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Embedded - Microcontrollers - Application Specific: Tailored Solutions for Precision and Performance

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 (64kB) |
| Controller Series | - |
| RAM Size | 8K x 8 |
| Interface | I ² C, SPI, UART |
| Number of I/O | 12 |
| Voltage - Supply | 3V ~ 24.5V |
| Operating Temperature | -40°C ~ 105°C (TA) |
| Mounting Type | Surface Mount |
| Package / Case | 24-UFQFN Exposed Pad |
| Supplier Device Package | 24-QFN (4x4) |
| Purchase URL | https://www.e-xfl.com/product-detail/infineon-technologies/cypd3175-24lqxq |

Functional Overview

MCU Subsystem

CPU

The Cortex-M0 CPU in EZ-PD CCG3PA is part of the 32-bit MCU subsystem, which is optimized for low-power operation with extensive clock gating.

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 CCG3PA has four break-point (address) comparators and two watchpoint (data) comparators.

Flash

The EZ-PD CCG3PA device has a flash module with one bank of 64-KB flash, a flash accelerator, tightly coupled to the CPU to improve average access times from the flash block.

SROM

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

USB-PD Subsystem (SS)

The USB-PD subsystem provides the interface to the Type-C USB port. This subsystem comprises a current sense amplifier, a high-voltage regulator, OVP, OCP, and supply switch blocks. This subsystem also includes all ESD required and supported on the Type-C port.

USB-PD Physical Layer

The USB-PD Physical Layer consists of a transmitter and receiver that communicate BMC-encoded data over the CC channel based on the PD 3.0 standard. All communication is half-duplex. The Physical Layer or PHY practices collision avoidance to minimize communication errors on the channel.

The USB-PD block includes all termination resistors (R_P and R_D) and their switches as required by the USB-PD spec. R_P and R_D resistors are required to implement connection detection, plug orientation detection, and for establishing USB DFP/UFP roles. The R_P resistor is implemented as a current source.

According to the USB Type-C spec, a Type-C controller such as CCG3PA must present certain termination resistors depending on its role in its unpowered state. The Sink role in a power bank application requires R_D resistors to be present on the CC pins whereas the DFP role, as in a power adapter, requires both CC lines to be open. To be flexible for such applications, CCG3PA includes the resistors required in the unpowered state on separate pads or pins. The dead battery R_D resistors are available on separate pads. The dead battery R_D is implemented as a bond option on parts for Power Bank applications. In these parts, each CC pin is bonded out together with its corresponding dead battery R_D resistor. On part numbers for the DFP application, the CC pins are not bonded with the dead battery R_D .

ADC

The ADC is a low-footprint 8-bit SAR ADC that is available for general-purpose A-D conversion applications in the chip. This ADC can be accessed from all GPIOs and the DP/DM pins through an on-chip analog mux. CCG3PA contains two instances of the ADC. The voltage reference for the ADCs is generated either from the VDDD supply or from internal bandgap. When

sensing the GPIO pin voltage with an ADC, the pin voltage cannot exceed the VDDIO supply value.

Charger Detection

The two charger detection blocks connected to the two pairs of DP/DM pins allow CCG3PA to detect conventional battery chargers conforming to BC 1.2, and the following proprietary charger specifications: Apple, Qualcomm's QuickCharge 4.0, and Samsung AFC.

VBUS Overcurrent and Overvoltage Protection

The CCG3PA chip has an integrated hardware block for VBUS overvoltage protection (OVP)/overcurrent protection (OCP) with configurable thresholds and response times on the Type C port.

VBUS Short Protection

CCG3PA provides four VBUS short protection pins: CC1, CC2, P2.2, and P2.3. These pins are protected from accidental shorts to high-voltage VBUS. Accidental shorts may occur because the CC1 and CC2 pins are placed next to the VBUS pins in the USB Type-C connector. A Power Delivery controller without the high-voltage VBUS short protection will be damaged in the event of accidental shorts. When the protection circuit is triggered, CCG3PA can handle up to 17 V forever and between 17 V to 22 VDC for 1000 hours on the OVT pins. When a VBUS short event occurs on the CC pins, a temporary high-ringing voltage is observed due to the RLC elements in the USB Type-C cable. Without CCG3PA connected, this ringing voltage can be twice (44 V) the maximum VBUS voltage (21.5 V). However, when CCG3PA is connected, it is capable of clamping temporary high-ringing voltage and protecting the CC pin using IEC ESD protection diodes.

Low-side Current Sense Amplifier (CSA)

The CCG3PA chip also has an integrated low-side current sense amplifier that is capable of detecting current in the order of 100 mA across a 5 mΩ external resistor. It also supports constant current mode of operation in power adapter application as a provider.

PFET Gate Drivers on VBUS Path

CCG3PA has two integrated PFET gate drivers to drive external PFETs on the VBUS provider and consumer path. The VBUS_P_CTRL gate driver has an active pull-up, and thus can drive high, low or High-Z.

The VBUS_C_CTRL gate driver can drive only low or high-Z, thus requiring an external pull-up. These pins are VBUS voltage-tolerant.

VBUS Discharge FETs

CCG3PA also has two integrated VBUS discharge FETs used to discharge VBUS to meet the USB-PD specification timing on a detach condition. VBUS Discharge FET on the provider side can be used to accelerate the ramp down of VBUS to default 5V on the secondary side.

Voltage (VBUS) Regulation

CCG3PA contains an integrated feedback control circuitry (for AC/DC applications) for secondary side control with analog regulation of the feedback/cathode pins to achieve the appro-

appropriate voltage on VBUS pin as per the negotiated contract with the peer device over Type-C.

Integrated Digital Blocks

Serial Communication Blocks (SCB)

EZ-PD CCG3PA 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 CCG3PA 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 the SCB blocks of EZ-PD CCG3PA are not completely compliant with the I²C spec in the following aspects:

- 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 CCG3PA has four 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.

I/O Subsystem

EZ-PD CCG3PA has up to 12 GPIOs of which, some of them can be re-purposed to support functions of SCB (I²C, UART, SPI). GPIO pins P0.0 and P0.1 are overvoltage-tolerant (OVT) (upto 7V).

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.

Port pins P1.0 and P1.1 can be configured to indicate Fault for OCP/SCP/OVP/UVF conditions. Any two fault conditions can be mapped to two GPIOs or all the four faults can be OR'ed to indicate over one GPIO.

Power Systems Overview

CCG3PA can operate from two possible external supply sources: VBUS_IN_DISCHARGE (3.0 V–24.5 V) or VDDD (2.7 V–5.5 V). When powered through VBUS_IN_DISCHARGE, the internal regulator generates VDDD of 3.3 V for chip operation. The regulated supply, VDDD, is either used directly inside some analog blocks or further regulated down to VCCD (1.8 V), which powers majority of the core using the regulators. CCG3PA has three different power modes: Active, Sleep, and Deep Sleep.

Transitions between these power modes are managed by the power system. When powered through the VBUS_IN_DISCHARGE pin, VDDD cannot be used to power external devices and should be connected to a 1-μF capacitor for the regulator stability only. These pins are not supported as power supplies. Refer to the application diagrams for capacitor connections.

