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USB Type-C Port Controller

General Description

EZ-PD™ CCG2 is a USB Type-C controller that complies with the latest USB Type-C and PD standards. EZ-PD CCG2 provides a complete USB Type-C and USB Power Delivery port control solution for powered accessories. It can also be used in many upstream and downstream facing port applications. EZ-PD CCG2 uses Cypress' proprietary M0S8 technology with a 32-bit, 48-MHz ARM® Cortex®-M0 processor with 32-KB flash and integrates a complete Type-C Transceiver including the Type-C termination resistors R_D and R_P.

Applications

- USB Type-C powered accessories
- USB Type-C upstream facing ports
- USB Type-C downstream facing ports

Features

32-bit MCU Subsystem

- Automotive Electronics Council (AEC) AEC-Q100 qualified
- 48-MHz ARM Cortex-M0 CPU
- 32-KB Flash
- 4-KB SRAM
- In-system reprogrammable

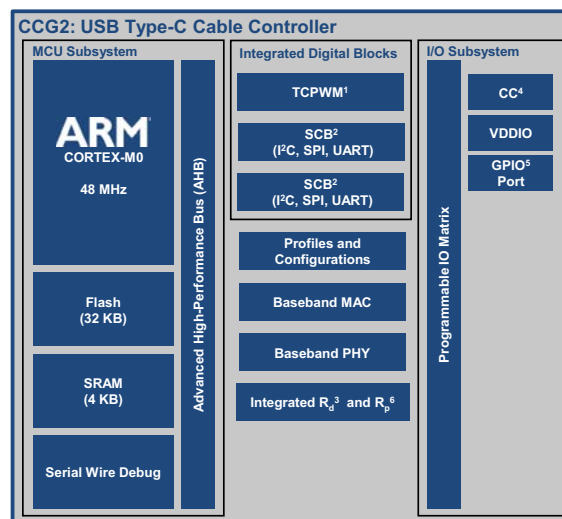
Integrated Digital Blocks

- Integrated timers and counters to meet response times required by the USB-PD protocol
- Run-time reconfigurable serial communication block (SCB) with reconfigurable I²C, SPI, or UART functionality

Clocks and Oscillators

- Integrated oscillator eliminating the need for external clock

Logic Block Diagram



¹ Timer, counter, pulse-width modulation block
² Serial communication block configurable as UART, SPI, or I²C
³ Termination resistor denoting a UFP
⁴ Configuration Channel
⁵ General-purpose input/output
⁶ Current Sources to indicate a DFP

Type-C Support

- Integrated transceiver (baseband PHY)
- Integrated UFP (R_D) and current sources for DFP (R_P)
- Supports one USB Type-C port

Low-Power Operation

- 2.7-V to 5.5-V operation
- Independent supply voltage pin for GPIO that allows 1.71-V to 5.5-V signaling on the I/Os
- Reset: 1.0 μA, Deep Sleep: 2.5 μA, Sleep: 2.0 mA

System-Level ESD on CC and VCONN Pins

- ±8-kV Contact Discharge and ±15-kV Air Gap Discharge based on IEC61000-4-2 level 4C

Packages

- 4.0 mm × 4.0 mm, 0.55 mm 24-pin QFN

Temperature Range

- Automotive Grade-A: -40 °C to +85 °C
- Automotive Grade-S: -40 °C to +105 °C

Available Firmware and Software Tools

EZ-PD Configuration Utility

The EZ-PD Configuration Utility is a GUI-based Microsoft Windows application developed by Cypress to guide a CCGx user through the process of configuring and programming the chip. The utility allows users to:

1. Select and configure the parameters they want to modify
2. Program the resulting configuration onto the target CCGx device.

The utility works with the Cypress supplied CCG1, CCG2, CCG3, and CCG4 kits, which host the CCGx controllers along with a USB interface. This version of the EZ-PD Configuration Utility supports configuration and firmware update operations on CCGx controllers implementing EMCA and Display Dongle applications. Support for other applications, such as Power Adapters and Notebook port controllers, will be provided in later versions of the utility.

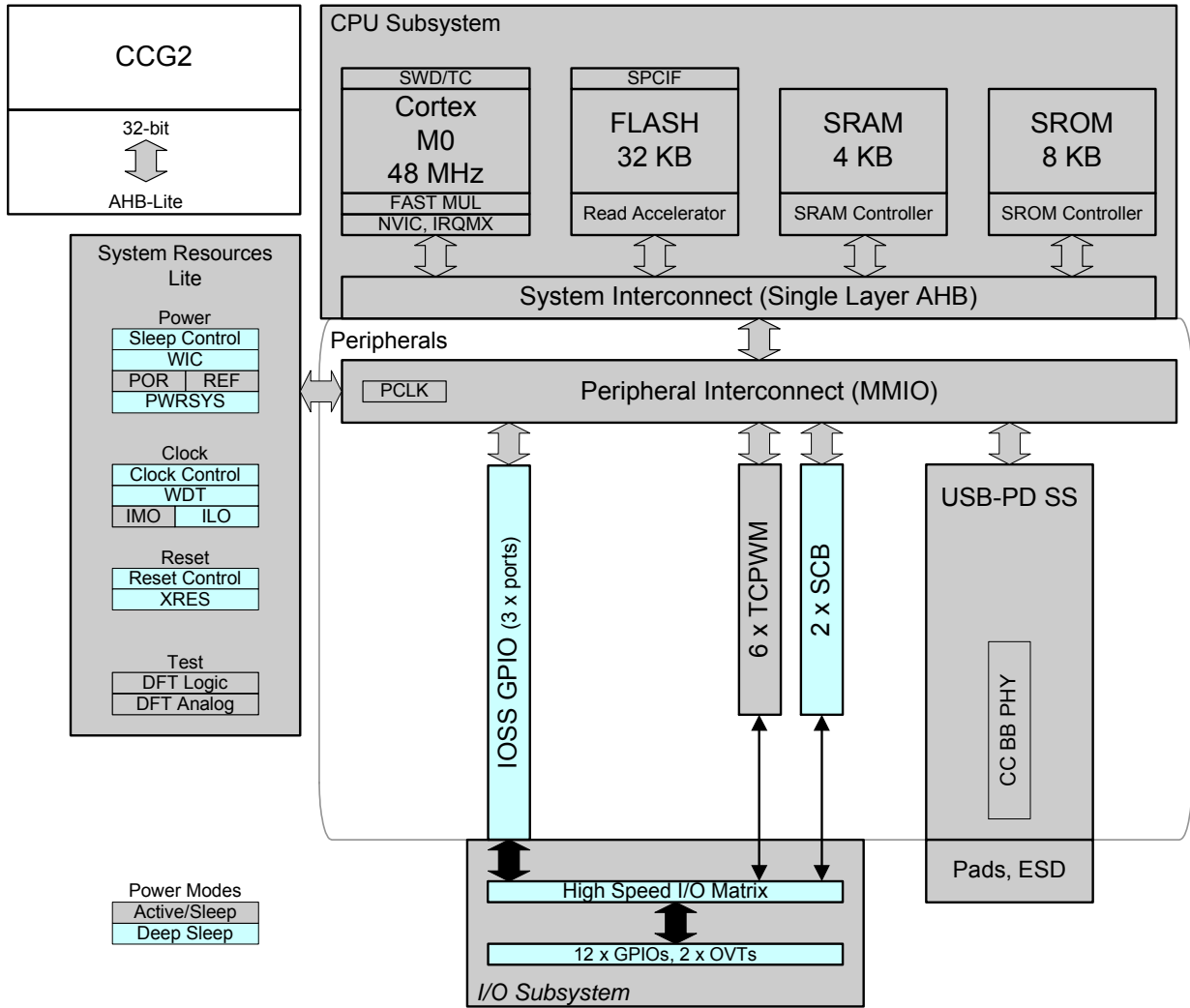
You can download the EZ-PD Configuration Utility and its associated documentation at the following link:

<http://www.cypress.com/documentation/software-and-drivers/ez-pd-configuration-utility>

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Figure 1. EZ-PD CCG2 Block Diagram



Functional Overview

CPU and Memory Subsystem

CPU

The Cortex-M0 CPU in EZ-PD CCG2 is part of the 32-bit MCU subsystem, which is optimized for low-power operation with extensive clock gating. It mostly uses 16-bit instructions and executes a subset of the Thumb-2 instruction set. This enables fully compatible binary upward migration of the code to higher performance processors such as the Cortex-M3 and M4, thus enabling upward compatibility. The Cypress implementation includes a hardware multiplier that provides a 32-bit result in one cycle. It includes a nested vectored interrupt controller (NVIC) block with 32 interrupt inputs and also includes a Wakeup Interrupt Controller (WIC). The WIC can wake the processor up from the Deep Sleep mode, allowing power to be switched off to the main processor when the chip is in the Deep Sleep mode. The Cortex-M0 CPU provides a Non-Maskable Interrupt (NMI) input, which is made available to the user when it is not in use for system functions requested by the user.

