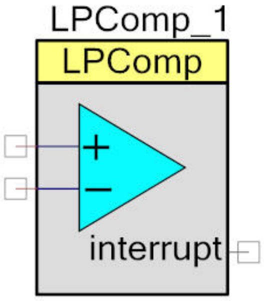
PSoC 4 Low Power Comparator (LPComp)

1.0



Features

- Low input offset
- User controlled offset calibration
- Multiple speed modes
- Low-power mode
- Wake from low power modes
- Multiple interrupt modes

General Description

The Low Power Comparator (LPComp) component provides access to the low power comparators implemented using the fixed function LP comparator block that is present in PSoC 4.

When to Use a LPComp

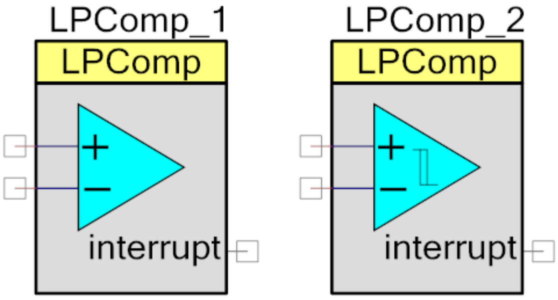
The main purpose of these comparators is to offer fast detection of a voltage change in normal operating modes and ultra-low power operation in hibernate mode. The two connection options are described as follows:

- Compare two voltages on external pins.
- Compare a voltage from an external pin against an internally generated signal.

The comparator output value can be inspected by the CPU. A pulse generated from a selectable edge trigger can be used to trigger an interrupt, routed to digital logic or sent to a pin. The selectable edge trigger signal ORed with the edge trigger signal from the other low power comparator on the device can be used as an interrupt/wakeup source from deep-sleep or hibernate. This combined signal is available as the output of the global signal reference component.

Input/Output Connections

This section describes the various input and output connections for the LPComp. The symbol for this component is annotated to denote the selection of hysteresis.



Positive Input – Analog Input

This input is usually connected to the voltage that is being compared. This input can be routed from a GPIO or from an internal source. When connected to an internal source the GPIO that is dedicated to this input will be consumed and not available for other uses.

Negative Input – Analog Input

This input is usually connected to the reference voltage. This input can be routed from a GPIO or from an internal source. When connected to an internal source the GPIO that is dedicated to this input will be consumed and not available for other uses.

interrupt –output

The edge detected comparison output. A pulse is generated when the selected edge occurs on the internal comparison signal. The direct result of the comparator is not available as a hardware signal. This output is normally connected to an interrupt, but can be routed to digital logic or a GPIO.

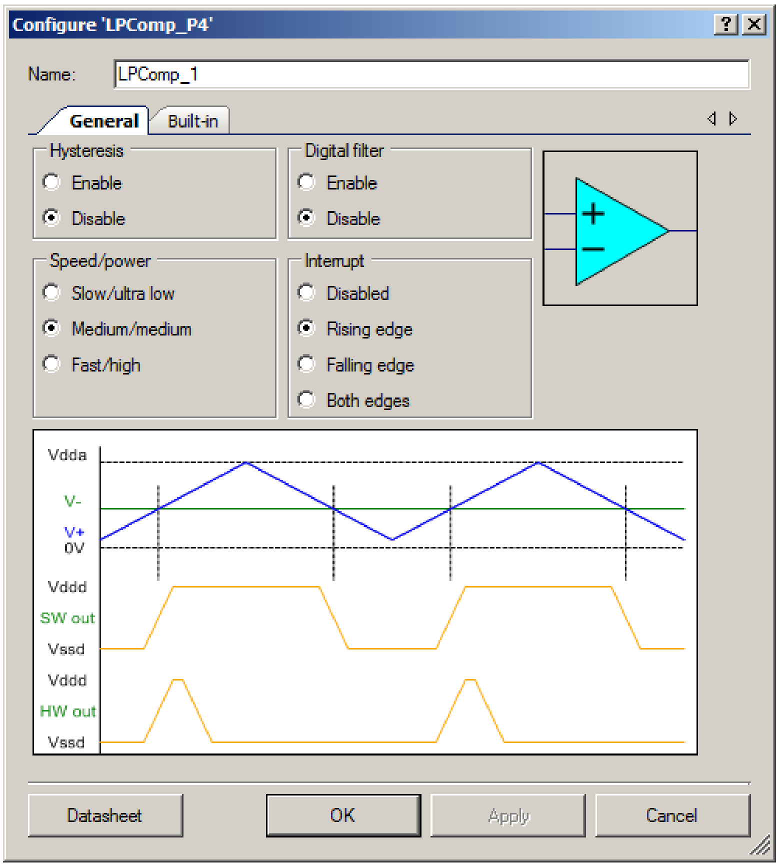
Note: This output cannot be used to awake a part from the Low Power Modes. Global Signal Reference interrupt signal must be used instead.