Table 1. CCG3PA Power Modes

| Mode | Description |
|----------------------|---------------------------------------------------------------------------------------------------------------------------|
| Power-On Reset (POR) | Power is valid and an internal reset source is asserted or SleepController is sequencing the system out of reset. |
| ACTIVE | Power is valid and CPU is executing instructions. |
| SLEEP | Power is valid and CPU is not executing instructions. All logic that is not operating is clock gated to save power. |
| DEEP SLEEP | Main regulator and most blocks are shut off. DeepSleep regulator powers logic, but only low-frequency clock is available. |

Figure 1. Power System Requirement Block Diagram

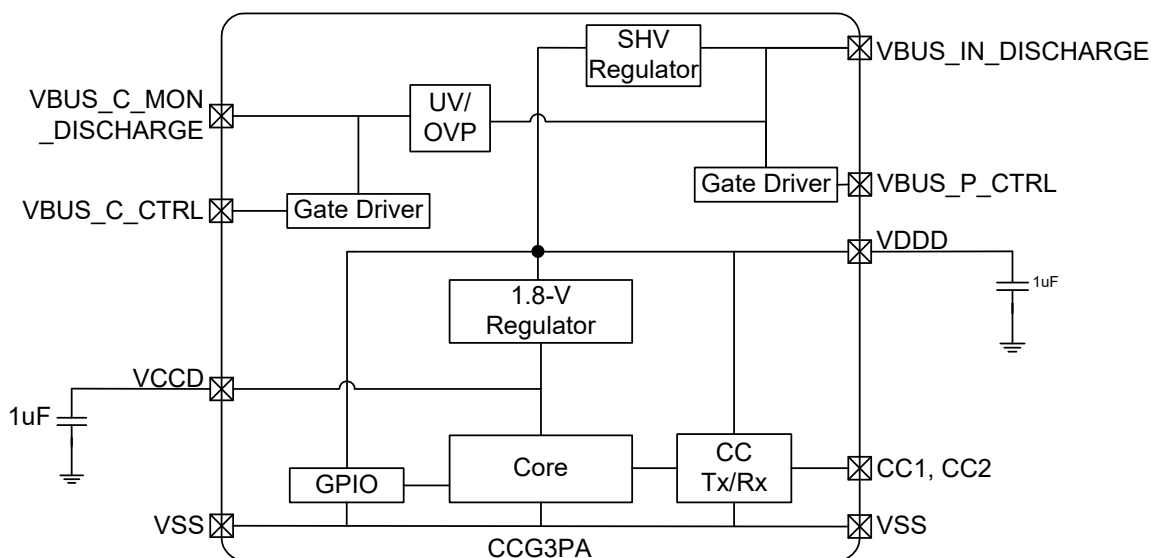


Table 3. GPIO Ports, Pins and Their Functionality

| Port | 24-QFN | 16-SOIC | SCB Function | | | TCPWM | Fault Indicator | Protection Capability | | USB Charging Signal | | | | IEC4 |
|------|--------|---------|--------------|------------|-------------|----------------|-----------------|-----------------------|-----|---------------------|----|-------|-------|------|
| Pin | Pin# | Pin# | UART | SPI | I2C | | | VBUS Short | OVT | AFC | QC | BC1.2 | Apple | |
| P0.0 | 7 | 6 | UART_0_CTS | SPI_1_MOSI | I2C_0_SDA | TCPWM_line_0:0 | – | – | Yes | – | – | – | – | – |
| P0.1 | 8 | 7 | UART_0_RTS | SPI_1_MISO | I2C_0_SCL | TCPWM_line_1:0 | – | – | Yes | – | – | – | – | – |
| P1.0 | 1 | | UART_1_CTS | SPI_0_SEL | I2C_1_SDA:1 | TCPWM_line_2:1 | Yes | – | – | – | – | – | – | – |
| P1.1 | 2 | | UART_1_RTS | SPI_0_MISO | I2C_1_SCL:1 | TCPWM_line_3:1 | Yes | – | – | – | – | – | – | – |
| P1.2 | 5 | | UART_1_TX1 | SPI_0_MOSI | – | – | – | – | – | D+ | D+ | D+ | D+ | – |
| P1.3 | 6 | | UART_1_RX1 | SPI_0_CLK | – | – | – | – | – | D- | D- | D- | D- | – |
| P2.0 | 9 | 8 | UART_0_TX0 | SPI_1_SEL | – | TCPWM_line_2:0 | – | – | – | – | – | – | – | – |
| P2.1 | 10 | | UART_0_RX0 | SPI_1_CLK | – | TCPWM_line_3:0 | – | – | – | – | – | – | – | – |
| P2.2 | 12 | | UART_0_TX1 | – | I2C_1_SDA:0 | TCPWM_line_0:1 | – | Yes | – | – | – | – | – | Yes |
| P2.3 | 13 | | UART_0_RX1 | – | I2C_1_SCL:0 | TCPWM_line_1:1 | – | Yes | – | – | – | – | – | Yes |
| P3.0 | 17 | 13 | UART_1_TX0 | – | – | – | – | – | – | D+ | D+ | D+ | D+ | Yes |
| P3.1 | 16 | 12 | UART_1_RX0 | – | – | – | – | – | – | D- | D- | D- | D- | Yes |

CCG3PA Programming and Bootloading

There are two ways to program application firmware into a CCG3PA device:

1. Programming the device flash over SWD Interface
2. Application firmware update over CC interface

Generally, the CCG3PA devices are programmed over SWD interface only during development or during the manufacturing process of the end product. Once the end product is manufactured, the CCG3PA device's application firmware can be updated via the CC bootloader interface.

Programming the Device Flash over SWD Interface

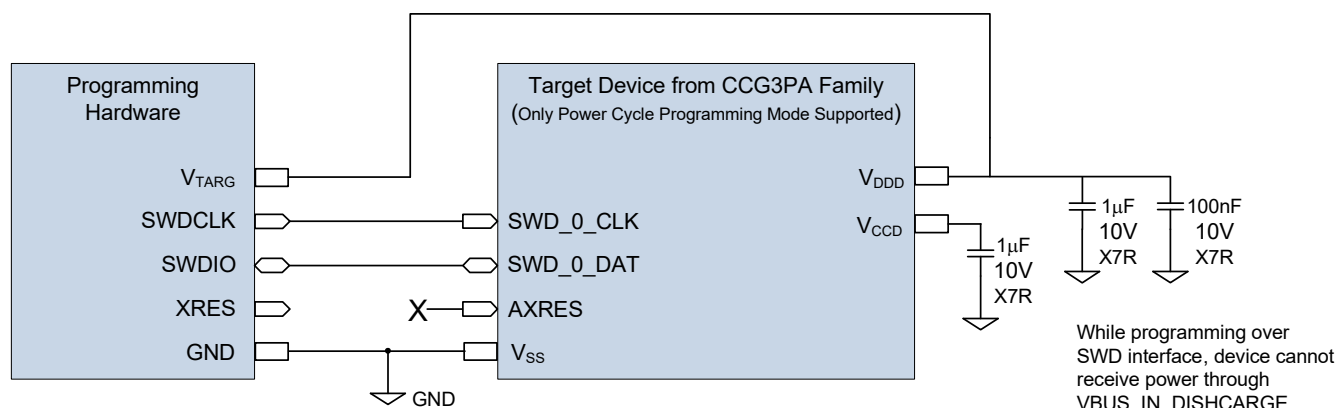
CCG3PA family of devices can be programmed using the SWD interface. Cypress provides a programming kit ([CY8CKIT-002 MiniProg3 Kit](#)) called MiniProg3 and [PSoC Programmer Software](#) which can be used to program the flash as well as debug firmware. The flash is programmed by downloading the information from a hex file. This hex file is a binary file generated as an output of building the firmware project in [PSoC Creator Software](#). Click [here](#) for more information on how to use the

MiniProg3 programmer. There are many third party programmers that support mass programming in a manufacturing environment.

As shown in the block diagram in [Figure 4](#), the SWD_0_DAT and SWD_0_CLK pins are connected to the host programmer's SWDIO (data) and SWDCLK (clock) pins respectively. During SWD programming, the CCG3PA device has to be powered by the host programmer by connecting its VTARG (power supply to the target device) to VDDD pin of CCG3PA device. While programming over SWD interface, the CCG3PA device cannot receive power through VBUS_IN_DISCHARGE.

The CCG3PA device family does not have the XRES pin. Due to that, the XRES line from the host programmer remains unconnected, and hence programming using Reset Mode is not supported. In other words, CCG3PA devices are supported by Power Cycle programming mode only since XRES line is not used. Contact Cypress for further details on CYPD3XXX Programming Specifications.

