

## SINGLE-CHIP HID USB TO UART BRIDGE

### Single-Chip HID USB to UART Data Transfer

- Integrated USB transceiver; no external resistors required
- Integrated clock; no external crystal required
- Integrated 343-byte one-time programmable ROM for storing customizable product information
- On-chip power-on reset circuit
- On-chip voltage regulator: 3.45 V output

### USB Peripheral Function Controller

- USB Specification 2.0 compliant; full-speed (12 Mbps)
- USB suspend states supported via SUSPEND pins

### HID Interface

- Standard USB class device requires no custom driver
- Windows 7, Vista, XP, Server 2003, 2000
- Win CE 6.0, 5.0, and 4.2
- Mac OS-X
- Linux
- Open access to interface specification

### Windows and MAC HID-to-UART Libraries

- APIs for quick application development
- Supports Windows 7, Vista, XP, Server 2003, 2000
- Supports Mac OS X

### Supply Voltage

- Self-powered: 3.0 to 3.6 V
- USB bus powered: 4.0 to 5.25 V
- I/O voltage: 1.8 V to  $V_{DD}$

### UART Interface Features

- Flow control options:
  - Hardware (CTS / RTS)
  - No flow control
- Data formats supported:
  - Data bits: 5, 6, 7, and 8
  - Stop bits: 1, 1.5, and 2
  - Parity: odd, even, mark, space, no parity
- Baud rates: 300 bps to 1 Mbps
- 480 Byte receive and transmit buffers
- RS-485 mode with bus transceiver control
- Line break transmission

### GPIO Interface Features

- 10 GPIO pins with configurable options
- Usable as inputs, open-drain or push-pull outputs
- Configurable clock output for external devices
  - 24 MHz to 47 kHz
- RS-485 bus transceiver control
- Toggle LED upon transmission
- Toggle LED upon reception

### Ordering Part Numbers

- CP2110-F01-GM (QFN24, 4 x 4 mm, Pb-free)
- CP2110-F02-GM1 (QFN28, 5 x 5 mm, Pb-free)
  - QFN28 is pin-compatible with the CP2102-GM.

Temperature Range:  $-40$  to  $+85$  °C

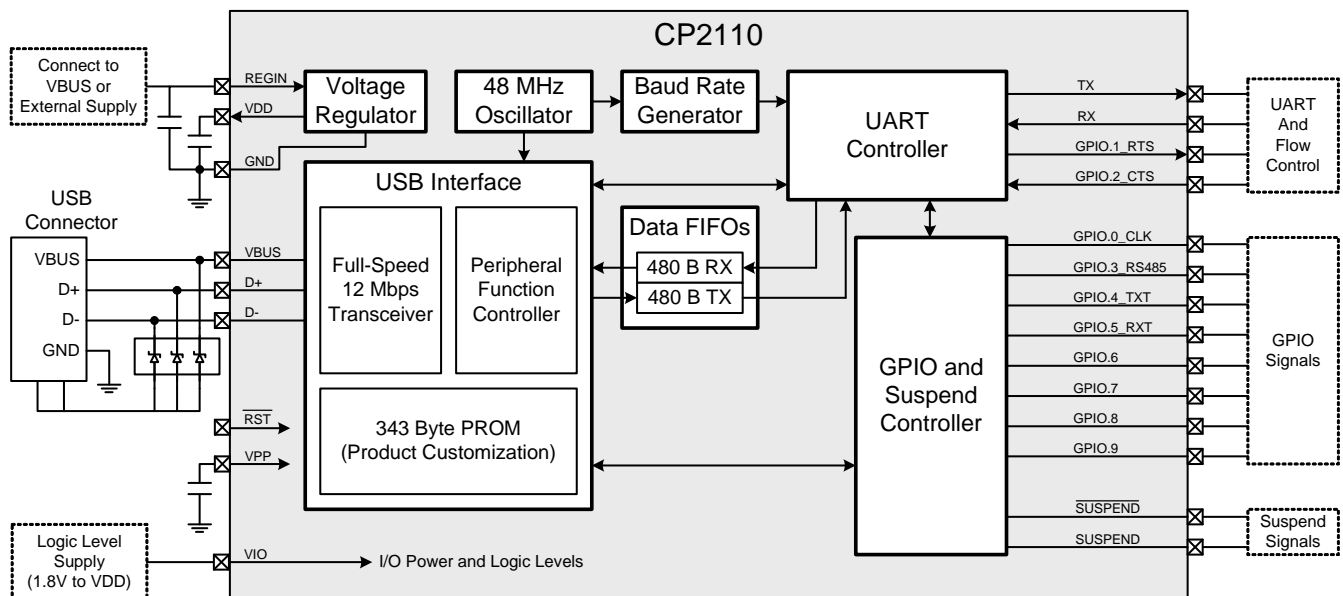


Figure 1. Example System Diagram



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## 1. System Overview

The CP2110 is a highly-integrated HID USB-to-UART Bridge Controller providing a simple solution for updating RS-232 designs to USB using a minimum of components and PCB space. The CP2110 includes a USB 2.0 full-speed function controller, USB transceiver, oscillator, one-time programmable ROM, and an asynchronous serial data bus (UART) in compact 4 x 4 mm QFN24 and 5 x 5 mm QFN28 packages (sometimes called “MLF” or “MLP”).

The on-chip, one-time programmable ROM provides the option to customize the USB Vendor ID, Product ID, Manufacturer Product String, Product Description String, Power Descriptor, Device Release Number, Device Serial Number, and GPIO configuration as desired for OEM applications.

The CP2110 uses the standard USB HID device class which is natively supported by most operating systems. A custom driver does not need to be installed for this device. Windows applications communicate with the CP2110 through a Windows DLL which is provided by Silicon Labs. The interface specification for the CP2110 is also available to enable development of an API for any operating system that supports HID.

**Note:** The CP2110 devices will not enumerate as a standard HID mouse or keyboard.

The CP2110 UART interface implements all RS-232 signals, including control and hardware handshaking, so existing system firmware does not need to be modified. The UART capabilities of the CP2110 include baud rate support from 300 to 1 Mbps, hardware flow control, support for 5-8 data bits, 5 types of parity and RS-485 support.

The device also features a total of 10 GPIO signals that are user-defined for status and control information. Six of the GPIO signals support alternate features including hardware flow control (RTS and CTS), a configurable clock output (24 MHz to 47 kHz), RS-485 transceiver control, and TX and RX LED toggle. On the -GM packages, support for I/O interface voltages down to 1.8 V is provided via a  $V_{IO}$  pin. On the -GM1 packages, the  $V_{IO}$  pin is internally tied to VDD.

An evaluation kit for the CP2110 (Part Number: CP2110EK) is available. It includes a CP2110-based USB-to-UART/RS-232 evaluation board, Windows DLL and test application, USB and RS-232 cables, and full documentation. See [www.silabs.com](http://www.silabs.com) for the latest application notes and product support information for the CP2110. Contact a Silicon Labs sales representatives or go to [www.silabs.com](http://www.silabs.com) to order the CP2110 Evaluation Kit.

## 2. Electrical Characteristics

**Table 1. Absolute Maximum Ratings**

| Parameter  | Conditions  | Min          | Typ    | Max                          | Units |
|--|---|--------------|--------|------------------------------|-------|
| Ambient Temperature under Bias   |   | -55          | —      | 125                          | °C    |
| Storage Temperature  |   | -65          | —      | 150                          | °C    |
| Voltage on $\overline{\text{RST}}$ , GPIO or UART Pins with respect to GND | $V_{\text{IO}} \geq 2.2 \text{ V}$<br>$V_{\text{IO}} < 2.2 \text{ V}$ | -0.3<br>-0.3 | —<br>— | 5.8<br>$V_{\text{IO}} + 3.6$ | V     |
| Voltage on $V_{\text{DD}}$ or $V_{\text{IO}}$ with respect to GND          |   | -0.3         | —      | 4.2                          | V     |
| Maximum Total Current through $V_{\text{DD}}$ , $V_{\text{IO}}$ , and GND  |   | —            | —      | 500                          | mA    |
| Maximum Output Current Sunk by $\overline{\text{RST}}$ or any I/O pin      |   | —            | —      | 100                          | mA    |

**Note:** Stresses above those listed may cause permanent damage to the device. This is a stress rating only, and functional operation of the devices at or exceeding the conditions in the operation listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

**Table 2. Global DC Electrical Characteristics**

$V_{\text{DD}} = 3.0$  to  $3.6 \text{ V}$ ,  $-40$  to  $+85 \text{ °C}$  unless otherwise specified.

| Parameter   | Conditions   | Min | Typ  | Max             | Units         |
|---|--|-----|------|-----------------|---------------|
| Digital Supply Voltage ( $V_{\text{DD}}$ )          |  | 3.0 | —    | 3.6             | V             |
| Digital Port I/O Supply Voltage ( $V_{\text{IO}}$ ) | -GM packages only<br>$V_{\text{DD}} = V_{\text{IO}}$ on -GM1 | 1.8 | —    | $V_{\text{DD}}$ | V             |
| Supply Current <sup>1</sup>                         | Normal Operation;<br>$V_{\text{REG}}$ Enabled                | —   | 11.3 | 12.5            | mA            |
| Supply Current <sup>1</sup>                         | Suspended;<br>$V_{\text{REG}}$ Enabled                       | —   | 120  | 220             | $\mu\text{A}$ |
| Supply Current - USB Pull-up <sup>2</sup>           |  | —   | 200  | 228             | $\mu\text{A}$ |
| Specified Operating Temperature Range               |  | -40 | —    | +85             | °C            |

**Notes:**

1. If the device is connected to the USB bus, the USB pull-up current should be added to the supply current to calculate total required current.
2. The USB pull-up supply current values are calculated values based on USB specifications.

