PSoC 4 Die Temperature (DieTemp)

1.0

Features

- Typical measured accuracy of +/- 1 ºC
- Valid operating range from –40 °C to +85 °C

General Description

The Die Temperature component provides access to the analog signal whose voltage represents the temperature of the die. It also provides the API needed to convert the digital voltage representation of that analog signal to a temperature. This component does not provide the mechanism to convert the analog voltage to a digital value. That must be done in the design by connecting the signal to the ADC in the device and sampling the voltage.

When to Use DieTemp

This component can be used to get a rough temperature measurement of the device. This value will also be correlated with the temperature within the enclosure the device is in.

Input/Output Connections

temp – Analog

This analog output is the connection of the die temperature to the SAR ADC for conversion.

Component Parameters

There are no parameters or user interface available for this component.

Placement

The DieTemp component uses the die temperature sensor, which is a part of SAR 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 "DieTemp_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 "DieTemp".

int32 DieTemp_CountsTo_Celsius(int32 adcCounts)

Description: Converts the ADC output to degrees Celsius.

Parameters: (int32) adcCounts

Return Value: Die Temperature in degrees Celsius.

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.

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 Die Temperature component does not have any specific deviations.

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	80	0

Functional Description

For all supported PSoC4 families except PSoC Analog Coprocessor, the DieTemp component is always used in conjunction with the ADC SAR Sequencer to sample the analog voltage and produce a digital value. Since the temperature changes slowly, this signal is commonly used with the injection channel to sample the value infrequently compared to other signals being converted by the ADC.

Recommended ADC SAR Sequencer settings for a die temperature measurement:

Note This configuration assumes that channel 0 is used by the application and must be connected to a driver.

Figure 1. Component Connection

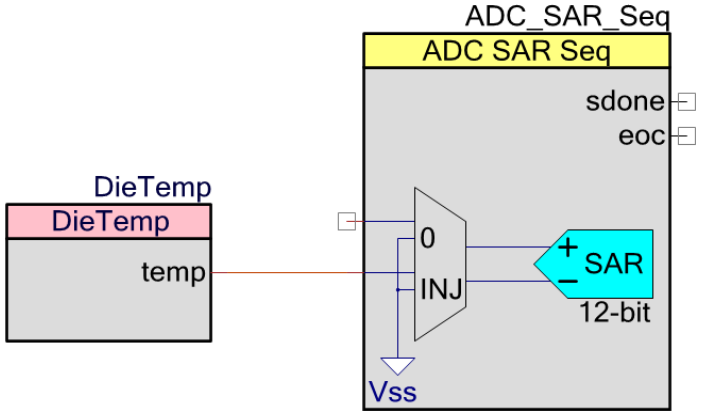


Figure 2 and Figure 3 show recommended ADC SAR Sequencer Settings.

