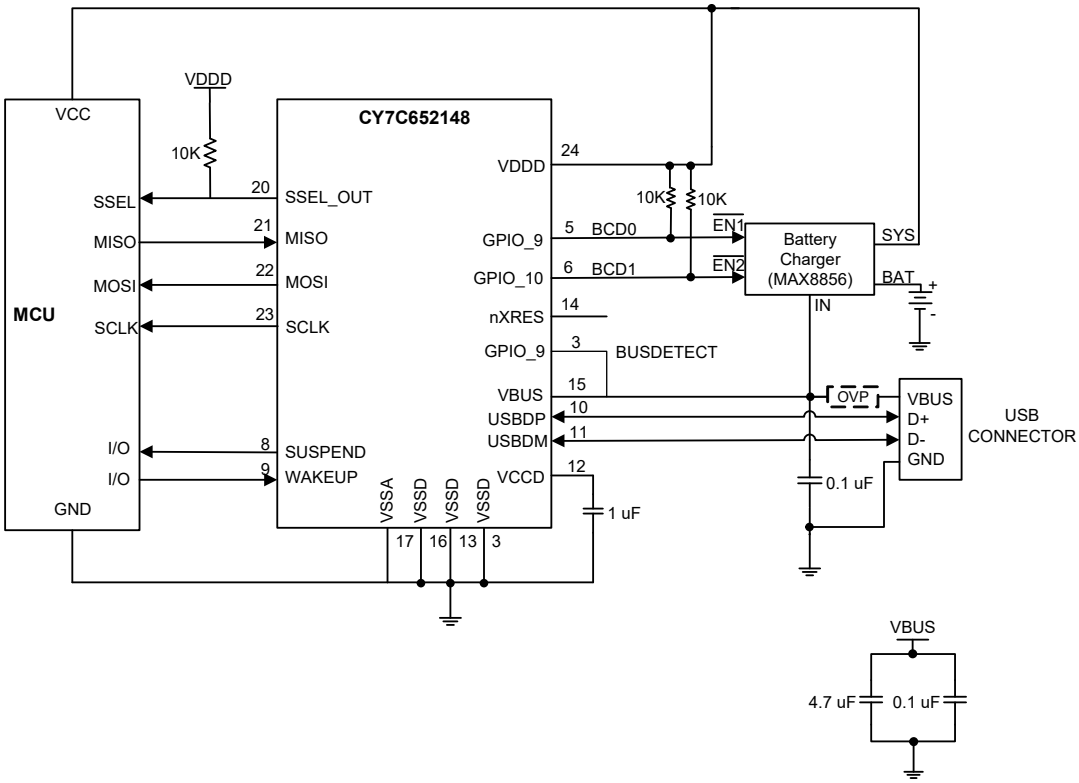
Battery-operated bus power systems must comply with the following conditions:

- The system can be powered from the battery (if not discharged) and can be operational if the VBUS is not connected or powered down.
- The system should not draw more than 100 mA from the VBUS prior to USB enumeration and USB Suspend.
- The system should not draw more than 500 mA for SDP and 1.5 A for CDP/DCP

To comply with the first requirement, the VBUS from the USB host is connected to the battery charger as well as to CY7C652148, as shown in Figure 8. When the VBUS is connected, CY7C652148 initiates battery charger detection and indicates the type of USB charger over BCD0 and BCD1. If the USB charger is SDP or CDP, CY7C652148 enables a 1.5-KΩ pull-up resistor on the USBDP for Full-Speed enumeration. When the VBUS is disconnected, CY7C652148 indicates an absence of the USB charger over BCD0 and BCD1, and removes the 1.5-KΩ pull-up resistor on USBDP. Removing this resistor ensures that no current flows from the supply to the USB host through the USBDP, to comply with the USB 2.0 specification.

To comply with the second and third requirements, two signals (BCD0 and BCD1) are configured over GPIO to communicate the type of USB host charger and the amount of current it can draw from the battery charger. BCD0 and BCD1 signals can be configured using the configuration utility.