**Table 3. UART and Suspend I/O DC Electrical Characteristics**

$V_{IO} = 1.8$  to  $3.6$  V,  $-40$  to  $+85$  °C unless otherwise specified.

| Parameters                       | Conditions                      | Min                 | Typ            | Max | Units   |
|----------------------------------|---------------------------------|---------------------|----------------|-----|---------|
| Output High Voltage ( $V_{OH}$ ) | $I_{OH} = -10 \mu A$            | $V_{IO} - 0.1$      | —              | —   | V       |
|                                  | $I_{OH} = -3 \text{ mA}$        | $V_{IO} - 0.2$      | —              | —   |         |
|                                  | $I_{OH} = -10 \text{ mA}$       | —                   | $V_{IO} - 0.4$ | —   |         |
| Output Low Voltage ( $V_{OL}$ )  | $I_{OL} = 10 \mu A$             | —                   | —              | 0.1 | V       |
|                                  | $I_{OL} = 8.5 \text{ mA}$       | —                   | —              | 0.4 |         |
|                                  | $I_{OL} = 25 \text{ mA}$        | —                   | 0.6            | —   |         |
| Input High Voltage ( $V_{IH}$ )  |                                 | $0.7 \times V_{IO}$ | —              | —   | V       |
| Input Low Voltage ( $V_{IL}$ )   |                                 | —                   | —              | 0.6 | V       |
| Input Leakage Current            | Weak Pull-Up Off                | —                   | —              | 1   | $\mu A$ |
|                                  | Weak Pull-Up On, $V_{IO} = 0$ V | —                   | 25             | 50  |         |
| Maximum Input Voltage            | Open drain, logic high (1)      | —                   | —              | 5.8 | V       |

**Table 4. Reset Electrical Characteristics**

$-40$  to  $+85$  °C unless otherwise specified.

| Parameter   | Conditions | Min                  | Typ | Max | Units   |
|---|------------|----------------------|-----|-----|---------|
| $\overline{\text{RST}}$ Input High Voltage                          |            | $0.75 \times V_{IO}$ | —   | —   | V       |
| $\overline{\text{RST}}$ Input Low Voltage                           |            | —                    | —   | 0.6 | V       |
| Minimum $\overline{\text{RST}}$ Low Time to Generate a System Reset |            | 15                   | —   | —   | $\mu s$ |

**Table 5. Voltage Regulator Electrical Specifications**

–40 to +85 °C unless otherwise specified.

| Parameter                      | Conditions                    | Min | Typ  | Max  | Units |
|--------------------------------|-------------------------------|-----|------|------|-------|
| Input Voltage Range            |                               | 3.0 | —    | 5.25 | V     |
| Output Voltage                 | Output Current = 1 to 100 mA* | 3.3 | 3.45 | 3.6  | V     |
| VBUS Detection Input Threshold |                               | 2.5 | —    | —    | V     |
| Bias Current                   |                               | —   | —    | 120  | μA    |

\*Note: The maximum regulator supply current is 100 mA. This includes the supply current of the CP2110.

**Table 6. GPIO Output Specifications**

–40 to +85 °C unless otherwise specified.

| Parameter                         | Conditions | Min               | Typ                 | Max               | Units                 |
|-----------------------------------|------------|-------------------|---------------------|-------------------|-----------------------|
| GPIO.0 Clock Output               |            | Output x<br>0.985 | Output <sup>1</sup> | Output x<br>1.015 | Hz                    |
| RS-485 Active Time After Stop Bit |            | —                 | 1                   | —                 | bit time <sup>2</sup> |
| TX Toggle Rate                    |            | —                 | 10                  | —                 | Hz                    |
| RX Toggle Rate                    |            | —                 | 10                  | —                 | Hz                    |

1. The output frequency is configurable from 24 MHz to 47 kHz.  
2. Bit-time is calculated as 1/ baud rate.

## 3. Pinout and Package Definitions

Table 7. CP2110 Pin Definitions

| Name                    | -GM<br>QFN24 | -GM1<br>QFN28 | Type      | Description   |
|-------------------------|--------------|---------------|-----------|---|
| V <sub>DD</sub>         | 6            | 6             | Power In  | Power Supply Voltage Input.   |
|                         |              |               | Power Out | Voltage Regulator Output. See Section 10.   |
| V <sub>IO</sub>         | 5            |               | Power In  | I/O Supply Voltage Input.<br>Internally connected to V <sub>DD</sub> on -GM1 packages.  |
| GND                     | 2            | 3             |           | Ground. Must be tied to ground.   |
| $\overline{\text{RST}}$ | 9            | 9             | D I/O     | Device Reset. Open-drain output of internal POR or V <sub>DD</sub> monitor. An external source can initiate a system reset by driving this pin low for the time specified in Table 4. |
| REGIN                   | 7            | 7             | Power In  | 5 V Regulator Input. This pin is the input to the on-chip voltage regulator.  |
| VBUS                    | 8            | 8             | D In      | VBUS Sense Input. This pin should be connected to the VBUS signal of a USB network.   |
| V <sub>PP</sub>         | 16*          | 18*           | Special   | Connect 4.7 $\mu$ F capacitor between this pin and ground to support ROM programming via the USB interface.   |
| D+                      | 3            | 4             | D I/O     | USB D+  |
| D-                      | 4            | 5             | D I/O     | USB D-  |
| TX                      | 21           | 26            | D Out     | Asynchronous data output (UART Transmit) for the UART Interface.  |
| RX                      | 20           | 25            | D In      | Asynchronous data input (UART Receive) for the UART Interface.  |
| GPIO.0                  | 1*           | 2*            | D I/O     | In GPIO mode, this pin is a user-configurable input or output.  |
| CLK                     |              |               | D Out     | In CLK mode, this pin outputs a configurable frequency clock signal.  |
| GPIO.1                  | 24*          | 24*           | D I/O     | In GPIO mode, this pin is a user-configurable input or output.  |
| RTS                     |              |               | D Out     | In hardware flow control mode, this pin is the Ready To Send control output (active low) for the UART interface.  |
| GPIO.2                  | 23*          | 23*           | D I/O     | In GPIO mode, this pin is a user-configurable input or output.  |
| CTS                     |              |               | D In      | In hardware flow control mode, this pin is the Clear To Send control input (active low) for the UART interface.   |
| GPIO.3                  | 22*          | 1*            | D I/O     | In GPIO mode, this pin is a user-configurable input or output.  |
| RS485                   |              |               | D Out     | In RS-485 mode, this pin is the transmit active pin for the RS-485 transceiver.   |

