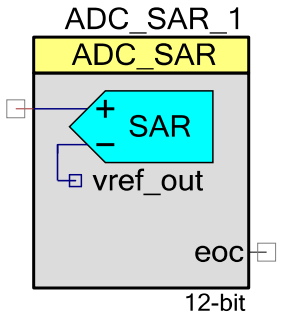
ADC Successive Approximation Register (ADC_SAR)

1.50

Features



- Supports PSoC 5 devices
- Resolution 12 bit at 1 Msps max
- Four Power modes
- Selectable resolution and sample rate
- Single-ended or differential input

General Description

The ADC Successive Approximation Register (ADC_SAR) component provides medium-speed (max 1 Msps sampling), medium-resolution (max 12 bits) analog to digital conversion.

When to Use an ADC_SAR

Example applications for the ADC_SAR component include:

- **LED lighting control**
- **Motor control**
- **Magnetic card reader**
- **High-speed data collection**
- **Power meter**
- **Pulse oximeter**

Input/Output Connections

This section describes the various input and output connections for the ADC_SAR. An asterisk (*) in the list of I/Os indicates that the I/O may be hidden on the symbol under the conditions listed in the description of that I/O.

+Input – Analog

This input is the positive analog signal input to the ADC_SAR. The conversion result is a function of the +Input minus the voltage reference. The voltage reference is either the –Input or Vssa.

–Input – Analog *

When shown, this optional input is the negative analog signal (or reference) input to the ADC_SAR. The conversion result is a function of the +Input minus the –Input. This pin will be visible when the **Input Range** parameter is set to one of the differential modes.

vdac_ref – Input *

The VDAC reference (vdac_ref) is an optional pin. It is shown if you have selected to use "Vssa to VDAC*2" or "0.0 +/- VDAC" **Input Range**, otherwise this I/O will be hidden. This pin is usable for VDAC component output only. No other signal can be connected here.

soc – Input *

The start of conversion (soc) is an optional pin. It is shown if you have selected the "Triggered" sample mode. A rising edge on this input will start an ADC conversion. If the **Sample Mode** parameter is set to "Free Running," this I/O will be hidden.

aclk – Input *

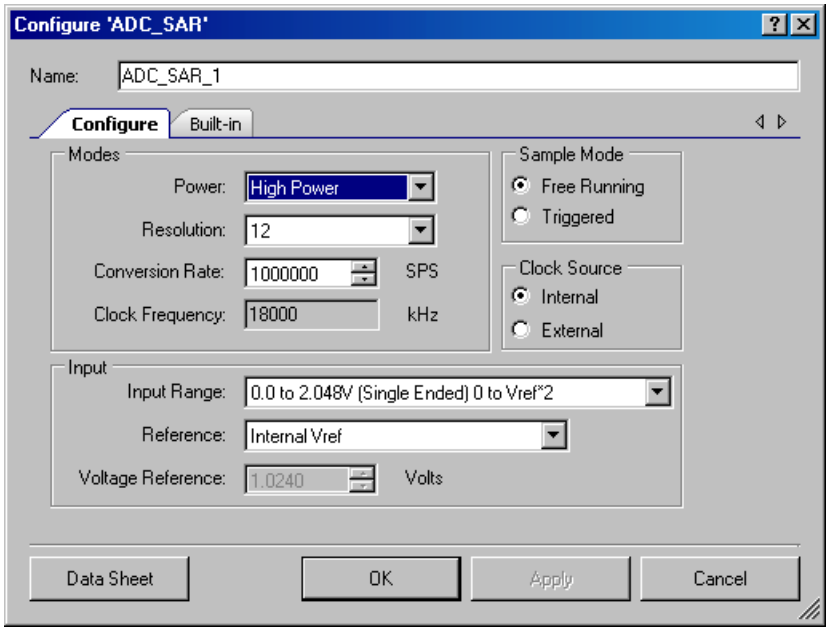
This optional pin is present if the **Clock Source** parameter is set to "External", otherwise the pin will not be shown. This clock determines the conversion rate as a function of conversion method and resolution. If the Clock Source is set to "Internal", this I/O will be hidden.

eoc – Output

A rising edge on the End Of Conversion (eoc) signals that a conversion is complete. A DMA request may be connected to this pin to transfer the conversion output to system RAM, DFB, or other component. An internal interrupt is also connected to this signal, or you may connect your own interrupt.