Figure 2. ADC SAR Sequencer Settings – General Tab

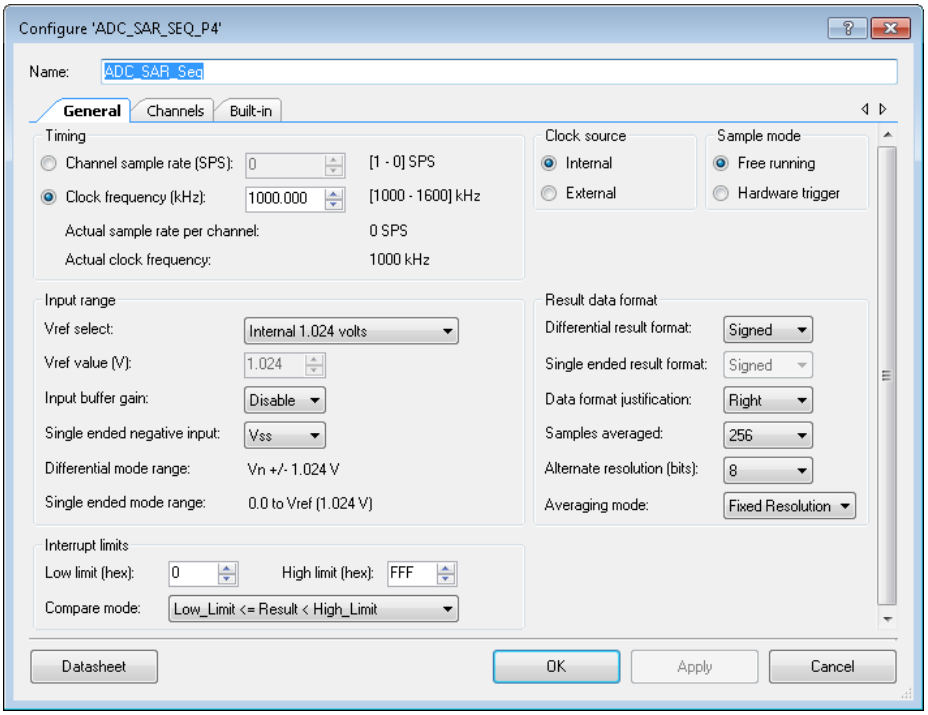
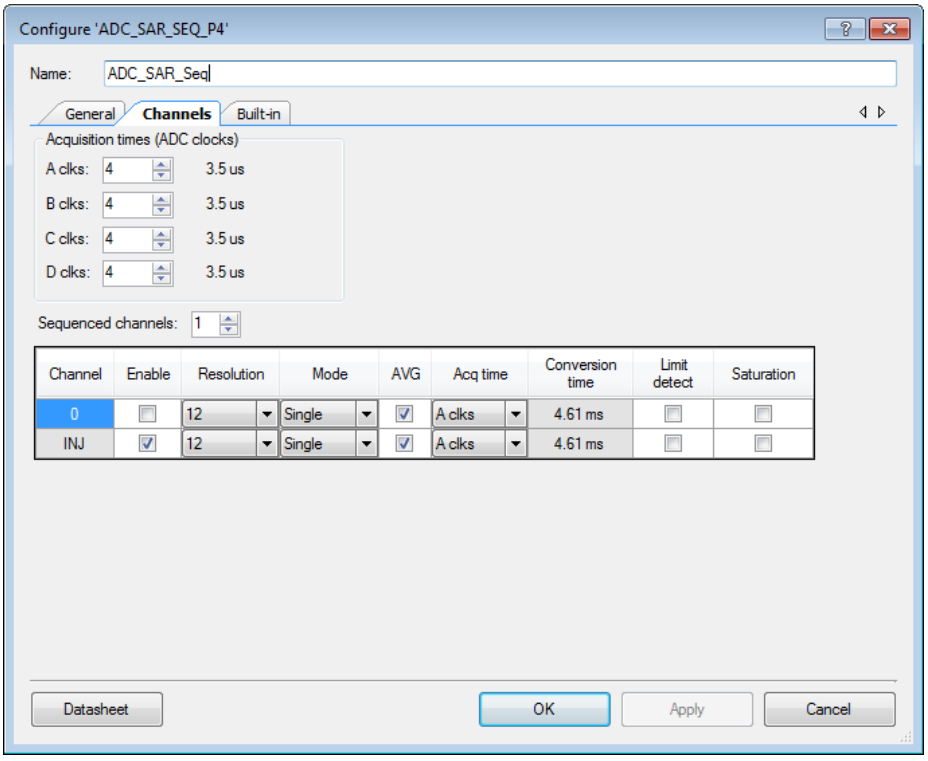


Figure 3. ADC SAR Sequencer Settings – Channels Tab



Key parameters of ADC SAR Sequencer include:

- Channel Mode [1] – Single
- Resolution [1] – 12 bit
- Data format justification – Right
- Reference – Internal, 1.024 volts
- Sample rate – <= 100 ksps
- Samples averaged – value >16 may be used to reduce noise
- Averaging mode – Fixed Resolution
- Single ended negative input – Vss.

Not following the proposed settings may lead to unexpected behavior of the component or poor accuracy of measurements. However, the value of Vref can be different from 1024 mV. If the value of Vref in the ADC SAR Sequencer settings is different from the proposed, the value of adcCounts that is passed to DieTemp_CountsTo_Celsius API should be adjusted:

$$ADCCountsCorrected = (Ref_{act}/1.024) * ADCCounts$$

Where:

- *ADCCountsCorrected* is the corrected number of ADC counts, which should be used as a parameter for the DieTemp_CountsTo_Celsius API.
- *ADCCounts* is the actual measurement result from ADC SAR.
- Ref_{act} is the actual voltage reference in volts.

Using the Injection channel is recommended because conversion can only be triggered with a firmware trigger and it is not a part of a regular scan. If the component is used with other channels, it is recommended to configure acquisition time to be at least 5 µs, otherwise temperature values will be unreliable due to temperature sensor settling time.

Triggering the Injection channel is recommended no sooner than one second after the previous trigger has completed.

The component is only intended for operation with the on-chip ADC SAR and should not be connected to any other analog resource or routed off the chip.

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[1] For Injection channel (or the one to which the component is connected.)

For the PSoC Analog Coprocessor family, the DieTemp component is used in conjunction with the Scan_ADC component (named ADC) shown in Figure 4.