**\*Note:** Pins can be left unconnected when not used.



Table 7. CP2110 Pin Definitions (Continued)

| Name                        | -GM<br>QFN24 | -GM1<br>QFN28                 | Type  | Description   |
|-----------------------------|--------------|-------------------------------|-------|---|
| GPIO.4                      | 19*          | 28*                           | D I/O | In GPIO mode, this pin is a user-configurable input or output.  |
| TXT                         |              |                               | D Out | In TXT mode, this pin is the Transmit Toggle pin and toggles to indicate UART transmission. The pin is logic high when a transmission is not in progress. |
| GPIO.5                      | 18*          | 27*                           | D I/O | In GPIO mode, this pin is a user-configurable input or output for the Standard Comm Interface.  |
| RXT                         |              |                               | D Out | In RXT mode, this pin is the Receive Toggle pin. The pin is logic high when the UART is not receiving data.   |
| GPIO.6                      | 15*          | 19*                           | D I/O | This pin is a user-configurable input or output.  |
| GPIO.7                      | 14*          | 17*                           | D I/O | This pin is a user-configurable input or output.  |
| GPIO.8                      | 13*          | 16*                           | D I/O | This pin is a user-configurable input or output.  |
| GPIO.9                      | 12*          | 10*                           | D I/O | This pin is a user-configurable input or output.  |
| SUSPEND                     | 11*          | 12*                           | D Out | This pin is logic high when the CP2110 is in the USB Suspend state.   |
| $\overline{\text{SUSPEND}}$ | 17*          | 11*                           | D Out | This pin is logic low when the CP2110 is in the USB Suspend state.  |
| N/C                         | 10*          | 13, 14,<br>15, 20,<br>21, 22* |       | No connect. This pin should be left unconnected or tied to $V_{IO}$ .   |

**\*Note:** Pins can be left unconnected when not used.

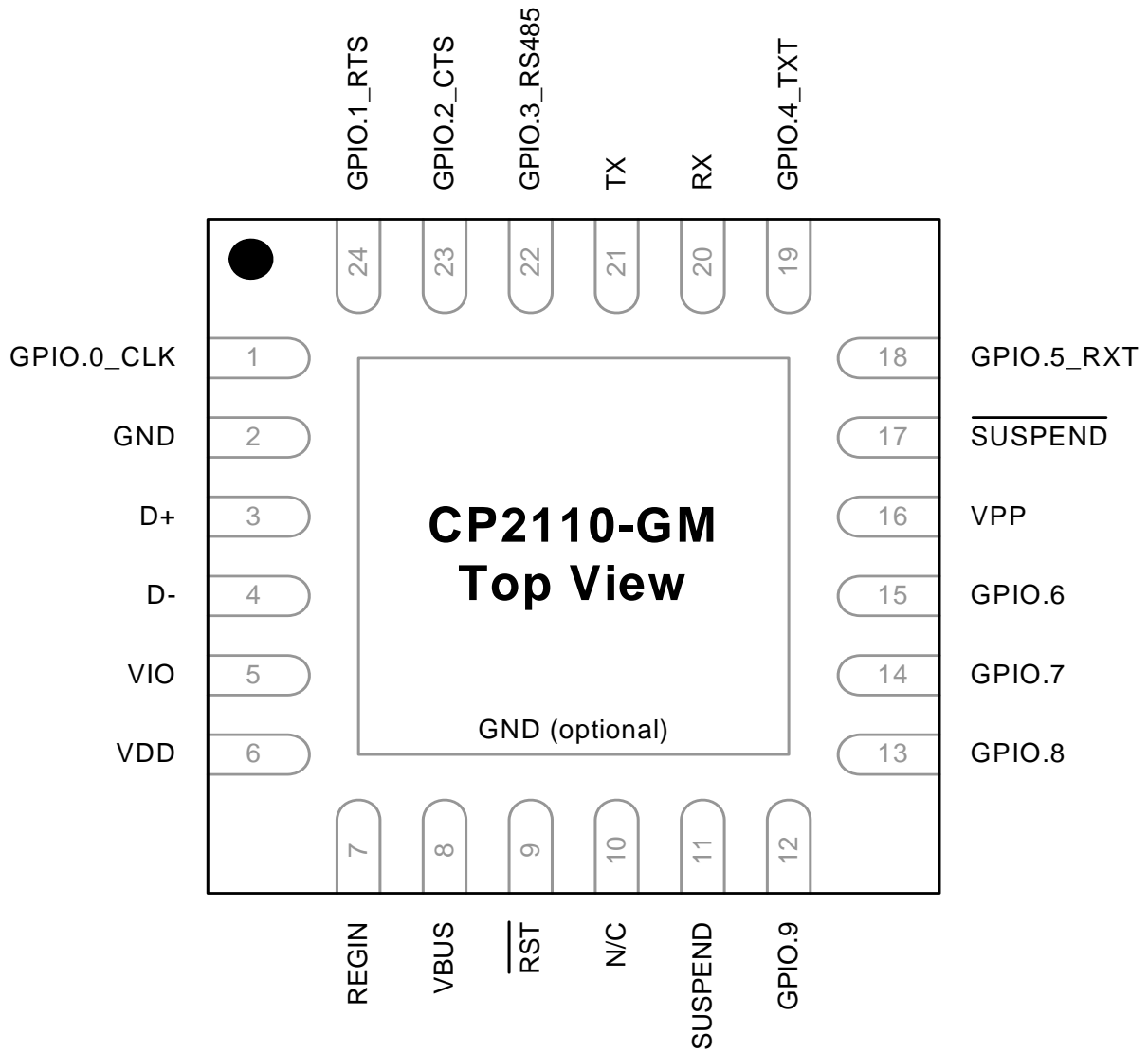


Figure 2. QFN-24 Pinout Diagram (Top View)

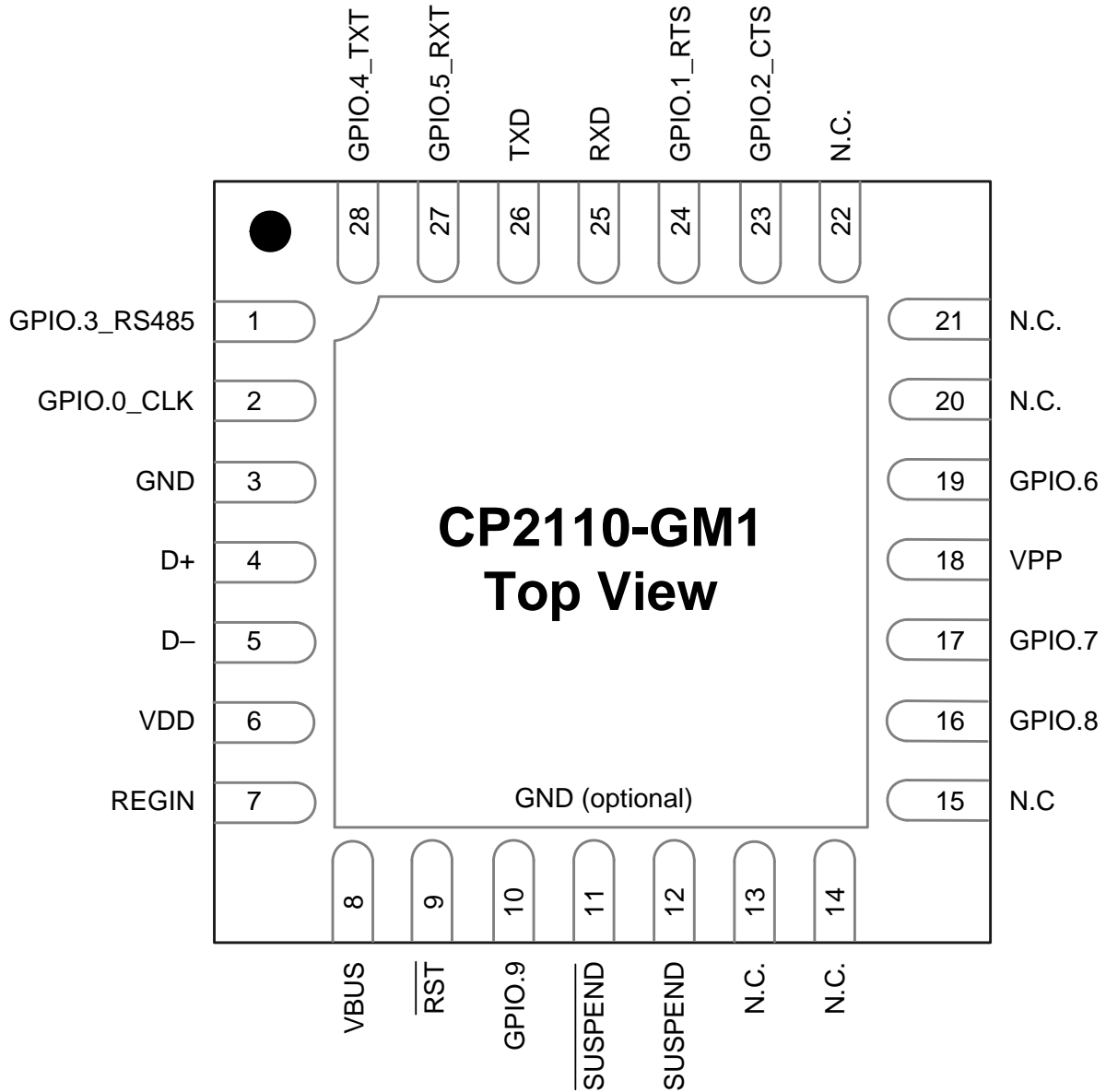
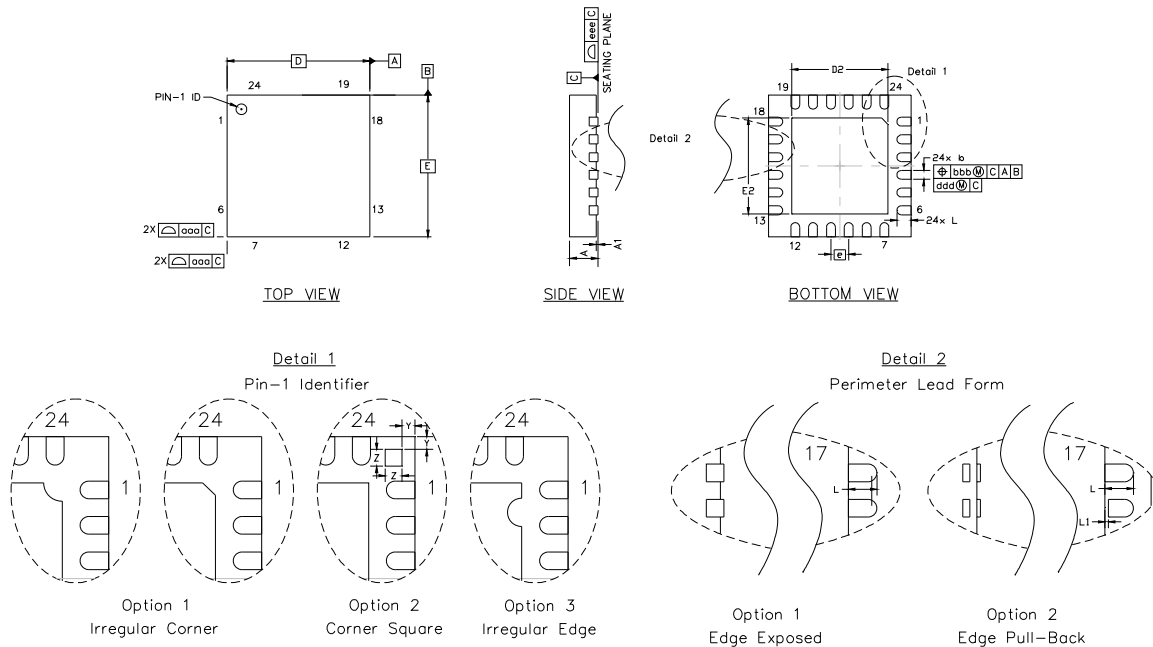