Parameters and Setup

The ADC_SAR component is a highly configurable analog to digital converter. Drag an ADC_SAR component onto your design and double-click it to open the Configure dialog.



The ADC_SAR has the following parameters. The option shown in bold is the default.

Modes

Power

This parameter sets the power level of the ADC. The higher power settings allow the ADC to operate at higher clock rates for faster conversion times. The lower power setting provides a low power alternative when fast conversion speed is not critical.

Parameters Name	Value	Description	Max Clock Frequency
High Power	0	Normal power	18 MHz
Medium Power	1	1/2 power	9 MHz
Low Power	2	1/3 power	6 MHz
Minimum Power	3	1/4 power	4.5 MHz

Resolution

Sets the resolution of the ADC.

ADC_Resolution	Value	Description
12	12	Sets resolution to 12 bits.
10	10	Sets resolution to 10 bits.
8	8	Sets resolution to 8 bits.

Conversion Rate

The ADC conversion rate is selected with this parameter. The conversion time is the inverse of the conversion rate. The conversion rate is entered in samples per second. The maximum conversion rate depends on the resolution. To convert one sample, it takes 18 cycles at 12 bit resolution, 16 cycles at 10 bits, and 14 cycles at 8 bits. The conversion rate of the ADC_SAR is as follows:

# of cycles = clock frequency / (resolution in bits + 6)

Clock Frequency

This text box is a non-editable (always grayed out) area used to display the required clock rate for the selected operating conditions: resolution, conversion rate. It is updated when any of these conditions are changed. Clock frequency can be anywhere between 1 MHz and 18 MHz. The error will appear at compiling, if clock could not be generated within this limit. In this case the Master Clock should be modified in the Design-Wide Resources Clock Editor.

Sample Mode

This parameter determines how the ADC operates in either "Free Running" or "Triggered" mode.

Start_of_Conversion	Description
Free Running	ADC runs continuously.
Triggered	A rising edge pulse on the SOC pin will cause a single conversion to start.

Clock Source

This parameter allows you to select either a clock that is internal to the ADC_SAR module or an external clock.

ADC_Clock	Description
Internal	Use an internal clock that is part of the ADC_SAR component.

ADC_Clock	Description
External	Use an external clock. The clock source may be analog, digital, or generated by another component.

Input

Input Range

This parameter configures the ADC for a given input range. The analog signals connected to the IC must be between Vssa and Vdda regardless of the input range settings.