The CPU also includes a serial wire debug (SWD) interface, which is a 2-wire form of JTAG. The debug configuration used for EZ-PD CCG2 has four break-point (address) comparators and two watchpoint (data) comparators.

Flash

The EZ-PD CCG2 device has a flash module with a flash accelerator, tightly coupled to the CPU to improve average access times from the flash block. The flash block is designed to deliver 1 wait-state (WS) access time at 48 MHz and with 0-WS access time at 24 MHz. The flash accelerator delivers 85% of single-cycle SRAM access performance on average. Part of the flash module can be used to emulate EEPROM operation if required.

SRAM

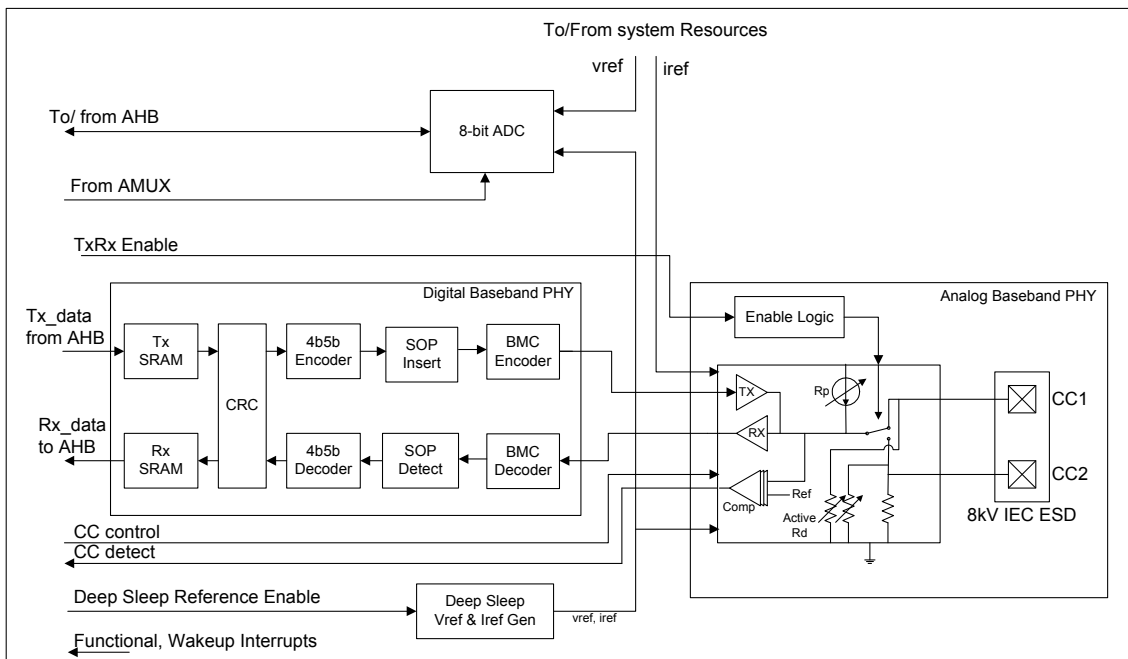
A supervisory ROM that contains boot and configuration routines is provided.

USB-PD Subsystem (SS)

EZ-PD CCG2 has a USB-PD subsystem consisting of a USB Type-C baseband transceiver and physical-layer logic. This transceiver performs the BMC and the 4b/5b encoding and decoding functions as well as the 1.2-V front end. This subsystem integrates the required termination resistors to identify the role of the EZ-PD CCG2 solution. R_D is used to identify EZ-PD CCG2 as a UFP device. When configured as a DFP, integrated current sources perform the role of R_P or pull-up resistors. These current sources can be programmed to indicate the complete range of current capacity on VBUS defined in the Type-C spec. EZ-PD CCG2 responds to all USB-PD communication. The EZ-PD CCG2 USB-PD sub-system can be configured to respond to SOP, SOP', or SOP'' messaging.

The USB-PD subsystem contains a 8-bit SAR (Successive Approximation Register) ADC for analog to digital conversions. The ADC includes a 8-bit DAC and a comparator. The DAC output forms the positive input of the comparator. The negative input of the comparator is from a 4-input multiplexer. The four inputs of the multiplexer are a pair of global analog multiplex busses an internal bandgap voltage and an internal voltage proportional to the absolute temperature. All GPIO inputs can be connected to the global Analog Multiplex Busses through a switch at each GPIO that can enable that GPIO to be connected to the mux bus for ADC use. The CC1 and CC2 pins are not available to connect to the mux busses.

Figure 2. USB-PD Subsystem



System Resources

Power System

The power system is described in detail in the section [Power on page 9](#). It provides assurance that voltage levels are as required for each respective mode and either delay mode entry (on power-on reset (POR), for example) until voltage levels are as required for proper function or generate resets (Brown-Out Detect (BOD)) or interrupts (Low Voltage Detect (LVD)). EZ-PD CCG2 can operate from three different power sources over the range of 2.7 to 5.5 V and has three different power modes, transitions between which are managed by the power system. EZ-PD CCG2 provides Sleep and Deep Sleep low-power modes.

Clock System

The clock system for EZ-PD CCG2 consists of the Internal Main Oscillator (IMO) and the Internal Low-power Oscillator (ILO).

Peripherals

Serial Communication Blocks (SCB)

EZ-PD CCG2 has two SCBs, which can be configured to implement an I²C, SPI, or UART interface. The hardware I²C blocks implement full multi-master and slave interfaces capable of multimaster arbitration. In the SPI mode, the SCB blocks can be configured to act as master or slave.

In the I²C mode, the SCB blocks are capable of operating at speeds of up to 1 Mbps (Fast Mode Plus) and have flexible buffering options to reduce interrupt overhead and latency for the CPU. These blocks also support I²C that creates a mailbox address range in the memory of EZ-PD CCG2 and effectively reduce I²C communication to reading from and writing to an array in memory. In addition, the blocks support 8-deep FIFOs for receive and transmit which, by increasing the time given for the CPU to read data, greatly reduce the need for clock stretching caused by the CPU not having read data on time.

The I²C peripherals are compatible with the I²C Standard-mode, Fast-mode, and Fast-mode Plus devices as defined in the NXP I²C-bus specification and user manual (UM10204). The I²C bus I/Os are implemented with GPIO in open-drain modes.

The I²C port on SCB 1 block of EZ-PD CCG2 is not completely compliant with the I²C spec in the following respects:

- The GPIO cells for SCB 1's I²C port are not overvoltage-tolerant and, therefore, cannot be hot-swapped or powered up independently of the rest of the I²C system.
- Fast-mode Plus has an I_{OL} specification of 20 mA at a V_{OL} of 0.4 V. The GPIO cells can sink a maximum of 8-mA I_{OL} with a V_{OL} maximum of 0.6 V.
- Fast-mode and Fast-mode Plus specify minimum Fall times, which are not met with the GPIO cell; Slow strong mode can help meet this spec depending on the bus load.