Figure 3. QFN-28 Pinout Diagram (Top View)

## 4. QFN-24 Package Specifications



**Figure 4. QFN-24 Package Drawing**

**Table 8. QFN-24 Package Dimensions**

| Dimension | Min       | Typ  | Max  | Dimension | Min  | Typ  | Max  |
|-----------|-----------|------|------|-----------|------|------|------|
| A         | 0.70      | 0.75 | 0.80 | L         | 0.30 | 0.40 | 0.50 |
| A1        | 0.00      | 0.02 | 0.05 | L1        | 0.00 | —    | 0.15 |
| b         | 0.18      | 0.25 | 0.30 | aaa       | —    | —    | 0.15 |
| D         | 4.00 BSC. |      |      | bbb       | —    | —    | 0.10 |
| D2        | 2.55      | 2.70 | 2.80 | ddd       | —    | —    | 0.05 |
| e         | 0.50 BSC. |      |      | eee       | —    | —    | 0.08 |
| E         | 4.00 BSC. |      |      | Z         | —    | 0.24 | —    |
| E2        | 2.55      | 2.70 | 2.80 | Y         | —    | 0.18 | —    |

**Notes:**

1. All dimensions shown are in millimeters (mm) unless otherwise noted.
2. Dimensioning and Tolerancing per ANSI Y14.5M-1994.
3. This drawing conforms to JEDEC Solid State Outline MO-220, variation WGGD except for custom features D2, E2, Z, Y, and L which are toleranced per supplier designation.
4. Recommended card reflow profile is per the JEDEC/IPC J-STD-020 specification for Small Body Components.

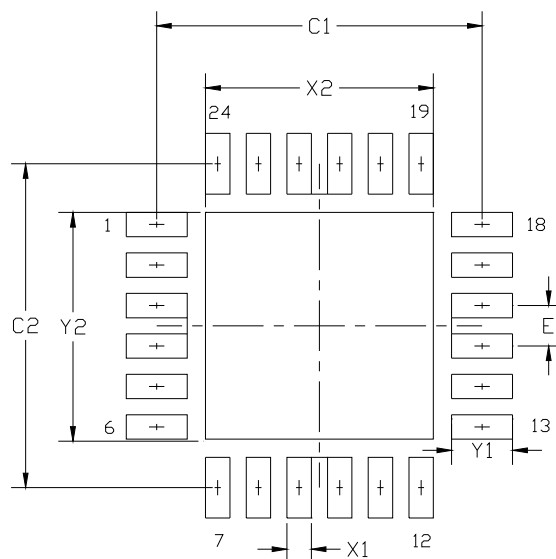


Figure 5. QFN-24 Recommended PCB Land Pattern

Table 9. QFN-24 PCB Land Pattern Dimensions

| Dimension | Min      | Max  | Dimension | Min  | Max  |
|-----------|----------|------|-----------|------|------|
| C1        | 3.90     | 4.00 | X2        | 2.70 | 2.80 |
| C2        | 3.90     | 4.00 | Y1        | 0.65 | 0.75 |
| E         | 0.50 BSC |      | Y2        | 2.70 | 2.80 |
| X1        | 0.20     | 0.30 |           |      |      |

**Notes:**

General

- 1. All dimensions shown are in millimeters (mm) unless otherwise noted.
- 2. This Land Pattern Design is based on the IPC-7351 guidelines.

Solder Mask Design

- 3. All metal pads are to be non-solder mask defined (NSMD). Clearance between the solder mask and the metal pad is to be 60 μm minimum, all the way around the pad.

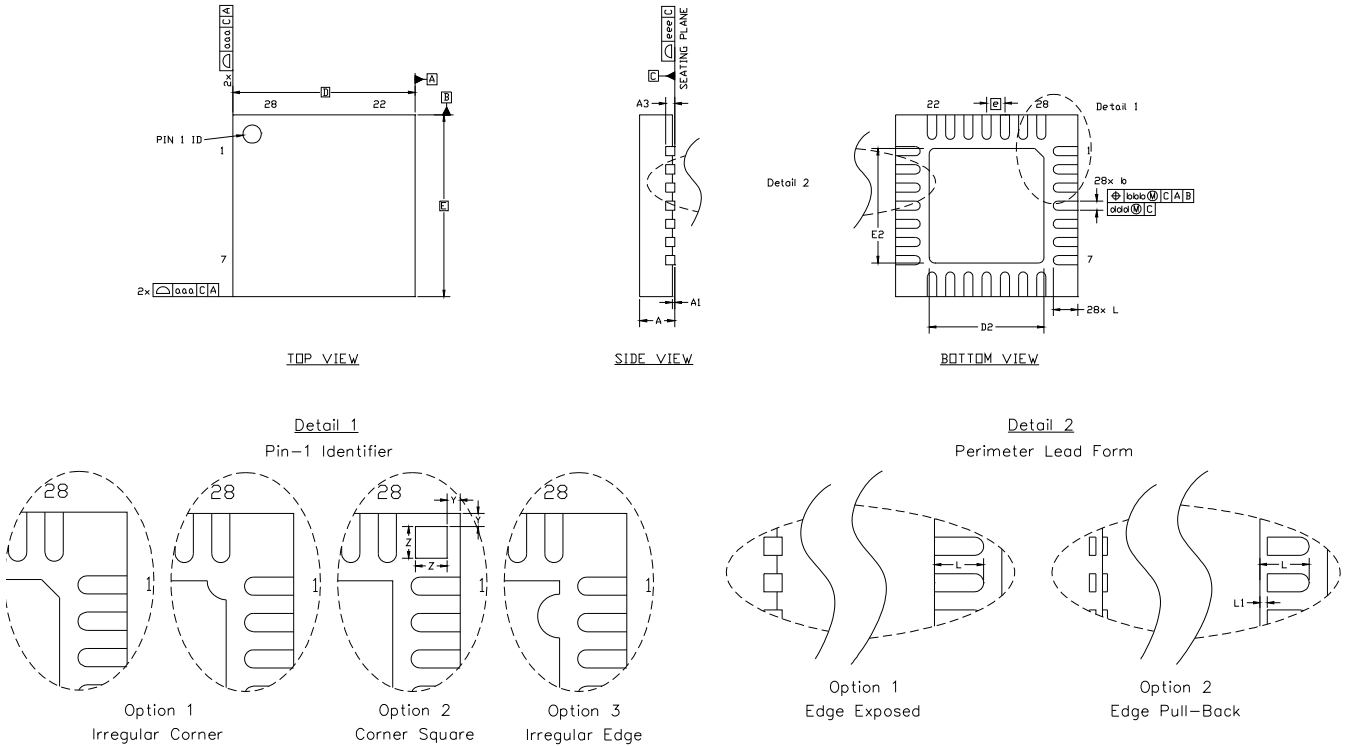
Stencil Design

- 4. A stainless steel, laser-cut and electro-polished stencil with trapezoidal walls should be used to assure good solder paste release.
- 5. The stencil thickness should be 0.125 mm (5 mils).
- 6. The ratio of stencil aperture to land pad size should be 1:1 for all perimeter pads.
- 7. A 2 x 2 array of 1.10 x 1.10 mm openings on a 1.30 mm pitch should be used for the center pad.