Input Range	Description
0.0 to 2.048V (Single Ended) 0 to Vref*2	When using the internal reference (1.024 V), the usable input range is 0.0 to 2.048 volts. The ADC will be configured to operate in a single ended input mode with the –Input connected internally to Vrefhi_out. If an external reference voltage is used, the usable input range will be 0.0 to Vref*2.
Vssa to Vdda (Single Ended)	This mode uses the Vdda/2 reference and the usable input range will cover the full analog supply voltage. The ADC is put in a single ended input mode with the –Input connected internally to Vrefhi_out.
Vssa to VDAC*2 (Single Ended)	This mode uses the VDAC reference, which should be connected to the vdac_ref pin. The usable input range is Vssa to VDAC*2 volts. The ADC will be configured to operate in a single ended input mode with the –Input connected internally to Vrefhi_out.
0.0 +/- 1.024V (Differential) -Input +/- Vref	This mode is configured for differential inputs. When using the internal reference (1.024 V), the input range will be –Input +/- 1.024 V. For example, if –Input is connected to 2.048 volts, then the usable input range is 2.048 +/- 1.024 V or 1.024 to 3.072 V. For systems where both single ended and differential signals are scanned, connect the –Input to Vssa when scanning a single ended input. An external reference may be used to provide a wider operating range. The usable input range can be calculated with the same equation, -Input +/- Vref.
0.0 +/- Vdda (Differential) -Input +/- Vdda	This mode is configured for differential inputs and is ratiometric with the supply voltage. The input range will be –Input +/- Vdda. For systems where both single ended and differential signals are scanned, connect the –Input to Vssa when scanning a single ended input.
0.0 +/- Vdda/2 (Differential) -Input +/- Vdda/2	This mode is configured for differential inputs and is ratiometric to the supply voltage. The input range will be –Input +/- Vdda/2. For systems where both single ended and differential signals are scanned, connect the –Input to Vssa when scanning a single ended input
0.0 +/- VDAC (Differential) -Input +/- VDAC	This mode is configured for differential inputs and uses the VDAC reference, which should be connected to the vdac_ref pin. The input range will be –Input +/- VDAC. For systems where both single ended and differential signals are scanned, connect the –Input to Vssa when scanning a single ended input.

Reference

This parameter selects the ADC_SAR reference voltage configuration. The reference voltage sets the range of the ADC. This parameter is editable when you select an **Input Range** value for all ranges except 0.0 to 2.048V (Single Ended) or 0.0 +/-1.024V (Differential).

ADC_Reference	Description
Internal Vref	Uses the internal 1.024 V reference
Internal Vref, bypassed	Uses internal 1.024 V reference; a bypass capacitor must be placed on pin P0[2] * for SAR1 or on pin P0[4] * for SAR0.
External Vref	Uses an external reference on pin P0[2] for SAR1 or on pin P0[4] for SAR0.

***** The use of an external bypass capacitor is recommended if the internal noise caused by digital switching exceeds what is required for the application's analog performance. To use this option, configure either port pin P0[2] or P0[4] as an analog "Hi-Z" pin and connect an external capacitor with a value between 0.01 uF and 10 uF.

Voltage Reference

The voltage reference is used for the ADC count to voltage conversion functions discussed in the API section. This parameter is non-editable when using the internal 1.024 volt reference. When using an external reference, you may edit this value to match the external reference voltage.

- When selecting input range "Vssa to Vdda", "-Input +/- Vdda", or "-Input +/- Vdda/2," the Vdda supply voltage value should be entered.
- When selecting the input range "Vssa to VDAC*2" or "–Input +/- VDAC," the VDAC supply voltage value should be entered.

Placement

The ADC_SAR component is placed in one of two available SAR blocks and placement information is provided to the API through the *cyfitter.h* file. If it becomes necessary to change default placement, use the Design-Wide Resources – Directives Editor (in the project's .cydwr file) to edit the parameters.

Resources

The ADC_SAR uses a fixed block SAR in the silicon, as well as a clock source.

Resources	Resource Type				API Memory (Bytes)		Pins (per External I/O)
	Clock Dividers	Macrocells	Interrupts	SAR Fixed Blocks	Flash	RAM	
8-12 Bits	1	1	1	1	1106	7	1

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 "ADC_SAR_1" to the first instance of a component in a given design. You can rename the instance 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 "ADC".

