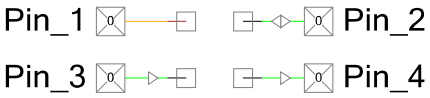
Pins
2.5

Features



- Rapid setup of all pin parameters and drive modes
- Allows PSoC Creator to automatically place and route signals
- Allows interaction with one or more pins simultaneously

General Description

The Pins component allows hardware resources to connect to a physical port-pin. It provides access to external signals through an appropriately configured physical IO pin. It also allows electrical characteristics (e.g., Drive Mode) to be chosen for one or more pins; these characteristics are then used by PSoC Creator to automatically place and route the signals within the component.

Pins can be used with schematic wire connections, software, or both. To access a Pins component from component APIs, the component must be contiguous and non-spanning. This ensures that the pins are guaranteed to be mapped into a single physical port. Pins components that span ports or are not contiguous can only be accessed from a schematic or with the global per-pin APIs (see the Application Programming Interface section for details).

Note There are #defines created for each pin in the Pins component to be used with global APIs.

A Pins component can be configured into many combinations of types. For convenience, the Component Catalog provides four preconfigured Pins components: Analog, Digital Bidirectional, Digital Input, and Digital Output.

When to Use a Pins Component

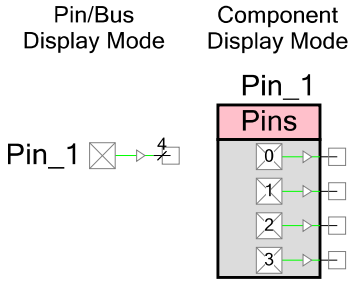
Use the Pins component when a design must generate or access an off-device signal through a physical IO pin. Pins are the most commonly used component in the Catalog. For example, they are used to interface with potentiometers, buttons, LEDs, peripheral sensors such as proximity detectors, and accelerometers.

Input/Output Connections

This section describes the various input and output connections for the Pins component.

Display of Pins

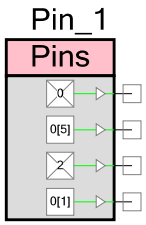
Pins can be configured into complex combinations of digital-input, digital-output, digital-bidirectional, and analog. Simple configurations are generally shown as single pins. More complex types of pins are shown as standard components with a bounding box (see the following diagram).



The default, and most common, configurations are shown in the following sections.

Display of Locked Pins

When you assign a Pins component to a physical GPIO or SIO pin using the PSoC Creator Design-Wide Resources Pin Editor, the tooltip for the Pins component shows the specific pin assignments. If you lock a pin assignment, the display of the component indicates the assignment, as shown in the following example:



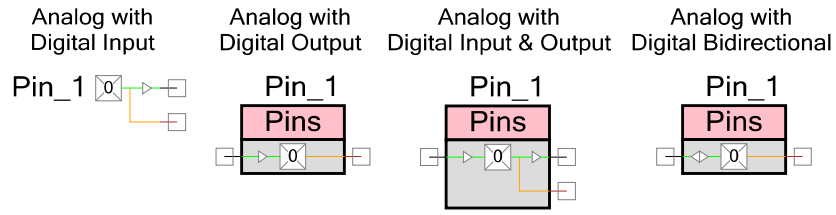
Note If the Pins component is set to **Display as Bus,** the display of the component does not display any locked pin assignments; however, the tooltip still displays this information.

Analog

Configure your Pins component as Analog any time your design requires a connection between a device pin and an internal analog terminal connected with an analog wire. When configured as analog, the terminal is shown on the right side of the symbol with the connection drawn in the color of an analog wire.



An analog Pins component may also support digital input or output connections, or both, as well as bidirectional connections. It is possible to short together digital output and analog signals on the same pin. This can be useful in some applications, but is not a general use case, and should be used with care.



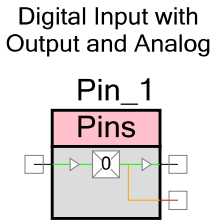
Digital Input

Configure a Pins component as digital input any time your design requires a connection between a device pin and an internal digital input terminal, or if the pin's state is read by the CPU/DMA. In all cases using digital-input pins, the pin state is readable by the CPU/DMA. Additionally, if the schematic terminal (HW Connection) is displayed it can be routed to other components in the schematic.

When visible, the terminal is shown on the right side of the symbol. The connection is drawn in the color of a digital wire with a small input buffer to show signal direction.



A digital-input Pins component may also support digital output and analog connections.

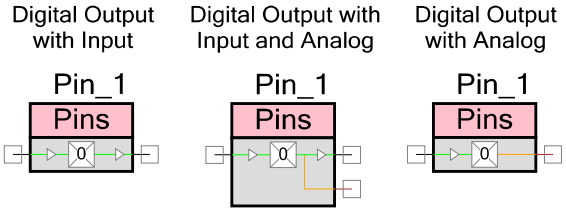


Digital Output

Configure a Pins component as digital output any time a device pin is to be driven to a logic high or low. In all such cases, the pin state is writeable by the CPU/DMA. Additionally, if the terminal is displayed it can be routed from other components in the schematic. When visible, the terminal is shown on the left side of the symbol. The connection is drawn in the color of a digital wire with a small output buffer to show signal direction.



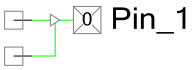
A digital-output Pins component may also support digital input and analog connections.



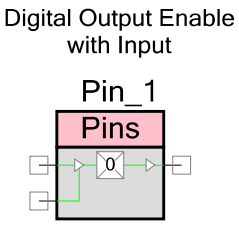
Digital Output Enable

Select digital output enable when digital logic is to be used to quickly control the pin output driver without CPU intervention. A high logic level on this terminal enables the pin output driver as configured by the **Drive Mode** parameter on the **General** subtab. A logic low level on this terminal disables the pin output driver and makes the pin assume the HI-Z drive mode. This terminal is shown when a component is configured with digital output using a schematic connection, and when the digital output enable has been selected. The digital output enable appears on the left side of the symbol and connects to the digital output buffer. It is drawn in the color of a digital wire.

When the pin is set to **Display as Bus**, only one output enable is provided regardless of the Pins component width because all of the pins share the same output enable. When not displayed as a bus, individual output enables are provided per pin.



A digital output enable Pins component may also support input and analog connections.



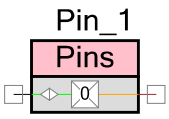
Digital Bidirectional

Configure a Pins component as digital bidirectional any time your design requires a connection between a device pin and an internal digital bidirectional terminal. Digital bidirectional mode is most often used with a communication component like I^2C. When configured as digital bidirectional, the terminal is shown on the left side of the symbol with the connection drawn in the color of a digital wire with input and output buffers showing that the signal is bidirectional.



A bidirectional Pins component may also support analog connections.

Digital Bidirectional with Analog



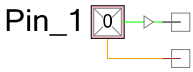
Vref

To configure a Pins component to use a Vref signal:

- Use a digital input or bidirectional terminal and set the **Threshold** parameter to **Vref** on the **Input** subtab, or
- Use a digital output or bidirectional terminal and configure the **Drive Level** to **Vref** on the **Output** subtab

Using a Vref requires an SIO pin, indicated with a pink outline. All pins can supply their respective V_{DDIO} supply voltages. SIO pins can also supply a programmable or analog-routed voltage for interface with devices at a different potential than the SIO's Vddio voltage. The Vref terminal provides the analog routed voltage supplied to the SIO pin. SIO pins can also use the Vref input as the input threshold for an SIO.

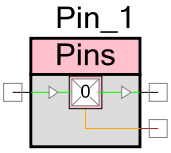
The Vref signal displays on the right side of the component, extending from the bottom of the SIO single pin or the SIO pin pair, depending on how it is configured. Each SIO pin pair shares a single Vref input.



Vref can only be used in conjunction with another digital input or output connection.