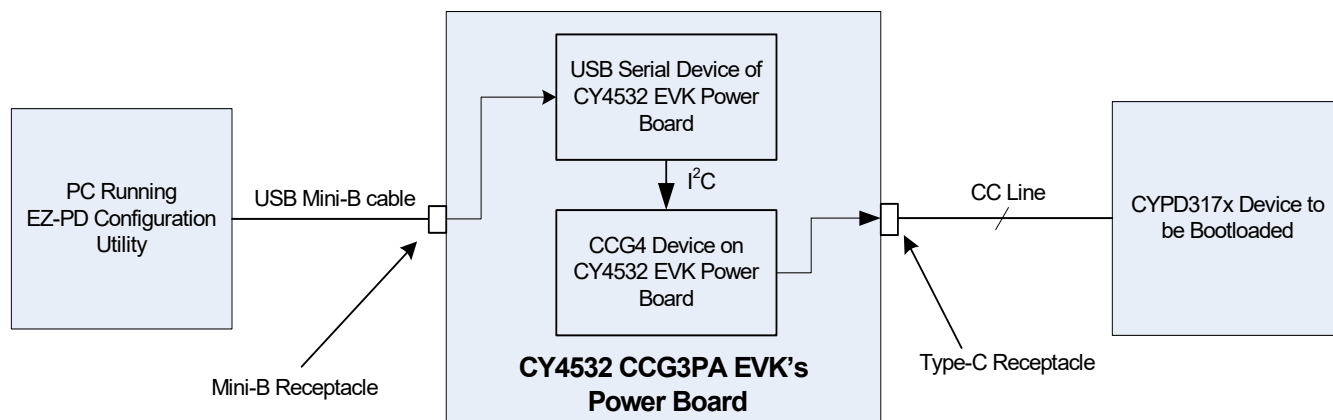
Figure 4. Connecting the Programmer to CYPD317x Device



Application Firmware Update over CC Interface

For bootloading CCG3PA applications, the CY4532 CCG3PA EVK can be used to send programming and configuration data as Cypress specific Vendor Defined Messages (VDMs) over the CC line. The CY4532 CCG3PA EVK's Power Board is connected to the system containing CCG3PA device on one end and a Windows PC running the EZ-PD™ Configuration Utility as shown in [Figure 5](#) on the other end to bootstrap the CCG3PA device.

Figure 5. Application Firmware Update over CC Interface



Application Diagrams

Figure 6 and Figure 7 show the application diagrams of CCG3PA-based Power Adapter with Opto-Coupler Feedback control using 16-pin SOIC and 24-pin QFN parts respectively. In an opto-feedback power adapter, CCG3PA implements a shunt regulator and the feedback to the primary controller is through an opto-coupler. The current drawn through the CATH path is proportional to the potential difference between FB pin and the internal bandgap reference voltage. At default 5-V VBUS, the FB pin will be held at the voltage set by the bandgap reference voltage using internal VBUS resistor dividers.

If VBUS needs to be changed from default 5 V, using internal IDACs and an error amplifier, CCG3PA draws a proportional current through the CATH pin. This in turn gets coupled to the primary controller through the opto-coupler.

Figure 6. CCG3PA Based Power Adapter Application Diagram with Opto Coupler Feedback Control (16-pin SOIC Device)

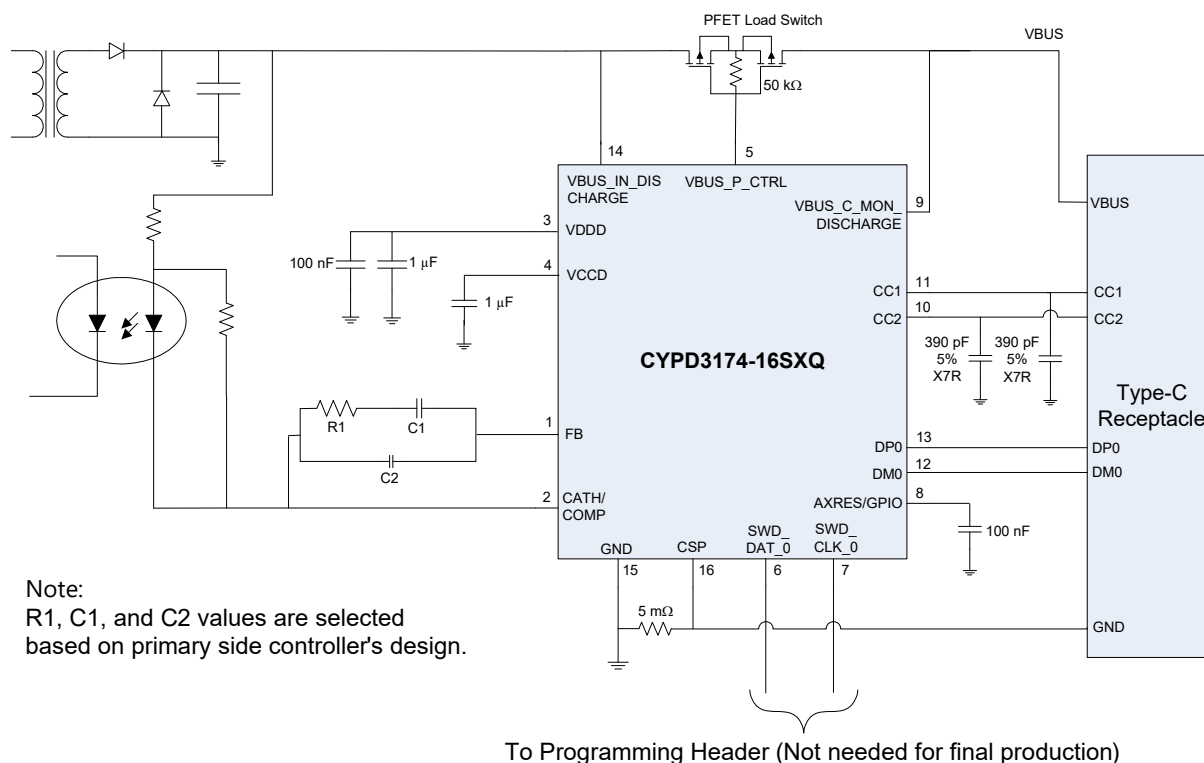


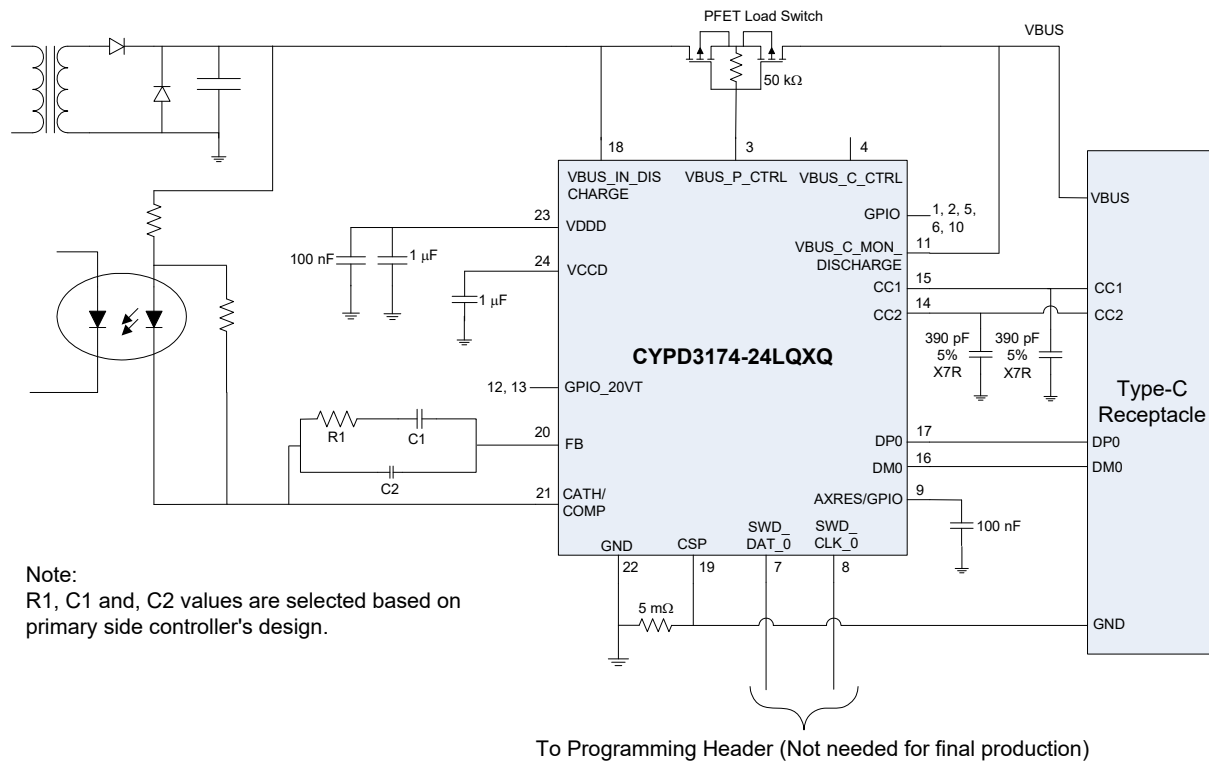
Figure 7. CCG3PA Based Power Adapter Application Diagram with Opto Coupler Feedback Control (24-pin QFN Device)