Function	Description
void ADC_Start(void)	Powers up the ADC and reset all states
void ADC_Stop(void)	Stops ADC conversions and power down
void ADC_SetPower(uint8 power)	Sets the power mode
void ADC_SetResolution(uint8 resolution)	Sets the resolution of the ADC
void ADC_StartConvert(void)	Starts conversions
void ADC_StopConvert(void)	Stops conversions
void ADC_IRQ_Enable(void)	An Internal IRQ is connected to the eoc. This API enables the internal ISR.
void ADC_IRQ_Disable(void)	An Internal IRQ is connected to the eoc. This API disables the internal ISR.
uint8 ADC_IsEndConversion(uint8 retMode)	Returns a non-zero value if conversion is complete
int8 ADC_GetResult8(void)	Returns a signed 8-bit conversion result
int16 ADC_GetResult16(void)	Returns a signed16-bit conversion result
void ADC_SetOffset(int32 offset)	Sets offset of ADC
void ADC_SetGain(int32 offset)	Sets ADC gain in counts per volt
float ADC_CountsTo_Volts(int16 adcCounts)	Convert ADC counts to floating-point Volts
int16 ADC_CountsTo_mVolts(int16 adcCounts)	Convert ADC counts to mVolts
int32 ADC_CountsTo_uVolts(int32 adcCounts)	Convert ADC counts to uVolts
void ADC_Sleep(void)	Stop ADC operation and saves the user configuration
void ADC_Wakeup(void)	Restores and enables the user configuration
void ADC_Init(void)	Initializes default configuration provided with customizer
void ADC_Enable(void)	Enables the clock and power for ADC
void ADC_SaveConfig(void)	Saves the current user configuration

Function	Description
void ADC_RestoreConfig(void)	Restores the user configuration

Global Variables

Variable	Description
ADC_initVar	Indicates whether the ADC has been initialized. The variable is initialized to 0 and set to 1 the first time ADC_Start() is called. This allows the component to restart without reinitialization after the first call to the ADC_Start() routine. If reinitialization of the component is required, then the ADC_Init() function can be called before the ADC_Start() or ADC_Enable() functions.
ADC_offset	This variable is used to calibrate the offset. It is set to 0 the first time ADC_Start() is called and can be modified using ADC_SetOffset(). The variable affects ADC_CountsTo_Volts(), ADC_CountsTo_mVolts(), and ADC_CountsTo_uVolts()by subtracting the given offset.
ADC_countsPerVolt	This variable is used to calibrate the gain. It is calculated the first time ADC_Start() is called and each time ADC_SetResolution() is called. The value depends on resolution, input range, and voltage reference. It can be modified using ADC_SetGain(). This variable affects the ADC_CountsTo_Volts, ADC_CountsTo_mVolts, and ADC_CountsTo_uVolts functions by supplying the correct conversion between ADC counts and the applied input voltage.
ADC_shift	In differential input mode the SAR ADC outputs digitally converted data in a binary offset scheme. This variable is used to convert the ADC counts to 2's complement form. Initially this variable is calculated the first time ADC_Start() is called and each time ADC_SetResolution is called. The calculated value depends on the resolution and input mode. This variable affects ADC_GetResult8() and ADC_GetResult16() by subtracting the correct shift value.

void ADC_Start(void)

Description: This is the preferred method to begin component operation. ADC_Start() sets the initVar variable, calls the ADC_Init() function, and then calls the ADC_Enable() function.

Parameters: None

Return Value: None

Side Effects: If the initVar variable is already set, this function only calls the ADC_Enable() function.

void ADC_Stop(void)

Description: Stops ADC conversions and powers down the ADC.

Note This API is not recommended for use on PSoC 3 ES2 and PSoC 5 ES1 silicon. These devices have a defect that causes connections to several analog resources to be unreliable when not powered. The unreliability manifests itself in silent failures (e.g. unpredictably bad results from analog components) when the component utilizing that resource is stopped. It is recommended that all analog components in a design should be powered up (by calling the ADC_Start() APIs) at all times. Do not call the ADC_Stop() APIs.

Parameters: None

Return Value: None

Side Effects: None

void ADC_SetPower(uint8 power)

Description: Sets the operational power of the ADC. The higher power settings should be used with faster clock speeds.

Parameters: (uint8) power: Power setting.