Card Assembly

- 8. A No-Clean, Type-3 solder paste is recommended.
- 9. The recommended card reflow profile is per the JEDEC/IPC J-STD-020 specification for Small Body Components.

## 5. QFN-28 Package Specifications



**Figure 6. QFN-28 Package Drawing**

**Table 10. QFN-28 Package Dimensions**

| Dimension | Min       | Typ  | Max  | Dimension | Min  | Typ  | Max  |
|-----------|-----------|------|------|-----------|------|------|------|
| A         | 0.80      | 0.90 | 1.00 | L         | 0.35 | 0.55 | 0.65 |
| A1        | 0.00      | 0.02 | 0.05 | L1        | 0.00 | —    | 0.15 |
| A3        | 0.25 REF  |      |      | aaa       | 0.15 |      |      |
| b         | 0.18      | 0.23 | 0.30 | bbb       | 0.10 |      |      |
| D         | 5.00 BSC. |      |      | ddd       | 0.05 |      |      |
| D2        | 2.90      | 3.15 | 3.35 | eee       | 0.08 |      |      |
| e         | 0.50 BSC. |      |      | Z         | 0.44 |      |      |
| E         | 5.00 BSC. |      |      | Y         | 0.18 |      |      |
| E2        | 2.90      | 3.15 | 3.35 |           |      |      |      |

**Notes:**

1. All dimensions shown are in millimeters (mm) unless otherwise noted.
2. Dimensioning and Tolerancing per ANSI Y14.5M-1994.
3. This drawing conforms to JEDEC Solid State Outline MO-220, variation VHHD except for custom features D2, E2, L, Z, and Y which are toleranced per supplier designation.
4. Recommended card reflow profile is per the JEDEC/IPC J-STD-020 specification for Small Body Components.

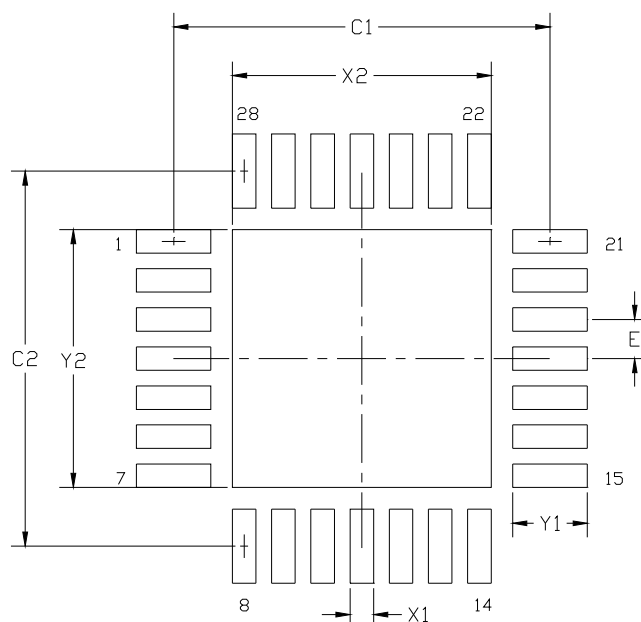


Figure 7. QFN-28 Recommended PCB Land Pattern

Table 11. QFN-28 PCB Land Pattern Dimensions

| Dimension | Min  | Max  | Dimension | Min  | Max  |
|-----------|------|------|-----------|------|------|
| C1        | 4.80 |      | X2        | 3.20 | 3.30 |
| C2        | 4.80 |      | Y1        | 0.85 | 0.95 |
| E         | 0.50 |      | Y2        | 3.20 | 3.30 |
| X1        | 0.20 | 0.30 |           |      |      |

**Notes:**  
**General**  
 1. All dimensions shown are in millimeters (mm) unless otherwise noted.  
 2. This Land Pattern Design is based on the IPC-7351 guidelines.

**Solder Mask Design**  
 3. All metal pads are to be non-solder mask defined (NSMD). Clearance between the solder mask and the metal pad is to be 60 μm minimum, all the way around the pad.

**Stencil Design**  
 4. A stainless steel, laser-cut and electro-polished stencil with trapezoidal walls should be used to assure good solder paste release.  
 5. The stencil thickness should be 0.125 mm (5 mils).  
 6. The ratio of stencil aperture to land pad size should be 1:1 for all perimeter pads.  
 7. A 3 x 3 array of 0.90 mm openings on a 1.1 mm pitch should be used for the center pad to assure the proper paste volume (67% Paste Coverage).

**Card Assembly**  
 8. A No-Clean, Type-3 solder paste is recommended.  
 9. The recommended card reflow profile is per the JEDEC/IPC J-STD-020 specification for Small Body Components.

## 6. USB Function Controller and Transceiver

The Universal Serial Bus (USB) function controller in the CP2110 is a USB 2.0-compliant, full-speed device with integrated transceiver and on-chip matching and pullup resistors. The USB function controller manages all data transfers between the USB and the UARTs as well as command requests generated by the USB host controller and commands for controlling the function of the UARTs and GPIO pins.

The USB Suspend and Resume modes are supported for power management of both the CP2110 device as well as external circuitry. The CP2110 enters Suspend mode when Suspend signaling is detected on the bus. Upon entering Suspend mode, the Suspend signals are asserted. The Suspend signals are also asserted after a CP2110 reset until device configuration during USB Enumeration is complete. SUSPEND is logic high when the device is in the Suspend state, and logic low when the device is in normal mode. The SUSPEND pin has the opposite logic value of the SUSPEND pin.

The CP2110 exits Suspend mode when any of the following occur: Resume signaling is detected or generated, a USB Reset signal is detected, or a device reset occurs. SUSPEND and SUSPEND are weakly pulled to VIO in a high impedance state during a CP2110 reset. If this behavior is undesirable, a strong pulldown (10 k $\Omega$ ) can be used to ensure SUSPEND remains low during reset.

The logic level and output mode (push-pull or open-drain) of various pins during USB Suspend is configurable in the PROM. See Section 9 for more information.



## 7. Asynchronous Serial Data Bus (UART) Interface

The UART interface consists of the TX (transmit) and RX (receive) data signals as well as the optional RTS and CTS flow control signals. The UART is programmable to support a variety of data formats and baud rates. The data format and baud rate are set during device configuration on the PC. The data formats and baud rates available to each interface are listed in Table 12.