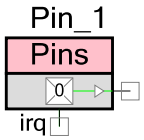
Note When using Vref, you cannot select **Analog**.

Vref with Digital Input & Output



IRQ

To configure a Pins component with an interrupt, you must use a digital input and configure the **Interrupt** parameter on the **Input** subtab. When interrupts are used, the Pins component displays with a bounding box, and the IRQ is displayed extending from the bottom of the component. The typical use case is to connect an Interrupt component to this terminal. If the Pin Interrupt is used to wake the part up from sleep or hibernate low-power mode, the Interrupt component connected to the Pins irq terminal may not have InterruptType set to "RISING_EDGE."



An Interrupt can be used in all configurations of the Pins component, as long as you include digital input.

For more information on configuring the interrupt, see the **Interrupt** parameter description in the **Input Subtab** section.

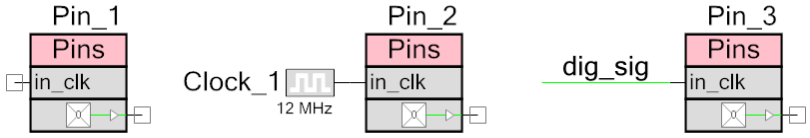
Any digital input hardware connection can also be connected to an isr component, providing the ability to generate a pin interrupt on high or low logic level versus on an edge event. Using the digital input connection for a level interrupt does not use the dedicated pin interrupt logic configured with this parameter, but instead consumes DSI routing resources.

PSoC 4 Specific Connections

The following terminals are only available on PSoC 4 devices. They can be used when **Sync Mode** is set to other modes besides “transparent.”

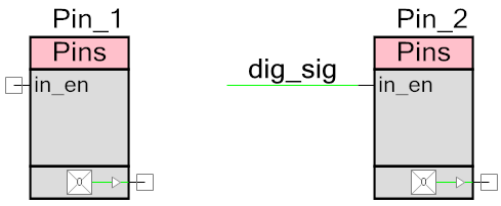
In Clock

On PSoC 4, the Pins component can use a Clock component or a digital signal as the clock for the input synchronization logic. If the **In Clock** parameter on the **Clocking** tab is specified to be **External**, the **in_clk** terminal is exposed to allow connection on the schematic.



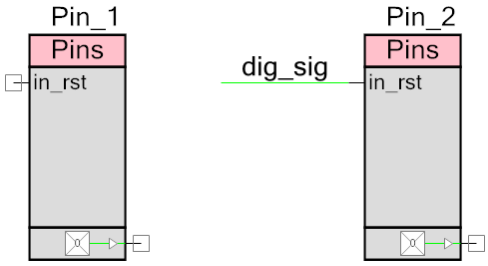
In Clock Enable

On PSoC 4, the Pins component can use a digital signal as the clock enable for the input synchronization logic. If the **In Clk En** parameter on the **Clocking** page is specified to be **External**, the **in_en** terminal is exposed to allow connection on the schematic.



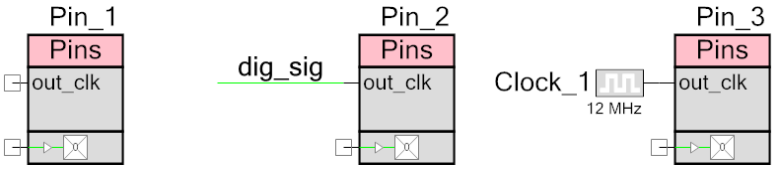
In Reset

On PSoC 4, the Pins component can use a digital signal as the reset for the input synchronization logic. If the **In Reset** parameter on the **Clocking** page is specified to be **External**, the **in_rst** terminal is exposed to allow connection on the schematic.



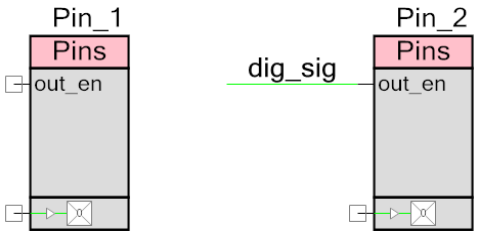
Out Clock

On PSoC 4, the Pins component can use a Clock component or a digital signal as the clock for the output synchronization logic. If the **Out Clock** parameter on the **Clocking** page is specified to be **External**, the **out_clk** terminal is exposed to allow connection on the schematic. Note that this configuration can be used to drive the clock signal to a pin on PSoC 4 devices. Refer to the **Output Mode** parameter for more information on its usage.



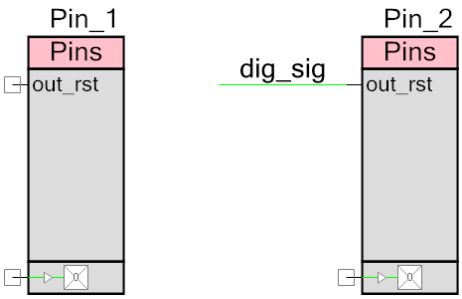
Out Clock Enable

On PSoC 4, the Pins component can use a digital signal as the clock enable for the input synchronization logic. If the **Out Clk En** parameter on the **Clocking** page is specified to be **External**, the **out_en** terminal is exposed to allow connection on the schematic. If the **Output Mode** is set to **Clock** or **Clock-Inverted,** then this signal will act as an enable signal to the clock.



Out Reset

On PSoC 4, the Pins component can use a digital signal as the reset for the output synchronization logic. If the **Out Reset** parameter on the **Clocking** page is specified to be **External**, the **out_rst** terminal is exposed to allow connection on the schematic.

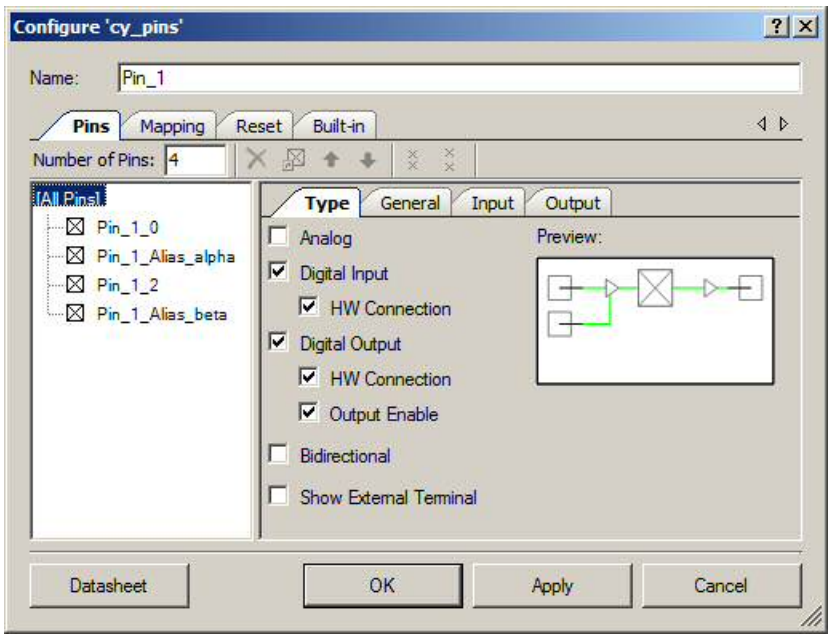


Component Parameters

Drag a Pins component onto the design schematic and double click it to open the **Configure** dialog. This dialog is used to set component-wide parameters, such as the power-on reset state and physical pin mapping constraints. The parameters are organized into separate tabs called subtabs.

Pins Tab

The **Pins** tab has three areas: a toolbar, pin tree, and a set of subtabs. The toolbar is used to determine how many physical pins are managed by the component and determine their order. The subtabs are used to set the pin-specific attributes, such as type, direction, drive mode, and initial state. The pin tree works with the subtabs to allow you to choose the specific pins to which these attributes are applied.



Toolbar

Contains these commands:

- **Number of Pins** – The number of device pins controlled by the component. Valid values are between 1 and 64. The default value is **1**.

