

# Spread Spectrum Clock Generator

## Features

- 50 to 166 MHz operating frequency range
- Wide range of spread selections: 9
- Accepts clock and crystal inputs
- Low power dissipation
  - 70 mW - Typ at 66 MHz
- Frequency spread disable function
- Center spread modulation
- Low cycle-to-cycle jitter
- 8-pin SOIC Package

## Functional Description

CY25561 is a spread spectrum clock generator (SSCG) IC used to reduce electromagnetic Interference (EMI) found in today's high speed digital electronic systems.

CY25561 uses a Cypress proprietary phase-locked loop (PLL) and spread spectrum clock (SSC) technology to synthesize and frequency modulate the input frequency of the reference clock. By doing this, the measured EMI at the fundamental and harmonic frequencies of clock (SSCLK) is reduced.

This reduction in radiated energy can significantly reduce the cost of complying with regulatory requirements and time to market without degrading the system performance.

CY25561 is a very simple and versatile device to use. The frequency and spread percentage range is selected by programming S0 and S1 digital inputs. These inputs use three logic states including high (H), low (L), and middle (M) logic levels to select one of the nine available spread percentage ranges. Refer to [Frequency and Spread Percentage Selection \(Center Spread\)](#) on page 3 for programming details.

CY25561 is intended for use with applications with a reference frequency in the range of 50 to 166 MHz.

A wide range of digitally selectable spread percentages is made possible by using tri-level (high, low, and middle) logic at the S0 and S1 digital control inputs.

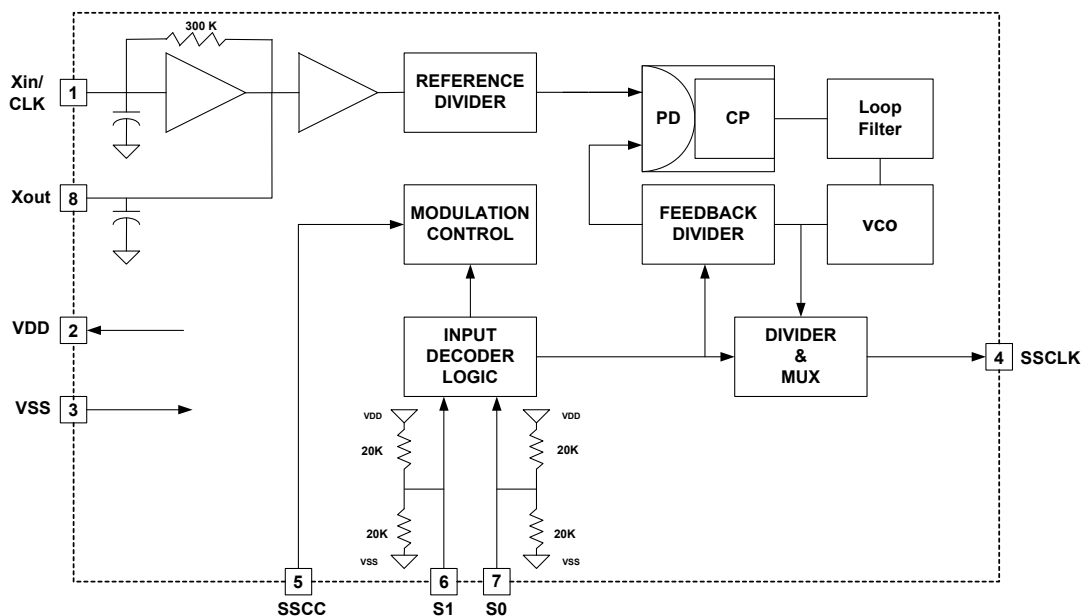
The output spread (frequency modulation) is symmetrically centered on the input frequency.

Spread spectrum clock control (SSCC) function enables or disables the frequency spread and is provided for easy comparison of system performance during EMI testing.

CY25561 is available in an eight-pin SOIC package with a 0 °C to 70 °C operating temperature range.

For a complete list of related documentation, click [here](#).

## Logic Block Diagram



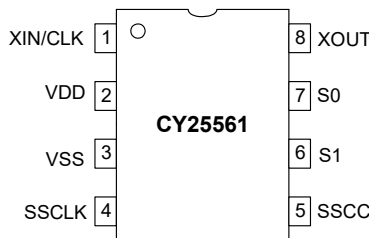
**Note:** Refer to the CY25560 data sheet for operation at frequencies from 25 to 100 MHz.

