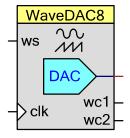


## **WaveDAC8 (8-Bit Waveform Generator)**

1.70

### **Features**

- Supports standard and arbitrary waveform generation
- Output may be voltage or current, sink or source
- Hardware selection between two waveforms
- Waveforms may be up to 4000 points
- Predefined sine, triangle, square, and sawtooth waveforms.
- May changed waveform arrays during runtime



## **General Description**

The WaveDAC8 component provides a simple and fast solution for automatic periodic waveform generation. A high level interface allows the user to select a predefined waveform or a custom arbitrary waveform. Two separate waveforms can be defined then selected with an external pin to create a modulated output. The input clock can also be used to change the sample rate, or modulate the output.

## Input/Output Connections

This section describes the various input and output connections for the VDAC8. 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.

### Vout - Analog

The Vout terminal is the connection to the DAC's voltage output. It may be routed to any analog compatible pin on the PSoC.

### ws – Input

This input selects which waveform will be generated. It can be used to switch quickly between two waveforms to generate an FSK signal.

### clk - Input\*

The clock input allows the user to use an alternate clock source. When internal clock is slected, this input is not visible.

#### wc1 - Output

This signal goes high for one bus clock at the end of the waveform 1.

### wc2 - Output

This signal goes high for one bus clock at the end of the waveform 2.

## **Parameters and Setup**

Drag a WaveDAC8 component onto your design and double-click it to open the Configure dialog.

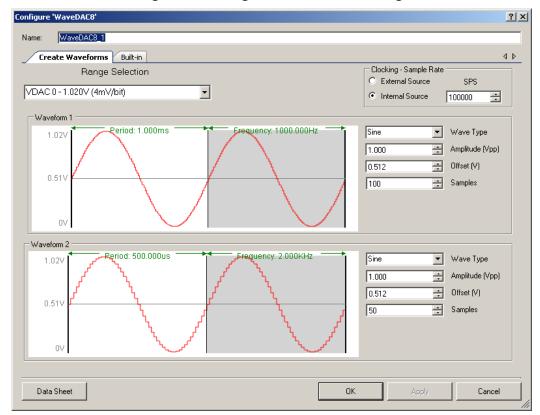


Figure 1 Configure WaveDAC8 Dialog

The WaveDAC8 component provides the following parameters.



Page 2 of 12 Version 1.70

### **Range Selection**

This parameter selects the output mode and range of the internal DAC.

Range	Mode	Ouput	Step Size
VDAC 0 - 1.020V (4mV/bit)	Voltage	0 to 1.020 Volts	4 mV
VDAC 0 - 4.080 (16mV/bit)	Voltage	0 to 4.080 volts	16 mV
ISink 0 – 2.040 mA	Current Sink	0 to 2.040 mA	8 uA
ISink 0 – 255 uA	Current Sink	0 to 255 uA	1 uA
ISink 0 – 32 uA	Current Sink	0 to 32 mA	0.125 uA
ISource 0 – 2.040 mA	Current Source	0 to 2.040 mA	8 uA
ISource 0 – 255 uA	Current Source	0 to 255 uA	1 uA
ISource 0 – 32 uA	Current Source	0 to 32 mA	0.125 uA

Note: Both waveforms share the range.

### **SPS** (Clocking – Sample Rate)

This parameter selects the sampling frequency rate in Hz. The maximum sample rate is 1 MHz. The frequency of the selected waveform will be the number of samples divided by the sample rate. Both waveforms will share the same sample rate.

$$Waveform\_Period = \frac{Samples}{SPS}$$
  $Waveform\_Frequency = \frac{SPS}{Samples}$ 

### Clock Source (Internal / External )

These radio buttons select whether the clock source is external or external. When an internal clock is selected, the clock pin will not be visible.

### **Wave Type**

This parameter selects one of five waveforms, four are fixed and one allows the user to input his own waveform.