**Table 12. Data Formats and Baud Rates**

|   |                                |
|---|--------------------------------|
| <b>Data Bits</b>  | 5, 6, 7, and 8                 |
| <b>Stop Bits</b>  | 1, 1.5 <sup>1</sup> , and 2    |
| <b>Parity Type</b>  | None, Even, Odd, Mark, Space   |
| <b>Baud Rate</b>  | 300 bps to 1 Mbps <sup>2</sup> |
| <b>Notes:</b>   |                                |
| 1. 1.5 stop bits only available when using 5 data bits.               |                                |
| 2. Baud rates above 500,000 baud not supported with 5 or 6 data bits. |                                |

The baud rate generator for the UART interface is very flexible and allows the user to request any baud rate in the range from 300 bps to 1 Mbps. If the baud rate cannot be directly generated from the internal 24 MHz oscillator, the device will choose the closest possible option. The actual baud rate is dictated by Equation 1 and Equation 2.

$$\text{Clock Divider} = \frac{24 \text{ MHz}}{2 \times \text{Prescale} \times \text{Requested Baud Rate}} \quad \begin{array}{l} \text{Prescale} = 4 \text{ if Requested Baud Rate} \leq 300 \text{ bps} \\ \text{Prescale} = 1 \text{ if Requested Baud Rate} > 300 \text{ bps} \end{array}$$

**Equation 1. Clock Divider Calculation**

$$\text{Actual Baud Rate} = \frac{24 \text{ MHz}}{2 \times \text{Prescale} \times \text{Clock Divider}} \quad \begin{array}{l} \text{Prescale} = 4 \text{ if Requested Baud Rate} \leq 300 \text{ bps} \\ \text{Prescale} = 1 \text{ if Requested Baud Rate} > 300 \text{ bps} \end{array}$$

**Equation 2. Baud Rate Calculation**

Most baud rates can be generated with an error of less than 1.0%. A general rule of thumb for the majority of UART applications is to limit the baud rate error on both the transmitter and the receiver to no more than  $\pm 2\%$ . The clock divider value obtained in Equation 1 is rounded to the nearest integer, which may produce an error source. Another error source will be the 24 MHz oscillator, which is accurate to  $\pm 0.25\%$ . Knowing the actual and requested baud rates, the total baud rate error can be found using Equation 3.

$$\text{Baud Rate Error (\%)} = 100 \times \left( 1 - \frac{\text{Actual Baud Rate}}{\text{Requested Baud Rate}} \right) \pm 0.25\%$$

**Equation 3. Baud Rate Error Calculation**

The UART also supports the transmission of a line break. The length of time for a line break is programmable from 1 to 125 ms, or it can be set to transmit indefinitely until a stop command is sent from the application.

## 8. GPIO Pins

The CP2110 supports 10 user-configurable GPIO pins. Each of these GPIO pins are usable as inputs, open-drain outputs, or push-pull outputs. Six of these GPIO pins also have alternate functions which are listed in Table 13. More information regarding the configuration and usage of these pins is available in “AN144: CP21xx Customization Guide” available on the Silicon Labs website.

**Table 13. GPIO Pin Alternate Functions**

| GPIO Pin | Alternate Function         |
|----------|----------------------------|
| GPIO.0   | CLK Output                 |
| GPIO.1   | RTS                        |
| GPIO.2   | CTS                        |
| GPIO.3   | RS-485 Transceiver Control |
| GPIO.4   | TX Toggle                  |
| GPIO.5   | RX Toggle                  |

The default configuration for all of the GPIO pins is provided in Table 14. The configuration of the pins is one-time programmable for each device. See Section 9 for more information about programming the GPIO pin functionality.

**Table 14. GPIO Pin Default Configuration**

| GPIO Pin | Default Function           |
|----------|----------------------------|
| GPIO.0   | GPIO Input                 |
| GPIO.1   | RTS                        |
| GPIO.2   | CTS                        |
| GPIO.3   | RS-485 Transceiver Control |
| GPIO.4   | TX Toggle                  |

| GPIO Pin | Default Function      |
|----------|-----------------------|
| GPIO.5   | RX Toggle             |
| GPIO.6   | GPIO Input            |
| GPIO.7   | GPIO Input            |
| GPIO.8   | GPIO Push-Pull Output |
| GPIO.9   | GPIO Push-Pull Output |

The difference between an open-drain output and a push-pull output is when the GPIO output is driven to logic high. A logic high, open-drain output pulls the pin to the VIO rail through an internal, pull-up resistor. A logic high, push-pull output directly connects the pin to the VIO voltage. Open-drain outputs are typically used when interfacing to logic at a higher voltage than the VIO pin. These pins can be safely pulled to the higher, external voltage through an external pull-up resistor. The maximum external pull-up voltage is 5 V.

The speed of reading and writing the GPIO pins is subject to the timing of the USB bus. GPIO pins configured as inputs or outputs are not recommended for real-time signalling.

## 8.1. GPIO.0—Clock Output

GPIO.0 is configurable to output a configurable CMOS clock output. The clock output appears at the pin at the same time the device completes enumeration and exits USB Suspend mode. The clock output is removed from the pin when the device enters USB Suspend mode. The output frequency is configurable through the use of a divider and the accuracy is specified in Table 6. When the divider is set to 0, the output frequency is 24 MHz. For divider values between 1 and 255, the output frequency is determined by the formula:

$$\text{GPIO.0 Clock Frequency} = \frac{24 \text{ MHz}}{2 \times \text{Divider}}$$

**Equation 4. GPIO.0 Clock Output Frequency**

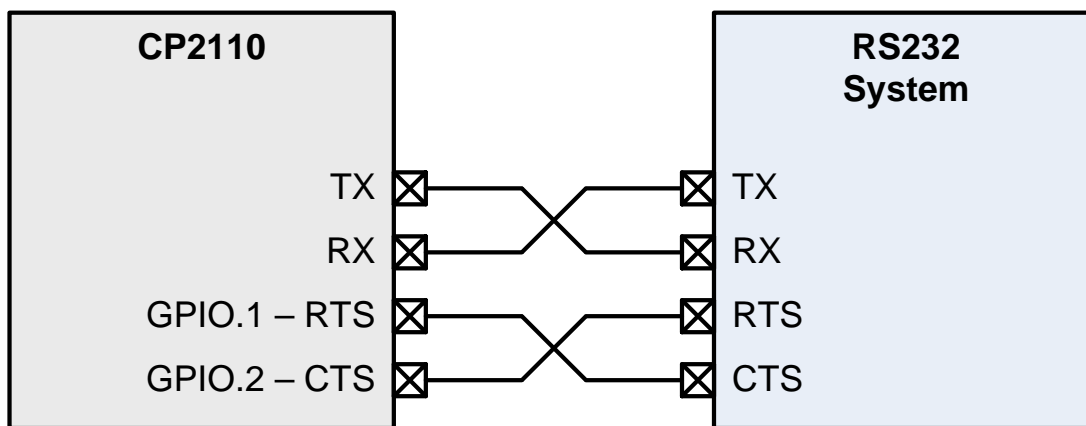
This divider is independent from the divider used to set UART baud rate.

## 8.2. GPIO.1-2—Hardware Flow Control (RTS and CTS)

By default, GPIO.1 and GPIO.2 are configured to operate as the hardware flow control pins RTS and CTS. In addition to the GPIO PROM configuration, the device must be configured to use hardware flow control to use these pins.

RTS, or Ready To Send, is an active-low output from the CP2110 and indicates to the external UART device that the CP2110's UART RX FIFO has not reached the watermark level of 450 bytes and is ready to accept more data. When the amount of data in the RX FIFO reaches the watermark, the CP2110 pulls RTS high to indicate to the external UART device to stop sending data.

CTS, or Clear To Send, is an active-low input to the CP2110 and is used by the external UART device to indicate to the CP2110 when the external UART device's RX FIFO is getting full. The CP2110 will not send more than two bytes of data once CTS is pulled high.



**Figure 8. Hardware Flow Control Typical Connection Diagram**

### 8.3. GPIO.3—RS-485 Transceiver Bus Control

GPIO.3 is configurable as an RS-485 bus transceiver control pin that is connected to the DE and  $\overline{RE}$  inputs of the transceiver. When configured for RS-485 mode, the pin is asserted during UART data transmission as well as line break transmission. The RS-485 mode of GPIO.3 is active-high by default, but is also configurable for active-low mode.

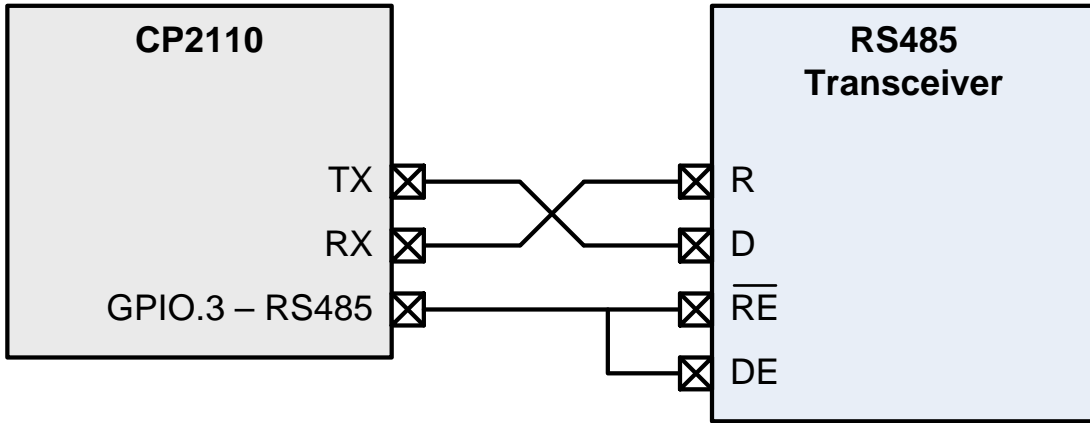


Figure 9. RS-485 Transceiver Typical Connection Diagram

### 8.4. GPIO.4-5—Transmit and Receive Toggle

GPIO.4 and GPIO.5 are configurable as Transmit Toggle and Receive Toggle pins. These pins are logic high when a device is not transmitting or receiving data, and they toggle at a fixed rate as specified in Table 6 when data transfer is in progress. Typically, these pins are connected to two LEDs to indicate data transfer.