Figure 8. USB to MCU Interface with Battery Charge Detection[7, 8, 9]

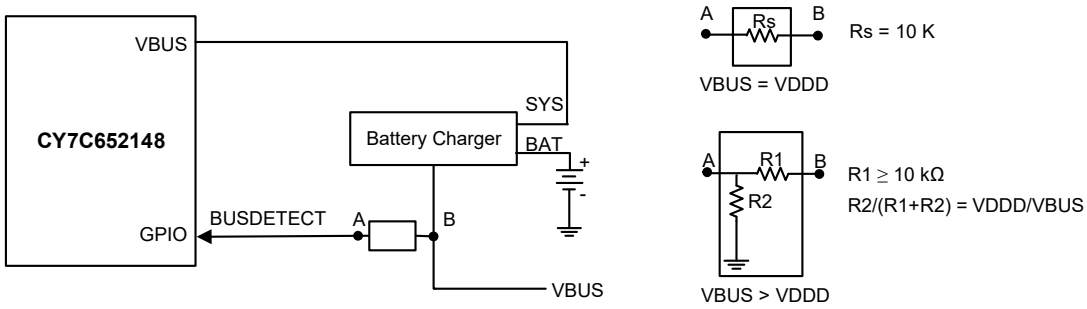


Notes

7. Add a 100-kΩ pull-down resistor on the V_{BUS} pin for quick discharge.
8. Refer Figure 9, Figure 10, Figure 11 and the corresponding descriptions for handling VBUS Over Voltage Protection (OVP).
9. BCD and BUSDETECT functionality are not enabled by default. USB-Serial Configuration Utility is provided to enable BCD and BUSDETECT functionality.

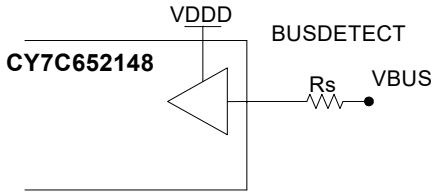
In a battery charger system, a 9-V spike on the VBUS is possible. The CY7C652148 VBUS pin is intolerant to voltage above 6 V. In the absence of over-voltage protection (OVP) on the VBUS line, the VBUS should be connected to BUSDETECT (GPIO configured) using the resistive network and the output of the battery charger to the VBUS pin of CY7C652148, as shown in Figure 9.

Figure 9. 9 V Tolerant



When the VBUS and VDDD are at the same voltage potential, the VBUS can be connected to the GPIO using a series resistor (Rs). This is shown in the following figure. If there is a charger failure and the VBUS becomes 9 V, then the 10-kΩ resistor plays two roles. It reduces the amount of current flowing into the forward-biased diodes in the GPIO, and it reduces the voltage seen on the pad.

Figure 10. GPIO VBUS Detection, VBUS = VDDD



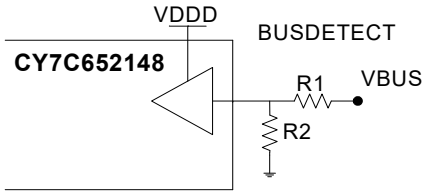
When the VBUS > VDDD, a resistor voltage divider is required to reduce the voltage from the VBUS down to VDDD for the GPIO sensing the VBUS voltage. This is shown in the following figure. The resistors should be sized as follows:

R1 >= 10 k

R2 / (R1 + R2) = VDDD / VBUS

The first condition limits the voltage and current for the charger failure situation, as described in the previous paragraph, while the second condition allows for normal-operation VBUS detection.