Timer/Counter/PWM Block (TCPWM)

EZ-PD CCG2 has six TCPWM blocks. Each implements a 16-bit timer, counter, pulse-width modulator (PWM), and quadrature decoder functionality. The block can be used to measure the period and pulse width of an input signal (timer), find the number of times a particular event occurs (counter), generate PWM signals, or decode quadrature signals.

GPIO

EZ-PD CCG2 has up to 10 GPIOs in addition to the I²C and SWD pins, which can also be used as GPIOs. The I²C pins from SCB 0 are overvoltage-tolerant. The number of available GPIOs vary with the package. The GPIO block implements the following:

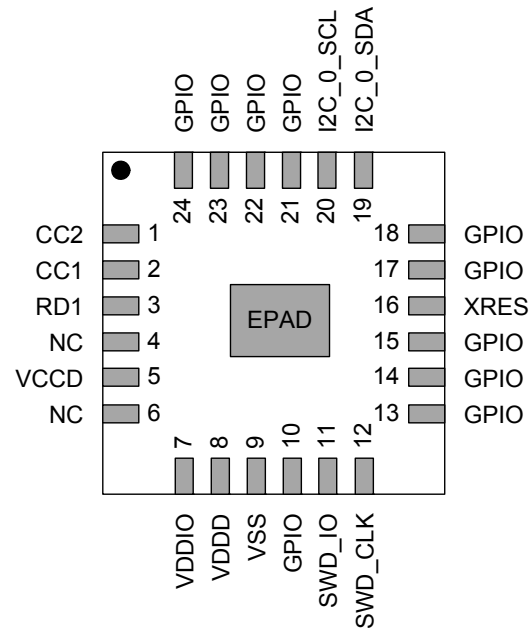
- Seven drive strength modes:
 - Input only
 - Weak pull-up with strong pull-down
 - Strong pull-up with weak pull-down
 - Open drain with strong pull-down
 - Open drain with strong pull-up
 - Strong pull-up with strong pull-down
 - Weak pull-up with weak pull-down
- Input threshold select (CMOS or LVTTTL)
- Individual control of input and output buffer enabling/disabling in addition to the drive strength modes
- Hold mode for latching previous state (used for retaining I/O state in Deep Sleep mode)
- Selectable slew rates for dV/dt related noise control to improve EMI

During power-on and reset, the I/O pins are forced to the disable state so as not to crowbar any inputs and/or cause excess turn-on current. A multiplexing network known as a high-speed I/O matrix is used to multiplex between various signals that may connect to an I/O pin.

Pinouts

Group	Name	Pin Map 24-QFN	Description
USB Type-C Port	CC1	2	USB PD connector detect/Configuration Channel 1
	CC2	1	USB PD connector detect/Configuration Channel 2
	RD1	3	Dedicated Rd resistor pin Must be left open
GPIOs and serial interfaces	GPIO	22	GPIO / SPI_0_CLK / UART_0_RX
	GPIO	18	GPIO / SPI_0_MOSI / UART_0_TX
	GPIO	13	GPIO / I2C_1_SDA / SPI_1_MISO / UART_1_RX
	GPIO	10	GPIO / I2C_1_SCL / SPI_1_CLK / UART_1_TX
	GPIO	15	GPIO / SPI_1_SEL / UART_1_RTS
	GPIO	14	GPIO
	GPIO	17	GPIO
	GPIO	21	GPIO
	GPIO	23	GPIO
	GPIO	24	GPIO
	I2C_0_SCL	20	GPIO / I2C_0_SCL / SPI_0_MISO / UART_0_RTS
	I2C_0_SDA	19	GPIO / I2C_0_SDA / SPI_0_SEL / UART_0_CTS
	SWD_IO	11	SWD IO / GPIO / UART_1_CTS / SPI_1_MOSI
	SWD_CLK	12	SWD clock / GPIO
RESET	XRES	16	Reset input
POWER	VDDIO	7	1.71-V to 5.5-V supply for I/Os
	VCCD	5	1.8-V regulator output for filter capacitor
	VDDD	8	VDDD supply input/output (2.7 V to 5.5 V)
	VSS	EPAD	Ground supply
	VSS	9	Ground supply
	NC	4	
NC	6		

Figure 3. 24-Pin QFN Pin Map (Top View)



Power

The following power system diagram shows the set of power supply pins as implemented in EZ-PD CCG2.

EZ-PD CCG2 can operate from 2.7 to 5.5 V when operated from the VDDD supply pin.

In UFP, DFP, and DRP applications, CCG2 can be operated from VDDD as the only supply input. In DFP applications, the lowest VDDD level that CCG2 can operate is 3.0 V due to the need to support disconnect detection thresholds of up to 2.7 V.

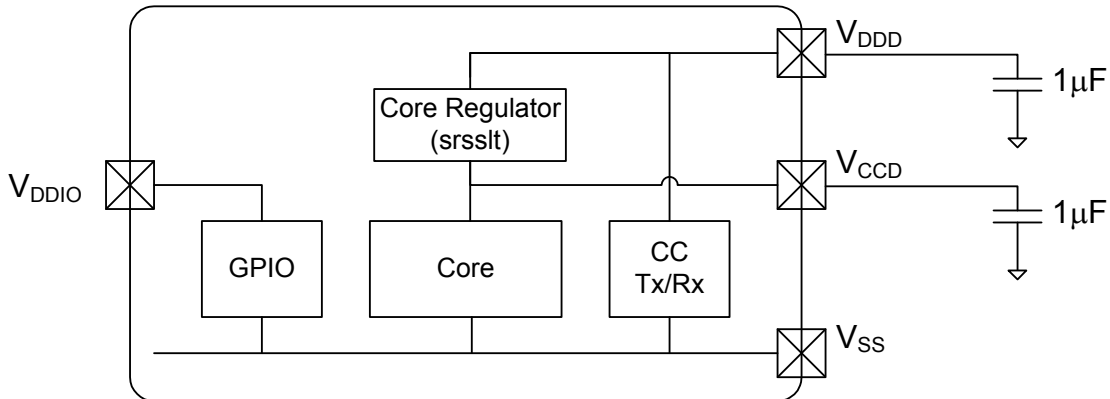
A separate I/O supply pin, VDDIO, allows the GPIOs to operate at levels from 1.71 to 5.5 V. The VDDIO pin can be equal to or less than the voltages connected to the VDDD pin.

The VCCD output of EZ-PD CCG2 must be bypassed to ground via an external capacitor (in the range of 1 to 1.6 μF ; X5R ceramic or better).

Bypass capacitors must be used from VDDD pin to ground; typical practice for systems in this frequency range is to use a 0.1- μF capacitor. Note that these are simply rules of thumb and that for critical applications, the PCB layout, lead inductance, and the bypass capacitor parasitic should be simulated to design and obtain optimal bypassing.

An example of the power supply bypass capacitors is shown in [Figure 4](#).

Figure 4. EZ-PD CCG2 Power and Bypass Scheme Example



Application Diagrams

Figure 5 shows an infotainment port application diagram using a CCG2 device. The Type-C port can be used as a power provider, USB host/device (Dual Role). The CCG2 device communicates with the Embedded controller (EC) over I²C. It also controls the Data Mux to route the High Speed signals either to the USB chipset (during normal mode) or the DisplayPort Chipset (during Alternate Mode). The SBU lines, SuperSpeed and HighSpeed lines are routed directly from the Display Mux to the Type-C receptacle.

Optional FETs are provided for applications that need to provide power for accessories and cables using the VCONN pin of the Type-C receptacle. VBUS FETs are also used for providing power over VBUS and for consuming power over VBUS. A VBUS_DISCHARGE FET controlled by CCG2 device is used to quickly discharge VBUS after the Type-C connection is detached. The VBUS_MON is used for detecting the Over Voltage (OV) and Under Voltage (UV) events. Using the polling method of the VBUS_MON pin, the Over Current (OC) event will be detected.