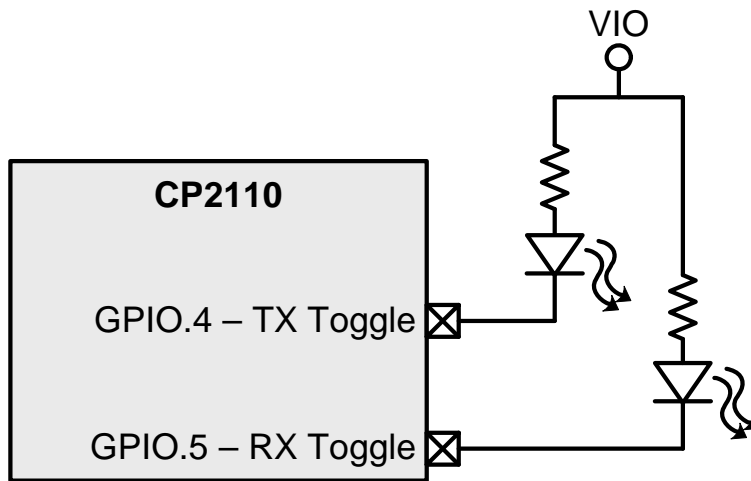


Figure 10. Transmit and Receive Toggle Typical Connection Diagram

More information regarding the configuration and usage of these pins can be found in Section 9 as well as “AN144: CP21xx Customization Guide” available on the Silicon Labs web site.

## 9. One-Time Programmable ROM

The CP2110 includes an internal, one-time programmable ROM that may be used to customize the USB Vendor ID (VID), Product ID (PID), Manufacturer String, Product Description String, Power Descriptor, Device Release Number, Device Serial Number, GPIO configuration, Suspend Pins and Modes as desired for OEM applications. If the programmable ROM has not been customized, the default configuration data shown in Table 15 and Table 16 is used.

**Table 15. Default USB Configuration Data**

| Name                          | Value   |
|-------------------------------|---|
| Vendor ID                     | 10C4h   |
| Product ID                    | EA80h   |
| Power Descriptor (Attributes) | 80h (Bus-powered)   |
| Power Descriptor (Max. Power) | 32h (100 mA)  |
| Release Number                | 0100h (Release Version 01.00)                                 |
| Manufacturer String           | “Silicon Laboratories” (62 ASCII characters maximum)          |
| Product Description String    | “CP2110 HID USB-to-UART Bridge” (62 ASCII characters maximum) |
| Serial String                 | Unique 8 character ASCII string (30 ASCII characters maximum) |

**Table 16. Default GPIO, UART, and Suspend Configuration Data**

| Name   | Value                      | Name          | Value                        |
|--------|----------------------------|---------------|------------------------------|
| GPIO.0 | GPIO input                 | GPIO.9        | GPIO push-pull output        |
| GPIO.1 | RTS                        | Flush_Buffers | Flush TX and RX FIFO on open |
| GPIO.2 | CTS                        | TX Mode       | Push-pull                    |
| GPIO.3 | RS-485 Transceiver Control | SUSPEND Mode  | Push-pull                    |
| GPIO.4 | TX Toggle                  | SUSPEND Mode  | Push-pull                    |
| GPIO.5 | RX Toggle                  | Suspend Latch | 0x0000                       |
| GPIO.6 | GPIO input                 | Suspend Mode  | 0x0000                       |
| GPIO.7 | GPIO input                 | RS-485 Level  | Active High                  |
| GPIO.8 | GPIO push-pull output      | Clock Divider | Divide by 1 (24 MHz)         |

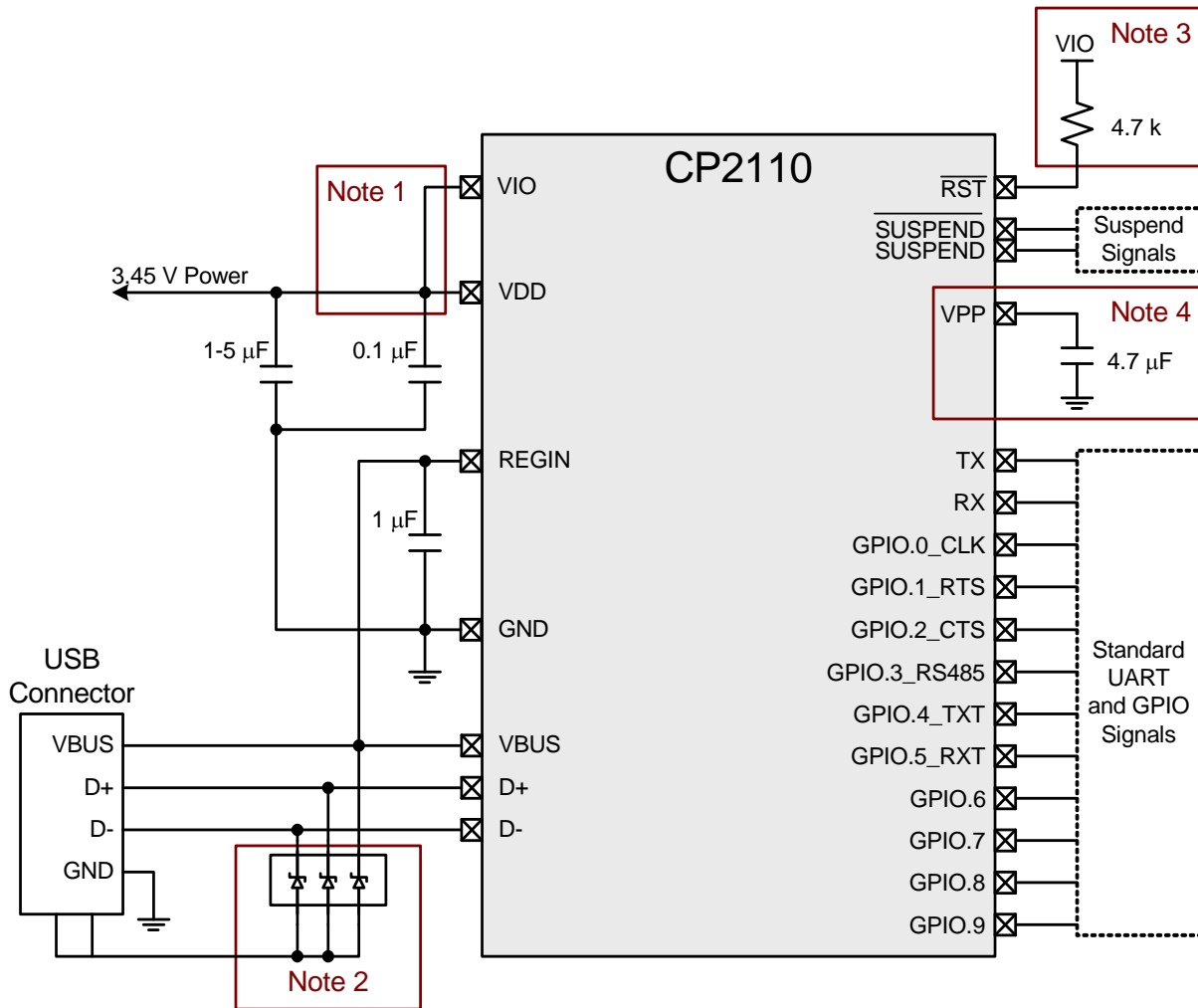
While customization of the USB configuration data is optional, customizing the VID/PID combination is strongly recommended. A unique VID/PID will prevent the device from being recognized by any other manufacturer’s software application. A vendor ID can be obtained from [www.usb.org](http://www.usb.org) or Silicon Labs can provide a free PID for the OEM product that can be used with the Silicon Labs VID. All CP2110 devices are pre-programmed with a unique serial number. It is important to have a unique serial if it is possible for multiple CP2110-based devices to be connected to the same PC.