Figure 11. GPIO VBUS Detection, VBUS > VDDD



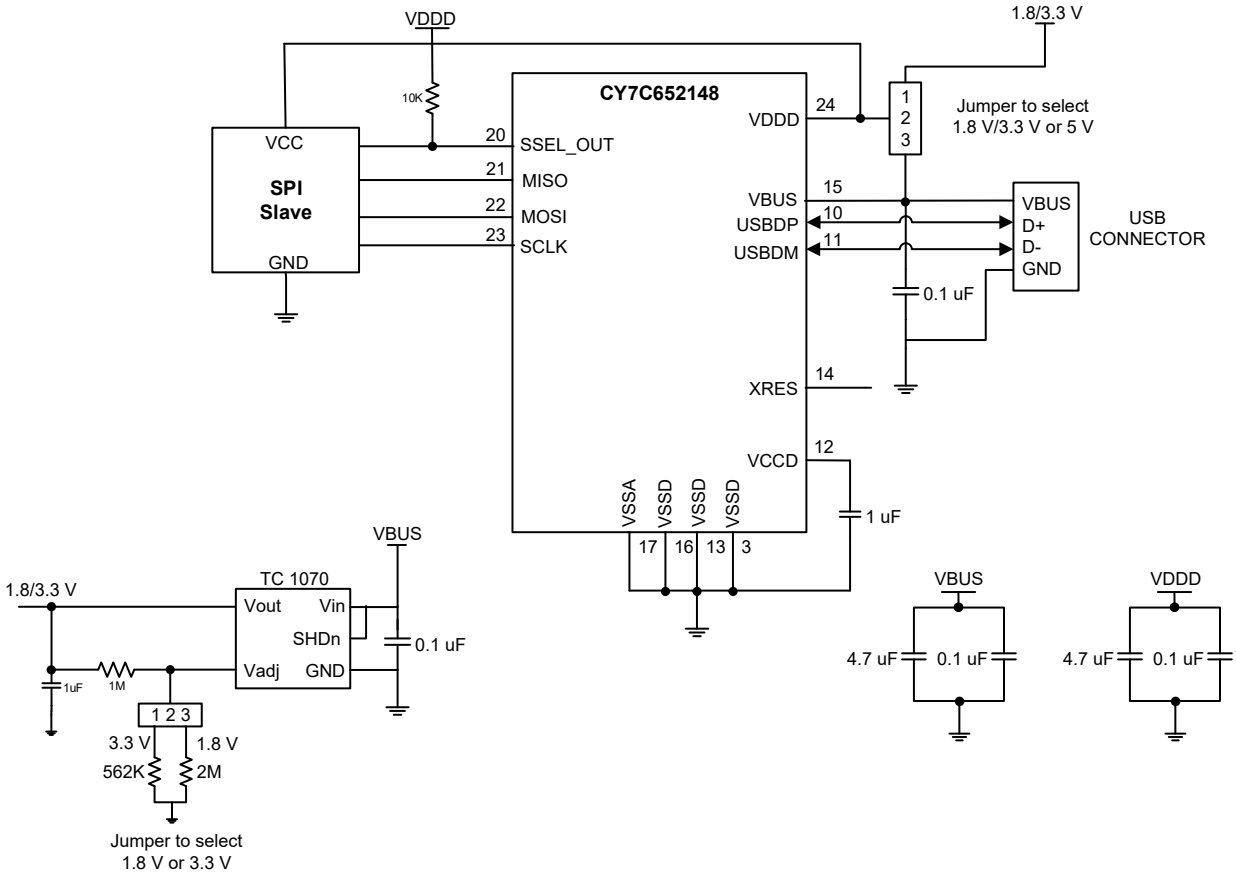
USB to SPI Bridge

In Figure 12, CY7C652148 is configured as a USB to SPI Bridge. The CY7C652148 SPI can be configured as a master or a slave using the configuration utility. CY7C652148 supports SPI master frequency up to 3 MHz and SPI slave frequency up to 1 MHz. It can support transaction sizes ranging from 4 bits to 16 bits, which can be configured using the configuration utility.

In the master mode, the SCLK, MOSI, and SSEL lines act as outputs and MISO acts as an input. In the slave mode, the SCL SCLK, MOSI, and SSEL lines act as inputs and MISO acts as an output.

GPIO8 and GPIO9 are configured as RXLED# and TXLED# to drive two LEDs to indicate USB receive and transmit.

Figure 12. USB to SPI Bridge



CY7C652148 supports three versions of the SPI protocol:

- Motorola - This is the original SPI protocol.
- Texas Instruments - A variation of the original SPI protocol in which the data frames are identified by a pulse on the SSEL line.
- National Semiconductors - A half-duplex variation of the original SPI protocol.

Motorola

The original SPI protocol is defined by Motorola. It is a full-duplex protocol: transmission and reception occur at the same time.

A single (full-duplex) data transfer follows these steps: The master selects a slave by driving its SSEL line to '0'. Next, it drives the data on its MOSI line and it drives a clock on its SCLK line. The slave uses the edges of the transmitted clock to capture the data on the MOSI line. The slave drives data on its MISO line. The master captures the data on the MISO line. Repeat the process for all bits in the data transfer.

