SGM8716A-1/SGM8716B-1
Small Size, Low Power, Low Voltage Comparators

GENERAL DESCRIPTION

The SGM8716A-1 and SGM8716B-1 are single, micro-power, small size comparators. They are optimized for low voltage operation from 1.6V to 5.5V single supply, and support rail-to-rail input operation. The SGM8716A-1 and SGM8716B-1 consume only 5.5μA quiescent current. Meanwhile, they also have a great trade-off between low power and high speed, with a low propagation delay of 290ns. This results in continuous system monitoring and quick respond to fault conditions without excessive battery power dissipation.

These devices have different output structures. The SGM8716A-1 has an open-drain output structure, which requires an external pull-up resistor to output a high level of V_S or a voltage below V_S. This enables conversion from bipolar to single-ended signals and level translation. The SGM8716B-1 has a push-pull output structure, which can easily drive LEDs, resistive or capacitive loads with the ability to source or sink current at the milliamp level.

The SGM8716A-1 and SGM8716B-1 are designed with internal hysteresis and prevent output phase reversal when the inputs are overdriven. Therefore, these comparators are capable of transforming slow-moving input signals into clear digital outputs and monitoring voltage in noisy and demanding settings.

The SGM8716A-1 and SGM8716B-1 are both available in a Green SOT-23-5 package. They are rated over the -40℃ to +125℃ operating temperature range.

FEATURES

- **Low Propagation Delay: 290ns (TYP)**
- **Low Quiescent Current: 5.5μA (TYP)**
- **Supply Voltage Range: 1.6V to 5.5V**
- **Rail-to-Rail Input Common Mode Voltage**
- **Output Structure:**
  - **Open-Drain Output: SGM8716A-1**
  - **Push-Pull Output: SGM8716B-1**
- **Internal Hysteresis: 4.2mV (TYP)**
- **No Phase Reversal with Overdriven Inputs**
- **-40℃ to +125℃ Operating Temperature Range**
- **Available in a Green SOT-23-5 Package**

APPLICATIONS

Smart Phone
Battery-Powered Equipment
Industrial Equipment
Medical Equipment
Telecom Equipment

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM8716A-1	SOT-23-5	-40℃ to +125℃	SGM8716A-1XN5G/TR	1SP XXXXX	Tape and Reel, 3000
SGM8716B-1	SOT-23-5	-40℃ to +125℃	SGM8716B-1XN5G/TR	1U2 XXXXX	Tape and Reel, 3000

MARKING INFORMATION

NOTE: XXXXX = Date Code, Trace Code and Vendor Code.

XXXXX
- Vendor Code
- Trace Code
- Date Code - Year

Green (RoHS & HSF): SG Micro Corp defines "Green" to mean Pb-Free (RoHS compatible) and free of halogen substances. If you have additional comments or questions, please contact your SGMICRO representative directly.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage, $+V_S$ to $-V_S$ 6V
Voltage at Input Pins (+IN, -IN) (1)...............$(-V_S)$ - 0.3V to 6V
Voltage at Output Pins (OUT)
SGM8716A-1 ....$(-V_S)$ - 0.3V to 6V
SGM8716B-1 (2)...................... $(-V_S)$ - 0.3V to $(+V_S)$ + 0.3V
Current into Input Pins (+IN, -IN) (1) ....±10mA
Output Short-Circuit Duration (3)..10s
Package Thermal Resistance
SOT-23-5, θ_{JA}... 193.6℃/W
SOT-23-5, θ_{JB}.. 82℃/W
Junction Temperature...+150℃
Storage Temperature Range ....-65℃ to +150℃
Lead Temperature (Soldering, 10s)............................+260℃
ESD Susceptibility (4) (5)
HBM..±8000V
CDM ....±1000V

NOTES:

1. A clamping diode is added between the input and negative power supply. So voltage at input pins can be $(-V_S)$ - 0.3V, and current of the input signal should be limited within the range of 10mA.
2. The output voltage is limited to the lower value between $(+V_S)$ + 0.3V and 6V.
3. Each package contains one comparator, which can be shorted to ground.
4. For human body model (HBM), all pins comply with ANSI/ESDA/JEDEC JS-001 specifications.
5. For charged device model (CDM), all pins comply with ANSI/ESDA/JEDEC JS-002 specifications.

