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**Embedded - Microcontrollers - Application Specific** represents a category of microcontrollers designed with unique features and capabilities tailored to specific application needs. Unlike general-purpose microcontrollers, application-specific microcontrollers are optimized for particular tasks, offering enhanced performance, efficiency, and functionality to meet the demands of specialized applications.

**What Are Embedded - Microcontrollers - Application Specific?**

Application specific microcontrollers are engineered to

#### Details

Product Status	Active
Applications	USB Type C
Core Processor	ARM® Cortex®-M0
Program Memory Type	FLASH (32KB)
Controller Series	-
RAM Size	4K x 8
Interface	I <sup>2</sup> C, SPI, UART/USART, USB
Number of I/O	14
Voltage - Supply	1.71V ~ 5.5V
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	24-UFQFN Exposed Pad
Supplier Device Package	24-QFN (4x4)
Purchase URL	<a href="https://www.e-xfl.com/product-detail/infineon-technologies/cypd2119-24lqxi">https://www.e-xfl.com/product-detail/infineon-technologies/cypd2119-24lqxi</a>

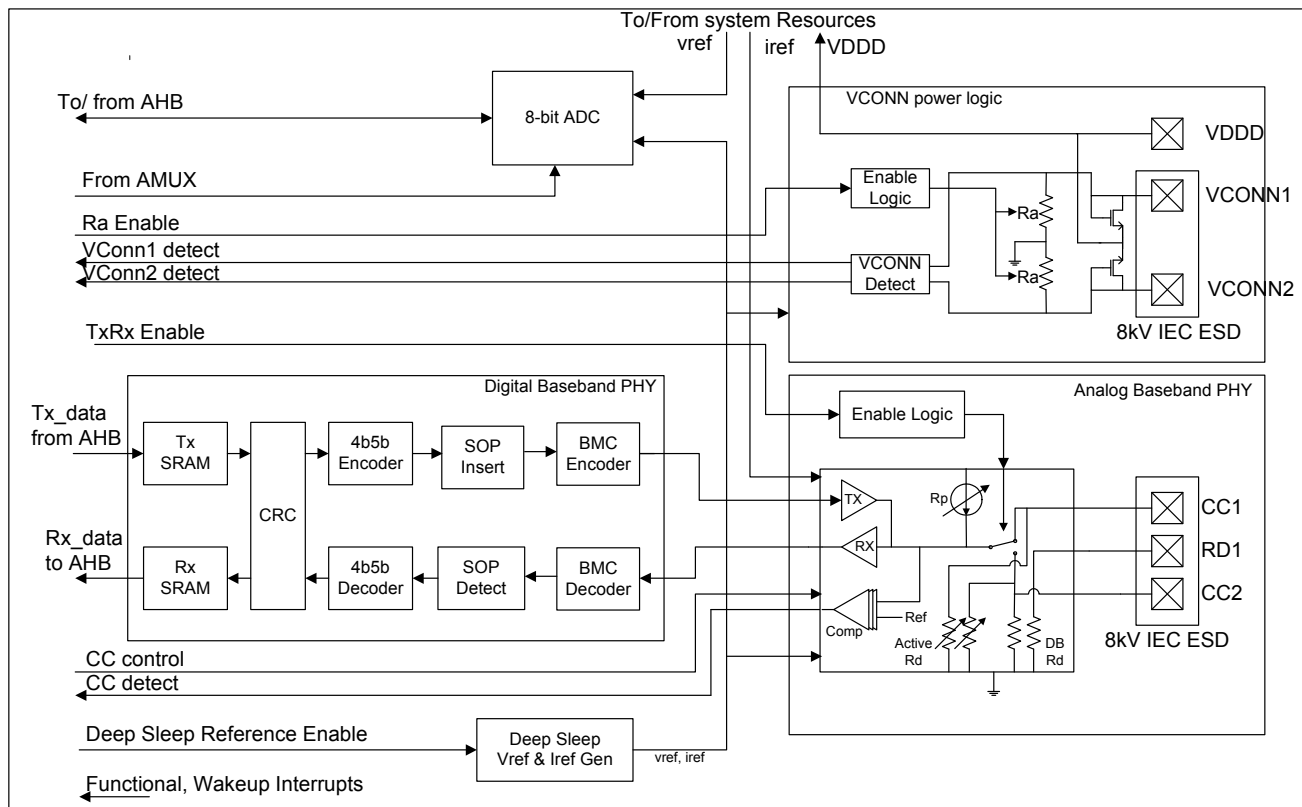
## USB-PD Subsystem (SS)