- Sine
- Square
- Triangle
- Sawtooth
- Arbitrary



### Resources

The WaveDAC8 component uses either a VDAC8 or IDAC8, two DMA channels, and an optional clock.

## **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 "WaveDAC8\_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 "WaveDAC8".

Function	Description
void WaveDAC8_Start(void)	Starts the DAC and DMA channels
void WaveDAC8_Stop(void)	Disables DAC and DMA channels
void WaveDAC8_Wave1Setup(uint8 * WavePtr, uint16 SampleSize)	Sets the array and size of array used for waveform generation for waveform 1.
void WaveDAC8_Wave2Setup(uint8 * WavePtr, uint16 SampleSize)	Sets the array and size of array used for waveform generation for waveform 2.
void WaveDAC8_SetSpeed(uint8 speed)	Set drive speed of DAC.
void WaveDAC8_Sleep(void)	Stops and saves the user configuration.
void WaveDAC8_Wakeup(void)	Restores and enables the user configuration.
void WaveDAC8_SaveConfig(void)	Empty function. Provided for future usage.
void WaveDAC8_RestoreConfig(void)	Empty function. Provided for future usage.



Page 4 of 12 Version 1.70

### void WaveDAC8\_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 input and feedback resistance values are configured for the operating mode selected in the design. When called to restart the WaveDAC8 following a WaveDAC8 Stop() call, the current component parameter settings

are retained.

Parameters: None
Return Value: None
Side Effects: None

## void WaveDAC8\_Stop(void)

**Description:** Turn off the WaveDAC8 block.

Parameters: None Return Value: None

Side Effects: Does not affect WaveDAC8 type or power settings

### void WaveDAC8\_Wave1Setup(uint8 \* WavePtr, uint16 SampleSize)

**Description:** Select new waveform array for waveform 1 output. The WaveDAC8\_Stop function should be

called prior to calling this function and WaveDAC8 Start should be called to restart

waveform.

Parameters: Uint8 \* WavePtr: Pointer to array containing waveform data

Uint16 SampleSize: Size of waveform array pointed to by WavePtr. (Maximum sample size is

4096)

Return Value: None

**Side Effects:** Does not affect WaveDAC8 type or power settings

#### void WaveDAC8 Wave2Setup(uint8 \* WavePtr, uint16 SampleSize)

**Description:** Select new waveform array for waveform 2 output. The WaveDAC8\_Stop function should be

called prior to calling this function and WaveDAC8\_Start should be called to restart

waveform.

**Parameters:** Uint8 \* WavePtr: Pointer to array containing waveform data

Uint16 SampleSize: Size of waveform array pointed to by WavePtr. (Maximum sample size is

4096)

Return Value: None

**Side Effects:** Does not affect WaveDAC8 type or power settings

#### void WaveDAC8\_Init(void)

**Description:** Initializes or restores the component according to the customizer Configure dialog settings. It

is not necessary to call WaveDAC8\_Init() because the WaveDAC8\_Start() API 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 WaveDAC8\_Enable(void)

**Description:** Activates the hardware and begins component operation. It is not necessary to call

WaveDAC8 Enable() because the WaveDAC8 Start() API calls this function, which is the

preferred method to begin component operation.

Parameters: None
Return Value: None
Side Effects: None



Page 6 of 12 Version 1.70

### void WaveDAC8\_SetSpeed(uint8 power)

**Description:** Sets the drive power to one of four settings;

**Parameters:** (uint8) power: See the following table for valid power settings.

Power Setting	Notes
WaveDAC8_LOWSPEED	Lowest active power and slowest slew rate.
WaveDAC8_HIGHSPEED	Highest power and fastest slew rate.

Return Value: None
Side Effects: None

## void WaveDAC8\_Sleep(void)

**Description:** This is the preferred API to prepare the component for sleep. The WaveDAC8\_Sleep() API

saves the current component state. Then it calls the WaveDAC8 Stop() function and calls

WaveDAC8\_SaveConfig() to save the hardware configuration.