Please, refer to the Functional Description section for more details of operation in Low Power Mode.

Component Parameters

Drag a LPComp onto your design and double click it to open the Configure dialog.

Configure LPComp Dialog – General Tab



Name: LPComp_1

Hysteresis
○ Enable
● Disable

Digital filter
○ Enable
● Disable

Speed/power
○ Slow/ultra low
● Medium/medium
○ Fast/high

Interrupt
○ Disabled
● Rising edge
○ Falling edge
○ Both edges

The LPComp provides the following parameters.

Hysteresis

This parameter allows you to add approximately 10 mV of hysteresis to the LPComp. This helps to ensure that slowly moving voltages or slightly noisy voltages will not cause the output of the LPComp to oscillate when the two input voltages are nearly equal.

Digital Filter

This parameter enables or disables the digital filter of the LPComp.

Interrupt

This parameter defines the event that will cause a pulse to be generated on the interrupt terminal. The Interrupt parameter allows you to select interrupt/output mode: Disabled, Rising edge, Falling edge, or Both edges.

Speed/Power

This parameter provides a way for the user to optimize speed verses power consumption. The **Speed/Power** parameter allows you to select the speed/power level: Slow/Ultra low power, Medium/Medium power, Fast/High power.

Placement

Each comparator is directly connected to specific GPIOs for its inputs. The output connection is routed to the digital fabric. Refer to the device datasheet for the part being used for the specific physical pin connections.

Resources

This component uses one of the LP Comparators from the pair of comparators in the LP Comparator hardware block.

Application Programming Interface

Application Programming Interface (API) routines allow you to configure the component using software. The following table lists and describes the interface to each function. The subsequent sections cover each function in more detail.

By default, PSoC Creator assigns the instance name "LPComp_1" to the first instance of a 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 "LPComp"

Functions

Function	Description
LPComp_Start()	Performs all of the required initialization for the component and enables power to the block.
LPComp_Init()	Initializes or restores the component according to the customizer settings.
LPComp_Enable()	Activates the hardware and begins component operation.
LPComp_Stop()	Turns off the LP Comparator block.

Function	Description
LPComp_GetCompare()	This function returns a nonzero value when the voltage connected to the positive input is greater than the negative input voltage.
LPComp_SetSpeed()	Sets the power and speed to one of three settings.
LPComp_SetInterruptMode()	Sets the interrupt edge detect mode.
LPComp_GetInterruptSource()	Gets the interrupt requests.
LPComp_ClearInterrupt()	Clears the interrupt request.
LPComp_SetInterrupt()	Sets a software interrupt request.
LPComp_SetHysteresis()	Enables or disables the hysteresis setting.
LPComp_SetFilter()	Enables or disables the digital filter setting.
LPComp_ZeroCal()	Performs custom calibration of the input offset to minimize error for a specific set of conditions.
LPComp_LoadTrim()	Writes a value into the comparator offset trim register.

Global Variables

Function	Description
LPComp_initVar	Indicates whether the Low Power Comparator has been initialized. The variable is initialized to 0 and set to 1 the first time LPComp_Start() is called. This allows the component to restart without reinitialization after the first call to the LPComp_Start() routine. If reinitialization of the component is required, call LPComp_Init() before calling LPComp_Start(). Alternatively, the Comparator can be reinitialized by calling the LPComp_Init() and LPComp_Enable() functions

void LPComp_Start(void)

Description: Performs all of the required initialization for the component and enables power to the block. The first time the routine is executed, the component is initialized to the configuration from the customizer. When called to restart the comparator following a LPComp_Stop() call, the current component parameter settings are retained.

Parameters: None

Return Value: None

Side Effects: None

void LPComp_Init(void)

Description: Initializes or restores the component according to the customizer settings. It is not necessary to call LPComp_Init() because the LPComp_Start() API calls this function and is the preferred method to begin component operation.

Parameters: None

Return Value: None

Side Effects: None

void LPComp_Enable(void)

Description: Activates the hardware and begins component operation. It is not necessary to call LPComp_Enable() because the LPComp_Start() API calls this function, which is the preferred method to begin component operation.