  Note Some configurations can only be placed into a single physical port; therefore, the default maximum number of pins is limited to 8 or less. When the component is configured as noncontiguous and spanning, the maximum number of pins can be set up to 64 because they no longer need to be placed into a single physical port.

-  **Delete Pin –** Deletes selected pins from the tree.

-  **Add/Change Alias –** Opens a dialog to add or change the alias name for a selected pin in the tree. You can also double-click a pin or press [**F2**] to open the dialog.
-  **Move Up/Down –** Moves the selected pins up or down in the tree.
-  **Pair/Unpair SIOs –** Pairs or unpairs selected SIO pins (identified by a pink outline) in the tree.

  This control specifies whether pins that require SIO should be placed in the same SIO pair on the device. Pairing pins results in fewer physical SIO pins being "wasted." This is because an unpaired pin that requires SIO cannot share its SIO pair on the device with another pin that requires SIO. For pins to share an SIO pair on the device, they must have their per-pair settings configured the same way and be adjacent.

  A pin requires SIO if **Hot Swap** is set to true, **Threshold** is set to anything but **LVTTL** or **CMOS**, **Drive Level** set to **Vref**, and/or **Drive Current** is set to **25mA sink**.

Pin Tree

This area displays all of the pins for the component. You can individually select one or more pins to use with the toolbar commands and subtabs. Each pin displays its name which consists of the Pins component name + '_' + individual pin alias.

Type Subtab

This is the default subtab displayed for the **Pins** tab. This is where you choose the type of pins for your component using the check boxes. The preview area shows what the selected Pins component symbol will look like with various options selected for that specific pin.

- **Analog** – Select **Analog** to enable the analog pin terminal to allow analog signal routing to other components. Selecting analog forces the pin to be physically placed on a GPIO pin and not an SIO pin.
- **Digital Input** – Select **Digital Input** to enable the digital input pin terminal (optional) and enable the **Input** subtab for additional configuration options related to inputs.
  - **HW Connection** – This parameter determines whether the digital input terminal for an input pin is displayed in the schematic. If displayed, the pin provides a digital signal to the digital system interconnect (DSI) for use with hardware components. Independent of this selection, all pins can always be read by the CPU through registers or APIs. If this option is not selected, the terminal is not displayed and it is controlled only by software APIs.
- **Digital Output** – Select **Digital Output** to enable the digital output pin terminal (optional) and enable the **Output** subtab for additional configuration options related to outputs.
  - **HW Connection** – This parameter determines whether the digital output terminal for a given output pin is displayed in the schematic. If displayed, the pin outputs the

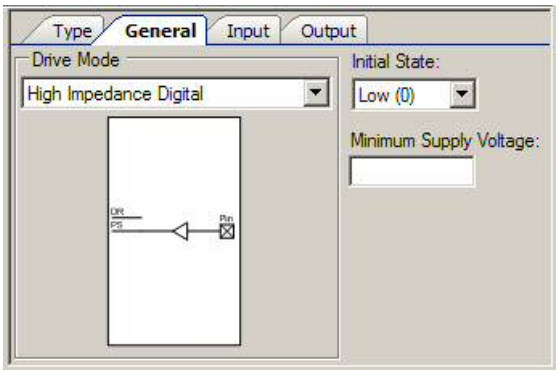
digital signal supplied by hardware components through the DSI. If not displayed, the output logic level is determined by CPU register or API writes. If this option is not selected, the terminal is not displayed and it is controlled only by software APIs.

- **Output Enable** – This parameter allows the use of the output enable feature of pins and displays the output enable input terminal. The output enable feature allows a hardware signal to control the pin's output drivers without requiring the CPU to write registers. A high logic level configures the output drivers, as set in the **Drive Mode** parameter. A low logic level disables the output drivers and places the pin into the HI-Z drive mode.

- **Bidirectional** – Enabling the **Bidirectional** parameter is functionally equivalent to enabling the **Digital Input** with **HW Connection** and the **Digital Output** with **HW Connection** parameters. The difference is that only a single bidirectional terminal is displayed on the component symbol rather than separate input and output terminals. Both **Input** and **Output** subtabs are enabled for further configuration.

- **Show External Terminal** – Allows connections to Off-Chip Components to illustrate circuitry external to PSoC.

General Subtab

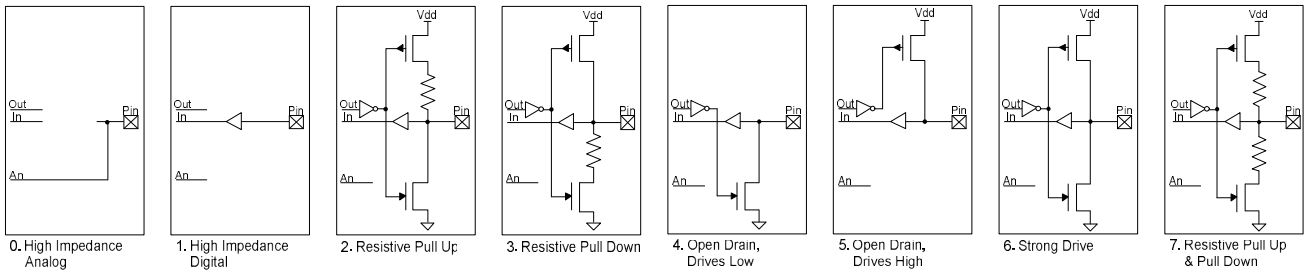


The **General** subtab allows you to set up parameters that apply to each pin, such as the drive mode, initial state, and minimum supply voltage of the selected pin. The settings on this subtab include:

- **Drive Mode** – This parameter configures the pin to provide one of the eight available pin drive modes. The defaults and legal choices are influenced from the selections on the **Type** subtab. Refer to the device datasheet for more details on each drive mode. A diagram shows the circuit representation for each drive mode as it is selected.
  - If the type is **Digital Input** or **Digital Input/Analog**, the default is **High Impedance Digital**.
  - If the pin type is **Analog**, the default is **High Impedance Analog**. This is the only pin drive mode that can support purely Analog pins.

- If the pin type is **Bidirectional** or **Bidirectional/Analog**, the default is **Open Drain, Drives Low**.
- All other pin types default to **Strong Drive**.

The diagram for each drive mode is as follows:



The **Out** connection is driven from either the Digital System (when the Digital Output terminal is connected) or the Data Register (when HW Connection is disabled).

The **In** connection drives the Pin State register, and the Digital System if the Digital Input terminal is enabled and connected.

The **An** connection connects to the Analog System.

Note If any of the three resistive drive modes (**Resistive Pull Up**, **Resistive Pull Down**, **Resistive Pull Up/Down**) is used, setting the output drive level to **Vref** does not work.

Note The following modes are not supported for PSoC 4000 series - **Resistive Pull Up**, **Resistive Pull Down**, **and Resistive Pull Up/Down**.

Note For over voltage tolerance to work properly, the pin must be in one of the following drive modes: **High Impedance Analog**, **High Impedance Digital**, or **Open Drain, Drives Low**.

Note The USBIO pins only support the **Open Drain, Drives Low** and **Strong Drive** drive modes. In order to use USBIO pins as inputs, the **Open Drain, Drives Low** drive mode should be used.

- **Initial State** – This parameter specifies the pin-specific initial value written to the pin's data register after power-on reset (POR). All pins default to a logic low (0) in hardware at POR. The initial state is written to the pin just after the drive mode is configured, which occurs as part of the configuration of the entire device.

On PSoC 3 and PSoC 5LP, the initial state is configured high by default only for the **Resistive Pull Up** and **Resistive Pull Up/Down** drive modes to ensure the pull-up resistor is active.