Figure 9 shows the application diagram of a CCG3PA based power adapter application with direct feedback control for two port car charger. The car charger application can charge portable devices connected to the Type-C and Type-A port simultaneously. The Type-C port supports USBPD 3.0 QC 4.0, Apple Charging 2.4A, and AFC. The Type-A port supports QC 3.0, Apple Charging and AFC.

Figure 9. CCG3PA Based Power Adapter Application with Direct Feedback Control for Two Port Car Charger

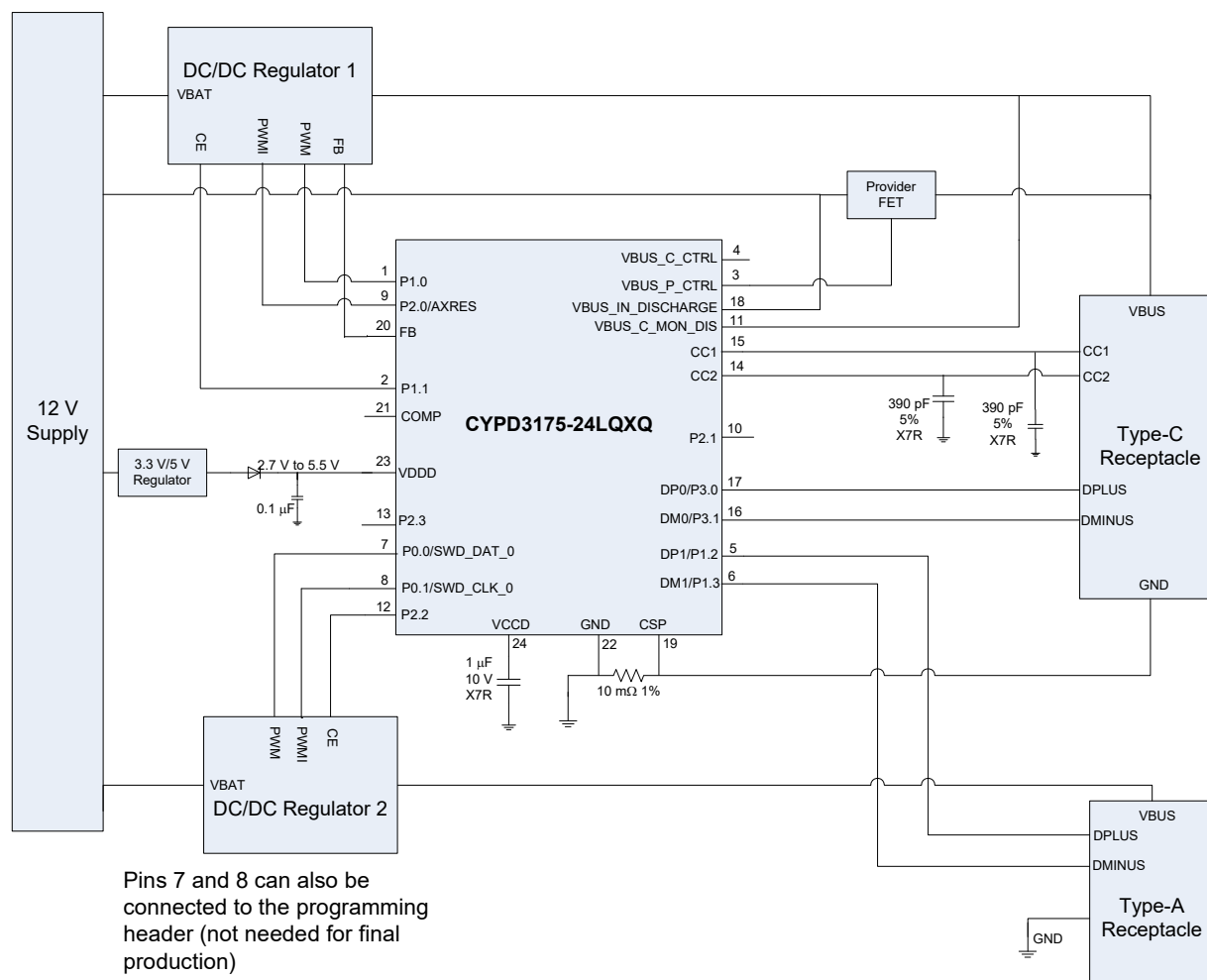


Figure 10 shows the application diagram of a CCG3PA based power bank application. It shows dual port power bank implementation using CCG3PA device. The power bank application can charge portable devices connected to the Type-C and Type-A port simultaneously. The Type-C port can be configured to support USBPD 3.0 QC 4.0, Apple Charging 2.4A, and AFC. The Type-A port can be configured to support QC3.0, Apple Charging, and AFC.

The battery can be charged from Type-C and USBPD power adapters or BC1.2 power adapters.