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.  $R_A$  is used to identify EZ-PD CCG2 as an accessory or an electronically marked cable.  $R_D$  is used to identify EZ-PD CCG2 as a UFP in a hybrid cable or a dongle. 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 sub-system 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, CC2 and RD1 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 I<sup>2</sup>C, SPI, or UART interface. The hardware I<sup>2</sup>C 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 I<sup>2</sup>C 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 I<sup>2</sup>C that creates a mailbox address range in the memory of EZ-PD CCG2 and effectively reduce I<sup>2</sup>C 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 I<sup>2</sup>C peripherals are compatible with the I<sup>2</sup>C Standard-mode, Fast-mode, and Fast-mode Plus devices as defined in the NXP I<sup>2</sup>C-bus specification and user manual (UM10204). The I<sup>2</sup>C bus I/Os are implemented with GPIO in open-drain modes.

The I<sup>2</sup>C port on SCB 1 block of EZ-PD CCG2 is not completely compliant with the I<sup>2</sup>C spec in the following respects:

- The GPIO cells for SCB 1's I<sup>2</sup>C port are not overvoltage-tolerant and, therefore, cannot be hot-swapped or powered up independently of the rest of the I<sup>2</sup>C system.
- Fast-mode Plus has an I<sub>OL</sub> specification of 20 mA at a V<sub>OL</sub> of 0.4 V. The GPIO cells can sink a maximum of 8-mA I<sub>OL</sub> with a V<sub>OL</sub> 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 I<sup>2</sup>C and SWD pins, which can also be used as GPIOs. The I<sup>2</sup>C pins from SCB 0 are overvoltage-tolerant. The number of available GPIOs vary with the package. The GPIO block implements the following:

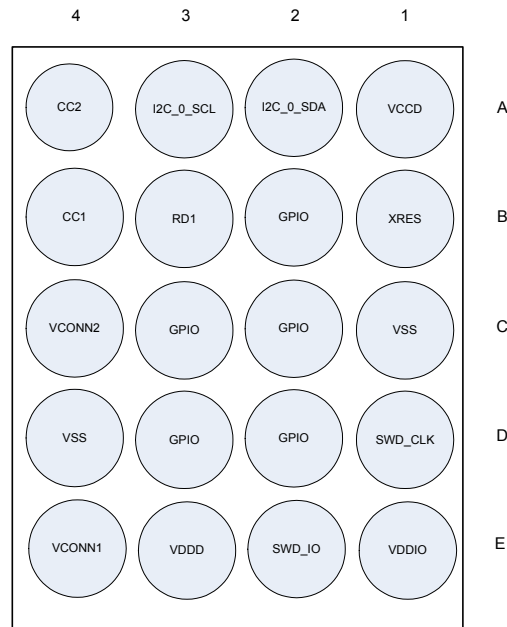
- Seven drive strength modes:
  - Input only
  - Weak pull-up with strong pull-down
  - Strong pull-up with weak pull-down
  - Open drain with strong pull-down
  - Open drain with strong pull-up
  - Strong pull-up with strong pull-down
  - Weak pull-up with weak pull-down
- Input threshold select (CMOS 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.

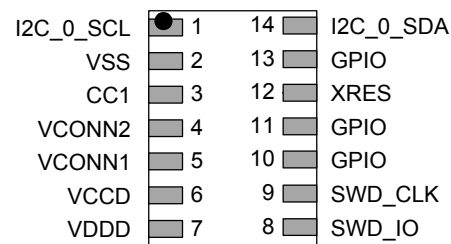
## Pinouts

Group	Name	Pin Map 24-QFN	Ball Location 20-CSP	Pin Map 14-DFN	Description
USB Type-C Port	CC1	2	B4	3	USB PD connector detect/Configuration Channel 1
	CC2	1	A4	N/A	USB PD connector detect/Configuration Channel 2
	RD1	3	B3	N/A	Dedicated Rd resistor pin for CC1 Must be left open for cable applications and connected together with CC1 ball for UFP or DFP with dead battery applications
GPIOs and serial interfaces	GPIO	22	C3	N/A	GPIO / SPI_0_CLK / UART_0_RX
	GPIO	18	D3	13	GPIO / SPI_0_MOSI / UART_0_TX
	GPIO	13	C2	10	GPIO / I2C_1_SDA / SPI_1_MISO / UART_1_RX
	GPIO	10	D2	N/A	GPIO / I2C_1_SCL / SPI_1_CLK / UART_1_TX
	GPIO	15	B2	11	GPIO / SPI_1_SEL / UART_1_RTS
	GPIO	14	N/A	N/A	GPIO
	GPIO	17	N/A	N/A	GPIO
	GPIO	21	N/A	N/A	GPIO
	GPIO	23	N/A	N/A	GPIO
	GPIO	24	N/A	N/A	GPIO
	I2C_0_SCL	20	A3	1	GPIO / I2C_0_SCL / SPI_0_MISO / UART_0_RTS
	I2C_0_SDA	19	A2	14	GPIO / I2C_0_SDA / SPI_0_SEL / UART_0_CTS
	SWD_IO	11	E2	8	SWD IO / GPIO / UART_1_CTS / SPI_1_MOSI
	SWD_CLK	12	D1	9	SWD clock / GPIO
	RESET	XRES	B1	12	Reset input
POWER	VCONN1	5	E4	5	VCONN 1 input (4.0 V to 5.5 V)
	VCONN2	4	C4	4	VCONN 2 input (4.0 V to 5.5 V)
	VDDIO	8	E1	N/A	1.71-V to 5.5-V supply for I/Os
	VCCD	7	A1	6	1.8-V regulator output for filter capacitor
	VDDD	9	E3	7	VDDD supply input/output (2.7 V to 5.5 V)
	VDDD	6			VDDD supply input/output (2.7 V to 5.5 V)
	VSS	EPAD	N/A	EPAD	Ground supply
	VSS		D4	2	Ground supply
	VSS		C1		Ground supply