RECOMMENDED OPERATING CONDITIONS

Supply Voltage Range....................................... 1.6V to 5.5V
Input Voltage Range....................$(-V_S)$ - 0.1V to $(+V_S)$ + 0.2V
Operating Temperature Range.................... -40℃ to +125℃

OVERSTRESS CAUTION

Stresses beyond those listed in Absolute Maximum Ratings may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect reliability. Functional operation of the device at any conditions beyond those indicated in the Recommended Operating Conditions section is not implied.

ESD SENSITIVITY CAUTION

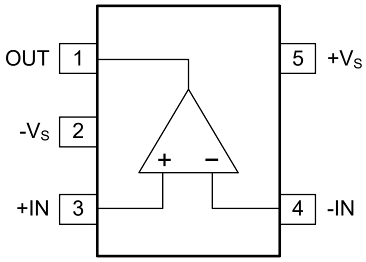
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because even small parametric changes could cause the device not to meet the published specifications.

DISCLAIMER

SG Micro Corp reserves the right to make any change in circuit design, or specifications without prior notice.

PIN CONFIGURATION

(TOP VIEW)



SOT-23-5

PIN DESCRIPTION

PIN	NAME	FUNCTION
1	OUT	Output.
2	$-V_S$	Negative Power Supply.
3	+IN	Non-Inverting Input.
4	-IN	Inverting Input.
5	$+V_S$	Positive Power Supply.

ELECTRICAL CHARACTERISTICS

(V_S = 1.8V to 5V, V_{CM} = V_S/2, Full = -40℃ to +125℃, typical values are at T_A = +25℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
Input Offset Voltage	V_{OS}	V_S = 1.8V	+25℃		±1.5	±6.5	mV
			Full			±8	
		V_S = 5V	+25℃		±1.35	±6	
			Full			±7.5	
Hysteresis	V_{HYST}	V_S = 1.8V and 5V	+25℃		4.2	6	mV
			Full	1		8	
Input Common Mode Voltage Range	V_{CM}	V_S = 2.5V to 5V	Full	0		(+V_S) +0.1	V
		V_S = 1.8V to 2.5V	Full	0.1		(+V_S) +0.1	
Input Bias Current	I_B	V_S = 5V	+25℃		±10	±200	pA
			Full			6	nA
Input Offset Current	I_{OS}	V_S = 5V	+25℃		±10	±200	pA
			Full			2.5	nA
Output Voltage High (for SGM8716B-1 Only)	V_{OH}	V_S = 5V, I_{OUT} = 3mA	+25℃	4.92	4.95		V
			Full	4.90			
Output Voltage Low	V_{OL}	V_S = 5V, I_{OUT} = 3mA	+25℃		90	110	mV
			Full			140	
Open-Drain Output Leakage Current (for SGM8716A-1 Only)	I_{LKG}	V_S = 5V, V_{ID} = +0.1V (output high), $V_{PULL-UP}$ = V_S	+25℃		50	200	pA
			Full			13	nA
Common Mode Rejection Ratio	CMRR	V_S = 5V, 0V < V_{CM} < 5.1V	+25℃	54	71		dB
			Full	52			
Power Supply Rejection Ratio	PSRR	V_S = 1.8V to 5V	+25℃	53	69		dB
			Full	51			
		V_S = 2.5V to 5V	+25℃	56	74		
			Full	54			
Short-Circuit Current	I_{SC}	V_S = 5V, sourcing (for SGM8716B-1 only)	+25℃	42	46		mA
			Full	33			
		V_S = 5V, sinking	+25℃	25	28		
			Full	14			
Quiescent Current	I_Q	I_{OUT} = 0A	+25℃		5.5	8.5	μA
			Full			10	