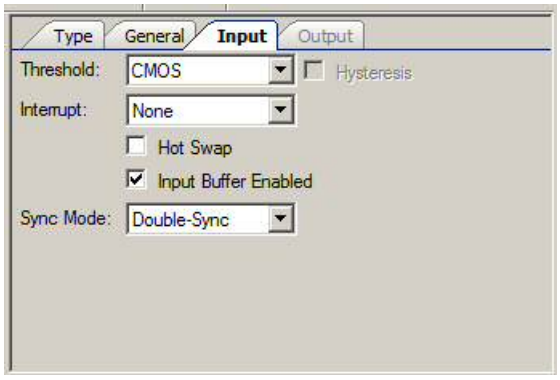
On PSoC 4, the initial state is configured high by default for Digital Output pins that do not expose the output enable terminal. In these configurations, the data register is used to control the output enable.

Note This should not be confused with the reset state under the main **Reset** tab. That attribute affects the state of the whole port of which the pin is a member, from the moment of reset, before any other device configuration (including Initial State configuration).

- **Minimum Supply Voltage** – This parameter selects the requested minimum high logic level output voltage. The requested voltage must be provided by one of the V_{DDIO} supply inputs. This selection ensures that the Pins component will be mapped onto pins that can support its required output voltage. If left blank, the component has no voltage requirements, allowing placement to a pin supplied by any of the available V_{DDIO} voltages.

  Valid values are determined by the settings in the **System** tab of the *<project>.cydwr* file for V_{DDIO0}/V_{DDIO1}/V_{DDIO2}/V_{DDIO3}, or V_{DDD} on devices that do not have independent V_{DDIO} settings. Depending on the selected device, you could have two USB pins that will use V_{DDD} as their voltage available for placement. The pin cannot be placed if this value is not less than or equal to the maximum value set for those settings. This range check is performed outside this dialog; the results appear in the Notice List window if the check fails.

Input Subtab



The **Input** subtab specifies input settings. If the pin type is not **Digital Input** or **Bidirectional** in the **Type** subtab, this subtab is disabled because you do not need to specify input information.

- **Threshold** – This parameter selects the threshold levels that define a logic high level (1) and a logic low level (0). **CMOS** is the default and should be used for the vast majority of application connections. The other threshold levels allow for easy interconnect with devices with custom interface requirements that differ from that of CMOS. A pin specified as **CMOS or LVTTL** will default to CMOS, but may be configured as LVTTL in order to be placed in a port configured as LVTTL. Thresholds that are derived from Vddio or Vref require the use of an SIO pin.
  - **CMOS** – Default
  - **LVTTL**
  - **CMOS or LVTTL**
  - **0.4 x Vddio** – Requires SIO

- **0.5 x Vddio** – Requires SIO
- **0.5 x Vref** – Requires SIO
- **Vref** – Requires SIO

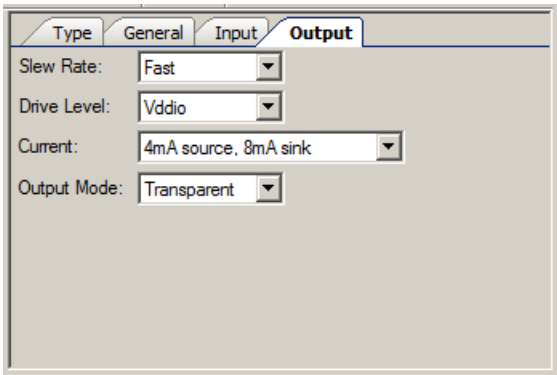
- **Hysteresis** – Enables or disables the SIO differential hysteresis for the pin. This feature is disabled if the **Threshold** is **CMOS**, **LVTTL**, or **CMOS or LVTTL**. Hysteresis control requires you to use an SIO pin. GPIO pins always have hysteresis enabled.
  - **Disabled** – Default
  - **Enabled**
- **Interrupt** – This parameter selects whether the pin can generate an interrupt and, if selected, the interrupt type. The pin interrupt can be generated with a rising edge, falling edge, or both edges. If set to anything but **None**, you must configure the component to be contiguous so that it is mapped into a single physical port. A single port is required because all pins in a port logically OR their interrupts together and generate a single interrupt signal and symbol terminal. The **Interrupt** parameter uses dedicated pin interrupt logic, which latches the pins that generated interrupted events. After an interrupt occurs, the Pin_ClearInterrupt() function must be called to clear the latched pin events to enable detection of future events. If more than one pin in the Pins component can generate an interrupt, the Pin_ClearInterrupt() return value can be decoded to determine which pins generated interrupt events.
  - **None** - Default
  - **Rising Edge**
  - **Falling Edge**
  - **Both Edges**
- **Hot Swap** – A pin configured for hot swap capability is mapped to an SIO pin that supports this capability in hardware. Hot swap capability allows the voltage present on the pin to rise above the pin's V_{DDIO} voltage, up to 6.0 V. Hot swap also does not allow a pin with any voltage up to 6.0 V present to leak current into the PSoC device even when the PSoC device is not powered. Hot swap is useful for connecting the PSoC device when unpowered to a communications bus like I^2C without shorting the bus or back powering the PSoC device.
  - **Disabled** – Default
  - **Enabled** – Requires SIO
- **Input Buffer Enabled** – This parameter enables or disables the pin's digital input buffer. The digital buffer is needed to read or use the logic level present on a pin through DSI routing or a CPU read. The input buffer is needed to use the pin as a digital input. Analog pins disable the digital input buffer by default to reduce pin leakage in low-power modes. If the pin type is **Analog**, the default is **Disabled**. All other pin types, including combinations

that include **Analog**, default to **Enabled**. You should disable the input buffers to reduce current when not needed, especially with analog signals.

- **Enabled**
- **Disabled**

- **Sync Mode** – Input synchronization occurs by default at pins to synchronize all signals entering the device to the input clock using a double-synchronizer (Double-Sync). On PSoC 3 and PSoC 5LP, the input clock is always BUS_CLK. On PSoC 4, the input clock defaults to HFCLK, but may be selected via the **In Clock** parameter on the **Clocking** page. Input synchronization can be optionally disabled at the pin in limited cases in which an asynchronous signal is required for application performance and does not violate device operational requirements (Transparent). On PSoC 4, synchronization can also be performed using a single flip-flop (Single-Sync).
  - **Double-Sync** – Default
  - **Single-Sync** (PSoC 4 only)
  - **Transparent**

Output Subtab



The **Output** subtab specifies output settings. If the pin type is not **Digital Output** or **Bidirectional** this tab is disabled because you do not need to specify output information.

- **Slew Rate** – The slew rate parameter determines the rise and fall ramp rate for the pin as it changes output logic levels. Fast mode is required for signals that switch at greater than 1 MHz. You can select slow mode for signals less than 1 MHz switching rate and benefit from slower transition edge rates, which reduce radiated EMI and coupling with neighboring signals. On PSoC 4, all pins on the same port must have the same Slew Rate.
  - **Fast** – Default
  - **Slow**

- **Drive Level** – This parameter selects the output drive voltage supply sourced by the pin. All pins can supply their respective V_{DDIO} supply voltages. SIO pins can also supply a

programmable or analog routed voltage for interface with devices at a different potential than the SIOs V_{DDIO} voltage.

- **Vddio** – Default
- **Vref** – Requires SIO

Note If any of the three resistive drive modes (**Resistive Pull Up**, **Resistive Pull Down**, **Resistive Pull Up/Down**) is used, setting the output drive level to **Vref** does not work.