## Contents

<b>Pin Configuration</b> .....	<b>3</b>	<b>Ordering Information</b> .....	<b>9</b>
<b>Pin Definitions</b> .....	<b>3</b>	Ordering Code Definitions .....	9
<b>Frequency and Spread Percentage Selection</b>		<b>Package Drawing and Dimensions</b> .....	<b>10</b>
<b>(Center Spread)</b> .....	<b>3</b>	<b>Acronyms</b> .....	<b>11</b>
<b>Tri-level Logic</b> .....	<b>4</b>	<b>Document Conventions</b> .....	<b>11</b>
<b>SSCG Theory of Operation</b> .....	<b>4</b>	Units of Measure .....	11
EMI .....	4	<b>Document History Page</b> .....	<b>12</b>
SSCG .....	4	<b>Sales, Solutions, and Legal Information</b> .....	<b>13</b>
Modulation Rate .....	5	Worldwide Sales and Design Support .....	13
<b>CY25561 Application Schematic</b> .....	<b>6</b>	Products .....	13
<b>Absolute Maximum Ratings</b> .....	<b>7</b>	PSoC® Solutions .....	13
<b>DC Electrical Characteristics</b> .....	<b>7</b>	Cypress Developer Community .....	13
<b>Thermal Resistance</b> .....	<b>7</b>	Technical Support .....	13
<b>XIN/CLK DC Specifications</b> .....	<b>8</b>		
<b>Electrical Timing Characteristics</b> .....	<b>8</b>		

## Pin Configuration

Figure 1. 8-pin SOIC pinout



## Pin Definitions

Pin	Name	Type	Description
1	X <sub>IN</sub> / CLK	I	Clock or crystal connection input. Refer to <a href="#">Frequency and Spread Percentage Selection (Center Spread)</a> for input frequency range selection.
2	V <sub>DD</sub>	P	Positive power supply
3	V <sub>SS</sub>	P	Power supply ground
4	SSCLK	O	Modulated clock output
5	SSCC	I	Spread spectrum clock control (enable/disable) function. SSCG function is enabled when input is high and disabled when input is low. This pin is pulled high internally.
6	S1	I	Tri-level logic input control pin used to select frequency and bandwidth. Frequency/Bandwidth selection and tri-level logic programming. See <a href="#">Figure 2</a> . Pin 6 has internal resistor divider network to V <sub>DD</sub> and V <sub>SS</sub> . Refer to <a href="#">Logic Block Diagram on page 1</a> .
7	S0	I	Tri-level logic input control pin used to select frequency and bandwidth. Frequency/Bandwidth selection and tri-level logic programming. See <a href="#">Figure 2</a> . Pin 7 has internal resistor divider network to V <sub>DD</sub> and V <sub>SS</sub> . Refer to <a href="#">Logic Block Diagram on page 1</a> .
8	X <sub>OUT</sub>	O	Oscillator output pin connected to crystal. Leave this pin unconnected if an external clock drives X <sub>IN</sub> / CLK.

## Frequency and Spread Percentage Selection (Center Spread)

### 50–100 MHz (Low Range)

Input Frequency (MHz)	S1=M S0=M (%)	S1=M S0=0 (%)	S1=1 S0=0 (%)	S1=0 S0=0 (%)	S1=0 S0=M (%)
50–60	4.3	3.9	3.3	2.9	2.7
60–70	4.0	3.6	3.1	2.6	2.5
70–80	3.8	3.4	2.9	2.5	2.4
80–100	3.5	3.1	2.7	2.2	2.1

Select the Frequency and Center Spread % desired and then set S1, S0 as indicated.