Call the WaveDAC8\_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 WaveDAC8\_Wakeup(void)

**Description:** This is the preferred API to restore the component to the state when WaveDAC8 Sleep()

was called. The WaveDAC8\_Wakeup() function calls the WaveDAC8\_RestoreConfig()

function to restore the configuration. If the component was enabled before the

WaveDAC8 Sleep() function was called, the WaveDAC8 Wakeup() function will also re-

enable the component.

Parameters: None Return Value: None

Side Effects: Calling the WaveDAC8 Wakeup() function without first calling the WaveDAC8 Sleep() or

WaveDAC8\_SaveConfig() function may produce unexpected behavior.

#### void WaveDAC8\_SaveConfig(void)

**Description:** This function saves the component configuration and nonretention 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 WaveDAC8 Sleep() function.

Parameters: None Return Value: None

Side Effects: None

#### void WaveDAC8\_RestoreConfig(void)

**Description:** This function restores the component configuration and nonretention registers. This function

will also restore the component parameter values to what they were before calling the

WaveDAC8\_Sleep() function.

Parameters: None
Return Value: None
Side Effects: None

## **Sample Firmware Source Code**

The following is a C language example demonstrating the basic functionality of the VDAC8 component. This example assumes the component has been placed in a design with the default name "WaveDAC8 1."

**Note** If you rename your component you must also edit the example code as appropriate to match the component name you specify.

```
#include <device.h>
uint8 otherWave1[8] = {0, 32, 64, 96, 128, 160, 192, 224 };
uint8 otherWave2[4] = {0, 64, 128, 255 };
extern uint8 WaveDAC8_1_wave1[];
extern uint8 WaveDAC8_1_wave2[];
void main()
{
   WaveDAC8_1_Start();
    for(;;)
      CyDelay(2200); // Change to alternate waveforms.
      WaveDAC8_1_Stop();
      WaveDAC8_1_Wave1Setup( otherWave1, 8);
      WaveDAC8_1_Wave2Setup( otherWave2, 4);
      WaveDAC8_1_Start();
      CyDelay(2200); // Change back to original waveforms.
      WaveDAC8_1_Stop();
      WaveDAC8_1_Wave1Setup(WaveDAC8_1_wave1, WaveDAC8_1_WAVE1_LENGTH);
```



Page 8 of 12 Version 1.70

```
WaveDAC8_1_Wave2Setup(WaveDAC8_1_wave2, WaveDAC8_1_WAVE2_LENGTH);
WaveDAC8_1_Start();
}
```

## **DC and AC Electrical Characteristics**

## **DC Characteristics (VDAC Mode)**

Parameter	Description	Conditions	Min	Тур	Max	Units
	Resolution		_	8	_	bits
INL1	Integral nonlinearity	1-V scale	_	±2.1	±2.5	LSB
DNL1	Differential nonlinearity	1-V scale	_	±0.3	±1	LSB
R <sub>out</sub>	Output resistance	1-V scale	_	4	_	kΩ
		4-V scale	_	16	_	kΩ
$V_{OUT}$	Output voltage range,	1-V scale	_	1	_	V
	code = 255	4-V scale, V <sub>DDA</sub> = 5 V	_	4	_	V
	Monotonicity		_	_	Yes	_
V <sub>OS</sub>	Zero-scale error		_	0	±0.9	LSB
FSGainErr	Full-scale gain error	1-V scale	_	±1.6	±2.5	%
	1	4-V scale	_	±1.5	±2.5	%
TCGainErr	Temperature coefficient,	1-V scale	_	_	0.02	%FSR/℃
	gain error	4-V scale	_	_	0.02	%FSR/℃
I <sub>DD</sub>	Operating current	Slow mode	_	_	100	μΑ
		Fast mode	_	_	500	μΑ