- **Current** – The drive current selection determines the maximum nominal logic level current required for a specific pin. Pins can supply more current at the cost of logic level compliance or can have a maximum value that is less than listed, based on system voltages. See the device datasheet for more details on drive currents.
  - **4mA source, 8mA sink** – Default
  - **4mA source, 25mA sink** – Requires SIO
- **Output Mode** – Output synchronization reduces pin-to-pin output signal skew in high-speed signals requiring minimal signal skew. By default, the Output Mode is Transparent and no synchronization occurs. If Single-Sync is selected, the output signal is synchronized to the output clock.
  - **Transparent** – Default
  - **Single-Sync**
  - **Clock** (PSoC 4 only)
  - **Clock-Inverted** (PSoC 4 only)

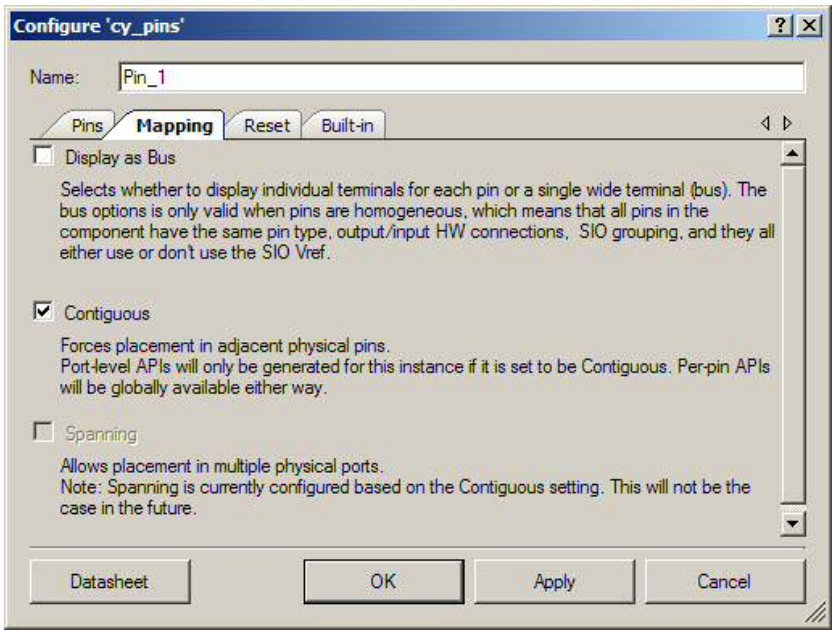
  On PSoC 3 and PSoC 5LP, the output clock is always BUS_CLK.

  On PSoC 4, the output clock defaults to HFCLK, but may be changed via the **Out Clock** parameter on the **Clocking** page.

  Choosing either **Clock** or **Clock-Inverted** output modes on PSoC 4 allows the externally connected clock or signal to drive the pin. In this configuration, the data register (DR) value is used as an enable to the out_clock terminal and must be set high either by initially setting it to 1 in the pin customizer or set using software. Note that if this is a HW output pin then the value of the signal connected to the output pin terminal does not affect the operation of the pin when in this mode. Instead, hardware control of the clock enable can be achieved if **Out Clock Enable** signal on the Clocking page is used with DR set high.
- **OE Synchronized** (PSoC 4 only) – Output Enable synchronization allows the Output Enable signal to be synchronized to the output clock.
  - **Disabled** – Default
  - **Enabled**

Mapping Tab

The **Mapping** tab contains parameters that define how the Pins component is displayed in the schematic view and mapped on to physical pins.



Display as Bus

This parameter selects whether to display individual terminals for each pin or a single wide terminal (bus). The bus option is only valid when pins are homogeneous. That means all pins in the component have the same pin type, output/input HW connections, and SIO grouping. They also must all either use or not use the SIO Vref. Displaying as a bus is useful when many of the same types of pin are required. This saves schematic space and time to configure and route.

Contiguous

This parameter forces placement in adjacent physical pins within a port. Actual pin placement is package dependent according to the device datasheet. This option has the following restrictions:

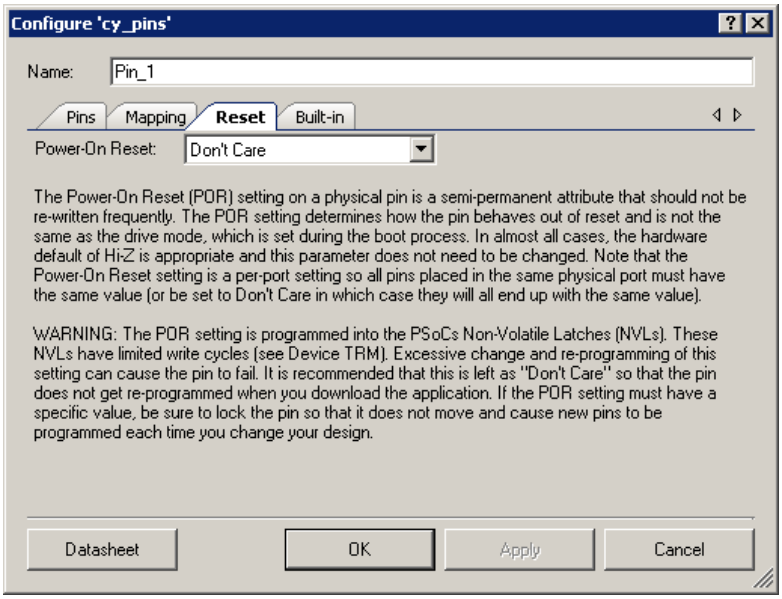
- If contiguous, port level APIs are generated for the component. If noncontiguous, port level APIs are not generated.
- If contiguous, the number of pins in the component must be less than or equal to 8.

Spanning

This parameter enables placement in multiple physical ports. This is currently controlled by the contiguous selection, where contiguous implies nonspanning and noncontiguous implies spanning. A future release of the software will support separate control of the **Spanning** parameter.

Reset Tab

The **Reset** tab is only available on PSoC 3 and PSoC 5LP.



Power-On Reset

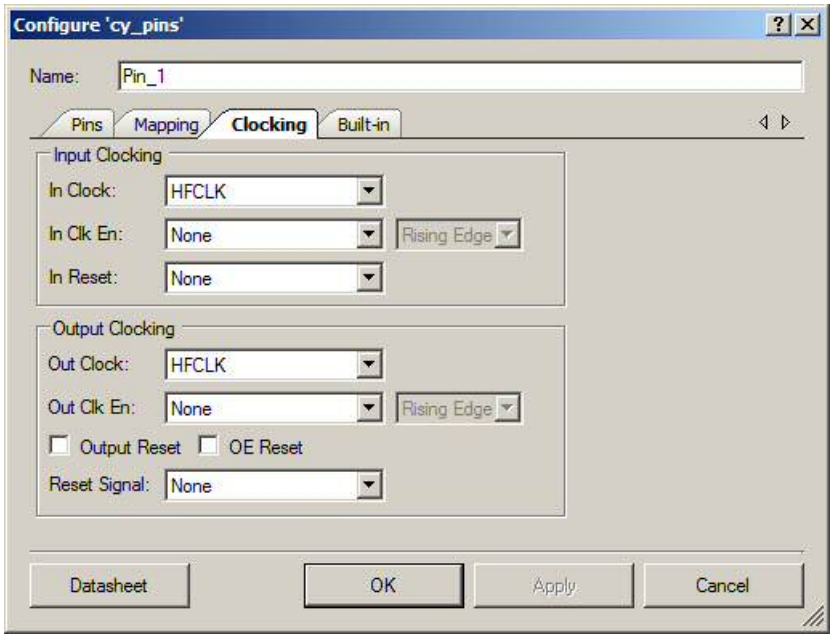
The Power-On Reset (POR) setting on a physical pin is a semi-permanent attribute that you should not rewrite frequently. The POR setting determines how the pin behaves out of reset. It is not the same as the drive mode, which is set during the boot process. In almost all cases, the hardware default of HI-Z is appropriate and you do not need to change this parameter. Note that the POR setting is a per-port setting, so all pins placed in the same physical port must have the same value (or be set to **Don't Care**, in which case they will all end up with the same value).

Warning: The POR setting is programmed into the PSoC's Non-Volatile Latches (NVLs). These NVLs have limited write cycles (see Device TRM). Excessive change and re-programming of this setting can cause the pin to fail. It is recommended that this is left as **Don't Care** so that the pin does not get re-programmed when you download the application. If the POR setting must have a specific value, be sure to lock the pin so that it does not move and cause new pins to be programmed each time you change your design.