Figure 10. CCG3PA Power Bank Application Diagram

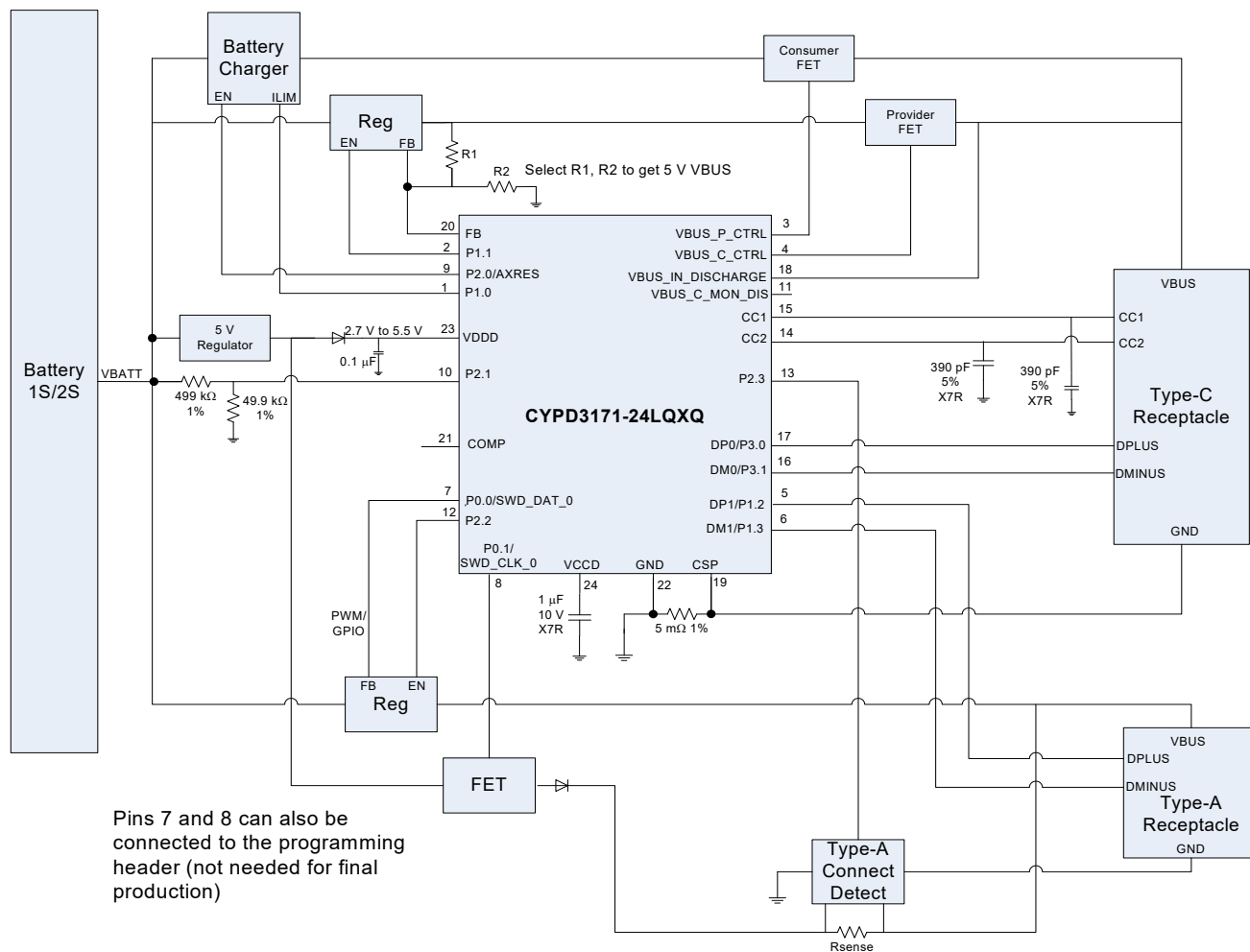


Table 5. DC Specifications (continued)

| Spec ID | Parameter | Description | Min | Typ | Max | Units | Details/Conditions |
|---------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|------------------------------------------------------------------------|-----|-----|-----|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Active Mode. Typical values measured at $V_{DD} = 5.0V$ or $V_{BUS} = 5.0V$ and $T_A = 25^\circ C$. | | | | | | | |
| SID.PWR#8 | I_{DD_A} | Supply current from V_{BUS} or V_{DD} | – | 10 | – | mA | $V_{DD} = 5V$ OR $V_{BUS} = 5V$, $T_A = 25^\circ C$. CC1/CC2 in Tx or Rx, no I/O sourcing current, 2 SCBs at 1 Mbps, EA/ADC/CSA/UVOV ON, CPU at 24 MHz. |
| Sleep Mode. Typical values measured at $V_{DD} = 3.3V$ and $T_A = 25^\circ C$. | | | | | | | |
| SID25A | I_{DD_S} | CC, I ² C, WDT wakeup on. IMO at 24 MHz. | – | 3 | – | mA | $V_{DD} = 3.3V$, $T_A = 25^\circ C$, All blocks except CPU are on, CC IO on, EA/ADC/CSA/UVOV On. |
| Deep Sleep Mode. Typical values measured at $T_A = 25^\circ C$. | | | | | | | |
| SID_PA_DS_UA | $I_{DD_PA_DS_UA}$ | $V_{BUS} = 4.5$ to $5.5V$. CC Attach, I ² C, WDT Wakeup on | – | 100 | – | μA | Power Adapter/Charger application Power Source = $V_{BUS} = 5V$, $T_A = 25^\circ C$, Type-C Not Attached. CC Attach, I ² C and WDT enabled for Wakeup. |
| SID_PA_DS_A | $I_{DD_PA_DS_A}$ | $V_{BUS} = 3.0$ to $24.5V$. CC, I ² C, WDT Wakeup on | – | 500 | – | μA | Power Adapter/Charger application $V_{BUS} = 24.5V$, $T_A = 25^\circ C$, Part is in deep sleep. Attached, CC I/O on, ADC/CSA/UVOV On |
| SID_PB_DS_UA | $I_{DD_PB_DS_UA}$ | $V_{DD} = 3.0$ to $5.5V$. CC Attach, I ² C, WDT Wakeup on | – | 100 | – | μA | Power Bank application Power Source = $V_{DD} = 5V$, $T_A = 25^\circ C$, Type-C Not Attached. CC Attach, I ² C and WDT enabled for Wakeup. |
| SID_P-B_DS_A_SRC | $I_{DD_P-B_DS_A_SRC}$ | $V_{DD} = 3.0$ to $5.5V$. CC, I ² C, WDT Wakeup on | – | 500 | – | μA | Power Bank Source application $V_{DD} = 5V$, $T_A = 25^\circ C$, Part is in deep sleep. Attached, CC I/O on, ADC/CSA/UVOV On. |
| SID_P-B_DS_A_SNK | $I_{DD_P-B_DS_A_SNK}$ | $V_{BUS} = 4.0$ to $24.5V$. CC, I ² C, WDT Wakeup on | – | 500 | – | μA | Power Bank Sink application $V_{BUS} = 24.5V$, $T_A = 25^\circ C$, Part is in deep sleep. Attached, CC I/O on, ADC/CSA/UVOV On |

Table 6. AC Specifications (Guaranteed by Characterization)

| Spec ID | Parameter | Description | Min | Typ | Max | Units | Details/Conditions |
|-------------|-------------------|-----------------------------------------------------------|-----|-----|-----|-------|--------------------|
| SID.CLK#4 | F_{CPU} | CPU input frequency | DC | – | 48 | MHz | All V_{DD} |
| SID.PWR#17 | T_{SLEEP} | Wakeup from sleep mode | – | 0 | – | μs | – |
| SID.PWR#18 | $T_{DEEPSLEEP}$ | Wakeup from Deep Sleep mode | – | – | 35 | μs | – |
| SYS.FES#1 | T_{PWR_RDY} | Power-up to “Ready to accept I ² C/CC command” | – | 5 | 25 | ms | – |
| SID.PWR#18A | $T_{POR_HIZ_T}$ | Power-on I/O Initialization Time | – | 3 | – | ms | – |