Application Note “AN433: CP2110 HID Interface Specification” includes more information about the programmable values and their valid options. Note that certain items in the PROM are programmed as a group and programming one of the items in the group prevents further programming of any of the other items in the group.

The configuration data ROM is programmable by Silicon Labs prior to shipment with the desired configuration information. It can also be programmed in-system over the USB interface by adding a capacitor to the PCB. If the configuration ROM is to be programmed in-system, a 4.7  $\mu$ F capacitor must be added between the VPP pin and ground. No other circuitry should be connected to VPP during a programming operation, and  $V_{DD}$  must remain at 3.3 V or higher to successfully write to the configuration ROM.

## 10. Voltage Regulator

The CP2110 includes an on-chip 5 to 3.45 V voltage regulator. This allows the CP2110 to be configured as either a USB bus-powered device or a USB self-powered device. A typical connection diagram of the device in a bus-powered application using the regulator is shown in Figure 11. When enabled, the voltage regulator output appears on the  $V_{DD}$  pin and can be used to power external devices. See Table 5 for the voltage regulator electrical characteristics. If the regulator is used to provide  $V_{DD}$  in a self-powered application, use the same connections from Figure 11, but connect REGIN to an on-board 5 V supply, and disconnect it from the VBUS pin.



Note 1 : VIO can be connected directly to VDD or to a supply as low as 1.8 V to set the I/O interface voltage. VIO is internally connected to VDD on -GM1 packages.

Note 2 : Avalanche transient voltage suppression diodes compatible with Full-speed USB should be added at the connector for ESD protection. Use Littelfuse p/n SP0503BAHT or equivalent.

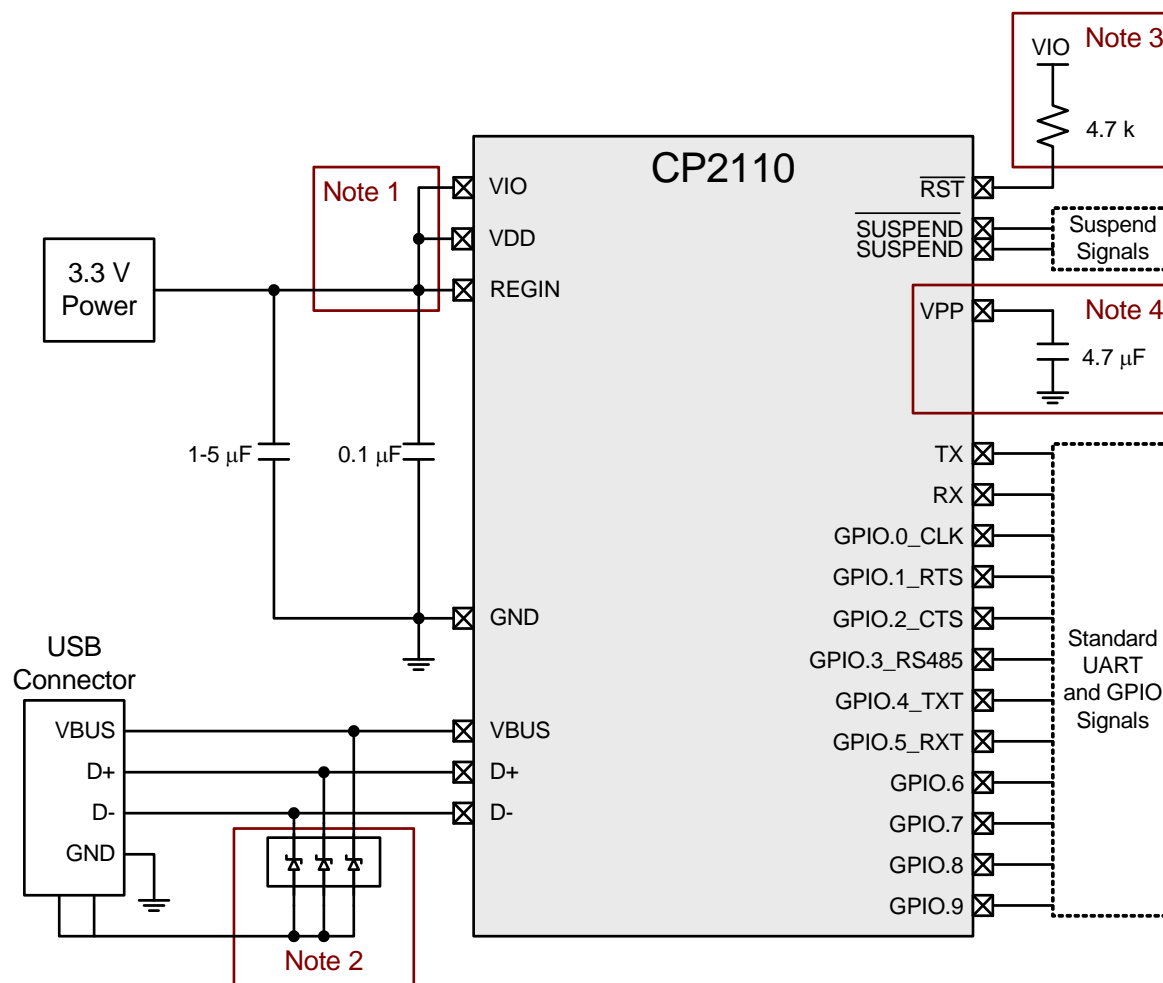
Note 3 : An external pull-up is not required, but can be added for noise immunity.

Note 4 : If programming the configuration ROM via USB, add a 4.7  $\mu$ F capacitor between VPP and ground. During a programming operation, do not connect the VPP pin to other circuitry, and ensure that VDD is at least 3.3 V.

**Figure 11. Typical Bus-Powered Connection Diagram**

Alternatively, if 3.0 to 3.6 V power is supplied to the  $V_{DD}$  pin, the CP2110 can function as a USB self-powered device with the voltage regulator bypassed. For this configuration, tie the REGIN input to  $V_{DD}$  to bypass the voltage regulator. A typical connection diagram showing the device in a self-powered application with the regulator bypassed is shown in Figure 12.

The USB max power and power attributes descriptor must match the device power usage and configuration. See application note “AN144: CP21xx Customization Guide” for information on how to customize USB descriptors for the CP2110.



- Note 1 : VIO can be connected directly to VDD or to a supply as low as 1.8 V to set the I/O interface voltage. VIO is internally connected to VDD on -GM1 packages.
- Note 2 : Avalanche transient voltage suppression diodes compatible with Full-speed USB should be added at the connector for ESD protection. Use Littelfuse p/n SP0503BAHT or equivalent.
- Note 3 : An external pull-up is not required, but can be added for noise immunity.
- Note 4 : If programming the configuration ROM via USB, add a 4.7 µF capacitor between VPP and ground. During a programming operation, do not connect the VPP pin to other circuitry, and ensure that VDD is at least 3.3 V.

**Figure 12. Typical Self-Powered Connection Diagram (Regulator Bypass)**

## 11. CP2110 Interface Specification and Windows Interface DLL

The CP2110 is a USB Human Interface Device (HID), and as most operating systems include native HID drivers, custom drivers do not need to be installed. The CP2110 does not fit one of the standard HID device types, such as a keyboard or mouse, and so any CP2110 PC application needs to use the CP2110's HID specification to communicate with the device. The low-level HID specification for the CP2110 is provided in "AN434: CP2110 HID Interface Specification." This document describes all of the basic functions for opening, reading from, writing to, and closing the device as well as the ROM programming functions.

A Windows DLL that encapsulates the CP2110 HID interface and also adds higher level features such as read/write time-outs is provided by Silicon Labs. This DLL is the recommended interface for the CP2110. The Windows DLL is documented in *CP2110 Windows DLL Specification*.

Both of these documents and the DLL are available in the CP2110EK CD as well as online at <http://www.silabs.com/>.

## 12. Relevant Application Notes

The following Application Notes are applicable to the CP2110. The latest versions of these application notes and their accompanying software are available at

<http://www.silabs.com/products/mcu/Pages/ApplicationNotes.aspx>.

- **AN144: CP21xx Device Customization Guide.** This application note describes how to use the AN144 software CP2110SetIDs to configure the USB parameters on the CP2110 devices.
- **AN434: CP2110 HID Interface Specification.** This application note describes how to interface to the CP2110 using the low-level, HID Interface.
- **AN433: CP2110 HID to UART API Specification.** This application note describes how to interface to the CP2110 using the Windows Interface dll and the Mac OS X dylib.



## DOCUMENT CHANGE LIST

### Revision 1.0 to Revision 1.1

- Added support for new CP2110-GM1 package throughout document.

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