- **Don't Care** – Default. When left set to **Don't Care**, the POR is determined by the physical port in which this component is placed. If all of the placed pins in the port are set to **Don't Care**, the default POR of the part is used. Otherwise, whatever POR is specified for the other pins placed in that physical port (they must all match) is used for the ones set to **Don't Care**.
- High-Z Analog
- Pulled-Up
- Pulled-Down

Clocking Tab

The **Clocking** tab is only available on PSoC 4.



In Clock

This parameter selects the clock to use for the input synchronization logic of this Pins component. By default, HFCLK is used as the input synchronization clock. It is also possible to use a Clock component or other signal by enabling the in_clk terminal (External). To use an off-chip signal as the input clock with minimal skew, any pin in this Pins component configured as Input or Bidirectional may be selected as the In Clock (Pin_N). Any of the options may also be inverted inside the Pins component.

- **HFCLK** – Default
- HFCLK (inverted)
- External
- External (inverted)
- Pin_N
- Pin_N (inverted)

In Clk En

This parameter selects a signal to use as the enable signal for the input synchronization logic of this Pins component. By default, no enable signal is used, and input synchronization is always enabled. A digital signal from the schematic may be used as the enable by displaying and

connecting the in_en terminal (External). To use an off-chip signal as the enable signal with minimal delay, any pin in this Pins component configured as Input or Bidirectional may be selected as the In Clk En (Pin_N). Any of the options may also be inverted inside the Pins component.

- **None** – Default
- External
- External (inverted)
- Pin_N
- Pin_N (inverted)

In Clock Enable Mode

The drop-down to the right of the In Clk En parameter controls the Enable Mode of the In Clock Enable. If the Enable Mode is set to Rising Edge, the input synchronization flip flops will only transition on the clock cycle immediately after the enable signal transitions from low to high. If the Enable Mode is set to Level, the input synchronization flip flops can transition on any clock cycle when the enable signal is high.

- **Rising Edge** – Default
- Level

In Reset

This parameter selects a signal to use as the reset signal for the input synchronization logic of this Pins component. By default, reset is not used. A digital signal from the schematic may be used as the enable by displaying and connecting the in_rst terminal (External). To use an off-chip signal as the reset signal with minimal delay, any pin in this Pins component configured as Input or Bidirectional may be selected as the In Reset (Pin_N). Any of the options may also be inverted inside the Pins component.

- **None** – Default
- External
- External (inverted)
- Pin_N
- Pin_N (inverted)

Out Clock

This parameter selects the clock to use for the output synchronization logic of this Pins component. By default, HFCLK is used as the output synchronization clock. It is also possible to use a Clock component or other signal by enabling the out_clk terminal (External). To use an off-chip signal as the output clock with minimal skew, any pin in this Pins component configured as Input or Bidirectional may be selected as the In Clock (Pin_N). Any of the options may also be inverted inside the Pins component.

- **HFCLK** – Default
- HFCLK (inverted)
- External
- External (inverted)
- Pin_N
- Pin_N (inverted)

Out Clk En

This parameter selects a signal to use as the enable signal for the output synchronization logic of this Pins component. By default, no enable signal is used, and output synchronization is always enabled. A digital signal from the schematic may be used as the enable by displaying and connecting the out_en terminal (External). To use an off-chip signal as the enable signal with minimal delay, any pin in this Pins component configured as Input or Bidirectional may be selected as the In Clk En (Pin_N). Any of the options may also be inverted inside the Pins component.

- **None** – Default
- External
- External (inverted)
- Pin_N
- Pin_N (inverted)

Out Clock Enable Mode

The drop-down to the right of the Out Clk En parameter controls the Enable Mode of the Out Clock Enable. If the Enable Mode is set to Rising Edge, the output synchronization flip flop will only transition on the clock cycle immediately after the enable signal transitions from low to high. If the Enable Mode is set to Level, the output synchronization flip flop can transition on any clock cycle when the enable signal is high.

- **Rising Edge** – Default
- Level

Output Reset

Allows the selected Out Reset Signal to be used to reset the output synchronization logic.

- **Disabled** – Default
- Enabled

OE Reset

Allows the selected Out Reset Signal to be used to reset the output enable synchronization logic.

- **Disabled** – Default
- Enabled

Out Reset Signal

This parameter selects a signal to use as the reset signal for either the output synchronization logic or the output enable synchronization logic of this Pins component. By default, reset is not used. A digital signal from the schematic may be used as the enable by displaying and connecting the out_rst terminal (External). To use an off-chip signal as the reset signal with minimal delay, any pin in this Pins component configured as Input or Bidirectional may be selected as the Out Reset (Pin_N). Any of the options may also be inverted inside the Pins component.

- **None** – Default
- External
- External (inverted)
- Pin_N
- Pin_N (inverted)

Application Programming Interface

Application Programming Interface (API) routines allow you to configure and use the component using software. The Pins component enables access on a per-pin basis, as well as a component-wide basis.

Per-Pin APIs

You can access individual pins in the component by using the global APIs defined in the *cypins.h* generated file (in the cy_boot directory). These APIs are documented in the *System Reference Guide* (Help > Documentation).

PSoC 3 and PSoC 5LP APIs

- CyPins_ReadPin()
- CyPins_SetPin()
- CyPins_ClearPin()
- CyPins_SetPinDriveMode()
- CyPins_ReadPinDriveMode()
- CyPins_FastSlew()
- CyPins_SlowSlew()

These APIs can be used with either physical pin register names or the pin alias from the component. Accessing physical pins directly from software is not recommended because there is no safeguard against the same pins being allocated to other functions by the tool. Even if a pin is only accessed from software, Cypress strongly recommends the use of a Pins component. You can use the generated aliases from the component with the above APIs to safely access individual pins without a performance or memory penalty.

To use the above APIs, the component generates aliases for the pin registers in the *Pin_aliases.h* file, where Pin is the instance name of the Pins component. By default the alias is the component name with the pin number appended to it:

Pin_x - x is the pin within the component (0 based)

If you provide an alias name in the Pins configuration dialog, then an additional #define is created with the form:

Pin_<AliasName>

Either of these aliases can be used. For example Pin has an <AliasName> called “MyAlias”. This generates aliases, Pin_0 and Pin_MyAlias. To read this pin using the per-pin APIs, you can use either of these methods:

```
CyPins_ReadPin(Pin_0)
CyPins_ReadPin(Pin_MyAlias)
```

PSoC 4 APIs

- CY_SYS_PINS_READ_PIN()
- CY_SYS_PINS_SET_PIN()
- CY_SYS_PINS_CLEAR_PIN()
- CY_SYS_PINS_SET_DRIVE_MODE()
- CY_SYS_PINS_READ_DRIVE_MODE()

PSoC 4 generates aliases similar to PSoC 3 and PSoC 5LP. However it currently does not use these in its per-pin APIs due to the differences in the structure of the pin registers. Instead the registers can be accessed by using the appropriate port register defined in *Pin.h*, where Pin is the instance name of the Pins component, and the actual pin position on the port.

For example if you would like to read the value of Pin that is place on P0[0] (assuming Pin is placed on port 0, pin 0) , you would call:

```
CY_SYS_PINS_READ_PIN (Pin_PS, 0)
```

Component APIs

These APIs access all pins in the component in a single function call. Efficient implementation of component-wide APIs is only possible if all pins are placed in a single physical port on the device. They are only generated if the component is configured to be contiguous. Noncontiguous Pins components only allow access on the per-pin basis described above.

By default, PSoC Creator assigns the instance name “Pin_1” to the first instance of a Pins component in a given design. You can rename it to any unique value that follows the syntactic rules for identifiers. The instance name becomes the prefix of every global function name, variable, and constant symbol. For readability, the instance name used in the following table is “Pin.”

The following table lists and describes the interface to each function. The subsequent sections cover each function in more detail.