I/O

Table 7. I/O DC Specifications

| Spec ID | Parameter | Description | Min | Typ | Max | Units | Details/Conditions |
|-------------|--------------------------|----------------------------------------------------------------------|----------------------|-----|---------------------|-------|-------------------------------------------------------------------------------------------------------|
| SID.GIO#37 | V _{IH_CMOS} | Input voltage HIGH threshold | $0.7 \times V_{DD}$ | – | – | V | CMOS input |
| SID.GIO#38 | V _{IL_CMOS} | Input voltage LOW threshold | – | – | $0.3 \times V_{DD}$ | V | CMOS input |
| SID.GIO#39 | V _{IH_VDDD2.7-} | LVTTL input, $V_{DD} < 2.7$ V | $0.7 \times V_{DD}$ | – | – | V | – |
| SID.GIO#40 | V _{IL_VDDD2.7-} | LVTTL input, $V_{DD} < 2.7$ V | – | – | $0.3 \times V_{DD}$ | V | – |
| SID.GIO#41 | V _{IH_VDDD2.7+} | LVTTL input, $V_{DD} \geq 2.7$ V | 2.0 | – | – | V | – |
| SID.GIO#42 | V _{IL_VDDD2.7+} | LVTTL input, $V_{DD} \geq 2.7$ V | – | – | 0.8 | V | – |
| SID.GIO#33 | V _{OH_3V} | Output voltage HIGH level | $V_{DD} - 0.6$ | – | – | V | I _{OH} = 4 mA at 3-V V _{DD} |
| SID.GIO#36 | V _{OL_3V} | Output voltage LOW level | – | – | 0.6 | V | I _{OL} = 10 mA at 3-V V _{DD} |
| SID.GIO#5 | R _{PU} | Pull-up resistor value | 3.5 | 5.6 | 8.5 | kΩ | +25 °C T _A , all V _{DD} |
| SID.GIO#6 | R _{PD} | Pull-down resistor value | 3.5 | 5.6 | 8.5 | kΩ | +25 °C T _A , all V _{DD} |
| SID.GIO#16 | I _{IL} | Input leakage current (absolute value) | – | – | 2 | nA | +25 °C T _A , 3-V V _{DD} |
| SID.GIO#17 | C _{PIN_A} | Max pin capacitance | – | – | 22 | pF | Capacitance on DP0, DM0, DP1, DMI pins. Guaranteed by characterization. |
| SID.GIO#17A | C _{PIN} | Max pin capacitance | – | 3 | 7 | pF | –40°C to +85°C T _A , All V _{DD} , all other I/Os. Guaranteed by characterization. |
| SID.GIO#43 | V _{HYSTTL} | Input hysteresis, LVTTL V _{DD} > 2.7 V | 15 | 40 | – | mV | Guaranteed by characterization. |
| SID.GIO#44 | V _{HYSCMOS} | Input hysteresis CMOS | $0.05 \times V_{DD}$ | – | – | mV | V _{DD} < 4.5 V. Guaranteed by characterization. |
| SID69 | I _{DIODE} | Current through protection diode to V _{DD} /V _{SS} | – | – | 100 | μA | Guaranteed by design. |
| SID.GIO#45 | I _{TOT_GPIO} | Maximum total sink chip current | – | – | 85 | mA | Guaranteed by design. |
| OVT | | | | | | | |
| SID.GIO#46 | I _{IHS} | Input current when Pad > V _{DD} for OVT inputs | – | – | 10.00 | μA | Per I ² C specification |

Table 8. I/O AC Specifications

(Guaranteed by Characterization)

| Spec ID | Parameter | Description | Min | Typ | Max | Units | Details/Conditions |
|---------|--------------------|-------------------------------|-----|-----|-----|-------|---------------------------------------------------|
| SID70 | T _{RISEF} | Rise time in Fast Strong mode | 2 | – | 12 | ns | 3.3-V V _{DD} , C _{load} = 25 pF |
| SID71 | T _{FALLF} | Fall time in Fast Strong mode | 2 | – | 12 | ns | 3.3-V V _{DD} , C _{load} = 25 pF |

Table 9. GPIO_20VT DC Specifications (Applicable to port pins P2.2 and P2.3 only)

(Guaranteed by Characterization)

| Spec ID# | Parameter | Description | Min | Typ | Max | Units | Details / Conditions |
|------------------|---------------------|---------------------------------------------------------------------------------|------|-----|-----|-------|------------------------------------------------------------------------|
| SID.GPIO_20VT#4 | GPIO_20VT_I_LU | GPIO_20VT Latch up current limits | -140 | - | 140 | mA | Max / min current in to any input or output, pin-to-pin, pin-to-supply |
| SID.GPIO_20VT#5 | GPIO_20VT_RPU | GPIO_20VT Pull-up resistor value | 1 | - | 25 | kΩ | +25 °C T _A , 1.4 V to GPIO_20VT_Voh(min) |
| SID.GPIO_20VT#6 | GPIO_20VT_RPD | GPIO_20VT Pull-down resistor value | 2.5 | - | 20 | kΩ | +25 °C T _A , 1.4-V to V _{DDD} |
| SID.GPIO_20VT#16 | GPIO_20VT_IIL | GPIO_20VT Input leakage current (absolute value) | - | - | 2 | nA | +25 °C T _A , 3-V V _{DDD} |
| SID.GPIO_20VT#17 | GPIO_20VT_CPIN | GPIO_20VT pin capacitance | 15 | - | 25 | pF | -40 °C to +85 °C T _A , All V _{DDD} , F = 1 MHz |
| SID.GPIO_20VT#36 | GPIO_20VT_VoI | GPIO_20VT Output Voltage low level. | - | - | 0.4 | V | I _{OL} = 2 mA |
| SID.GPIO_20VT#41 | GPIO_20VT_Vih_LVTTL | GPIO_20VT LVTTL Input Voltage high level. | 2 | - | - | V | V _{DDD} ≥ 2.7 V |
| SID.GPIO_20VT#42 | GPIO_20VT_Vil_LVTTL | GPIO_20VT LVTTL Input Voltage low level. | - | - | 0.8 | V | V _{DDD} ≥ 2.7 V |
| SID.GPIO_20VT#43 | GPIO_20VT_Vhysttl | GPIO_20VT Input hysteresis LVTTL | 15 | 40 | - | mV | V _{DDD} ≥ 2.7 V |
| SID.GPIO_20VT#69 | GPIO_20VT_IDIODE | GPIO_20VT Current through protection diode to V _{DDD} /V _{SS} | - | - | 100 | μA | |

Table 10. GPIO_20VT AC Specifications (Applicable to port pins P2.2 and P2.3 only)

(Guaranteed by Characterization)

| Spec ID# | Parameter | Description | Min | Typ | Max | Units | Details / Conditions |
|------------------|------------------|-----------------------------------------|-----|-----|-----|-------|--------------------------------------------------|
| SID.GPIO_20VT#70 | GPIO_20VT_TriseF | GPIO_20VT Rise time in Fast Strong Mode | 1 | - | 45 | ns | All V _{DDD} , C _{load} = 25 pF |
| SID.GPIO_20VT#71 | GPIO_20VT_TfallF | GPIO_20VT Fall time in Fast Strong Mode | 2 | - | 15 | ns | All V _{DDD} , C _{load} = 25 pF |

Internal Low-Speed Oscillator Power Down
Table 25. ILO DC Specifications

(Guaranteed by Design)

| Spec ID | Parameter | Description | Min | Typ | Max | Units | Details/Conditions |
|---------|----------------------|-----------------------------------|-----|-----|------|-------|--------------------|
| SID231 | I _{ILO1} | I _{LO} operating current | – | 0.3 | 1.05 | μA | – |
| SID233 | I _{ILOLEAK} | I _{LO} leakage current | – | 2 | 15 | nA | – |

Table 26. ILO AC Specifications

| Spec ID | Parameter | Description | Min | Typ | Max | Units | Details/Conditions |
|-----------|------------------------|-------------------------------|-----|-----|-----|-------|--------------------------------|
| SID234 | T _{STARTILO1} | I _{LO} start-up time | – | – | 2 | ms | Guaranteed by Characterization |
| SID238 | T _{ILODUTY} | I _{LO} duty cycle | 40 | 50 | 60 | % | Guaranteed by Characterization |
| SID.CLK#5 | F _{ILO} | I _{LO} frequency | 20 | 40 | 80 | kHz | – |

Table 27. 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 | 194.4 | μA | – |
| SID.PD.3 | Rp_3.0A | DFP CC termination for 3.0A power | 304 | 330 | 356.4 | μA | – |
| SID.PD.4 | Rd | UFP CC termination | 4.59 | 5.1 | 5.61 | kΩ | – |
| SID.PD.5 | Rd_DB | UFP (Power Bank) Dead Battery CC Termination on CC1 and CC2 | 4.08 | 5.1 | 6.12 | kΩ | All supplies forced to 0V and 1.32 V applied at CC1 or CC2 |
| SID.PD.6 | V _{gndoffset} | Ground offset tolerated by BMC receiver | –500 | – | 500 | mV | Relative to the remote BMC transmitter. |