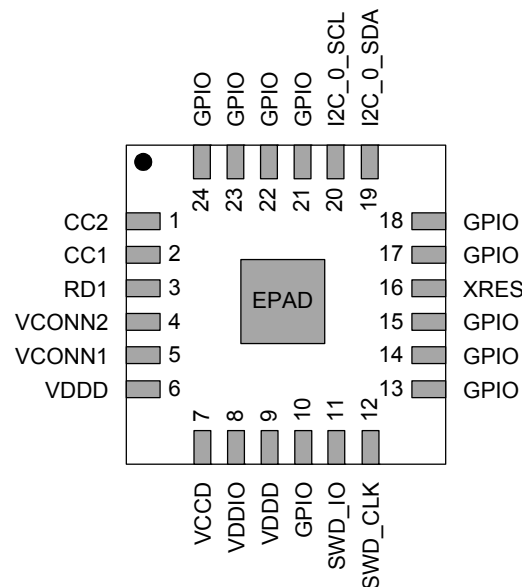
**Figure 3. 20-ball WLCSP EZ-PD CCG2 Ball Map (Bottom (Balls Up) View)**



**Figure 4. 14-pin DFN Pin Map (Top View)**



**Figure 5. 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 three different power sources. VCONN1 and VCONN2 pins can be used as connections to the VCONN pins on a Type-C plug of a cable or VCONN-powered accessory. Each of these inputs support operation over 4.0 to 5.5 V. An internal isolation between VCONN1 and VCONN2 pins is provided allowing them to be at different levels simultaneously. CCG2 can be used in EMCA applications with only one or both VCONN pins as power sources. This is illustrated later in the section on Applications. Besides being power inputs, each VCONN pin is also internally connected to a  $R_A$  termination resistor required for EMCA and VCONN-powered accessories.

EZ-PD CCG2 can also be operated from 2.7 to 5.5 V when operated from the VDDD supply pin. VCONN-powered accessory applications require that CCG2 work down to 2.7 V. In such applications, both the VDDD and VCONN pins should be connected to the VCONN pin of the Type-C plug in the accessory.

In UFP, DFP, and DRP applications, CCG2 can be operated from VDDD as the only supply input. In such applications, the VCONN pins are left open. 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.

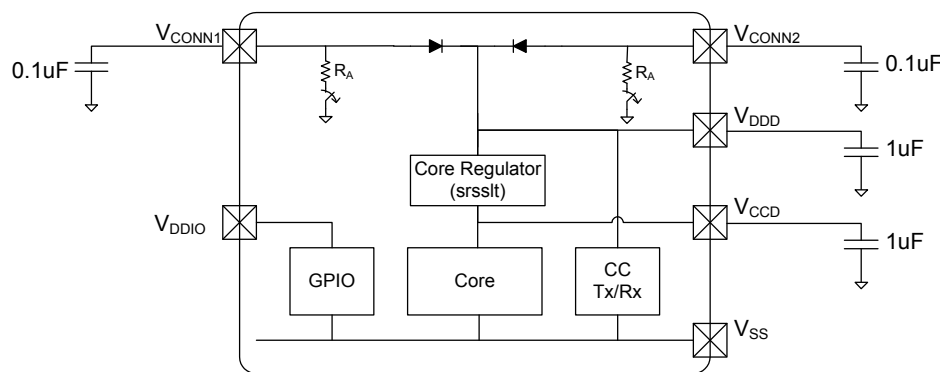
A separate I/O supply pin, VDDIO, allows the GPIOs to operate at levels from 1.71 to 5.5 V. The VDDIO pin can be equal to or less than the voltages connected to the VCONN1, VCONN2, and VDDD pins. The independent VDDIO supply is not available on the 14-DFN package. On this package, the VDDIO rail is internally connected to the VDDD rails.