Parameters Name	Value	Description	Clock Rate
ADC__HIGHPOWER	0	Normal power	18 MHz
ADC__MEDPOWER	1	1/2 power	9 MHz
ADC__LOWPOWER	2	1/3 power	6 MHz
ADC__MINPOWER	3	1/4 power	4.5 MHz

Return Value: None

Side Effects: Power setting may affect conversion accuracy.

void ADC_SetResolution(uint8 resolution)

Description: Sets the resolution of the ADC.

Parameters: (uint8) resolution: Resolution setting.

Parameters Name	Value	Description
ADC__BITS_12	12	Sets resolution to 12 bits.
ADC__BITS_10	10	Sets resolution to 10 bits.
ADC__BITS_8	8	Sets resolution to 8 bits.

Return Value: None

Side Effects: The ADC resolution cannot be changed during a conversion cycle. The recommended best practice is to stop conversions with ADC_StopConvert(), change the resolution, then restart the conversions with ADC_StartConvert().

If you decide not to stop conversions before calling this API, you should use ADC_IsEndConversion() to wait until conversion is complete before changing the resolution.

If you call ADC_SetResolution() during a conversion, the resolution will not be changed until the current conversion is complete. Data will not be available in the new resolution for another 6+"New Resolution(in bits)" clock cycles. You may be required to add a delay of this number of clock cycles after SetResolution() is called before data is valid again.
Affects ADC_CountsTo_Volts, ADC_CountsTo_mVolts, and ADC_CountsTo_uVolts by calculating the correct conversion between ADC counts and the applied input voltage. Calculation depends on resolution, input range and voltage reference.

void ADC_StartConvert(void)

Description: Forces the ADC to initiate a conversion. In Free Running mode, the ADC will run continuously. In the triggered mode of operation, the function also acts as a software version of the SOC, and every conversion has to be triggered by ADC_StartConvert().

Parameters: None

Return Value: None

Side Effects: Calling ADC_StartConvert() will disable the external SOC pin.

void ADC_StopConvert(void)

Description: Forces the ADC to stop all conversions.

Parameters: None

Return Value: None

Side Effects: In the triggered mode of operation, this function sets a software version of the SOC to low level and switches the SOC source to hardware SOC input.

void ADC_IRQ_Enable(void)

Description: Enables interrupts to occur at the end of a conversion. Global interrupts must also be enabled for the ADC interrupts to occur. To enable global interrupts, call the enable global interrupt macro "`CYGlobalIntEnable;`" in your *main.c* file before enabling any interrupts.

Parameters: None

Return Value: None

Side Effects: Enables interrupts to occur. Reading the result will clear the interrupt.

void ADC_IRQ_Disable(void)

Description: Disables interrupts at the end of a conversion.

Parameters: None

Return Value: None

Side Effects: None

uint8 ADC_IsEndConversion(uint8 retMode)

Description: Immediately returns the status of the current conversion OR does not return (blocking) until the conversion completes, depending on the retMode parameter.

Parameters: (uint8) retMode: Check conversion return mode. See table below for options.

Options	Description
ADC_RETURN_STATUS	Immediately returns conversion result status.
ADC_WAIT_FOR_RESULT	Does not return until ADC conversion is complete.

Return Value: (uint8) If a non-zero value is returned, the last conversion has completed. If the returned value is zero, the ADC is still calculating the last result.

Side Effects: None

int8 ADC_GetResult8(void)

Description: This function will return the result of an 8-bit conversion. If the resolution is set greater than 8-bits, the LSB of the result will be returned. ADC_IsEndConversion() should be called to verify that the data sample is ready.

Parameters: None

Return Value: (int8) The LSB of the last ADC conversion.

Side Effects: Converts the ADC counts to the 2's complement form.

int16 ADC_GetResult16(void)

Description: Returns a 16-bit result for a conversion with a result that has a resolution of 8 to 12 bits. ADC_IsEndConversion() should be called to verify that the data sample is ready.

Parameters: None

Return Value: (int16) The 16-bit result of the last ADC conversion.