Multiple data transfers may happen without the SSEL line changing from '0' to '1' and back from '1' to '0' in between the individual transfers. As a result, slaves must keep track of the progress of data transfers to separate individual transfers.

When not transmitting data, the SSEL line is '1' and the SCLK is typically off.

The Motorola SPI protocol has four modes that determine how data is driven and captured on the MOSI and MISO lines. These modes are determined by clock polarity (CPOL) and clock phase (CPHA). Clock polarity determines the value of the SCLK line when not transmitting data:

- CPOL is '0': SCLK is '0' when not transmitting data.
- CPOL is '1': SCLK is '1' when not transmitting data.

The clock phase determines when data is driven and captured. It is dependent on the value of CPOL.

Table 14. SPI Protocol Modes

Mode	CPOL	CPHA	Description
0	0	0	Data is driven on a falling edge of SCLK. Data is captured on a rising edge of SCLK.
1	0	1	Data is driven on a rising edge of SCLK. Data is captured on a falling edge of SCLK.
2	1	0	Data is driven on a rising edge of SCLK. Data is captured on a falling edge of SCLK.
3	1	1	Data is driven on a falling edge of SCLK. Data is captured on a rising edge of SCLK.

Figure 13. Driving and Capturing MOSI/MISO Data As A Function of CPOL and CPHA

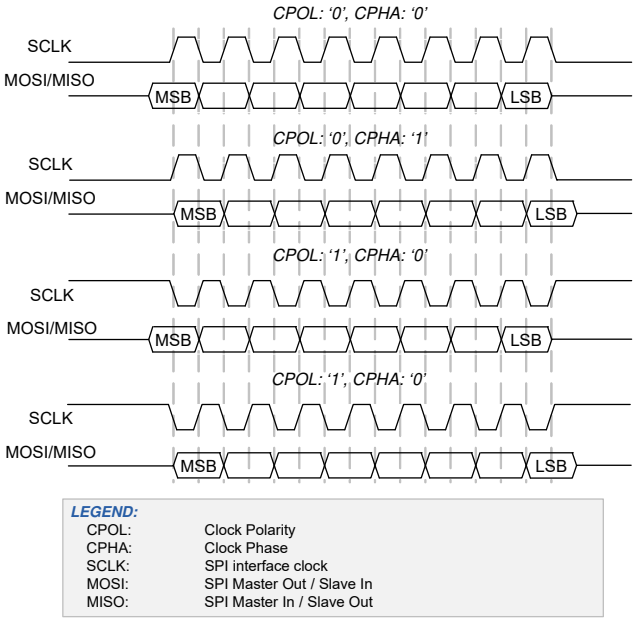
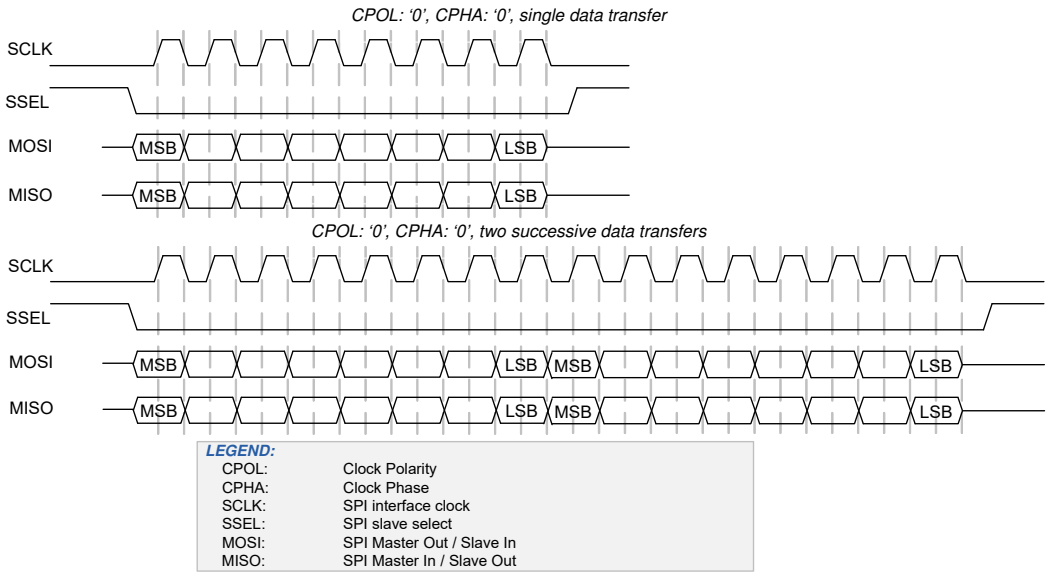