Table 28. LS-CSA Specifications

| Spec ID | Parameter | Description | Min | Typ | Max | Units | Details/Conditions |
|--------------|--------------|----------------------------------------------------------------|-------|-----|-----|-------|--------------------------------|
| SID.LSCSA.1 | Cin_inp | CSP Input capacitance | 7 | – | 10 | pF | Guaranteed by characterization |
| SID.LSCSA.2 | Csa_Acc1 | CSA accuracy 5 mV < Vsense < 10 mV | –15 | – | 15 | % | Active Mode |
| SID.LSCSA.3 | Csa_Acc2 | CSA accuracy 10 mV < Vsense < 15 mV | –10 | – | 10 | % | |
| SID.LSCSA.4 | Csa_Acc3 | CSA accuracy 15 mV < Vsense < 20 mV | –6 | – | 6 | % | |
| SID.LSCSA.5 | Csa_Acc4 | CSA accuracy 20 mV < Vsense < 30 mV | –5 | – | 5 | % | |
| SID.LSCSA.6 | Csa_Acc5 | CSA accuracy 30 mV < Vsense < 50 mV | –4 | – | 4 | % | |
| SID.LSCSA.7 | Csa_Acc6 | CSA accuracy 50 mV < Vsense | –4 | – | 4 | % | |
| SID.LSCSA.8 | Csa_SCP_Acc1 | CSA SCP 80 mV | –16.5 | – | 30 | % | |
| SID.LSCSA.9 | Csa_SCP_Acc2 | CSA SCP 100 mV | –13.4 | – | 24 | % | |
| SID.LSCSA.10 | Csa_SCP_Acc3 | CSA SCP 150 mV | –9.4 | – | 16 | % | |
| SID.LSCSA.11 | Csa_SCP_Acc4 | CSA SCP 200 mV | –7.5 | – | 12 | % | |
| SID.LSCSA.12 | Av | Nominal Gain values supported: 5, 10, 20, 35, 50, 75, 125, 150 | 5 | – | 150 | V/V | |
| SID.LSCSA.24 | Av1_E_Trim | Gain Error | –3 | – | 3 | % | Guaranteed by characterization |
| SID.LSCSA.31 | Av_E_SCP | Gain Error of SCP stage | –3.5 | – | 3.5 | % | Guaranteed by characterization |

Gate Driver Specifications

Table 32. Gate Driver DC Specifications

| Spec ID | Parameter | Description | Min | Typ | Max | Units | Details/Conditions |
|-----------|----------------------|------------------------------------------------|------|-------|------|-------|------------------------------------------------------------------------------------------------------------|
| SID.GD.1 | R _{PD} | Pull-down resistance | – | – | 3 | kΩ | Applicable on VBUS_P_CTRL and VBUS_C_CTRL to turn ON external PFET. |
| SID.GD.2 | R _{PU} | Pull-up resistance | – | – | 4 | kΩ | Applicable on VBUS_P_CTRL to turn OFF external PFET |
| SID.GD.3 | I _{PD0} | Pull-down current sink at drive strength of 1 | 25 | – | 75 | μA | I-mode (current mode) pull down at 5 V. Applicable on VBUS_P_CTRL and VBUS_C_CTRL to turn ON external PFET |
| SID.GD.4 | I _{PD1} | Pull-down current sink at drive strength of 2 | 50 | – | 150 | μA | |
| SID.GD.5 | I _{PD2} | Pull-down current sink at drive strength of 4 | 140 | – | 300 | μA | |
| SID.GD.6 | I _{PD3} | Pull-down current sink at drive strength of 8 | 280 | – | 580 | μA | |
| SID.GD.7 | I _{PD4} | Pull-down current sink at drive strength of 16 | 560 | – | 1200 | μA | |
| SID.GD.8 | I _{PD5} | Pull-down current sink at drive strength of 32 | 1120 | – | 2300 | μA | |
| SID.GD.9 | I _{leak_p1} | Pin leakage on VBUS_P_CTRL | – | 0.003 | – | μA | +25 °C T _J , 5-V V _{DD} , 20-V V _{BUS} |
| SID.GD.10 | I _{leak_c1} | Pin leakage on VBUS_C_CTRL | – | 0.003 | – | μA | +25 °C T _J , 5-V V _{DD} , 20-V V _{BU} |
| SID.GD.11 | I _{leak_p2} | Pin leakage on VBUS_P_CTRL | – | – | 2 | μA | +85 °C T _J , 5-V V _{DD} , 20-V V _{BU} |
| SID.GD.12 | I _{leak_c2} | Pin leakage on VBUS_C_CTRL | – | – | 2 | μA | +85 °C T _J , 5-V V _{DD} , 20-V V _{BU} |
| SID.GD.13 | I _{leak_p3} | Pin leakage on VBUS_P_CTRL | – | – | 7 | μA | +125 °C T _J , 5-V V _{DD} , 20-V V _{BU} |
| SID.GD.14 | I _{leak_c3} | Pin leakage on VBUS_C_CTRL | – | – | 7 | μA | +125 °C T _J , 5-V V _{DD} , 20-V V _{BU} |

Table 33. Gate Driver AC Specifications

(Guaranteed by Characterization)

| Spec ID | Parameter | Description | Min | Typ | Max | Units | Details/Conditions |
|-----------|--------------------------|----------------------------------------------|-----|-----|-----|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| SID.GD.15 | T _{PD1} | Pull down delay on VBUS_C_CTRL | – | – | 2 | μs | Cl _{oad} = 2 nF, Delay to VBUS –1.5 V from initiation of falling edge, VBUS = 5 V to 20 V, 50 kΩ tied between VBUS_C_CTRL and VBUS |
| SID.GD.16 | T _{r_discharge} | Discharge rate of output node on VBUS_C_CTRL | – | – | 5 | V/μs | 80% to 20%, 50 kΩ tied between VBUS_C_CTRL and VBUS, Cl _{oad} = 2 nF, V _{initial} = 24 V |
| SID.GD.17 | T _{PD2} | Pull down delay on VBUS_P_CTRL | – | – | 2 | μs | Cl _{oad} = 2 nF, Delay to VBUS –1.5 V from initiation of falling edge, V _{BUS} = 5 V to 20 V, 50 kΩ tied between VBUS_C_CTRL and VBUS |
| SID.GD.18 | T _{PU} | Pull up delay on VBUS_P_CTRL | – | – | 18 | μs | Cl _{oad} = 2 nF, Delay to VBUS –1.5 V from initiation of falling edge, VBUS = 5 V to 20 V, 50 kΩ tied between VBUS_C_CTRL and VBUS |
| SID.GD.19 | SR _{PU} | Output slew rate on VBUS_P_CTRL | – | – | 5 | V/μs | Cl _{oad} = 2 nF, 20% to 80% of VBUS_P_CTRL range |
| SID.GD.20 | SR _{PD} | Output slew rate on VBUS_P_CTRL | – | – | 5 | V/μs | Cl _{oad} = 2 nF, 80% to 20% of VBUS_P_CTRL range |

Packaging

Table 43. Package Characteristics

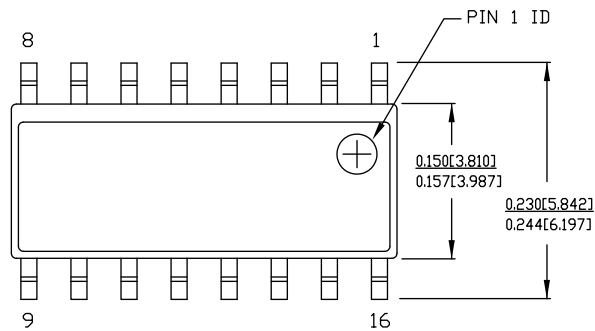
| Parameter | Description | Conditions | Min | Typ | Max | Units |
|-----------------|---------------------------------|---------------------|-----|-----|-------|-------|
| T _A | Operating ambient temperature | Extended Industrial | -40 | 25 | 105 | °C |
| T _J | Operating junction temperature | Extended Industrial | -40 | 25 | 120 | °C |
| T _{JA} | Package θ_{JA} (24-QFN) | - | - | - | 19.98 | °C/W |
| T _{JC} | Package θ_{JC} (24-QFN) | - | - | - | 4.78 | °C/W |
| T _{JA} | Package θ_{JA} (16-SOIC) | - | - | - | 84 | °C/W |
| T _{JC} | Package θ_{JC} (16-SOIC) | - | - | - | 33.9 | °C/W |