Side Effects: Converts the ADC counts to the 2's complement form.

void ADC_SetOffset(int16 offset)

Description: Sets the ADC offset, which is used by ADC_CountsTo_Volts(), ADC_CountsTo_mVolts(), and ADC_CountsTo_uVolts() to subtract the offset from the given reading before calculating the voltage conversion.

Parameters: (int16) offset: This value is measured when the inputs are shorted or connected to the same input voltage.

Return Value: None

Side Effects: Affects ADC_CountsTo_Volts(), ADC_CountsTo_mVolts(), and ADC_CountsTo_uVolts() by subtracting the given offset.

void ADC_SetGain(int16 adcGain)

Description: Sets the ADC gain in counts per volt for the voltage conversion functions below. This value is set by default by the reference and input range settings. It should only be used to further calibrate the ADC with a known input or if an external reference is used.

Parameters: (int16) adcGain: ADC gain in counts per volt.

Return Value: None

Side Effects: Affects ADC_CountsTo_Volts(), ADC_CountsTo_mVolts(), ADC_CountsTo_uVolts() by supplying the correct conversion between ADC counts and the applied input voltage.

float ADC_CountsTo_Volts(int16 adcCounts)

Description: Converts the ADC output to volts as a floating point number. For example, if the ADC measured 0.534 volts, the return value would be 0.534.

Parameters: (int16) adcCounts: Result from the ADC conversion.

Return Value: (float) Result in volts.

Side Effects: None

int16 ADC_CountsTo_mVolts(int16 adcCounts)

Description: Converts the ADC output to mVolts as a 16-bit integer. For example, if the ADC measured 0.534 volts, the return value would be 534.

Parameters: (int16) adcCounts: Result from the ADC conversion.

Return Value: (int16) Result in mVolts.

Side Effects: None

int32 ADC_CountsTo_uVolts(int16 adcCounts)

Description: Converts the ADC output to uVolts as a 32-bit integer. For example, if the ADC measured 0.534 volts, the return value would be 534000.

Parameters: (int16) adcCounts: Result from the ADC conversion.

Return Value: (int32) Result in uVolts.

Side Effects: None

void ADC_Sleep(void)

Description: This is the preferred routine to prepare the component for sleep. The ADC_Sleep() routine saves the current component state. Then it calls the ADC_Stop() function and calls ADC_SaveConfig() to save the hardware configuration.

Call the ADC_Sleep() function before calling the CyPmSleep() or the CyPmHibernate() function. Refer to the PSoC Creator *System Reference Guide* for more information about power management functions.

Parameters: None

Return Value: None

Side Effects: None

void ADC_Wakeup(void)

Description: This is the preferred routine to restore the component to the state when ADC_Sleep() was called. The ADC_Wakeup() function calls the ADC_RestoreConfig() function to restore the configuration. If the component was enabled before the ADC_Sleep() function was called, the ADC_Wakeup() function will also re-enable the component.

Parameters: None

Return Value: None

Side Effects: Calling the ADC_Wakeup() function without first calling the ADC_Sleep() or ADC_SaveConfig() function may produce unexpected behavior.

void ADC_SaveConfig(void)

Description: This function saves the component configuration and non-retention registers. This function will also save the current component parameter values, as defined in the Configure dialog or as modified by appropriate APIs. This function is called by the ADC_Sleep() function.

Parameters: None

Return Value: None

Side Effects: All ADC configuration registers are retained. This function does not have an implementation and is meant for future use. It has been provided here so that the APIs are consistent across components.

void ADC_RestoreConfig(void)

Description: This function restores the component configuration and non-retention registers. This function will also restore the component parameter values to what they were prior to calling the ADC_Sleep() function.

Parameters: None

Return Value: None

Side Effects: Calling this function without first calling the ADC_Sleep() or ADC_SaveConfig() function may produce unexpected behavior. This function does not have an implementation and is meant for future use. It has been provided here so that the APIs are consistent across components.

void ADC_Init(void)

Description: Initializes or restores the component according to the customizer Configure dialog settings. It is not necessary to call ADC_Init() because the ADC_Start() routine calls this function and is the preferred method to begin component operation.