Function	Description
Pin_Read()	Reads the physical port and returns the current value for all pins in the component
Pin_Write()	Writes the value to the component pins while protecting other pins in the physical port if shared by multiple Pins components
Pin_ReadDataReg()	Reads the current value of the port's data output register and returns the current value for all pins in the component
Pin_SetDriveMode()	Sets the drive mode for each of the Pins component's pins
Pin_ClearInterrupt()	Clears any active interrupts on the port into which the component is mapped. Returns value of interrupt status register

uint8 Pin_Read(void)

Description: Reads the associated physical port (pin status register) and masks the required bits according to the width and bit position of the component instance. The pin's status register returns the current logic level present on the physical pin.

Parameters: None

Return Value: The current value for the pins in the component as a right justified number.

Side Effects: None

void Pin_Write(uint8 value)

Description: Writes the value to the physical port (data output register), masking and shifting the bits appropriately. The data output register controls the signal applied to the physical pin in conjunction with the drive mode parameter. This function avoids changing other bits in the port by using the appropriate method (read-modify-write or bit banding).

Parameters: uint8 value: Value to write to the component instance.

Return Value: None

Side Effects: If you use read-modify-write operations that are not atomic; the Interrupt Service Routines (ISR) can cause corruption of this API. An ISR that interrupts this API and performs writes to the Pins component data register can cause corrupted port data. To avoid this issue, you should either use the Per-Pin APIs (primary method) or disable interrupts around this API.

uint8 Pin_ReadDataReg(void)

Description: Reads the associated physical port's data output register and masks the correct bits according to the width and bit position of the component instance. The data output register controls the signal applied to the physical pin in conjunction with the drive mode parameter. This is not the same as the preferred Pin_Read() API because the Pin_ReadDataReg() reads the data register instead of the status register. For output pins this is a useful API to determine the value just written to the pin.

Parameters: None

Return Value: The current value of the data register masked and shifted into a right justified number for the component instance.

Side Effects: None

void Pin_SetDriveMode(uint8 mode)

Description: Sets the drive mode for each of the Pins component's pins.

Parameters: uint8 mode: Mode for the selected signals. Defined legal options are:

Pin_1_DM_STRONG	Strong Drive
Pin_1_DM_OD_HI	Open Drain, Drives High
Pin_1_DM_OD_LO	Open Drain, Drives Low
Pin_1_DM_RES_UP	Resistive Pull Up
Pin_1_DM_RES_DWN	Resistive Pull Down
Pin_1_DM_RES_UPDWN	Resistive Pull Up/Down
Pin_1_DM_DIG_HIZ	High Impedance Digital
Pin_1_DM_ALG_HIZ	High Impedance Analog

Return Value: None

Side Effects: If you use read-modify-write operations that are not atomic, the Interrupt Service Routines (ISR) can cause corruption of this API. An ISR that interrupts this API and performs writes to the Pins component Drive Mode registers can cause corrupted port data. To avoid this issue, you should either use the Per-Pin APIs (primary method) or disable interrupts around this API.

uint8 Pin_ClearInterrupt(void)

Description:	Clears any active interrupts attached with the component and returns the value of the interrupt status register allowing determination of which pins generated an interrupt event.
Parameters:	None
Return Value:	uint8: The right-shifted current value of the interrupt status register. Each pin has one bit set if it generated an interrupt event. For example, bit 0 is for pin 0 and bit 1 is for pin 1 of the Pins component.
Side Effects:	Clears all bits of the physical port's interrupt status register, not just those associated with the Pins component.

Functional Description

The pins component allows easy configuration of common pin settings in most designs. It also provides more advanced configurations for those designs requiring settings beyond the basic functionality. This section highlights some of the more advanced pin modes that may not be obvious from the given parameter descriptions.

- **SIO Pins –** The Special Input/Output SIO pins (available in PSoC 3 and PSoC 5LP) provide differential input buffer and a means to regulate the high-level output voltage (VOH). The SIO pins are tolerant to input voltages higher than the I/O supply voltage and can sink up to 25 mA current. There are several ways to choose an SIO pin in your design. A pin requires SIO if any of the following parameters are set.
  - **Hot Swap** is set to true
  - **Threshold Level** is set to 0.5 VDDIO, 0.4 VDDIO, 0.5 VREF, VREF
  - **Drive Level** is set to Vref,
  - **Drive Current** is set to 25mA sink.

  An SIO will always be placed on Port 12, where the pin resides. Two SIO pins can be paired from the component configuration, which allows them to share a common reference generator block.

- **POR –** Power on Reset (POR) option is available on PSoC 3 and PSoC 5LP. The POR setting on a physical pin is a semi-permanent attribute that should not be re-written frequently. The POR setting determines how the pin behaves out of reset. The setting is port-wide and is not the same as the drive mode, which is set during the boot process. In almost all cases, the hardware default of Hi-Z is appropriate and this parameter does not need to be changed.

- **PSoC 4 Initial State –** The initial state for pins on PSoC 4 devices also act as the output enable for output pins that do not explicitly expose the "Output Enable" terminal. This

allows the software to control the output enable of a pin by writing to the pin's Data Register (DR).

- **PSoC 4 pin clocking –** The input and output values can be synchronized with an external clock using the PSoC 4 pin clocking options. Use this if the pin state needs to be synchronized with other clocks aside from HFCLK.
- **Route PSoC 4 clock to pin –** Unlike PSoC 3 and PSoC 5LP, clocks in PSoC 4 cannot be connected directly to a pin terminal unless it is specified to be a clock. To enable this mode, the **Output Mode** parameter can be set to either Clock or Clock-Inverted.
- **PSoC Port Adaptor –** Some devices such as PSoC 4000 series do not have Port Adaptors, which limits some pin functionalities such as input **Sync Mode**, **Output Mode** and PSoC4 pin clocking options. Keep this in mind when migrating devices and consult the device TRM.

MISRA Compliance

This section describes the MISRA-C:2004 compliance and deviations for the component. There are two types of deviations defined: project deviations – deviations that are applicable for all PSoC Creator components and specific deviations – deviations that are applicable only for this component. This section provides information on component specific deviations. The project deviations are described in the MISRA Compliance section of the *System Reference Guide* along with information on the MISRA compliance verification environment.

The Pins component does not have any specific deviations.

Sample Firmware Source Code

PSoC Creator provides many example projects that include schematics and example code in the Find Example Project dialog. For component-specific examples, open the dialog from the Component Catalog or an instance of the component in a schematic. For general examples, open the dialog from the Start Page or **File** menu. As needed, use the **Filter Options** in the dialog to narrow the list of projects available to select.

Refer to the "Find Example Project" topic in the PSoC Creator Help for more information.

Resources

Each Pins component consumes one physical pin per bit of the **Number of Pins** parameter.

API Memory Usage

The component memory usage varies significantly, depending on the compiler, device, number of APIs used and component configuration. The following table provides the memory usage for all APIs available in the given component configuration.

The measurements have been done with the associated compiler configured in Release mode with optimization set for Size. For a specific design, the map file generated by the compiler can be analyzed to determine the memory usage.

Configuration	PSoC 3 (Keil_PK51)		PSoC 4 (GCC)		PSoC 5LP (GCC)	
	Flash Bytes	SRAM Bytes	Flash Bytes	SRAM Bytes	Flash Bytes	SRAM Bytes
Default with interrupt	50	0	92	0	96	0

DC and AC Electrical Characteristics

The following values indicate of expected performance and are based on initial characterization data.