The VCCD output of EZ-PD CCG2 must be bypassed to ground via an external capacitor (in the range of 1 to 1.6  $\mu\text{F}$ ; X5R ceramic or better).

Bypass capacitors must be used from VDDD and VCONN pins to ground; typical practice for systems in this frequency range is to use a 0.1- $\mu\text{F}$  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 6](#).

**Figure 6. EZ-PD CCG2 Power and Bypass Scheme Example**





The application diagram shown in [Figure 7](#) requires a single VCONN wire to run through the cable so that the CCG2 device can be powered irrespective of which plug is connected to the host (DFP). However, in the application diagram shown in [Figure 8](#), the VCONN signal does not run through the entire cable, but only runs to the respective VCONN pin of the CCG2 device at each end of the plug. Also, only one CCG2 device is powered at any given instance, depending on which one is nearer to the DFP that supplies VCONN.

The Type-C receptacle brings in HighSpeed and SuperSpeed lines, which are connected directly to the applications processor. The VBUS line from the Type-C receptacle goes directly to the UFP (tablet) charger circuitry. The applications processor communicates over the I<sup>2</sup>C signal with the CCG2 device, and the CC1 and CC2 lines from the Type-C receptacle are connected directly to the respective CC1/2 pins of the CCG2 device.

The schematic diagram illustrates the CCG2 USB-to-UART bridge IC. The IC is connected to a USB bus (VBUS, D+, D-) and a UART interface (TX, RX). Key components include a 1.8V regulator for the CCG2 core, a 5.0V regulator for the USB interface, and various pull-up and pull-down resistors. The CCG2 is configured as a USB-to-UART bridge, with the UART interface connected to the TX and RX pins of the UART IC.

Figure 10 shows a Notebook DRP application diagram using a CCG2 device. The Type-C port can be used as a power provider or a power consumer. The CCG2 device communicates with the Embedded controller (EC) over I<sup>2</sup>C. 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 of the notebook 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.