## **AC Electrical Characteristics (VDAC Mode)**

Parameter	Description	Conditions	Min	Тур	Max	Units
F <sub>DAC</sub>	Update rate	1-V scale	_	_	1000	ksps
		4-V scale	_	_	250	ksps
TsettleP	Settling time to 0.1%,	1-V scale, C <sub>LOAD</sub> = 15 pF	_	0.45	1	μs
	step 25% to 75%	4-V scale, $C_{LOAD} = 15 pF$	_	0.8	3.2	μs
TsettleN	Settling time to 0.1%,	1-V scale, C <sub>LOAD</sub> = 15 pF	_	0.45	1	μs
	step 75% to 25%	4-V scale, C <sub>LOAD</sub> = 15 pF	_	0.7	3	μs
SRP	Slew rate, step 10% to 90%	1-V scale, C <sub>LOAD</sub> = 15 pF	_	0.3	0.5	μs
		4-V scale, C <sub>LOAD</sub> = 15 pF	_	0.5	1.3	μs
SRN	Slew rate, step 90% to 10%	1-V scale, C <sub>LOAD</sub> = 15 pF	_	0.3	0.5	μs
		4-V scale, C <sub>LOAD</sub> = 15 pF	_	0.3	1.3	μs
Vn4V	Noise density <sup>1</sup>	4-V scale, code 255	_	3	_	μV/rtHz
Vn1V	Noise density <b>Error! Unknown</b>	1-V scale, code 255	_	750	_	nV/rtHz

<sup>&</sup>lt;sup>1</sup> Output noise is directly proportional to code value.



Version 1.70

switch argument.			

## **DC Characteristics (IDAC Mode)**

Parameter	Description	Conditions	Min	Тур	Max	Units
	Resolution		_	_	8	bits
l <sub>оит</sub>	Output current at code = 255	Range = 2.040 mA, code = 255, $V_{DDA} \ge 2.7 \text{ V}, R_{LOAD} = 600 \Omega$	-	2.040	-	mA
		Range = 2.040 mA, High mode, code = 255, $V_{DDA} \le 2.7 V$ , $R_{LOAD} = 300 \Omega$	_	2.040	_	mA
		Range = 255 $\mu$ A, code = 255, R <sub>LOAD</sub> = 600 $\Omega$	-	255	_	μΑ
		Range = 31.875 $\mu$ A, code = 255, R <sub>LOAD</sub> = 600 $\Omega$	-	31.875	_	μΑ
	Monotonicity		-	_	Yes	
Ezs	Zero scale error		1	0	±1	LSB
Eg	Gain error		-	_	3.5	%
INL	Integral nonlinearity	Sink mode, range = 255 $\mu$ A, Codes 8 to 255, R <sub>LOAD</sub> = 2.4 k $\Omega$ , Cload = 15 pF	-	±1.2	±1.5	LSB
		Source mode, range = 255 $\mu$ A, Codes 8 – 255, R <sub>LOAD</sub> = 2.4 k $\Omega$ , C <sub>LOAD</sub> = 15 pF	-	±0.9	±1	LSB
DNL	Differential nonlinearity	Sink mode, range = 255 $\mu$ A, R <sub>LOAD</sub> = 2.4 k $\Omega$ , C <sub>LOAD</sub> = 15 pF	1	±0.3	±0.5	LSB
		Source mode, range = 255 $\mu$ A, R <sub>LOAD</sub> = 2.4 k $\Omega$ , C <sub>LOAD</sub> = 15 pF	1	±0.3	±0.5	LSB
Vcompliance	Dropout voltage, source or sink mode	Voltage headroom at max current, $R_{\text{LOAD}}$ to $V_{\text{DDA}}$ or $R_{\text{LOAD}}$ to $V_{\text{SSA}}$ , $V_{\text{DIFF}}$ from $V_{\text{DDA}}$	1	_	ı	V
I <sub>DD</sub>	Operating current, code = 255	Slow mode, source mode, range = 31.875 μA	-	_	44	μΑ
		Slow mode, source mode, range = 255 µA,	_	_	33	μΑ
		Slow mode, source mode, range = 2.04 mA	_	_	33	μΑ
		Slow mode, sink mode, range = 31.875 μA	1	-	36	μΑ
		Slow mode, sink mode, range = 255 μΑ	-	-	33	μΑ
		Slow mode, sink mode, range = 2.04 mA	-	_	33	μΑ
		Fast mode, source mode, range = 31.875 μA	_	_	310	μΑ
		Fast mode, source mode, range = 255 µA	_	_	305	μΑ
		Fast mode, source mode, range = 2.04 mA	_	_	305	μΑ