Figure 5. Infotainment Port Application

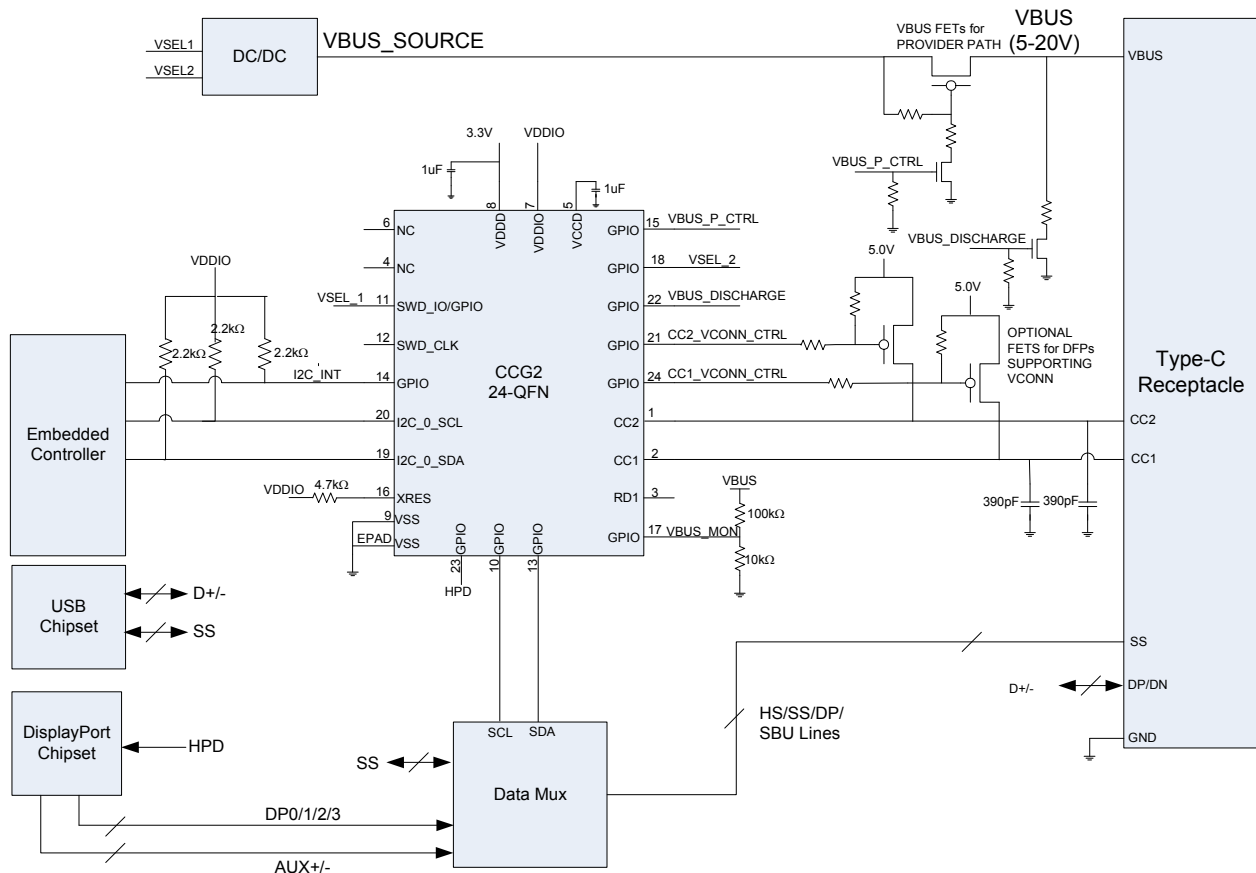
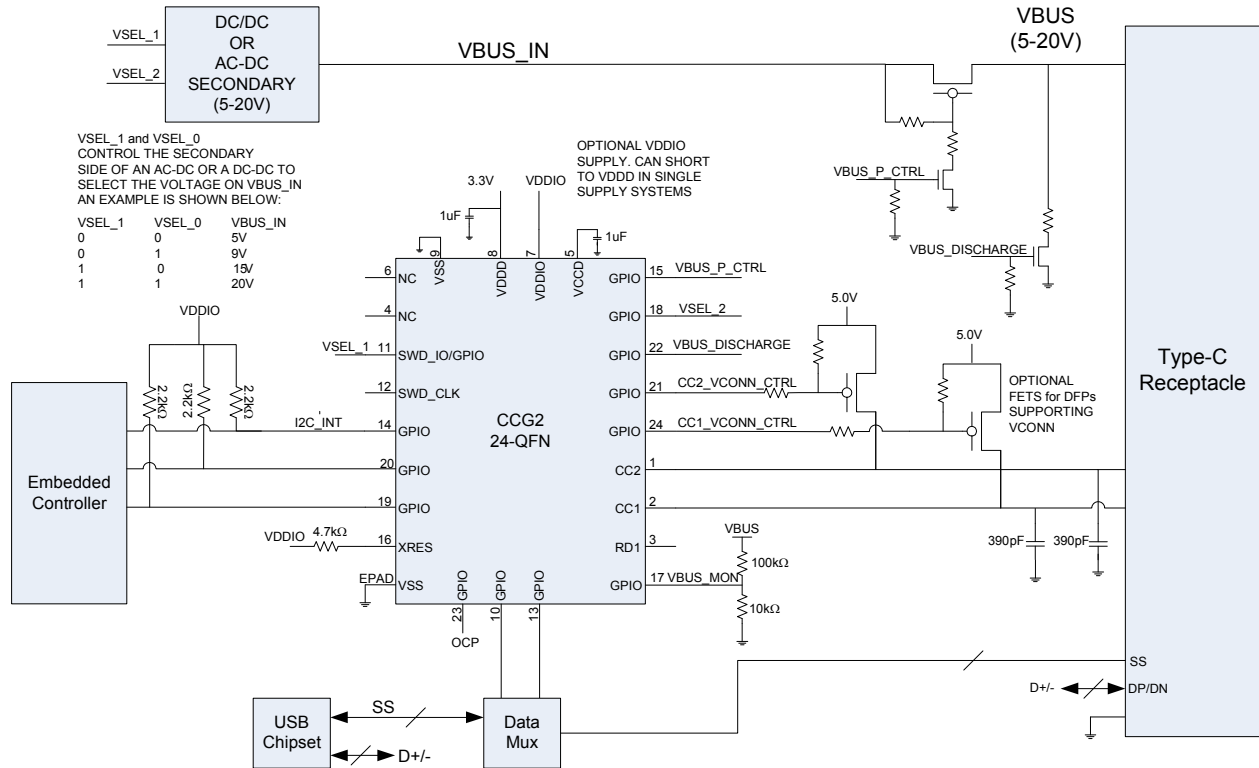


Figure 6 shows a CCG2 receptacle-based Charging Port application in which the CCG2 device is used as a DFP. CCG2 integrates all termination resistors and uses GPIOs (VSEL_0 and VSEL_1) to indicate the negotiated power profile. The VBUS voltage on the Type-C port is monitored using internal ADC to detect undervoltage and overvoltage conditions on VBUS. To ensure quick discharge of VBUS when the power adapter cable

is detached, a discharge path is also provided. The VBUS_MON is used for detecting the OV and UV events. Using the polling method of the VBUS_MON pin, the OC event will be detected. The OCP is supported using a dedicated pin which will be connected to an external OC event detect circuit. This pin can be used for Over Temperature (OT) detection with an external circuit.