**Figure 10. Dual Role Port (DRP) Application**

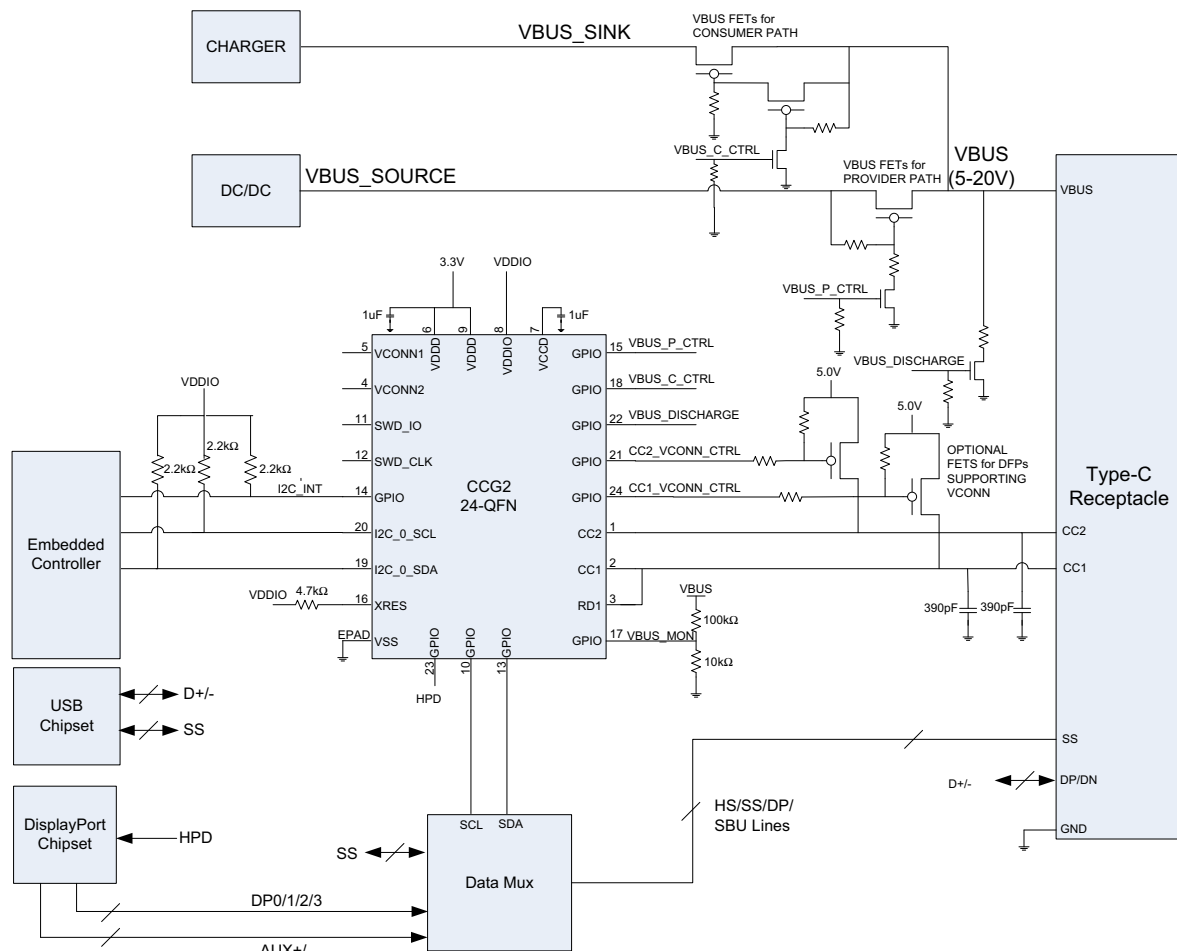


Figure 11 shows a CCG2 receptacle-based Power Adapter application in which the CCG2 device is used as a DFP. CCG2 integrates all termination resistors and uses GPIOs (VSEL\_0 and VSEL\_1) to indicate the negotiated power profile. The VBUS

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.

### Figure 11. Downstream Facing Port (DFP) Application

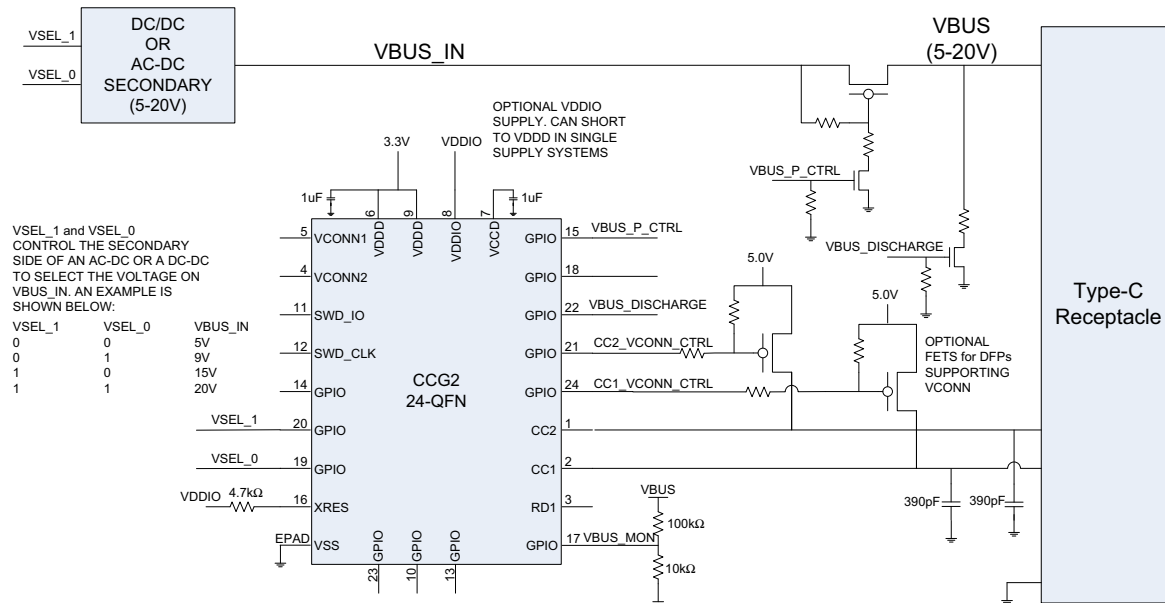
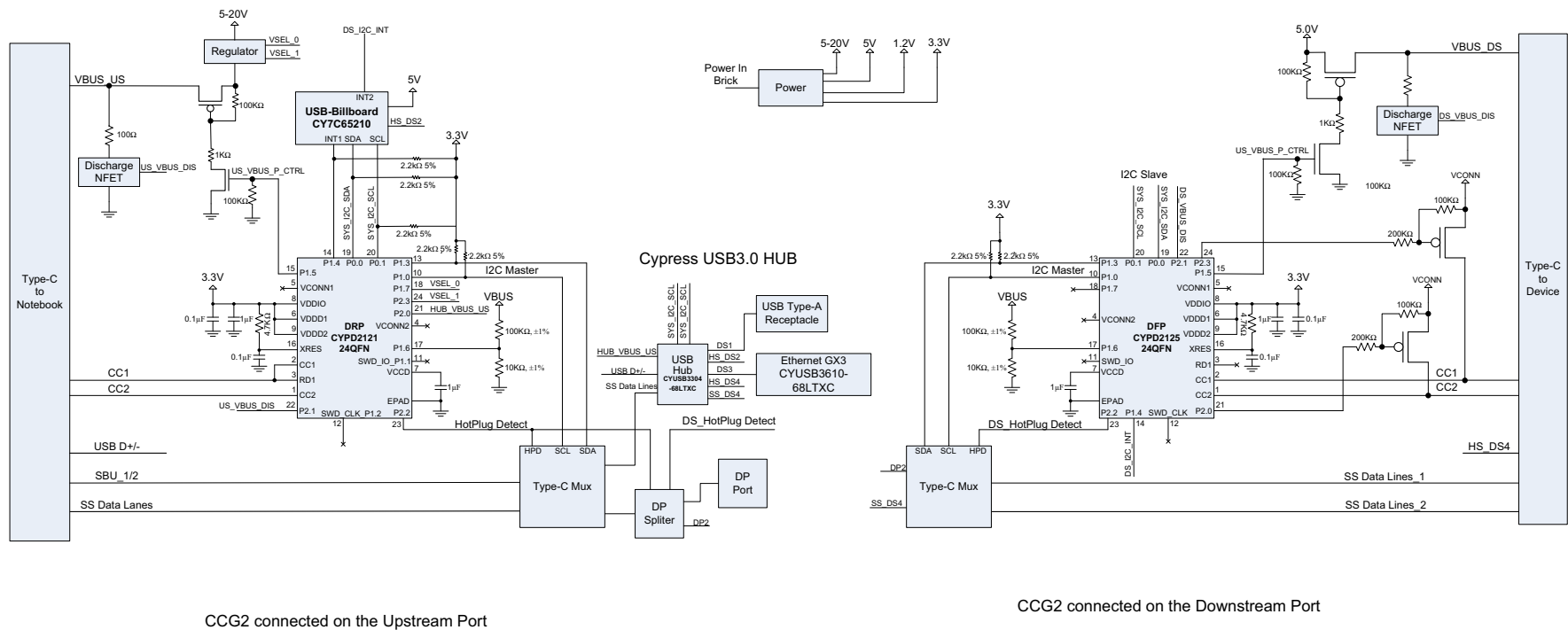