Figure 14. Single 8-bit Data Transfer and Two Successive 8-bit Data Transfers in Mode 0 (CPOL is '0', CPHA is '0')

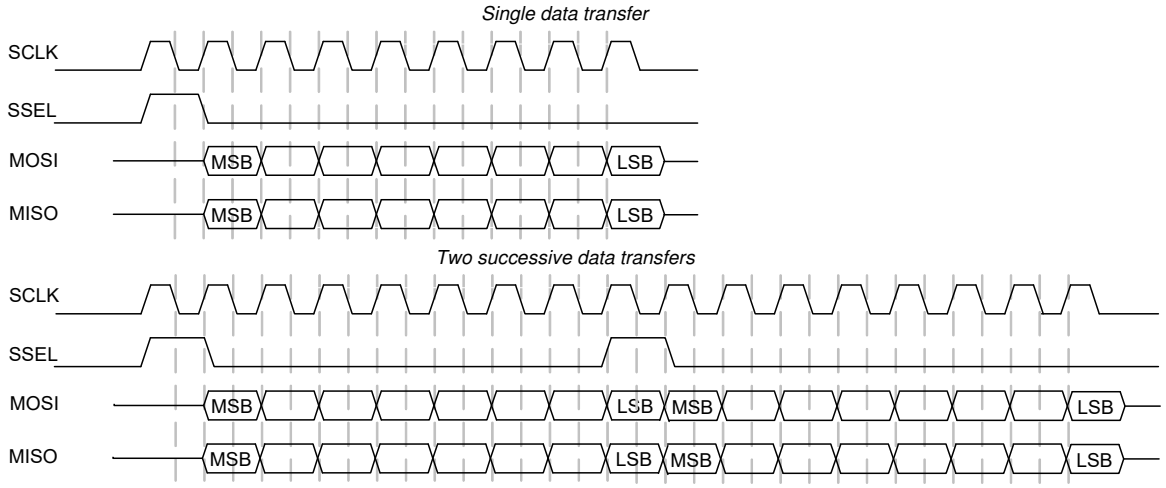


Texas Instruments

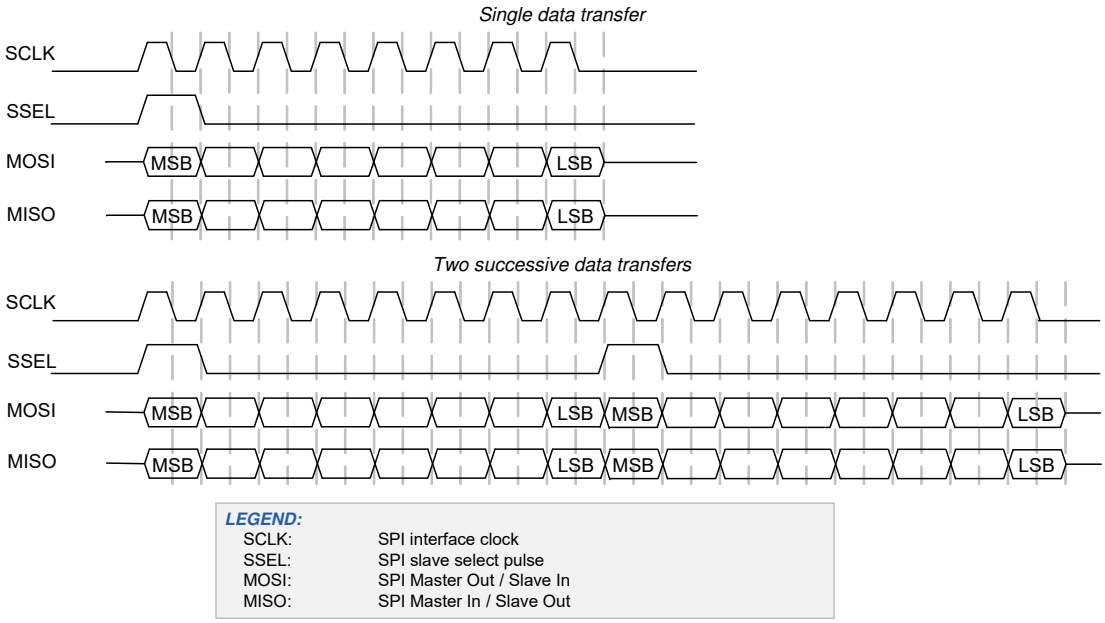
Texas Instruments' SPI protocol redefines the use of the SSEL signal. It uses the signal to indicate the start of a data transfer, rather than a low, active slave-select signal. The start of a transfer is indicated by a high, active pulse of a single-bit transfer period. This pulse may occur one cycle before the transmission of the first data bit, or it may coincide with the transmission of the first data bit. The transmitted clock SCLK is a free-running clock.