Figure 6. Charging Port Application



Electrical Specifications

Absolute Maximum Ratings

Table 1. Absolute Maximum Ratings^[1]

Parameter	Description	Min	Typ	Max	Units	Details/Conditions
V _{DDD_MAX}	Digital supply relative to V _{SS}	-0.5	-	6	V	Absolute max
V _{DDIO_MAX}	Max supply voltage relative to V _{SS}	-	-	6	V	Absolute max
V _{GPIO_ABS}	GPIO voltage	-0.5	-	V _{DDIO} + 0.5	V	Absolute max
V _{CC_ABS}	Absolute max voltage for CC1 and CC2 pins	-	-	6	V	Absolute max
I _{GPIO_ABS}	Maximum current per GPIO	-25	-	25	mA	Absolute max
I _{GPIO_injection}	GPIO injection current, Max for V _{IH} > V _{DDD} , and Min for V _{IL} < V _{SS}	-0.5	-	0.5	mA	Absolute max, current injected per pin
ESD_HBM	Electrostatic discharge human body model	2200	-	-	V	-
ESD_CDM	Electrostatic discharge charged device model	500	-	-	V	-
LU	Pin current for latch-up	-200	-	200	mA	-
ESD_IEC_CON	Electrostatic discharge IEC61000-4-2	8000	-	-	V	Contact discharge on CC1, CC2 pins
ESD_IEC_AIR	Electrostatic discharge IEC61000-4-2	15000	-	-	V	Air discharge for CC1, CC2 pins

Note

- Usage above the absolute maximum conditions listed in Table 1 may cause permanent damage to the device. Exposure to absolute maximum conditions for extended periods of time may affect device reliability. The maximum storage temperature is 150 °C in compliance with JEDEC Standard JESD22-A103, High Temperature Storage Life. When used below absolute maximum conditions but above normal operating conditions, the device may not operate to specification.

Device Level Specifications

All specifications are valid for $-40\text{ }^{\circ}\text{C} \leq T_A \leq 85\text{ }^{\circ}\text{C}$ for Grade-A devices and $-40\text{ }^{\circ}\text{C} \leq T_A \leq 105\text{ }^{\circ}\text{C}$ for Grade-S devices, except where noted. Specifications are valid for 3.0 V to 5.5 V, except where noted.

Table 2. DC Specifications

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID.PWR#1	V _{DDD}	Power supply input voltage	2.7	–	5.5	V	UFP Applications
SID.PWR#1_A	V _{DDD}	Power supply input voltage	3.0	–	5.5	V	DFP/DRP Applications
SID.PWR#13	V _{DDIO}	GPIO power supply	1.71	–	5.5	V	–
SID.PWR#24	V _{CCD}	Output voltage (for core logic)	–	1.8	–	V	–
SID.PWR#15	C _{EFC}	External regulator voltage bypass on V _{CCD}	1	1.3	1.6	μF	X5R ceramic or better
SID.PWR#16	C _{EXC}	Power supply decoupling capacitor on V _{DDD}	–	1	–	μF	X5R ceramic or better
Active Mode, V_{DDD} = 2.7 V to 5.5 V. Typical values measured at V_{DD} = 3.3 V.							
SID.PWR#12	I _{DD12}	Supply current	–	7.5	–	mA	T _A = 25 °C, CC I/O IN Transmit or Receive, no I/O sourcing current, CPU at 12 MHz
Sleep Mode, V_{DDD} = 2.7 V to 5.5 V							
SID25A	I _{DD20A}	I ² C wakeup. WDT ON. IMO at 48 MHz	–	2.0	3.0	mA	V _{DDD} = 3.3 V, T _A = 25 °C, all blocks except CPU are ON, CC I/O ON, no I/O sourcing current
Deep Sleep Mode, V_{DDD} = 2.7 V to 3.6 V (Regulator on)							
SID34	I _{DD29}	V _{DDD} = 2.7 V to 3.6 V. I ² C wakeup and WDT ON	–	50	–	μA	V _{DDD} = 3.3 V, T _A = 25 °C
SID_DS	I _{DD_DS}	V _{DDD} = 2.7 V to 3.6 V. CC wakeup ON	–	2.5	–	μA	Power source = V _{DDD} , Type-C not attached, CC enabled for wakeup, R _P disabled
XRES Current							
SID307	I _{DD_XR}	Supply current while XRES asserted	–	1	10	μA	–

Table 3. AC Specifications

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID.CLK#4	F _{CPU}	CPU frequency	DC	–	48	MHz	3.0 V ≤ V _{DDD} ≤ 5.5 V
SID.PWR#20	T _{SLEEP}	Wakeup from sleep mode	–	0	–	μs	Guaranteed by characterization
SID.PWR#21	T _{DEEPSLEEP}	Wakeup from Deep Sleep mode	–	–	35	μs	24-MHz IMO. Guaranteed by characterization.
SID.XRES#5	T _{XRES}	External reset pulse width	5	–	–	μs	Guaranteed by characterization
SYS.FES#1	T _{PWR_RDY}	Power-up to “Ready to accept I2C / CC command”	–	TBD	TBD	ms	Guaranteed by characterization

I/O

Table 4. I/O DC Specifications

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID.GIO#37	$V_{IH}^{[2]}$	Input voltage HIGH threshold	$0.7 \times V_{DDIO}$	–	–	V	CMOS input
SID.GIO#38	V_{IL}	Input voltage LOW threshold	–	–	$0.3 \times V_{DDIO}$	V	CMOS input
SID.GIO#39	$V_{IH}^{[2]}$	LVTTL input, $V_{DDIO} < 2.7$ V	$0.7 \times V_{DDIO}$	–	–	V	–
SID.GIO#40	V_{IL}	LVTTL input, $V_{DDIO} < 2.7$ V	–	–	$0.3 \times V_{DDIO}$	V	–
SID.GIO#41	$V_{IH}^{[2]}$	LVTTL input, $V_{DDIO} \geq 2.7$ V	2.0	–	–	V	–
SID.GIO#42	V_{IL}	LVTTL input, $V_{DDIO} \geq 2.7$ V	–	–	0.8	V	–
SID.GIO#33	V_{OH}	Output voltage HIGH level	$V_{DDIO} - 0.6$	–	–	V	$I_{OH} = 4$ mA at 3-V V_{DDIO}
SID.GIO#34	V_{OH}	Output voltage HIGH level	$V_{DDIO} - 0.5$	–	–	V	$I_{OH} = 1$ mA at 1.8-V V_{DDIO}
SID.GIO#35	V_{OL}	Output voltage LOW level	–	–	0.6	V	$I_{OL} = 4$ mA at 1.8-V V_{DDIO}
SID.GIO#36	V_{OL}	Output voltage LOW level	–	–	0.6	V	$I_{OL} = 8$ mA at 3 V V_{DDIO}
SID.GIO#5	R_{PULLUP}	Pull-up resistor	3.5	5.6	8.5	k Ω	–
SID.GIO#6	$R_{PULLDOWN}$	Pull-down resistor	3.5	5.6	8.5	k Ω	–
SID.GIO#16	I_{IL}	Input leakage current (absolute value)	–	–	2	nA	25 °C, $V_{DDIO} = 3.0$ V. Guaranteed by characterization
SID.GIO#17	C_{IN}	Input capacitance	–	–	7	pF	Guaranteed by characterization
SID.GIO#43	V_{HYSTTL}	Input hysteresis LVTTL	25	40	–	mV	$V_{DDIO} \geq 2.7$ V. Guaranteed by characterization.
SID.GPIO#44	$V_{HYSCMOS}$	Input hysteresis CMOS	$0.05 \times V_{DDIO}$	–	–	mV	Guaranteed by characterization
SID69	I_{DIODE}	Current through protection diode to V_{DDIO}/V_{SS}	–	–	100	μ A	Guaranteed by characterization
SID.GIO#45	I_{TOT_GPIO}	Maximum total source or sink chip current	–	–	200	mA	Guaranteed by characterization

Table 5. I/O AC Specifications

(Guaranteed by Characterization)

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID70	T_{RISEF}	Rise time	2	–	12	ns	3.3-V V_{DDIO} , Load = 25 pF
SID71	T_{FALLF}	Fall time	2	–	12	ns	3.3-V V_{DDIO} , Load = 25 pF

Note

2. V_{IH} must not exceed $V_{DDIO} + 0.2$ V.

XRES

Table 6. XRES DC Specifications

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID.XRES#1	V _{IH}	Input voltage HIGH threshold	0.7 × V _{DDIO}	–	–	V	CMOS input
SID.XRES#2	V _{IL}	Input voltage LOW threshold	–	–	0.3 × V _{DDIO}	V	CMOS input
SID.XRES#3	C _{IN}	Input capacitance	–	–	7	pF	Guaranteed by characterization
SID.XRES#4	V _{HYSXRES}	Input voltage hysteresis	–	–	0.05 × V _{DDIO}	mV	Guaranteed by characterization

Digital Peripherals

The following specifications apply to the Timer/Counter/PWM peripherals in the Timer mode.