Figure 14 shows a CCG2 Monitor/Dock application diagram. It enables connectivity between a USB Type-C host system on the Upstream port and multiple Display/Data devices on the Downstream port. This application has a USB Type-C receptacle on the Upstream port, which supports data, power, and display. On the Downstream port, this application supports: USB Type-A, Gigabit Ethernet, DisplayPort, and USB Type-C receptacle.

The main features of this solution are:

- Powered from an external 24-V DC power adapter
- Provides up to 45 W (15 V at 3A) on the Upstream Type-C port and up to 15 W (5 V at 3A) on the Downstream USB Type-C port
- Provides simultaneous 4K display output with USB 3.1 Gen 1 on the USB Type-A port
- Four-lane display on the DisplayPort connector
- Multi-Stream support on DisplayPort and Downstream Type-C port
- USB 3.1 Gen 1 hub for USB port expansion
- Gigabit Ethernet using RJ45 connector
- Supports firmware upgrade of CCG2 controllers, HX3 Hub controller, and Billboard controller

**Figure 14. CCG2 in Dock/Monitor Application Diagram**



## Electrical Specifications

### Absolute Maximum Ratings

**Table 1. Absolute Maximum Ratings<sup>[1]</sup>**

Parameter	Description	Min	Typ	Max	Units	Details/Conditions
V <sub>DDD_MAX</sub>	Digital supply relative to V <sub>SS</sub>	−0.5	—	6	V	Absolute max
V <sub>CONN1_MAX</sub>	Max supply voltage relative to V <sub>SS</sub>	—	—	6	V	Absolute max
V <sub>CONN2_MAX</sub>	Max supply voltage relative to V <sub>SS</sub>	—	—	6	V	Absolute max
V <sub>DDIO_MAX</sub>	Max supply voltage relative to V <sub>SS</sub>	—	—	6	V	Absolute max
V <sub>GPIO_ABS</sub>	GPIO voltage	−0.5	—	V <sub>DDIO</sub> + 0.5	V	Absolute max
V <sub>CC_ABS</sub>	Absolute max voltage for CC1 and CC2 pins	—	—	6	V	Absolute max
I <sub>GPIO_ABS</sub>	Maximum current per GPIO	−25	—	25	mA	Absolute max
I <sub>GPIO_injection</sub>	GPIO injection current, Max for V <sub>IH</sub> > V <sub>DDD</sub> , and Min for V <sub>IL</sub> < V <sub>SS</sub>	−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, VCONN1, and VCONN2 pins
ESD_IEC_AIR	Electrostatic discharge IEC61000-4-2	15000	—	—	V	Air discharge for pins CC1, CC2, VCONN1, and VCONN2