### 100–166 MHz (High Range)

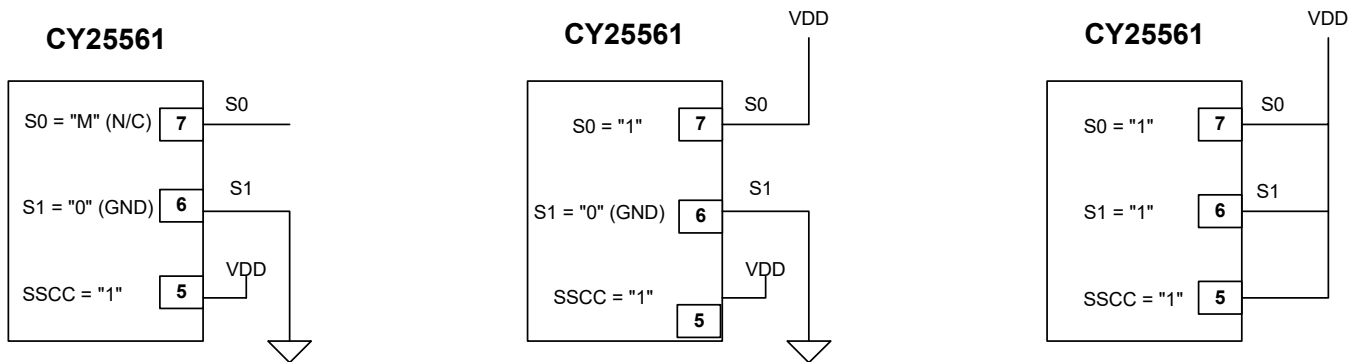
Input Frequency (MHz)	S1=1 S0=M (%)	S1=0 S0=1 (%)	S1=1 S0=1 (%)	S1=M S0=1 (%)
100–120	3.0	2.4	1.5	1.3
120–130	2.7	2.1	1.4	1.1
130–140	2.6	2.0	1.3	1.1
140–150	2.6	2.0	1.3	1.1
150–166	2.5	1.8	1.2	1.0

Select the Frequency and Center Spread % desired and then set S1, S0 as indicated.

### Tri-level Logic

With binary logic, four states can be programmed with two control lines, whereas tri-level logic can program nine logic states using two control lines. Tri-level logic in CY25561 is implemented by defining a third logic state in addition to the standard logic “1” and “0”. Pins 6 and 7 of CY25561 recognize a logic state by the voltage applied to the respective pin. These states are defined as “0” (low), “M” (middle), and “1” (one). Each of these states has a defined voltage range that is interpreted by CY25561 as a “0,” “M,” or “1” logic state. Refer to [DC Electrical Characteristics on page 7](#) for voltage ranges for each logic state. CY25561 has two equal value resistors connected internally to pin 6 and pin 7 that produce the default “M” state. Pins 6 and/or 7 can be tied directly to ground or V<sub>DD</sub> to program a logic “0” or “1” state, respectively. Refer to [Figure 2](#) for examples.

Figure 2. Tri-level Logic Examples



### SSCG Theory of Operation

CY25561 is a PLL-type clock generator using a proprietary Cypress design. By precisely controlling the bandwidth of the output clock, CY25561 becomes a low-EMI clock generator. The theory and detailed operation of CY25561 is discussed in the following sections.

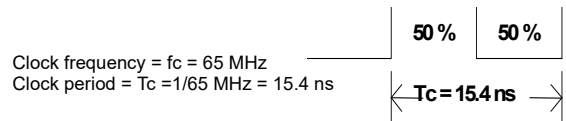
#### EMI

All digital clocks generate unwanted energy in their harmonics. Conventional digital clocks are square waves with a duty cycle that is very close to 50 percent. Because of this 50/50 duty cycle, digital clocks generate most of their harmonic energy in odd harmonics, that is; third, fifth, seventh, etc. The amount of energy contained in the fundamental and odd harmonics can be reduced by increasing the bandwidth of the fundamental clock frequency. Conventional digital clocks have a very high Q factor; all the energy at that frequency is concentrated in a very narrow bandwidth, and consequently, higher energy peaks. Regulatory agencies test electronic equipment by the amount of peak energy radiated from the equipment. By reducing the peak energy at the fundamental and harmonic frequencies, the equipment under test is able to satisfy agency requirements for EMI. Conventional methods of reducing EMI use shielding, filtering, multilayer PCBs, etc. CY25561 uses the approach of reducing the peak energy in the clock by increasing the clock bandwidth, and lowering the Q.

#### SSCG

SSCG uses a patented technology of modulating the clock over a very narrow bandwidth and controlled rate of change, both

peak and cycle-to-cycle. CY25561 takes a narrow band digital reference clock in the range of 50 to 166 MHz and produces a clock that sweeps between a controlled start and stop frequency and precise rate of change. To understand what happens to a clock when SSCG is applied, consider a 65 MHz clock with a 50 percent duty cycle, as shown in the following figure:



If this clock is applied to the Xin/CLK pin of CY25561, the output clock at pin 4 (SSCLK) sweeps back and forth between two frequencies. These two frequencies, F1 and F2, are used to calculate total amount of spread or bandwidth applied to the reference clock at pin 1. As the clock is making the transition from F1 to F2, the amount of time and sweep waveform play a very important role in the amount of EMI reduction realized from an SSCG clock.