Pulse Width Modulation (PWM) for GPIO Pins

Table 7. PWM AC Specifications

(Guaranteed by Characterization)

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID.TCPWM.3	T _{CPWMFREQ}	Operating frequency	–	F _c	–	MHz	F _c max = CLK_SYS. Maximum = 48 MHz.
SID.TCPWM.4	T _{PWMENEXT}	Input trigger pulse width	–	2/F _c	–	ns	For all Trigger Events
SID.TCPWM.5	T _{PWMEXT}	Output trigger pulse width	–	2/F _c	–	ns	Minimum possible width of Overflow, Underflow, and CC (Counter equals Compare value) outputs
SID.TCPWM.5A	T _{CREG}	Resolution of counter	–	1/F _c	–	ns	Minimum time between successive counts
SID.TCPWM.5B	PWM _{RES}	PWM resolution	–	1/F _c	–	ns	Minimum pulse width of PWM output
SID.TCPWM.5C	Q _{RES}	Quadrature inputs resolution	–	1/F _c	–	ns	Minimum pulse width between quadrature-phase inputs

I²C

Table 8. Fixed I²C DC Specifications

(Guaranteed by Characterization)

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID149	I _{I2C1}	Block current consumption at 100 kbps	–	–	60	μA	–
SID150	I _{I2C2}	Block current consumption at 400 kbps	–	–	185	μA	–
SID151	I _{I2C3}	Block current consumption at 1 Mbps	–	–	390	μA	–
SID152	I _{I2C4}	I ² C enabled in Deep Sleep mode	–	–	1.4	μA	–

Table 9. Fixed I²C AC Specifications

(Guaranteed by Characterization)

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID153	F _{I2C1}	Bit rate	–	–	1	Mbps	–

Table 10. Fixed UART DC Specifications

(Guaranteed by Characterization)

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID160	I _{UART1}	Block current consumption at 100 Kbps	–	–	125	μA	Guaranteed by characterization
SID161	I _{UART2}	Block current consumption at 1000 Kbps	–	–	312	μA	Guaranteed by characterization

Table 11. Fixed UART AC Specifications

(Guaranteed by Characterization)

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID162	F _{UART}	Bit rate	–	–	1	Mbps	Guaranteed by characterization

Table 12. Fixed SPI DC Specifications

(Guaranteed by Characterization)

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID163	I _{SPI1}	Block current consumption at 1 Mbps	–	–	360	μA	Guaranteed by characterization
SID164	I _{SPI2}	Block current consumption at 4 Mbps	–	–	560	μA	Guaranteed by characterization
SID165	I _{SPI3}	Block current consumption at 8 Mbps	–	–	600	μA	Guaranteed by characterization

Table 13. Fixed SPI AC Specifications

(Guaranteed by Characterization)

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID166	F _{SPI}	SPI Operating frequency (Master; 6X oversampling)	–	–	8	MHz	Guaranteed by characterization

Table 14. Fixed SPI Master Mode AC Specifications

(Guaranteed by Characterization)

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID167	T _{DMO}	MOSI Valid after SClk driving edge	–	–	15	ns	Guaranteed by characterization
SID168	T _{DSI}	MISO Valid before SClk capturing edge	20	–	–	ns	Full clock, late MISO sampling. Guaranteed by characterization
SID169	T _{HMO}	Previous MOSI data hold time	0	–	–	ns	Referred to Slave capturing edge. Guaranteed by characterization

Table 15. Fixed SPI Slave Mode AC Specifications

(Guaranteed by Characterization)

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID170	T _{DMI}	MOSI Valid before Sclock Capturing edge	40	–	–	ns	Guaranteed by characterization
SID171	T _{DSO}	MISO Valid after Sclock driving edge	–	–	42 + 3 * T _{CPU}	ns	T _{CPU} = 1/FCPU. Guaranteed by characterization.
SID171A	T _{DSO_EXT}	MISO Valid after Sclock driving edge in Ext Clk mode	–	–	48	ns	Guaranteed by characterization
SID172	T _{HSD}	Previous MISO data hold time	0	–	–	ns	Guaranteed by characterization
SID172A	T _{SSELCK}	SSEL Valid to first SCK Valid edge	100	–	–	ns	Guaranteed by characterization

Memory

Table 16. Flash AC Specifications

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID.MEM#4	T _{ROWWRITE} ^[3]	Row (block) write time (erase and program)	–	–	20	ms	Row (block) = 128 bytes
SID.MEM#3	T _{ROWERASE} ^[3]	Row erase time	–	–	13	ms	–
SID.MEM#8	T _{ROWPROGRAM} ^[3]	Row program time after erase	–	–	7	ms	–
SID178	T _{BULKERASE} ^[3]	Bulk erase time (32 KB)	–	–	35	ms	–
SID180	T _{DEVPROG} ^[3]	Total device program time	–	–	7.5	seconds	Guaranteed by characterization
SID181	F _{END}	Flash endurance	100 K	–	–	cycles	Guaranteed by characterization
SID182	F _{RET1}	Flash retention. T _A ≤ 55 °C, 100 K P/E cycles	20	–	–	years	Guaranteed by characterization
SID182A	F _{RET2}	Flash retention. T _A ≤ 85 °C, 10 K P/E cycles	10	–	–	years	Guaranteed by characterization

Note

- It can take as much as 20 milliseconds to write to Flash. During this time the device should not be Reset, or Flash operations will be interrupted and cannot be relied on to have completed. Reset sources include the XRES pin, software resets, CPU lockup states and privilege violations, improper power supply levels, and watchdogs. Make certain that these are not inadvertently activated.

System Resources

Power-on-Reset (POR) with Brown Out

Table 17. Imprecise Power On Reset (PRES)

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID185	V _{RISEIPOR}	Rising trip voltage	0.80	–	1.50	V	Guaranteed by characterization
SID186	V _{FALLIPOR}	Falling trip voltage	0.75	–	1.4	V	Guaranteed by characterization

Table 18. Precise Power On Reset (POR)

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID190	V _{FALLPPOR}	BOD trip voltage in active and sleep modes	1.48	–	1.62	V	Guaranteed by characterization
SID192	V _{FALLDPSLP}	BOD trip voltage in Deep Sleep	1.1	–	1.5	V	Guaranteed by characterization

SWD Interface

Table 19. SWD Interface Specifications

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID.SWD#1	F_SWDCLK1	$3.3\text{ V} \leq V_{DDIO} \leq 5.5\text{ V}$	–	–	14	MHz	SWDCLK \leq 1/3 CPU clock frequency
SID.SWD#2	F_SWDCLK2	$1.8\text{ V} \leq V_{DDIO} \leq 3.3\text{ V}$	–	–	7	MHz	SWDCLK \leq 1/3 CPU clock frequency
SID.SWD#3	T_SWDI_SETUP	$T = 1/f\text{ SWDCLK}$	$0.25 \cdot T$	–	–	ns	Guaranteed by characterization
SID.SWD#4	T_SWDI_HOLD	$T = 1/f\text{ SWDCLK}$	$0.25 \cdot T$	–	–	ns	Guaranteed by characterization
SID.SWD#5	T_SWDO_VALID	$T = 1/f\text{ SWDCLK}$	–	–	$0.5 \cdot T$	ns	Guaranteed by characterization
SID.SWD#6	T_SWDO_HOLD	$T = 1/f\text{ SWDCLK}$	1	–	–	ns	Guaranteed by characterization

Internal Main Oscillator

Table 20. IMO DC Specifications

(Guaranteed by Design)

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID218	I _{IMO}	IMO operating current at 48 MHz	–	–	1000	μA	–

Table 21. IMO AC Specifications

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID.CLK#13	F _{IMOTOL}	Frequency variation at 24, 36, and 48 MHz (trimmed)	–	–	±2	%	–
SID226	T _{STARTIMO}	IMO startup time	–	–	7	μs	Guaranteed by characterization
SID229	T _{JITRMSIMO}	RMS jitter at 48 MHz	–	145	–	ps	Guaranteed by characterization
F _{IMO}	–	IMO frequency	24	–	48	MHz	–