#### 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.

**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 $V_{DDIO}$ , $C_{load} = 25$ pF
SID71	$T_{FALLF}$	Fall time	2	–	12	ns	3.3-V $V_{DDIO}$ , $C_{load} = 25$ pF

## 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	$0.7 \times V_{DDIO}$	–	–	V	CMOS input
SID.XRES#2	$V_{IL}$	Input voltage LOW threshold	–	–	$0.3 \times V_{DDIO}$	V	CMOS input
SID.XRES#3	$C_{IN}$	Input capacitance	–	–	7	pF	Guaranteed by characterization
SID.XRES#4	$V_{HYSXRES}$	Input voltage hysteresis	–	–	$0.05 \times V_{DDIO}$	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	$T_{PWMNEXT}$	Input trigger pulse width	–	$2/F_c$	–	ns	For all Trigger Events
SID.TCPWM.5	$T_{PWMENT}$	Output trigger pulse width	–	$2/F_c$	–	ns	Minimum possible width of Overflow, Underflow, and CC (Counter equals Compare value) outputs
SID.TCPWM.5A	$T_{CRES}$	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

$I^2C$ 
**Table 8. Fixed  $I^2C$  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	$\mu A$	–
SID150	$I_{I2C2}$	Block current consumption at 400 kbps	–	–	185	$\mu A$	–
SID151	$I_{I2C3}$	Block current consumption at 1 Mbps	–	–	390	$\mu A$	–
SID152	$I_{I2C4}$	$I^2C$ enabled in Deep Sleep mode	–	–	1.4	$\mu A$	–

**Table 9. Fixed  $I^2C$  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	$\mu A$	Guaranteed by characterization
SID161	$I_{UART2}$	Block current consumption at 1000 Kbps	–	–	312	$\mu A$	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	$\mu A$	Guaranteed by characterization
SID164	$I_{SPI2}$	Block current consumption at 4 Mbps	–	–	560	$\mu A$	Guaranteed by characterization
SID165	$I_{SPI3}$	Block current consumption at 8 Mbps	–	–	600	$\mu A$	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

## 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 <sub>RISEIPOR</sub>	Rising trip voltage	0.80	–	1.50	V	Guaranteed by characterization
SID186	V <sub>FALLIPOR</sub>	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 <sub>FALLPPOR</sub>	BOD trip voltage in active and sleep modes	1.48	–	1.62	V	Guaranteed by characterization
SID192	V <sub>FALLDPSLP</sub>	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_SWDCCLK1	$3.3\text{ V} \leq V_{DDIO} \leq 5.5\text{ V}$	–	–	14	MHz	SWDCCLK ≤ 1/3 CPU clock frequency
SID.SWD#2	F_SWDCCLK2	$1.8\text{ V} \leq V_{DDIO} \leq 3.3\text{ V}$	–	–	7	MHz	SWDCCLK ≤ 1/3 CPU clock frequency
SID.SWD#3	T_SWDI_SETUP	$T = 1/f\text{ SWDCCLK}$	0.25*T	–	–	ns	Guaranteed by characterization
SID.SWD#4	T_SWDI_HOLD	$T = 1/f\text{ SWDCCLK}$	0.25*T	–	–	ns	Guaranteed by characterization
SID.SWD#5	T_SWDO_VALID	$T = 1/f\text{ SWDCCLK}$	–	–	0.5 * T	ns	Guaranteed by characterization
SID.SWD#6	T_SWDO_HOLD	$T = 1/f\text{ SWDCCLK}$	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 <sub>IMO</sub>	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 <sub>IMOTOL</sub>	Frequency variation at 24, 36, and 48 MHz (trimmed)	–	–	±2	%	–
SID226	T <sub>STARTIMO</sub>	IMO startup time	–	–	7	μs	Guaranteed by characterization
SID229	T <sub>JITRMSIMO</sub>	RMS jitter at 48 MHz	–	145	–	ps	Guaranteed by characterization
F <sub>IMO</sub>	–	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 <sub>ILO</sub>	ILO operating current at 32 kHz	–	0.3	1.05	μA	Guaranteed by Characterization
SID233	I <sub>ILOLEAK</sub>	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 <sub>STARTILO</sub>	ILO startup time	–	–	2	ms	Guaranteed by characterization
SID236	T <sub>ILODUTY</sub>	ILO duty cycle	40	50	60	%	Guaranteed by characterization
SID.CLK#5	F <sub>ILO</sub>	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	–
SID.PD.5	Rd_DB	UFP Dead Battery CC termination on RD1 and CC2	4.08	5.1	6.12	kΩ	All supplies forced to 0 V and 0.6 V applied at RD1 or CC2
SID.PD.6	R <sub>A</sub>	Power cable termination	0.8	1.0	1.2	kΩ	All supplies forced to 0 V and 0.2 V applied at V <sub>CONN1</sub> or V <sub>CONN2</sub>
SID.PD.7	Ra_OFF	Power cable termination - Disabled	0.4	0.75	–	MΩ	2.7 V applied at V <sub>CONN1</sub> or V <sub>CONN2</sub> with R <sub>A</sub> disabled
SID.PD.8	Rleak_1	V <sub>CONN</sub> leaker for 0.1-μF load	–	–	216	kΩ	Managed Active Cable (MAC) discharge
SID.PD.9	Rleak_2	V <sub>CONN</sub> leaker for 0.5-μF load	–	–	41.2	kΩ	
SID.PD.10	Rleak_3	V <sub>CONN</sub> leaker for 1.0-μF load	–	–	19.6	kΩ	
SID.PD.11	Rleak_4	V <sub>CONN</sub> leaker for 2.0-μF load	–	–	9.8	kΩ	
SID.PD.12	Rleak_5	V <sub>CONN</sub> leaker for 5.0-μF load	–	–	4.1	kΩ	
SID.PD.13	Rleak_6	V <sub>CONN</sub> leaker for 10-μF load	–	–	2.0	kΩ	
SID.PD.14	Ileak	Leaker on V <sub>CONN1</sub> and V <sub>CONN2</sub> for discharge upon cable detach	150	–	–	μA	–