The modulation domain analyzer is used to visualize the sweep waveform and sweep period. [Figure 4 on page 6](#) shows the modulation profile of a 65 MHz SSCG clock. Notice that the actual sweep waveform is not a simple sine or sawtooth waveform. [Figure 4 on page 6](#) also shows a scan of the same SSCG clock using a spectrum analyzer. In this scan, you can see a 6.48 dB reduction in the peak RF energy when using the SSCG clock.

## Modulation Rate

Spectrum spread clock generators use frequency modulation (FM) to distribute energy over a specific band of frequencies. The maximum frequency of the clock (Fmax) and minimum frequency of the clock (Fmin) determine this band of frequencies. The time required to transition from Fmin to Fmax and back to Fmin is the period of the modulation rate, Tmod. Modulation rates of SSCG clocks are most commonly referred to in terms of frequency or Fmod = 1/Tmod.

The input clock frequency, Fin, and the internal divider count, Cdiv, determine the modulation rate. In some SSCG clock generators, the selected range determines the internal divider count. In other SSCG clocks, the internal divider count is fixed over the operating range of the part. CY25561 has a fixed divider count, as shown in [Figure 3](#).

**Figure 3. SSCG Clock, Part Number, Fin = 65 MHz**

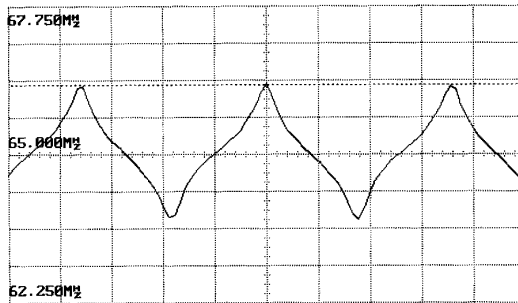
<b>Device</b>	<b>Cdiv</b>
CY25561	2332 (All Ranges)

Example:

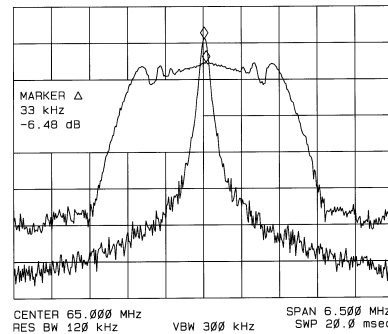
Device =	CY25561
Fin =	65 MHz
Range =	S1 = 1, S0 = 0

Then;

Modulation Rate = Fmod = 65 MHz/2332 = 27.9 kHz.



**Modulation Profile**

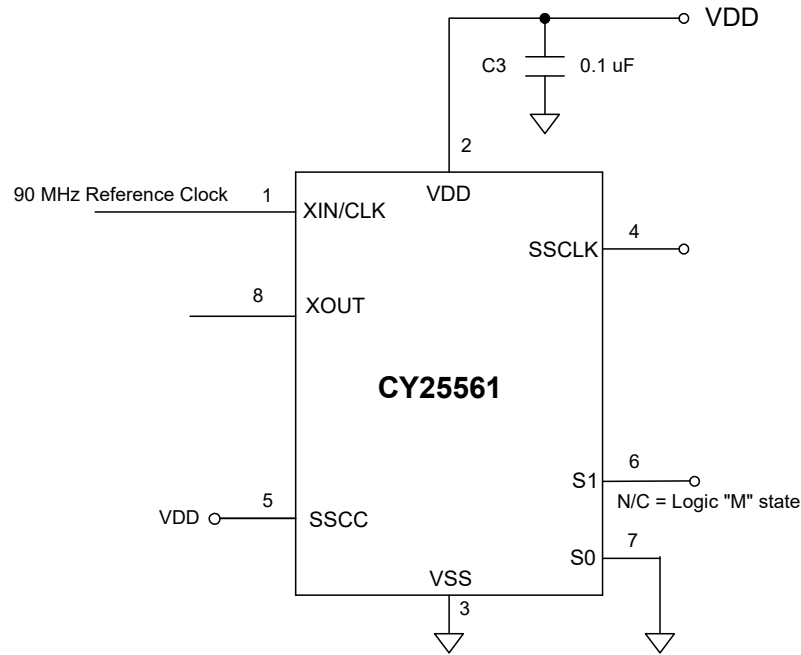


**Spectrum**

Analyzer

## CY25561 Application Schematic

Figure 4. Application Schematic



The schematic in [Figure 4](#) above demonstrates how CY25561 is configured in a typical application. This application is using a 90 MHz reference clock connected to pin 1. Because an external reference clock is used, pin 8 (XOUT) is left unconnected.