The TI SPI protocol only supports mode 1 (CPOL is '0' and CPHA is '1'): Data is driven on a rising edge of SCLK and data is captured on a falling edge of SCLK.

The following figure illustrates a single 8-bit data transfer and two successive 8-bit data transfers. The SSEL pulse precedes the first data bit. Note how the SSEL pulse of the second data transfer coincides with the last data bit of the first data transfer.



The following figure illustrates a single 8-bit data transfer and two successive 8-bit data transfers. The SSEL pulse coincides with the first data bit.



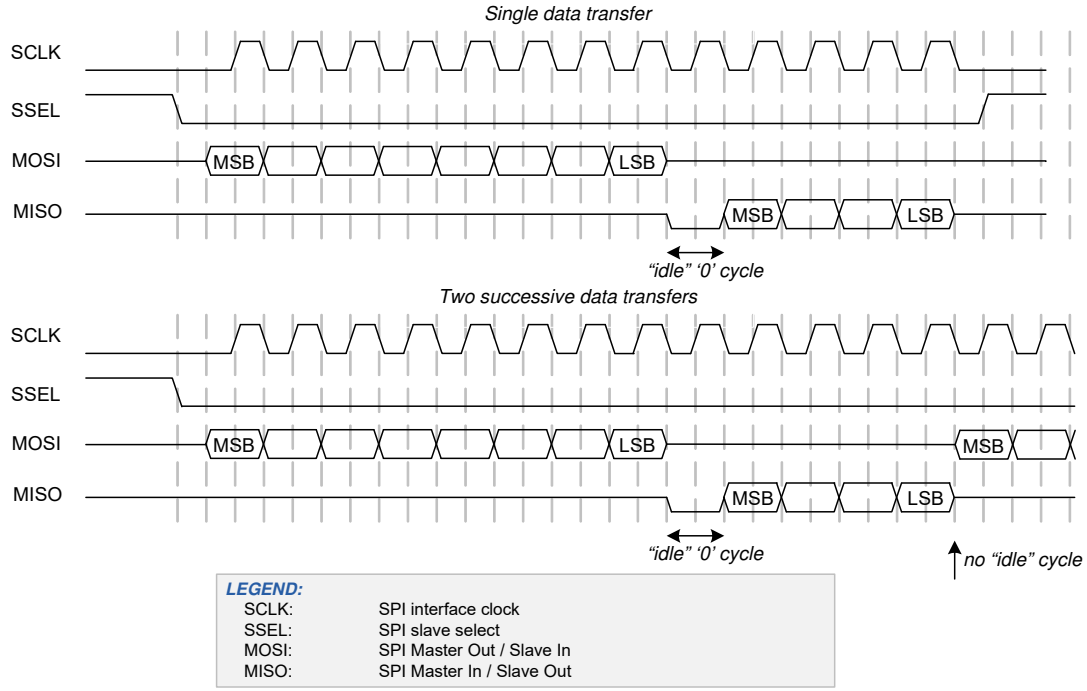
National Semiconductor

National Semiconductor's SPI protocol is a half-duplex protocol. Rather than transmission and reception occurring at the same time, they take turns (transmission happens before reception). A single "idle" bit transfer period separates transmission from reception.