Internal Low-Speed Oscillator

Table 22. ILO DC Specifications

(Guaranteed by Design)

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID231	I _{ILO}	ILO operating current at 32 kHz	–	0.3	1.05	μA	Guaranteed by Characterization
SID233	I _{ILOLEAK}	ILO leakage current	–	2	15	nA	Guaranteed by Design

Table 23. ILO AC Specifications

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID234	T _{STARTILO}	ILO startup time	–	–	2	ms	Guaranteed by characterization
SID236	T _{ILODUTY}	ILO duty cycle	40	50	60	%	Guaranteed by characterization
SID.CLK#5	F _{ILO}	ILO Frequency	20	40	80	kHz	–

Power Down

Table 24. PD DC Specifications

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID.PD.1	Rp_std	DFP CC termination for default USB Power	64	80	96	μA	–
SID.PD.2	Rp_1.5A	DFP CC termination for 1.5A power	166	180	194	μA	–
SID.PD.3	Rp_3.0A	DFP CC termination for 3.0A power	304	330	356	μA	–
SID.PD.4	Rd	UFP CC termination	4.59	5.1	5.61	kΩ	–

Analog-to-Digital Converter

Table 25. ADC DC Specifications

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID.ADC.1	Resolution	ADC resolution	–	8	–	bits	Guaranteed by characterization
SID.ADC.2	INL	Integral non-linearity	–1.5	–	1.5	LSB	Guaranteed by characterization
SID.ADC.3	DNL	Differential non-linearity	–2.5	–	2.5	LSB	Guaranteed by characterization
SID.ADC.4	Gain Error	Gain error	–1	–	1	LSB	Guaranteed by characterization

Table 26. ADC AC Specifications

Spec ID	Parameter	Description	Min	Typ	Max	Units	Details/Conditions
SID.ADC.5	SLEW_Max	Rate of change of sampled voltage signal	–	–	3	V/ms	Guaranteed by characterization

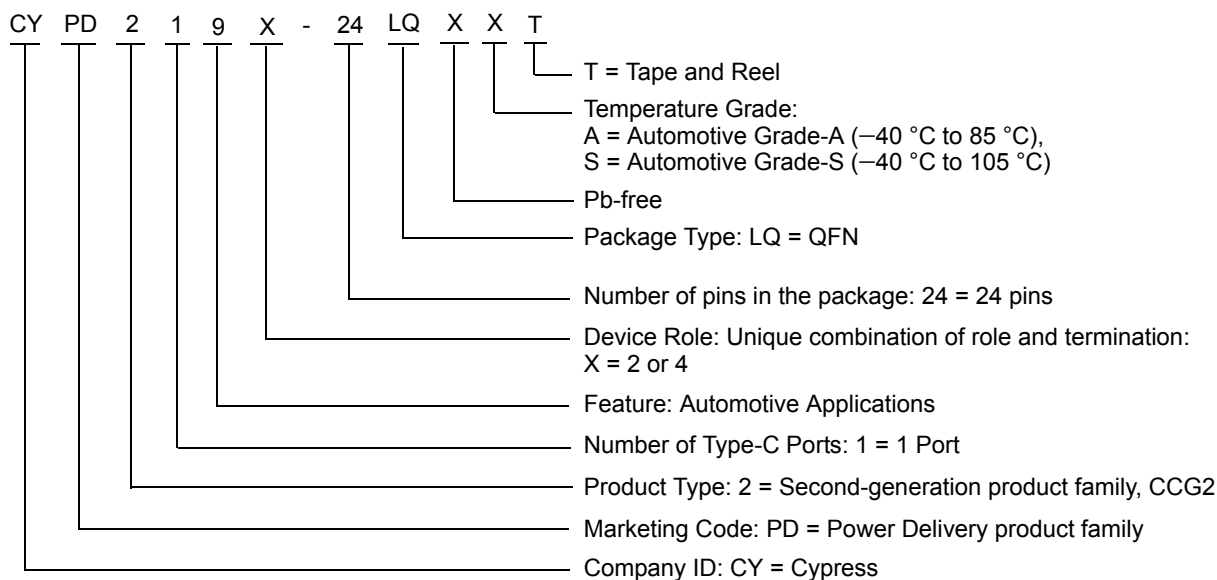
Ordering Information

Table 27 lists the EZ-PD CCG2 part numbers and features.

Table 27. EZ-PD CCG2 Ordering Information

Part Number	Application	Type-C Ports	Termination Resistor	Role	Package
CYPD2192-24LQXA	Infotainment Port	1	R _P ^[5] , R _D ^[4]	DRP	24-pin QFN
CYPD2192-24LQXS	Infotainment Port	1	R _P ^[5] , R _D ^[4]	DRP	24-pin QFN
CYPD2194-24LQXA	Charging Port	1	R _P ^[5]	DFP	24-pin QFN
CYPD2194-24LQXS	Charging Port	1	R _P ^[5]	DFP	24-pin QFN

Ordering Code Definitions



Notes

4. Termination resistor denoting an upstream facing port.
5. Termination resistor denoting a downstream facing port.

Packaging

Table 28. Package Characteristics

Parameter	Description	Conditions	Min	Typ	Max	Units
T _A	Operating ambient temperature	For Grade-A devices	-40	25	85	°C
		For Grade-S devices			105	°C
T _J	Operating junction temperature	For Grade-A devices	-40	-	100	°C
		For Grade-S devices			125	°C
T _{JA}	Package θ _{JA} (24-pin QFN)	-	-	19.84	-	°C/W
T _{JC}	Package θ _{JC} (24-pin QFN)	-	-	4.7	-	°C/W

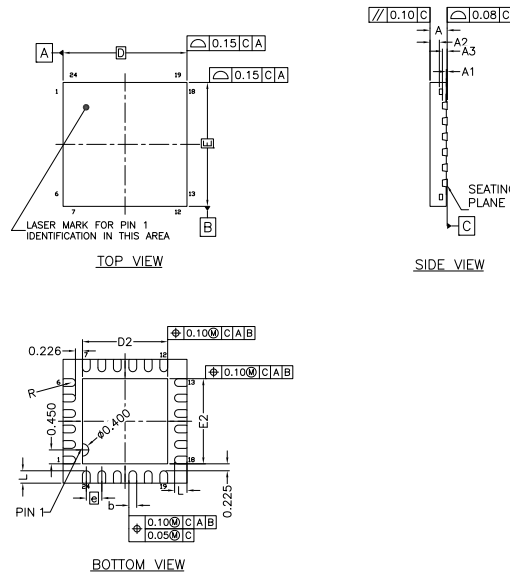
Table 29. Solder Reflow Peak Temperature

Package	Maximum Peak Temperature	Maximum Time within 5 °C of Peak Temperature
24-pin QFN	260 °C	30 seconds

Table 30. Package Moisture Sensitivity Level (MSL), IPC/JEDEC J-STD-2

Package	MSL
24-pin QFN	MSL 3

Figure 7. 24-Pin QFN 4.0x4.0x0.6 MM LQ24C, 2.75x2.75 MM EPAD (Sawn) Package Outline, 002-16934



SYMBOL	DIMENSIONS			NOTES
	MIN.	NOM.	MAX.	
A	—	—	0.60	1. ALL DIMENSIONS ARE IN MILLIMETERS. 2. DIE THICKNESS ALLOWABLE IS 0.305 mm MAXIMUM (0.12 INCHES MAXIMUM) 3. DIMENSIONING & TOLERANCES CONFORM TO ASME Y14.5M -1994. 4. THE PIN #1 IDENTIFIER MUST BE PLACED ON THE TOP SURFACE OF THE PACKAGE BY USING INDENTATION MARK OR OTHER FEATURE OF PACKAGE BODY. 5. EXACT SHAPE AND SIZE OF THIS FEATURE IS OPTIONAL. 6. PACKAGE WARPAGE MAX 0.08 mm. 7. APPLIED FOR EXPOSED PAD AND TERMINALS. EXCLUDE EMBEDDING PART OF EXPOSED PAD FROM MEASURING. 8. APPLIED ONLY TO TERMINALS. 9. JEDEC SPECIFICATION NO. REF: N.A.
A1	0.00	—	0.05	
A2	—	0.40	0.425	
A3	—	0.152 REF	—	
b	0.18	0.25	0.30	
D	—	4.00 BSC	—	
D2	2.65	2.75	2.85	
E	—	4.00 BSC	—	
E2	2.65	2.75	2.85	
L	0.30	0.40	0.50	
e	—	0.50 BSC	—	
R	0.09	—	—	