Pins DC Specifications

Parameter	Description	Conditions	Min	Typ	Max	Units
V_{INMAX}	Maximum input voltage	All allowed values of V_{DDIO} and V_{DDD}	–	–	5.5	V
V_{INREF}	Input voltage reference (Differential input mode)		0.5	–	$0.52 \times V_{DDIO}$	V
V_{OUTREF}	Output voltage reference (Regulated output mode)					
		$V_{DDIO} > 3.7$	1	–	$V_{DDIO} – 1$	V
		$V_{DDIO} < 3.7$	1	–	$V_{DDIO} – 0.5$	V
V_{IH}	Input voltage high threshold					
	GPIO mode	CMOS input	$0.7 \times V_{DDIO}$	–	–	V
	Differential input mode	Hysteresis disabled	SIO_ref + 0.2	–	–	V
V_{IL}	Input voltage low threshold					
	GPIO mode	CMOS input	–	–	$0.3 \times V_{DDIO}$	V
	Differential input mode	Hysteresis disabled	–	–	SIO_ref – 0.2	V
V_{OH}	Output voltage high					
	Unregulated mode	I_{OH} = 4 mA, V_{DDIO} = 3.3 V	$V_{DDIO} – 0.4$	–	–	V

Parameter	Description	Conditions	Min	Typ	Max	Units
	Regulated mode	I_{OH} = 1 mA	SIO_ref – 0.65	–	SIO_ref + 0.2	V
	Regulated mode	I_{OH} = 0.1 mA	SIO_ref – 0.3	–	SIO_ref + 0.2	V
V_{OL}	Output voltage low					
		V_{DDIO} = 3.30 V, I_{OL} = 25 mA	–	–	0.8	V
		V_{DDIO} = 1.80 V, I_{OL} = 4 mA	–	–	0.4	V
R_{PULLUP}	Pull-up resistor		3.5	5.6	8.5	kΩ
$R_{PULLDOWN}$	Pull-down resistor		3.5	5.6	8.5	kΩ
I_{IL}	Input leakage current (Absolute value) [1]					
	GPIO	25 °C, V_{DDIO} = 3.0 V	–	–	2	nA
	SIO: $V_{IH} \le V_{DDSIO}$	25 °C, V_{DDSIO} = 3.0 V, V_{IH} = 3.0 V	–	–	14	nA
	SIO: $V_{IH} > V_{DDSIO}$	25 °C, V_{DDSIO} = 0 V, V_{IH} = 3.0 V	–	–	10	µA
C_{IN}	Input Capacitance[1]		–	–	7	pF
V_H	Input voltage hysteresis (Schmitt-Trigger)[1]	Single-ended mode (GPIO mode)	–	40	–	mV
		Differential mode	–	35	–	mV
I_{DIODE}	Current through protection diode to V_{SSIO}		–	–	100	µA

Pins AC Specifications

Parameter	Description	Conditions	Min	Typ	Max	Units
TriseF	Rise time in fast strong mode (90/10%) [1]	Cload = 25 pF, V_{DDIO} = 3.3 V	–	–	12	ns
TfallF	Fall time in fast strong mode (90/10%) [1]	Cload = 25 pF, V_{DDIO} = 3.3 V	–	–	12	ns
TriseS	Rise time in slow strong mode (90/10%) [1]	Cload = 25 pF, V_{DDIO} = 3.0 V	–	–	75	ns
TfallS	Fall time in slow strong mode (90/10%) [1]	Cload = 25 pF, V_{DDIO} = 3.0 V	–	–	60	ns

1. Based on device characterization (Not production tested).

Parameter	Description	Conditions	Min	Typ	Max	Units
Fsioout	SIO output operating frequency					
	3.3 V < V_{DDIO} < 5.5 V, Unregulated output (GPIO) mode, fast strong drive mode	90/10% V_{DDIO} into 25 pF	–	–	33	MHz
	1.71 V < V_{DDIO} < 3.3 V, Unregulated output (GPIO) mode, fast strong drive mode	90/10% V_{DDIO} into 25 pF	–	–	16	MHz
	3.3 V < V_{DDIO} < 5.5 V, Unregulated output (GPIO) mode, slow strong drive mode	90/10% V_{DDIO} into 25 pF	–	–	5	MHz
	1.71 V < V_{DDIO} < 3.3 V, Unregulated output (GPIO) mode, slow strong drive mode	90/10% V_{DDIO} into 25 pF	–	–	4	MHz
	3.3 V < V_{DDIO} < 5.5 V, Regulated output mode, fast strong drive mode	Output continuously switching into 25 pF	–	–	20	MHz
	1.71 V < V_{DDIO} < 3.3 V, Regulated output mode, fast strong drive mode	Output continuously switching into 25 pF	–	–	10	MHz
	1.71 V < V_{DDIO} < 5.5 V, Regulated output mode, slow strong drive mode	Output continuously switching into 25 pF	–	–	2.5	MHz
Fsioin	SIO input operating frequency					
	1.71 V < V_{DDIO} < 5.5 V	90/10% V_{DDIO}	–	–	66	MHz

Component Changes

This section lists the major changes in the component from the previous version.

Version	Description of Changes	Reason for Changes / Impact
2.5	Fixed a firmware bug that switched the POR settings for "Pulled-Up" and "Pulled-Down" modes.	To address a glitch with POR settings at power up.
2.0.c	Added Errata section to datasheet.	Document known problems with the component.
2.0.b	Fixed a defect with SIO pairs on PSoC 3 and PSoC 5LP. If a Pins component was used to configure a pair of SIOs, the settings for the first pin would be silently applied to the second. As a result, it was not possible to set up SIO pairs where the parameters were not identical for both pins.	Version 2.0 of the Pins component allows independent settings of parameters on the pins. Note, however, that certain parameters, such as the input threshold, are still required to match. Normal parameter value checking within the customizer will catch these errors and force you to make appropriate corrections.
	Updated the handling of SIO pin pairs. When migrating from an earlier version of the Pins component, the pin pair can show as being unpaired.	If the unpairing occurs, delete the pair and add the pins back.

Version	Description of Changes	Reason for Changes / Impact
2.0.a	Datasheet edits.	Updated the screen capture of the Reset tab. Added a Functional Description section.
2.0	Added support for PSoC 4000 devices.	PSoC 4000 device pins have restrictions on routing and synchronization features.
	Added documentation for PSoC 4 Per-Pin APIs.	PSoC 4 Per-Pin APIs differ from PSoC 3 and PSoC 5LP
	Added clock driving pin information for PSoC 4 devices.	This requires specific configuration
1.90.a	Clarified Drive Mode diagrams.	Clarification
	Minor datasheet edits.	
1.90	Added PSoC 4 Support.	PSoC 4 enables new pin clocking options.
1.80	Added MISRA Compliance section.	The component does not have any specific deviations.
	Added note about interrupt type for isr terminal connection.	Clarification
	Added note about drive mode support on USBIOs.	Clarification
	Changed Input Synchronized check-box on Input page to Sync Mode drop-down.	Drop-down allows future modes to be added.
	Changed Output Synchronized check-box on Output page to Output Mode drop-down.	Drop-down allows future modes to be added.
1.70	Minor datasheet edits and updates	
1.60.a	Minor datasheet edits and updates	
1.60	Added External Terminal capability	Allows pins to connect to Off-Chip Components.
	Added note about power-on reset for PSoC 5 to datasheet	Clarification
	Added note about API availability for P15[7:6] on PSoC 3 ES2 and PSoC 5 to datasheet	Clarification
1.50.a	The summary has been changed for each of the four pin macros.	Improved readability.
	Added characterization data to datasheet	
	Improved interrupt information in datasheet	
	Added note regarding Vref drive level to datasheet	
	Minor datasheet edits and updates	
1.50	Added Keil function reentrancy support to the APIs.	Add the capability for customers to specify individual generated functions as reentrant.

Version	Description of Changes	Reason for Changes / Impact
	Added a sentence to the Reset tab in the Configure dialog clarifying that Power-On Reset applies to an entire physical port.	Clarification.
1.20	Display as Bus now gives an error if checked and the Pins component is not homogeneous. The homogeneous check has been extended to include the HW connections settings. The only changes needed to go from the older version to the new would come from having 'Display as Bus' checked and having some HW connections unchecked.	

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