Table 44. Solder Reflow Peak Temperature

| Package | Maximum Peak Temperature | Maximum Time within 5° C of Peak Temperature |
|-------------|--------------------------|----------------------------------------------|
| 24-pin QFN | 260 ° C | 30 seconds |
| 16-pin SOIC | 260 ° C | 30 seconds |

Table 45. Package Moisture Sensitivity Level (MSL), IPC/JEDEC J-STD-2

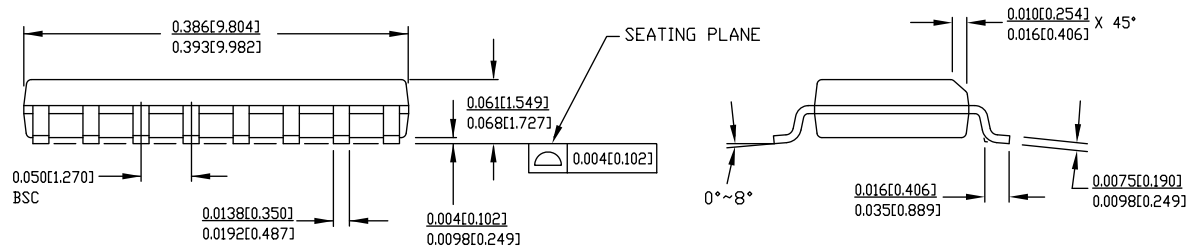
| Package | MSL |
|-------------|------|
| 24-pin QFN | MSL3 |
| 16-pin SOIC | MSL3 |

Figure 12. 16-pin SOIC Package Outline


NOTE:

1. DIMENSIONS IN INCHES[MM] **MAX.**
2. REFERENCE JEDEC MS-012
3. PACKAGE WEIGHT : refer to PMDD spec. 001-04308

| PART # | |
|---------|----------------|
| S16.15 | STANDARD PKG. |
| SZ16.15 | LEAD FREE PKG. |



51-85068 *E

Acronyms

Table 46. Acronyms Used in this Document

| Acronym | Description |
|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| ADC | analog-to-digital converter |
| AES | advanced encryption standard |
| API | application programming interface |
| ARM® | advanced RISC machine, a CPU architecture |
| CC | configuration channel |
| CCG3 | Cable Controller Generation 3 |
| 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 | electronically marked cable assembly, 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 |
| 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 |
| LDO | low-dropout regulator |
| LVD | low-voltage detect |
| LVTTTL | low-voltage transistor-transistor logic |
| MCU | microcontroller unit |
| NC | no connect |
| NMI | nonmaskable interrupt |
| NVIC | nested vectored interrupt controller |
| opamp | operational amplifier |

Table 46. Acronyms Used in this Document *(continued)*

| Acronym | Description |
|---------|--------------------------------------------------------------------------------------------------------------|
| OCP | overcurrent protection |
| OTP | over temperature protection |
| OVP | overvoltage protection |
| OVT | overvoltage tolerant |
| 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 |
| SCP | short circuit protection |
| SDA | I ² C serial data |
| S/H | sample and hold |
| SHA | secure hash algorithm |
| 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 |
| UVP | undervoltage protection |
| XRES | external reset I/O pin |

Document Conventions

Units of Measure

Table 47. 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 | mega samples per second |
| μA | microampere |
| μF | microfarad |
| μs | microsecond |
| 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 |

Document History Page

| Document Title: EZ-PD™ CCG3PA Datasheet, USB Type-C Port Controller Document Number: 002-16951 | | | | |
|---------------------------------------------------------------------------------------------------|---------|-----------------|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Revision | ECN | Orig. of Change | Submission Date | Description of Change |
| ** | 5473667 | VGT | 10/13/2016 | New datasheet |
| *A | 5544333 | VGT | 12/13/2016 | Changed datasheet status to Preliminary. Updated Features . Updated Logic Block Diagram . Updated Functional Overview . Updated Figure 2, Figure 3, Figure 6 , Figure 8 , Figure 9 , and Figure 10 . Updated Pinouts . Updated Table 4 with VCC_PIN_ABS and VSBU_PIN_ABS parameters. Added Q-temp parts in Table 42 . |
| *B | 5583660 | VGT | 01/18/2017 | Updated General Description , Features , I/O Subsystem , CPU , Charger Detection , and Ordering Information . Updated Table 2 and Table 4 . Updated Figure 6 through Figure 10 . Updated Sales page. |
| *C | 5665676 | VGT | 03/22/2017 | Updated Figure 2 , Figure 6 , Figure 8 , Figure 10 , Table 1 , Table 2 , Table 4 , Table 42 , Features , Logic Block Diagram , Functional Overview , Power Systems Overview , Ordering Code Definitions , Acronyms . Added Internal Block Diagram . Added Table 5 through Table 41 in Device-Level Specifications . Updated compliance with USB spec in Sales , Solutions , and Legal Information . Updated Cypress logo. |
| *D | 5738854 | VGT | 05/19/2017 | Added Application Diagram description before Figure 6 , Figure 8 , Figure 9 , and Figure 10 . Added Figure 1 . Added CCG3PA Programming and Bootloading section. Added Document History Page section. Added Table 3 . Updated Figure 3 , Figure 4 , Figure 6 , Figure 8 , Figure 9 , and Figure 10 . Updated Table 2 , Table 4 , Table 5 , and Table 42 . Updated Figure 11 (spec 002-16934 Rev. ** to *A) in Packaging . Updated Cypress logo, Sales page, and Copyright information. |
| *E | 5984670 | VGT | 12/06/2017 | Removed Preliminary document status. Updated System-Level Fault Protection , Power , and System-Level ESD Protection . Updated Internal Block Diagram . Updated Figure 2 . Table 2 : Updated Pins 12 and 13. Added Note 5. Updated Figure 6 . Added Figure 7 . Table 4 : Updated max value for V _{CC_PIN_ABS} . Table 5 : Removed SID_DS and updated typ value for SID_PB_DS_UA. Table 7 : Added new SID.GIO#17 spec and changed SID.GIO#17 to SID.GIO#17A. Added Table 9 and Table 10 . Table 12 : Updated max value for SID149. Table 22 : Added "Guaranteed by Characterization" Table 24 : Updated Conditions for SID226 and SID228. Updated typ value and conditions for SID.CLK#1. Table 26 : Updated Conditions for SID234 and SID238. Table 28 : Updated min, typ, and max values for SID.LSCSA.1, SID.LSCSA.7, and SID.LSCSA.24 Updated Conditions for SID.GIO#17A, SID.GIO#43, SID.GIO#44, SID.GIO#45, and SID69. Table 31 : Added "Guaranteed by Characterization" Table 32 : Added SID.GD.9, SID.GD.10, SID.GD.11, SID.GD.12, SID.GD.13, SID.GD.14. Changed description of spec IDs SID.GD.1 to SID.GD.8. Table 33 : Renumbered all spec IDs starting from SID.GD.15 to SID.GD.20. Modified max values of SID.GD.15, SID.GD.17 and SID.GD.18. Modified Details/Conditions of all parameters. Table 34 : Removed spec IDs SID.VBUS.DISC.1 to SID.VBUS.DISC5. Renumbered SID.VBUS.DISC6 to SID.VBUS.DISC11. Added new spec IDs SID.VBUS.DISC6 to SID.VBUS.DISC10. |