002-16934 *A

Acronyms

Table 31. Acronyms Used in this Document

Acronym	Description
ADC	analog-to-digital converter
API	application programming interface
ARM®	advanced RISC machine, a CPU architecture
CC	configuration channel
CCG2	Cable Controller Generation 2
CPU	central processing unit
CRC	cyclic redundancy check, an error-checking protocol
CS	current sense
DFP	downstream facing port
DIO	digital input/output, GPIO with only digital capabilities, no analog. See GPIO.
DRP	dual role port
EEPROM	electrically erasable programmable read-only memory
EMCA	a USB cable that includes an IC that reports cable characteristics (such as current rating) to the Type-C ports
EMI	electromagnetic interference
ESD	electrostatic discharge
FPB	flash patch and breakpoint
FS	full-speed
GPIO	general-purpose input/output
IC	integrated circuit
IDE	integrated development environment
I ² C, or IIC	Inter-Integrated Circuit, a communications protocol
ILO	internal low-speed oscillator, see also IMO
IMO	internal main oscillator, see also ILO
I/O	input/output, see also GPIO
LVD	low-voltage detect
LVTTTL	low-voltage transistor-transistor logic
MCU	microcontroller unit
NC	no connect
NMI	nonmaskable interrupt

Table 31. Acronyms Used in this Document (continued)

Acronym	Description
NVIC	nested vectored interrupt controller
opamp	operational amplifier
OCP	overcurrent protection
OVP	overvoltage protection
PCB	printed circuit board
PD	power delivery
PGA	programmable gain amplifier
PHY	physical layer
POR	power-on reset
PRES	precise power-on reset
PSoC®	Programmable System-on-Chip™
PWM	pulse-width modulator
RAM	random-access memory
RISC	reduced-instruction-set computing
RMS	root-mean-square
RTC	real-time clock
RX	receive
SAR	successive approximation register
SCL	I ² C serial clock
SDA	I ² C serial data
S/H	sample and hold
SPI	Serial Peripheral Interface, a communications protocol
SRAM	static random access memory
SWD	serial wire debug, a test protocol
TX	transmit
Type-C	a new standard with a slimmer USB connector and a reversible cable, capable of sourcing up to 100 W of power
UART	Universal Asynchronous Transmitter Receiver, a communications protocol
USB	Universal Serial Bus
USBIO	USB input/output, CCG2 pins used to connect to a USB port
XRES	external reset I/O pin

Document Conventions

Units of Measure

Table 32. Units of Measure

Symbol	Unit of Measure
°C	degrees Celsius
Hz	hertz
KB	1024 bytes
kHz	kilohertz
kΩ	kilo ohm
Mbps	megabits per second
MHz	megahertz
MΩ	mega-ohm
Msps	megasamples per second
μA	microampere
μF	microfarad
μs	microsecond

Table 32. Units of Measure (continued)

Symbol	Unit of Measure
μV	microvolt
μW	microwatt
mA	milliampere
ms	millisecond
mV	millivolt
nA	nanoampere
ns	nanosecond
Ω	ohm
pF	picofarad
ppm	parts per million
ps	picosecond
s	second
sps	samples per second
V	volt

References and Links To Applications Collaterals

Knowledge Base Articles

- Key Differences Among EZ-PD™ CCG1, CCG2, CCG3 and CCG4 - KBA210740
- Programming EZ-PD™ CCG2, EZ-PD™ CCG3 and EZ-PD™ CCG4 Using PSoC® Programmer and MiniProg3 - KBA96477
- CCGX Frequently Asked Questions (FAQs) - KBA97244
- Handling Precautions for CY4501 CCG1 DVK - KBA210560
- Cypress EZ-PD™ CCGx Hardware - KBA204102
- Difference between USB Type-C and USB-PD - KBA204033
- CCGx Programming Methods - KBA97271
- Getting started with Cypress USB Type-C Products - KBA04071
- Type-C to DisplayPort Cable Electrical Requirements
- Dead Battery Charging Implementation in USB Type-C Solutions - KBA97273
- Termination Resistors Required for the USB Type-C Connector – KBA97180
- VBUS Bypass Capacitor Recommendation for Type-C Cable and Type-C to Legacy Cable/Adapter Assemblies – KBA97270
- Need for Regulator and Auxiliary Switch in Type-C to DisplayPort (DP) Cable Solution - KBA97274
- Need for a USB Billboard Device in Type-C Solutions – KBA97146
- CCG1 Devices in Type-C to Legacy Cable/Adapter Assemblies – KBA97145
- Cypress USB Type-C Controller Supported Solutions – KBA97179
- Termination Resistors for Type-C to Legacy Ports – KBA97272
- Handling Instructions for CY4502 CCG2 Development Kit – KBA97916
- Thunderbolt™ Cable Application Using CCG3 Devices - KBA210976
- Power Adapter Application Using CCG3 Devices - KBA210975
- Methods to Upgrade Firmware on CCG3 Devices - KBA210974
- Device Flash Memory Size and Advantages - KBA210973
- Applications of EZ-PD™ CCG4 - KBA210739

Application Notes

- AN96527 - Designing USB Type-C Products Using Cypress's CCG1 Controllers
- AN95615 - Designing USB 3.1 Type-C Cables Using EZ-PD™ CCG2
- AN95599 - Hardware Design Guidelines for EZ-PD™ CCG2
- AN210403 - Hardware Design Guidelines for Dual Role Port Applications Using EZ-PD™ USB Type-C Controllers
- AN210771 - Getting Started with EZ-PD™ CCG4

Reference Designs

- CCG1 USB Type-C to DisplayPort Cable Solution
- CCG1 USB Type-C to HDMI/DVI/VGA Adapter Solution
- EZ-PD™ CCG2 USB Type-C to HDMI Adapter Solution
- CCG1 Electronically Marked Cable Assembly (EMCA) Paddle Card Reference Design
- CCG1 USB Type-C to Legacy USB Device Cable Paddle Card Reference Schematics
- EZ-USB GX3 USB Type-C to Gigabit Ethernet Dongle
- EZ-PD™ CCG2 USB Type-C Monitor/Dock Solution
- CCG2 20W Power Adapter Reference Design
- CCG2 18W Power Adapter Reference Design
- EZ-USB GX3 USB Type-A to Gigabit Ethernet Reference Design Kit

Kits

- CY4501 CCG1 Development Kit
- CY4502 EZ-PD™ CCG2 Development Kit
- CY4531 EZ-PD CCG3 Evaluation Kit
- CY4541 EZ-PD™ CCG4 Evaluation Kit

Datasheets

- CCG1 Datasheet: USB Type-C Port Controller with Power Delivery
- CYPD1120 Datasheet: USB Power Delivery Alternate Mode Controller on Type-C
- CCG3: USB Type-C Controller Datasheet
- CCG4: Two-Port USB Type-C Controller Datasheet

Document History Page

Description Title: Automotive EZ-PD™ CCG2 Datasheet, USB Type-C Port Controller				
Document Number: 002-18510				
Revision	ECN	Orig. of Change	Submission Date	Description of Change
**	5351519	MVRE	01/30/2017	Initial release
*A	5833516	MVRE	07/31/2017	Changed datasheet status to Preliminary. Updated the Cypress logo. Updated USB-PD Subsystem (SS) . Updated RD1 pin description. Updated Application Diagrams . Removed SID.PWR#25 and SID.PD.5 specs. Updated package spec.

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