Note Successive data transfers are NOT separated by an "idle" bit transfer period.

The transmission data transfer size and reception data transfer size may differ. National Semiconductor's SPI protocol supports only mode 0: Data is driven on a falling edge of SCLK, and data is captured on a rising edge of SCLK.

The following figure illustrates a single data transfer and two successive data transfers. In both cases, the transmission data transfer size is 8 bits and the reception transfer size is 4 bits.



Note The above figure defines MISO and MOSI as undefined when the lines are considered idle (not carrying valid information). It will drive the outgoing line values to '0' during idle time (to satisfy the requirements of specific master devices (NXP LPC17xx) and specific slave devices (Microchip EEPROM).

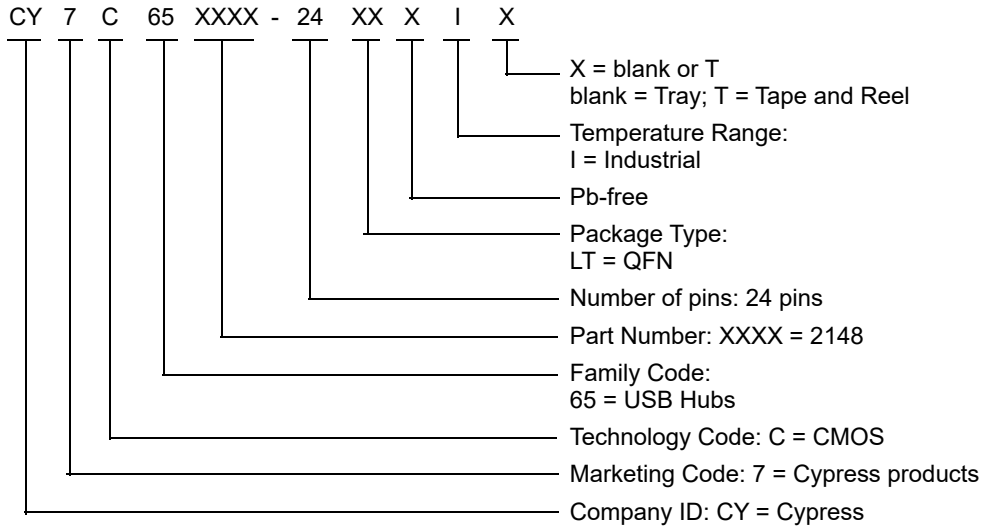
Ordering Information

Table 15 lists the key package features and ordering codes of the CY7C652148. For more information, contact your local sales representative.

Table 15. Key Features and Ordering Information

Package	Ordering Code	Operating Range
24-pin QFN (4.00 × 4.00 × 0.55 mm, 0.5 mm pitch) (Pb-free)	CY7C652148-24LTXI	Industrial
24-pin QFN (4.00 × 4.00 × 0.55 mm, 0.5 mm pitch) (Pb-free) – Tape and Reel	CY7C652148-24LTXIT	Industrial

Ordering Code Definitions



Package Information

Support currently is planned for the 24-pin QFN package.

Figure 15. 24-pin QFN 4 mm × 4 mm × 0.55 mm LQ24A 2.65 × 2.65 EPAD (Sawn)