Parameters: None

Return Value: None

Side Effects: All registers will be set to values according to the customizer Configure dialog.

void ADC_Enable(void)

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

Parameters: None

Return Value: None

Side Effects: None

DMA

The DMA component can be used to transfer converted results from ADC_SAR register to RAM. The DMA data request signal (DRQ) should be connected to the EOC pin from the ADC. The DMA Wizard can be used to configure DMA operation as follows:

Name of DMA source	Length	Direction	DMA Request Signal	DMA Request Type	Description
ADC_SAR_WRK0_PTR	2	Source	EOF	Rising Edge	Receive a 2 byte result for a conversion with a result that has a resolution of 8 to 12 bits.

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.

Interrupt Service Routine

The ADC_SAR contains a blank interrupt service routine in the file ADC_SAR_1_INT.c file, where "ADC_SAR_1" is the instance name. You may place custom code in the designated areas to perform whatever function is required at the end of a conversion. A copy of the blank interrupt service routine is shown below. Place custom code between the " /* `#START MAIN_ADC_ISR` */ " and "/* `#END` */ " comments. This ensures that the code will be preserved when a project is regenerated.

```
CY_ISR( ADC_SAR_1_ISR )
{
    /* Place user ADC ISR code here. This can be a good place */
    /* to place code that is used to switch the input to the  */
    /* ADC. It may be good practice to first stop the ADC     */
    /* before switching the input then restart the ADC.       */

    /* `#START MAIN_ADC_ISR` */
    /* Place user code here. */
    /* `#END` */
}
```

A second designated area is made available to place variable definitions and constant definitions.

```
/* System variables */

/* `#START ADC_SYS_VAR` */
```

```
    /* Place user code here. */
/* `#END`  */
```

Below is an example code that uses an interrupt to capture data.

```
#include <device.h>

int16  result = 0;
uint8 dataReady = 0;
void main()
{
    int16 newReading = 0;
    CYGlobalIntEnable;           /* Enable Global interrupts */
    ADC_SAR_1_Start();           /* Initialize ADC */
    ADC_SAR_1_IRQ_Enable();      /* Enable ADC interrupts */
    ADC_SAR_1_StartConvert();    /* Start ADC conversions */
    for(;;)
    {
        if (dataReady != 0)
        {
           dataReady = 0;
           newReading = result;
           /* More user code */
        }
    }
}
```

Interrupt code segments in the file ADC_SAR_1_INT.c.

```
   /*********************************
   *      System variables
   *********************************/
   /* `#START ADC_SYS_VAR`  */
    extern int16 result;
    extern uint8 dataReady;
    /* `#END`  */

CY_ISR(ADC_SAR_1_ISR )
{
    /*********************************************/
    /* Place user ADC ISR code here.             */
    /* This can be a good place to place code    */
    /* that is used to switch the input to the   */
    /* ADC. It may be good practice to first     */
    /* Stop the ADC before switching the input   */
    /* then restart the ADC.                     */
    /*********************************************/
    /* `#START MAIN_ADC_ISR`  */
        result = ADC_SAR_1_GetResult16();
        dataReady = 1;
    /* `#END`  */
}
```

It is important to set the Conversion Rate and Master Clock parameters correctly.