Parameters: None

Return Value: None

Side Effects: None

void LPComp_Stop(void)

Description: Turns off the LP Comparator.

Parameters: None

Return Value: None

Side Effects: The function doesn’t change component power settings.

uint32 LPComp_GetCompare(void)

Description: This function returns a nonzero value when the voltage connected to the positive input is greater than the negative input voltage.

Parameters: None

Return Value: Comparator output state. This value is not impacted by the interrupt edge detect setting.

Side Effects: None

void LPComp_SetSpeed(uint32 speed)

Description: Sets the power and speed to one of three settings.

Parameters: speed: Enumerated speed mode value

Name	Description
LPComp_LOWSPEED	Slow speed / Ultra low power
LPComp_MEDSPEED	Medium speed / Medium power
LPComp_HIGHSPEED	High speed / High power

Return Value: None

Side Effects: None

void LPComp_SetInterruptMode(uint32 mode)

Description: Sets the interrupt edge detect mode. This also controls the value provided on the output.

Parameters: mode: Enumerated edge detect mode value

Name	Description
LPComp_INTR_DISABLE	Disable
LPComp_INTR_RISING	Rising edge detect
LPComp_INTR_FALLING	Falling edge detect
LPComp_INTR_BOTH	Detect both edges

Return Value: None

Side Effects: None

uint32 LPComp_GetInterruptSource(void)

Description: Gets the interrupt requests. This function is used with the combined interrupt signal from the global signal reference. This function from either component instance can be used to determine the interrupt source for both the interrupts combined.

Parameters: None

Return Value: Interrupt source. Each component instance has a mask value: LPComp_INTR_MASK.

Side Effects: None

void LPComp_ClearInterrupt(uint32 interruptMask)

Description: Clears the interrupt request. This function is used with the combined interrupt signal from the global signal reference. This function from either component instance can be used to clear either or both interrupts.

Parameters: interruptMask: Mask of interrupts to clear. Each component instance has a mask value: LPComp_INTR_MASK.

Return Value: None

Side Effects: None

void LPComp_SetInterrupt(uint32 interruptMask)

Description: Sets a software interrupt request. This function is used with the combined interrupt signal from the global signal reference. This function from either component instance can be used to trigger either or both software interrupts.

Parameters: interruptMask: Mask of interrupts to set. Each component instance has a mask value: LPComp_INTR_MASK.

Return Value: None

Side Effects: None

void LPComp_SetHysteresis(uint32 hysteresis)

Description: Enables or disables the hysteresis setting.

Parameters: hysteresis: Hysteresis enable

Name	Description
LPComp_HYST_ENABLE	Enable hysteresis
LPComp_HYST_DISABLE	Disable hysteresis

Return Value: None

Side Effects: None

void LPComp_SetFilter(uint32 filter)

Description: Enables or disables the digital filter setting.

Parameters: filter: filter enable

Name	Description
LPComp_FILT_ENABLE	Enable filter
LPComp_FILT_DISABLE	Disable filter

Return Value: None

Side Effects: None

uint32 LPComp_ZeroCal(void)

Description: Performs custom calibration of the input offset to minimize error for a specific set of conditions: comparator reference voltage, supply voltage, and operating temperature. A reference voltage in the range at which the comparator will be used must be applied to the negative input. The positive input will be disconnected from the external source and shorted internally to the negative input to perform the offset calibration.

Parameters: None

Return Value: The value from the comparator trim register after the offset calibration is complete. This value has the same format as the input parameter for the LPComp_LoadTrim() API routine.

Side Effects: During this function the positive input terminal is disconnected. This may impact other components that are also using this signal.

void LPComp_LoadTrim(uint32 trimVal)

Description: This function writes a value into the comparator offset trim register.

Parameters: trimVal: Value to be stored in the comparator offset trim register. This value has the same format as the parameter returned by the LPComp_ZeroCal() API routine.

Return Value: None

Side Effects: None

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
- specific deviations – deviations that are applicable only for this component

This section provides information on component-specific deviations. Project deviations are described in the MISRA Compliance section of the *System Reference Guide* along with information on the MISRA compliance verification environment.

The Low Power Comparator does not have any specific deviations.

Sample Firmware Source Code

PSoC Creator provides numerous 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.