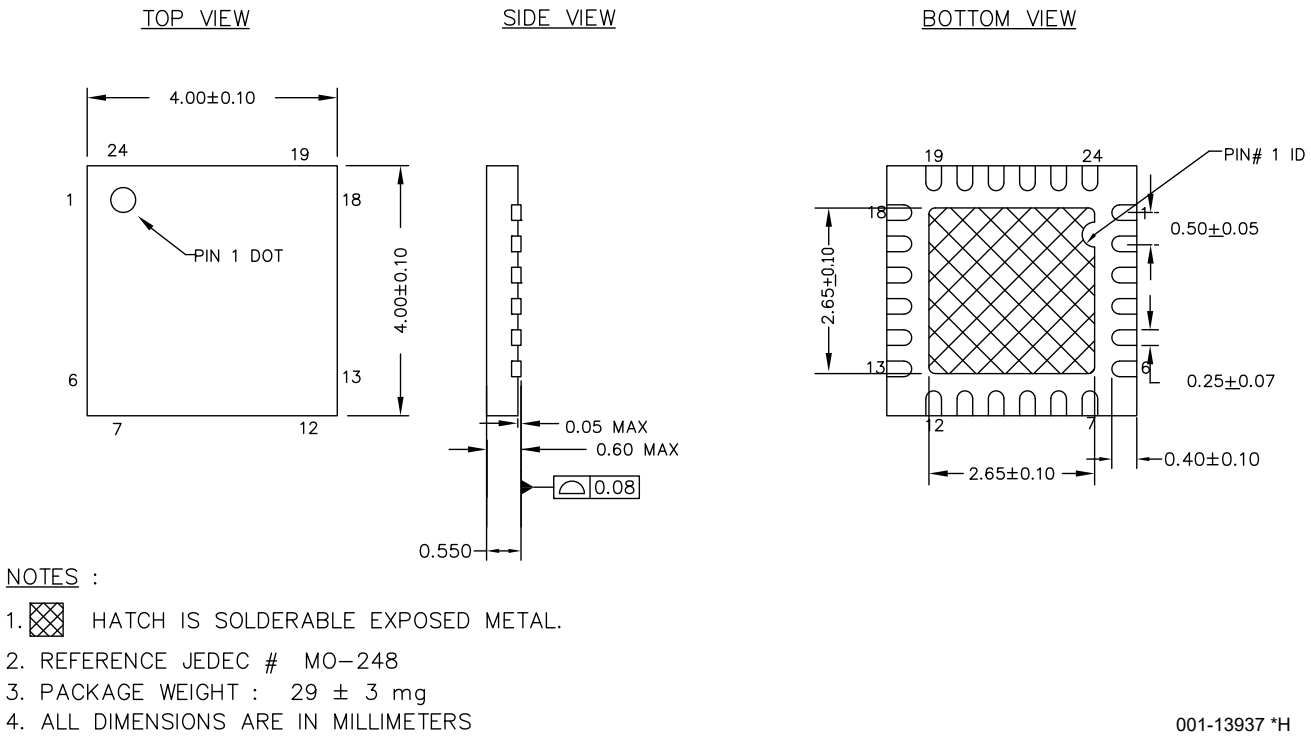


Table 16. Package Characteristics

Parameter	Description	Min	Typ	Max	Units
T_A	Operating ambient temperature	–40	25	85	°C
THJ	Package θ_{JA}	–	18.4	–	°C/W

Table 17. Solder Reflow Peak Temperature

Package	Maximum Peak Temperature	Maximum Time at Peak Temperature
24-pin QFN	260 °C	30 seconds

Table 18. Package Moisture Sensitivity Level (MSL), IPC/JEDEC J-STD-2

Package	MSL
24-pin QFN	MSL 3

Acronyms

Table 19. Acronyms Used in this Document

Acronym	Description
BCD	battery charger detection
CDC	communication driver class
CDP	charging downstream port
DCP	dedicated charging port
DLL	dynamic link library
ESD	electrostatic discharge
GPIO	general purpose input/output
HBM	human-body model
MCU	microcontroller unit
OSC	oscillator
PHDC	personal health care device class
PID	product identification
SCB	serial communication block
SDP	standard downstream port
SIE	serial interface engine
SPI	serial peripheral interface
VCOM	virtual communication port
USB	Universal Serial Bus
VID	vendor identification

Document Conventions

Units of Measure

Table 20. Units of Measure

Symbol	Unit of Measure
°C	degree Celsius
DMIPS	Dhrystone million instructions per second
kΩ	kilo-ohm
KB	kilobyte
kHz	kilohertz
kV	kilovolt
Mbps	megabits per second
MHz	megahertz
mm	millimeter
V	volt

Document History Page

Document Title: CY7C652148, USB-SPI Single Channel Bridge Controller Document Number: 002-31601			
Revision	**ECN**	**Submission Date**	**Description of Change**
**	7021631	11/26/2020	Final datasheet to NSO.

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