SWITCHING CHARACTERISTICS (SGM8716A-1)

(V_S = 5V, V_{CM} = 2.5V, C_L = 15pF, input overdrive = 100mV, typical values are at T_A = +25℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
Propagation Delay Time, High-to-Low	t_{PHL}	R_P = 2.5kΩ, midpoint of input to midpoint of output	+25℃		270		ns
Propagation Delay Time, Low-to-High	t_{PLH}	R_P = 2.5kΩ, midpoint of input to midpoint of output	+25℃		290		ns
Fall Time	t_F	80% to 20%	+25℃	3	6	10	ns
Power-Up Time (1)	t_{ON}		+25℃		17		μs

NOTE: 1. When powering up, ensure that V_S is above 1.6V for a certain duration (t_{ON}) before the output begins to follow the input signal.

SWITCHING CHARACTERISTICS (SGM8716B-1)

(V_S = 5V, V_{CM} = 2.5V, C_L = 15pF, input overdrive = 100mV, typical values are at T_A = +25℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
Propagation Delay Time, High-to-Low	t_{PHL}	Midpoint of input to midpoint of output	+25℃		285		ns
Propagation Delay Time, Low-to-High	t_{PLH}	Midpoint of input to midpoint of output	+25℃		280		ns
Rise Time	t_R	20% to 80%	+25℃	4	5.5	7.5	ns
Fall Time	t_F	80% to 20%	+25℃	4	5.5	8	ns
Power-Up Time (1)	t_{ON}		+25℃		23.5		μs

NOTE: 1. When powering up, ensure that V_S is above 1.6V for a certain duration (t_{ON}) before the output begins to follow the input signal.

TIMING DIAGRAM

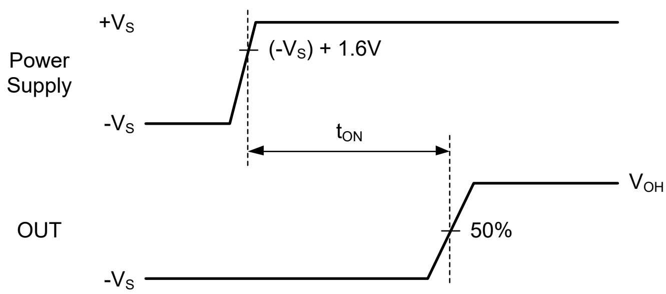


Figure 1. Power-Up Delay (Out) Diagram (Push-Pull, +IN > -IN)

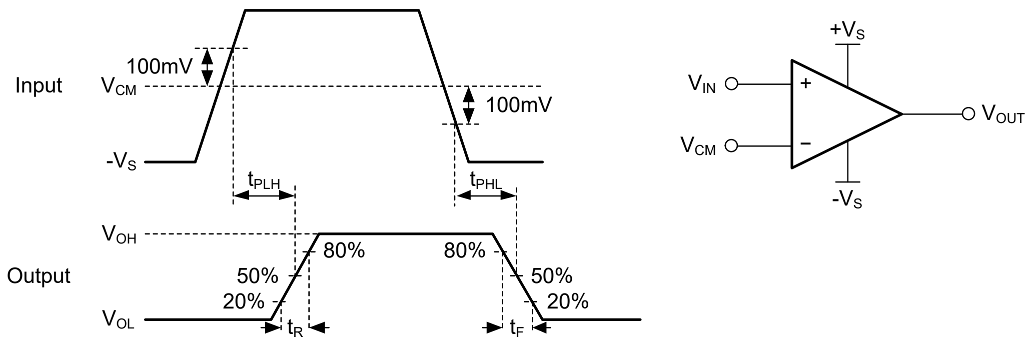
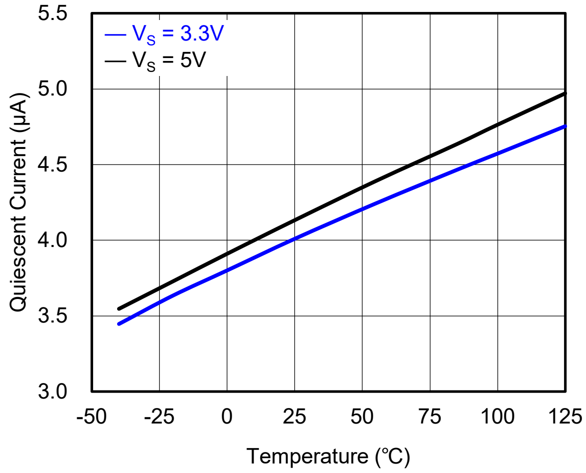