Page 10 of 12 Version 1.70

Parameter	Description	Conditions	Min	Тур	Max	Units
		Fast mode, sink mode, range = 31.875 μA	ı	-	310	μΑ
		Fast mode, sink mode, range = 255 µA	ı	-	300	μΑ
		Fast mode, sink mode, range = 2.04 mA	-	_	300	μΑ

## AC Characteristics (IDAC Mode)

Parameter	Description	Conditions	Min	Тур	Max	Units
$F_{DAC}$	Update rate		ĺ	ĺ	8	Msps
T <sub>SETTLE</sub>		Independent of IDAC range setting ( $I_{OUT}$ ), full-scale transition, $600-\Omega$ load, $C_L = 15$ pF, Fast mode	ı	ı	100	ns
		Independent of IDAC range setting ( $I_{OUT}$ ), full-scale transition, $600-\Omega$ load, $C_L = 15$ pF, Slow mode	ı	ı	1000	Ns

For more detailed specifications of the AC and DC performance of the WaveDAC8, refer to the VDAC8 and IDAC8 data sheets.

# **Component Changes**

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

Version	Description of Changes	Reason for Changes / Impact
1.10		Initial document
1.20	Added the ability to changed waveform arrays during runtime.	Add flexibility.
1.24	Changed component placement	
1.30	Fixed some user interface issues.	
1.50	Replaced viDAC8 primitive with IDAC8 and VDAC8 instance.	
1.60	Added cystate file	For concept type components

© Cypress Semiconductor Corporation, 2012. The information contained herein is subject to change without notice. Cypress Semiconductor Corporation assumes no responsibility for the use of any circuitry other than circuitry embodied in a Cypress product. Nor does it convey or imply any license under patent or other rights. Cypress products are not warranted nor intended to be used for medical, life support, life saving, critical control or safety applications, unless pursuant to an express written agreement with Cypress. Furthermore, Cypress does not authorize its products for use as critical components in life-support systems where a malfunction or failure may reasonably be expected to result in significant injury to the user. The inclusion of Cypress products in life-support systems application implies that the manufacturer assumes all risk of such use and in doing so indemnifies Cypress against all charges.

PSoC® is a registered trademark, and PSoC Creator™ and Programmable System-on-Chip™ are trademarks of Cypress Semiconductor Corp. All other trademarks or registered trademarks referenced herein are property of the respective corporations.

Any Source Code (software and/or firmware) is owned by Cypress Semiconductor Corporation (Cypress) and is protected by and subject to worldwide patent protection (United States and foreign), United States copyright laws and international treaty provisions. Cypress hereby grants to licensee a personal, non-exclusive, non-transferable license to copy, use, modify, create derivative works of, and compile the Cypress Source Code and derivative works for the sole purpose of creating custom software and or firmware in support of licensee product to be used only in conjunction with a Cypress integrated circuit as specified in the applicable agreement. Any reproduction, modification, translation, compilation, or representation of this Source Code except as specified above is prohibited without the express written permission of Cypress.

Disclaimer: CYPRESS MAKES NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH REGARD TO THIS MATERIAL, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Cypress reserves the right to make changes without further notice to the materials described herein. Cypress does not assume any liability arising out of the application or use of any product or circuit described herein. Cypress does not authorize its products for use as critical components in life-support systems where a malfunction or failure may reasonably be expected to result in significant injury to the user. The inclusion of Cypress' product in a life-support systems application implies that the manufacturer assumes all risk of such use and in doing so indemnifies Cypress against all charges.

Use may be limited by and subject to the applicable Cypress software license agreement.



Page 12 of 12 Version 1.70