## 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 (e.g., 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 <sup>2</sup> 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 <sup>2</sup> C serial clock
SDA	I <sup>2</sup> 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

- EZ-PD™ CCG2 Electronically Marked Cable Assembly (EMCA) Paddle Card Reference Design
- EZ-PD™ CCG2 USB Type-C to DisplayPort Cable Solution
- 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: EZ-PD™ CCG2 Datasheet USB Type-C Port Controller Document Number: 001-93912				
Revision	ECN	Orig. of Change	Submission Date	Description of Change
*E	4680071	GAYA	03/07/2015	Release to web
*F	4718374	AKN	04/09/2015	Added 24-pin QFN pin and package information. Added DRP and DFP Application diagrams
*G	4774142	AKN	06/15/2015	Changed datasheet status from Preliminary to Final. Updated Logic Block Diagram. Changed number of GPIOs to 10 and added a note about the number of GPIOs varying depending on the package. Updated Power and Digital Peripherals section. Updated Application diagrams. Added SID.PWR#1_A parameter. Added CYPD2122-20FNXIT part in Ordering Information. Removed Errata.
*H	4979175	VGT	10/23/2015	Updated Figure 1 and Figure 5. Added VCC_ABS spec and updated the SID.ADC.4 parameter. Added "Guaranteed by characterization" note for the following specs: SID.GIO#16, SID.GIO#17, SID.XRES#3, SID 160 to SID 172A, SID 2226, SID 229, SID.ADC.1 to SID.ADC.5.
*I	5028128	VGT	12/04/2015	Updated <a href="#">Application Diagrams</a> : Added <a href="#">Figure 12</a> . Added <a href="#">Figure 13</a> . Added <a href="#">Figure 14</a> . Updated <a href="#">Ordering Information</a> . Added part numbers CYPD2119-24LQXIT, CYPD2120-24LQXIT, CYPD2121-24LQXIT, CYPD2125-24LQXIT.
*J	5186972	VGT	03/28/2016	Updated temperature ranges in <a href="#">Features</a> . Updated <a href="#">Table 28</a> . Updated <a href="#">Ordering Information</a> .
*K	5303957	VGT	06/13/2016	Added <a href="#">Available Firmware and Software Tools</a> . Updated <a href="#">Figure 8</a> : Per the USB PD3.0 spec, SOP" implementation is no longer valid for passive cables. Updated <a href="#">Figure 9</a> , <a href="#">Figure 10</a> , and <a href="#">Figure 11</a> . Added descriptive notes for the application diagrams. Added <a href="#">References and Links To Applications Collaterals</a> . Updated <a href="#">Ordering Information</a> . Updated Cypress logo and copyright information.
*L	5387677	VGT	08/02/2016	Added CYPD2122-24LQXI part number in <a href="#">Ordering Information</a> .