[Figure 4](#) shows that pin 6 has no connection, which programs the logic “M” state, due to the internal resistor divider network of CY25561. Programming a logic “0” state is as simple as connecting to logic ground, as shown on pin 7.

With this configuration, CY25561 produces an SSCG clock that is at a center frequency of 90 MHz. Referring to [DC Electrical Characteristics on page 7](#), range “M, 0” at 90 MHz generates a modulation profile that has a 3.1 percent peak-to-peak spread.

## Absolute Maximum Ratings

Exceeding maximum ratings [1, 2] may shorten the useful life of the device. User guidelines are not tested.

Supply voltage ( $V_{DD}$ ) ..... -0.5 V to +6.0 V

DC input voltage ..... -0.5 V to  $V_{DD} + 0.5$  V  
 Junction temperature ..... -40 °C to +140 °C  
 Operating temperature ..... 0 °C to 70 °C  
 Storage temperature ..... -65 °C to +150 °C  
 Static discharge voltage (ESD) ..... 2,000 V min

## DC Electrical Characteristics

$V_{DD} = 3.3$  V,  $T_A = 25$  °C and  $C_L$  (Pin 4) = 15 pF, unless otherwise noted.

Parameter	Description	Conditions	Min	Typ	Max	Unit
$V_{DD}$	Power supply range	$\pm 10\%$	2.97	3.3	3.63	V
$V_{INH}$	Input high voltage	S0 and S1 only.	$0.85 \times V_{DD}$	$V_{DD}$	$V_{DD}$	V
$V_{INM}$	Input middle voltage	S0 and S1 only.	$0.40 \times V_{DD}$	$0.50 \times V_{DD}$	$0.60 \times V_{DD}$	V
$V_{INL}$	Input low voltage	S0 and S1 only.	0.0	0.0	$0.15 \times V_{DD}$	V
$V_{OH1}$	Output high voltage	$I_{OH} = 6$ mA	2.4	–	–	V
$V_{OH2}$	Output high voltage	$I_{OH} = 20$ mA	2.0	–	–	V
$V_{OL1}$	Output low voltage	$I_{OH} = 6$ mA	–	–	0.4	V
$V_{OL2}$	Output low voltage	$I_{OH} = 20$ mA	–	–	1.2	V
$C_{in1}$	Input capacitance	$X_{IN}$ / CLK (Pin 1)	3	4	5	pF
$C_{in2}$	Input capacitance	$X_{OUT}$ (Pin 8)	6	8	10	pF
$C_{in2}$	Input capacitance	S0, S1, SSCC (Pins 7, 6, 5)	3	4	5	pF
$I_{DD1}$	Power supply current	$F_{in} = 65$ MHz, $CL = 0$	–	23	30	mA
$I_{DD2}$	Power supply current	$F_{in} = 166$ MHz, $CL = 0$	–	48	60	mA

## Thermal Resistance

Parameter [3]	Description	Test Conditions	8-pin SOIC	Unit
$\theta_{JA}$	Thermal resistance (junction to ambient)	Test conditions follow standard test methods and procedures for measuring thermal impedance, in accordance with EIA/JESD51.	131	°C/W
$\theta_{JC}$	Thermal resistance (junction to case)		41	°C/W

### Notes

1. Operation at any absolute maximum rating is not implied.
2. Single power supply: The voltage on any input or I/O pin cannot exceed the power pin during power-up.
3. These parameters are guaranteed by design and are not tested.

### X<sub>IN</sub>/CLK DC Specifications

Parameter	Description	Conditions	Min	Max	Units
V <sub>IH(X)</sub>	Input high voltage, X <sub>IN</sub> Clock Input	F ≤ 100 MHz	80	–	% of V <sub>DD</sub>
		F ≤ 133 MHz	86	–	% of V <sub>DD</sub>
		F ≤ 166 MHz	92	–	% of V <sub>DD</sub>
V <sub>IL(X)</sub>	Input low voltage, X <sub>IN</sub> Clock Input		–	15	% of V <sub>DD</sub>

### Electrical Timing Characteristics

V<sub>DD</sub> = 3.3 V, T<sub>A</sub> = 25 °C and C<sub>L</sub> = 15 pF, unless otherwise noted.