Figure 4. Component Connection

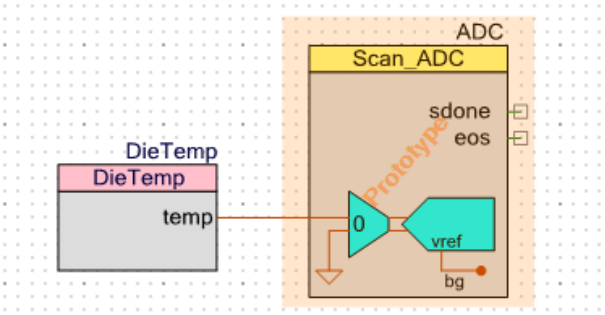
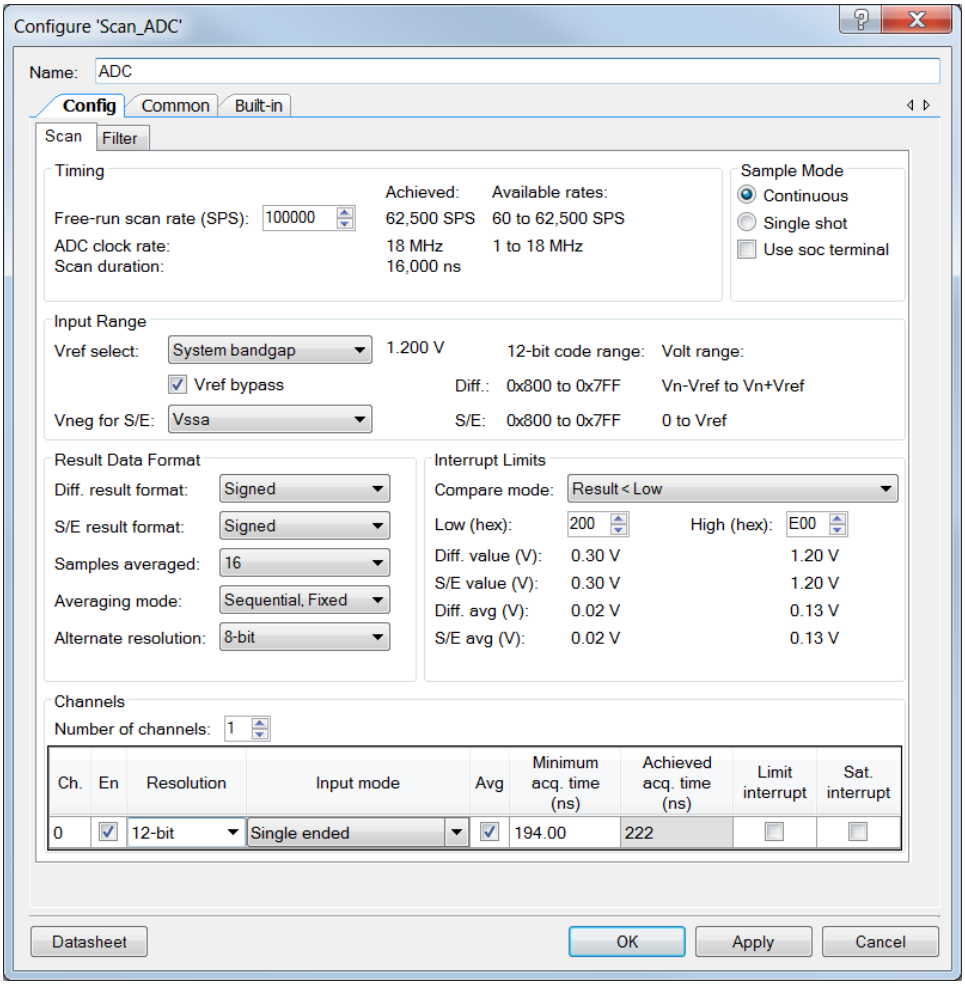


Figure 5 shows the recommended settings for a die temperature measurement.

Figure 5. ADC Settings – Config Tab



Key parameters of the ADC include:

- VPOS connected to the temp sensor diode
- VNEG connected to VSSA
- 12-bit output from the Results register
- Vref select: System bandgap
- Averaging is enabled (checkbox is checked) for appropriate channel
- Samples averaged ≥ 16
- Averaging mode: Sequential, Fixed

Not following the proposed settings may lead to unexpected behavior of the component or poor accuracy of measurements.

Resources

Configuration	Resource Type
	Die tempersture sensor of the SAR block
Default	1

DC and AC Electrical Characteristics

Parameter	Description	Min	Typ	Max	Units	Details/Conditions
$T_{SENSACC}$	Temperature sensor accuracy	–5	±1	+5	°C	–40 to +85 °C

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.h	Minor datasheet edits.	
1.0.g	Edited datasheet.	Added guidance for how to use the ADC with the PSoC Analog Coprocessor family. Removed characterization note because it doesn't apply to this component.
1.0.f	Edited datasheet.	Final characterization data for PSoC 4000S, PSoC 4100S and PSoC Analog Coprocessor devices is not available at this time. Once the data is available, the component datasheet will be updated on the Cypress web site.
1.0.e	Updated the Component Catalog visibility expression to support PSoC 4100S and PSoC Analog Coprocessor devices.	Added new device support.
1.0.d	Updated datasheet.	
1.0.c	Updated datasheet.	Updated the MISRA Compliance section. Clarified the Features section. Clarified the Functional Description section.
1.0.b	Updated the Functional Description section of the datasheet.	To clarify ADC SAR Sequencer required settings and timing information.
1.0.a	Updated datasheet.	Updated MISRA Compliance section.
1.0	First release	