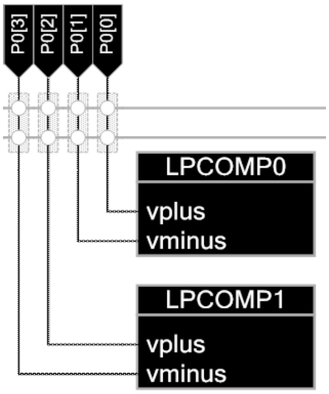
Functional Description

The Low Power Comparator is intended to be operational in all power modes, including Hibernate/Deep Sleep. The main purpose of this component is to offer fast detection capability in normal operating modes and ultra-low power operation in hibernate mode.

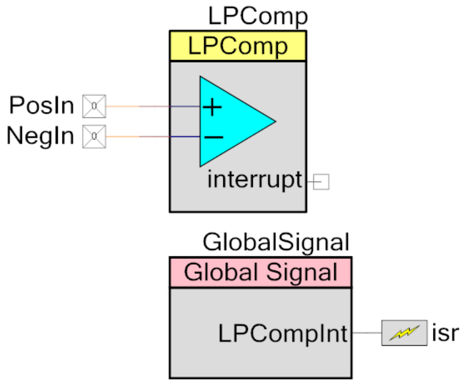
LPComp can be offset calibrated. However, even without trim, the offset is around 10 mV, and thus it is not recommended to trim it.

Operation in Low Power Mode

Low Power Comparator operates in Deep Sleep/Hibernate Mode only if Speed/Power option is set to Slow/Ultra Low. The component input pins must be assigned to dedicated inputs only (P0[0], P0[1] for LPCOMP0, and P0[2], P0[3] for LPCOMP1):



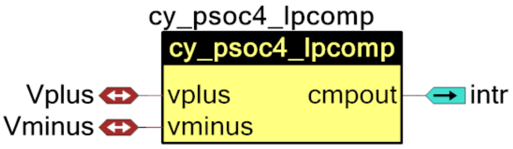
This component can be used along with the Global Signal component as a wakeup source from Deep Sleep/Hibernate mode as shown below:



The option "Combined low power comparator interrupt (LPCompInt)" should be selected as a source for an interrupt in the Global Signal Reference component. This component triggers the output each time any of the enabled low power comparators generates an interrupt. The ISR should normally clear an interrupt using *LPComp_ClearInterrupt(LPComp_INTR_MASK).*

Block Diagram and Configuration

This component uses cy_psoc4_lpcomp primitive.



Registers

See the chip Technical *Reference Manual (TRM)* for more information about registers.

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 4 (GCC)	
	Flash Bytes	SRAM Bytes
Default	484	4

DC and AC Electrical Characteristics

Specifications are valid for –40 °C ≤ T_A ≤ 85 °C and T_J ≤ 100 °C, except where noted.
Specifications are valid for 1.71 V to 5.5 V, except where noted.

LPComp DC Specifications

Parameter	Description	Min	Typ	Max	Units	Conditions
$V_{OFFSET2}$	Input offset voltage, custom trim	–	–	±4	mV	
V_{HYST}	Hysteresis when enabled	–	10	35	mV	
V_{ICM1}	Input common mode voltage in normal mode	0	–	V_{DDD} – 0.1	V	Modes 1 and 2
V_{ICM2}	Input common mode voltage in low power mode	0	–	V_{DDD}	V	
V_{ICM2}	Input common mode voltage in ultra low power mode	0	–	V_{DDD} – 1.15	V	
CMRR	Common mode rejection ratio	50	–	–	dB	VDDD ≥ 2.7V
CMRR	Common mode rejection ratio	42	–	–	dB	VDDD < 2.7V
I_{CMP1}	Block current, normal mode	–	–	280	µA	
I_{CMP2}	Block current, low power mode	–	–	50	µA	
I_{CMP3}	Block current, ultra low power mode	–	–	6	µA	
Z_{CMP}	DC input impedance of comparator	35	–	–	MΩ	

LPComp AC Specifications

Parameter	Description	Min	Typ	Max	Units	Conditions
T_{RESP1}	Response time, normal mode	–	–	38	ns	50 mV overdrive
T_{RESP2}	Response time, low power mode	–	–	70	ns	50 mV overdrive
T_{RESP3}	Response time, ultra low power mode	–	–	2.3	µs	200 mV overdrive

Component Changes

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

Version	Description of Changes	Reason for Changes / Impact
1.0.b	Updated description of the Interrupt output	
1.0.a	Updated datasheet.	Removed the $V_{OFFSET1}$ spec.
1.0	New Component	

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