Parameter	Description	Conditions	Min	Typ	Max	Unit
I <sub>CLKFR</sub>	Input clock frequency range	V <sub>DD</sub> = 3.3 V	50	–	166	MHZ
t <sub>RISE</sub>	Clock rise time (Pin 4)	SSCLK1 @ 0.4 V–2.4 V	1.1	1.4	1.7	ns
t <sub>FALL</sub>	Clock fall time (Pin 4)	SSCLK1 @ 0.4 V–2.4 V	1.1	1.4	1.7	ns
D <sub>TYin</sub>	Input clock duty cycle	X <sub>IN</sub> / CLK (Pin 1)	30	50	70	%
D <sub>TYout</sub>	Output clock duty cycle	SSCLK1 (Pin 4)	45	50	55	%
C <sub>CJ1</sub>	Cycle-to-Cycle jitter	50 MHz–100 MHz, (S1 = M, S0 = M)	–	150	225	ps
C <sub>CJ2</sub>	Cycle-to-Cycle jitter	100 MHz–166 MHz, (S1 = 1, S0 = M)	–	200	300	ps







## Acronyms

Acronym	Description
EMI	Electromagnetic Interference
PCB	Printed Circuit Board
PLL	Phase-Locked Loop
SOIC	Small Outline Integrated Circuit
SSC	Spread Spectrum Clock
SSCC	Spread Spectrum Clock Control
SSCG	Spread Spectrum Clock Generator

## Document Conventions

### Units of Measure

Symbol	Unit of Measure
°C	degree Celsius
mA	milliampere
ns	nanosecond
%	percent
pF	picofarad
V	volt

## Document History Page

Document Title: CY25561, Spread Spectrum Clock Generator Document Number: 38-07242				
Rev.	ECN No.	Orig. of Change	Submission Date	Description of Change
**	115369	OXC	07/05/2002	New data sheet.
*A	119443	RGL	10/17/2002	Updated <a href="#">Absolute Maximum Ratings</a> : Updated details corresponding to "Supply Voltage". Added "DC Input Voltage" and its corresponding details. Added "Junction Temperature" and its corresponding details. Added "Static Discharge Voltage (ESD)" and its corresponding details.
*B	122694	RBI	12/27/2002	Updated <a href="#">Absolute Maximum Ratings</a> : Added Note 2 and referred the same note in maximum ratings.
*C	2567245	PYG / KVM / AESA	09/16/2008	Updated <a href="#">Ordering Information</a> (Updated part numbers). Updated <a href="#">Package Drawing and Dimensions</a> : spec 51-85066 – Changed revision from *A to *C. Updated to new template.
*D	3187957	CXQ	03/04/2011	Updated <a href="#">Package Drawing and Dimensions</a> : spec 51-85066 – Changed revision from *C to *D. Completing Sunset Review.
*E	3528781	PURU	02/21/2012	Removed Applications. Removed Benefits. Updated <a href="#">Ordering Information</a> : No change in part numbers. Added <a href="#">Ordering Code Definitions</a> . Updated <a href="#">Package Drawing and Dimensions</a> : spec 51-85066 – Changed revision from *D to *E. Added <a href="#">Acronyms</a> and <a href="#">Units of Measure</a> . Updated to new template. Completing Sunset Review.
*F	3944833	PURU	03/26/2013	Updated <a href="#">Pin Definitions</a> (Replaced "GND" with "V <sub>SS</sub> " for Name of Pin 3).
*G	4198708	CINM	11/21/2013	Added <a href="#">XIN/CLK DC Specifications</a> . Updated <a href="#">Package Drawing and Dimensions</a> : spec 51-85066 – Changed revision from *E to *F. Updated to new template.
*H	4586478	AJU	12/03/2014	Updated <a href="#">Functional Description</a> : Added "For a complete list of related documentation, click <a href="#">here</a> ." at the end.
*I	4708301	TAVA	03/31/2015	Updated <a href="#">Package Drawing and Dimensions</a> : spec 51-85066 – Changed revision from *F to *G. Completing Sunset Review.
*J	5278942	PSR	05/20/2016	Added <a href="#">Thermal Resistance</a> . Updated <a href="#">Package Drawing and Dimensions</a> : spec 51-85066 – Changed revision from *G to *H. Updated to new template.
*K	6063808	PAWK	02/08/2018	Updated <a href="#">Package Drawing and Dimensions</a> : spec 51-85066 – Changed revision from *H to *I. Updated to new template. Completing Sunset Review.

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