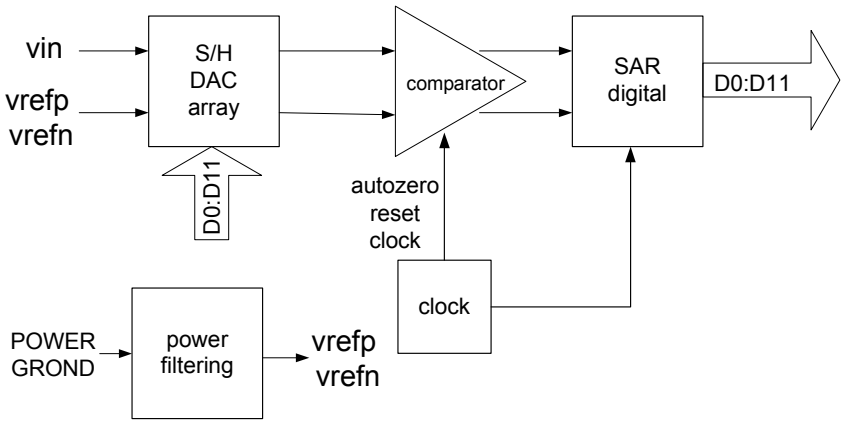
For example, at the maximum conversion rate (1 Msps at 12 bits) the Master Clock should be set to 72 MHz (4 x 18 MHz) in the Design-Wide Resources Clock Editor, and the ISR routine should be optimized. Otherwise, the processor will not be able to handle the ISR quickly enough. If a lower Master Clock is selected, the run time of the ISR will be longer than ADC_SAR conversion time.

You can optimize the ISR by reading sample registers directly:

```
CY_ISR(ADC_SAR_1_ISR )
{
    /*********************************************/
    /* Place user ADC ISR code here.             */
    /* This can be a good place to place code    */
    /* that is used to switch the input to the   */
    /* ADC. It may be good practice to first     */
    /* Stop the ADC before switching the input   */
    /* then restart the ADC.                     */
    /*********************************************/
    /* `#START MAIN_ADC_ISR`  */
        result = (ADC_SAR_1_SAR_WRK1_REG << 8) | ADC_SAR_1_SAR_WRK0_REG;
        dataReady = 1;
    /* `#END`  */
}
```

Functional Description

The block diagram is shown in the following figure. An input analog signal is sampled and compared with the output of a DAC using a binary search algorithm to determine the conversion bits in succession from MSB to LSB.



Registers

Sample Registers

The ADC results may be between 8 and 12 bits of resolution. The output is divided into two 8 bit registers. The CPU or DMA may access these register to read the ADC result.

ADC_SAR_WRK0_REG (SAR working register 0)

Bits	7	6	5	4	3	2	1	0
Value	Data[7:0]							

ADC_SAR_WRK1_REG (SAR working register 1)

Bits	7	6	5	4	3	2	1	0
Value	overrun_det	NA			Data[11:8]			

- Data[11:0] - the ADC results
- overrun_det - data overrun detection flag, this function is disabled by default.

DC and AC Electrical Characteristics

Not applicable.

Component Changes

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

Version	Description of Changes	Reason for Changes / Impact
1.50.a	Added Clock Frequency verification.	This change provides a way to avoid using the SAR ADC with an out of spec clock. If updating from version 1.10 of the SAR ADC component and using an out of working range clock, select a correct clock frequency.
	Added information to the component that advertizes its compatibility with silicon revisions.	The tool reports an error/warning if the component is used on incompatible silicon. If this happens, update to a revision that supports your target device.
	Minor datasheet edits and updates	

Version	Description of Changes	Reason for Changes / Impact
1.50	Added Sleep/Wakeup and Init/Enable APIs.	To support low power modes, as well as to provide common interfaces to separate control of initialization and enabling of most components.
	Added ADC_CountsTo_Volts and ADC_CountsTo_uVolts APIs.	Extend functionality. This APIs returns converted result in Volts and uVolts.
	Added DMA Capabilities file to the component.	This file allows the ADC_SAR to be supported by the DMA Wizard tool in PSoC Creator.
	Conversion of the ADC counts to the 2's complement form has been implemented in the ADC_GetResult8 and ADC_GetResult16 APIs. The same removed from ADC_CountsTo_mVolts function.	This change has been done for consistency with the ADC DelSig.