Figure 2. Propagation Delay Diagram

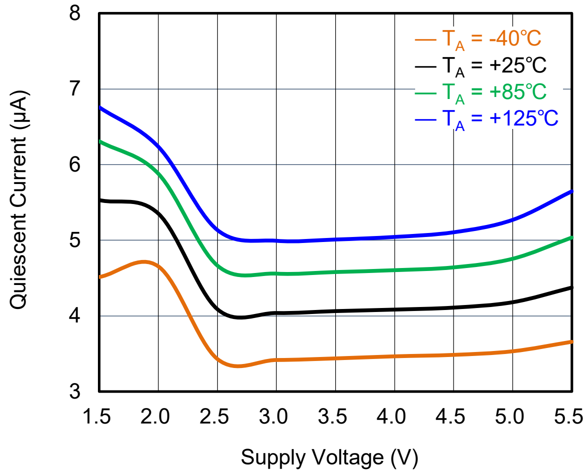
TYPICAL PERFORMANCE CHARACTERISTICS

At T_A = +25℃, V_S = 5V, V_{CM} = V_S/2, unless otherwise noted.

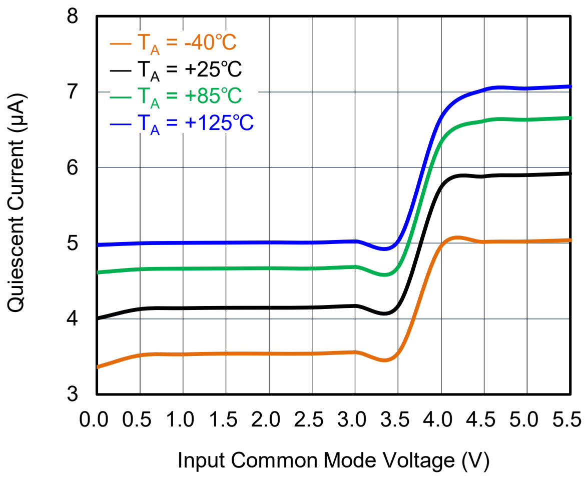
Quiescent Current vs. Temperature



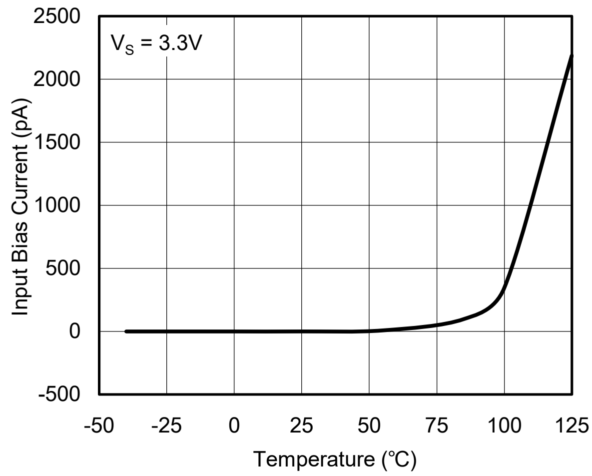
Quiescent Current vs. Supply Voltage



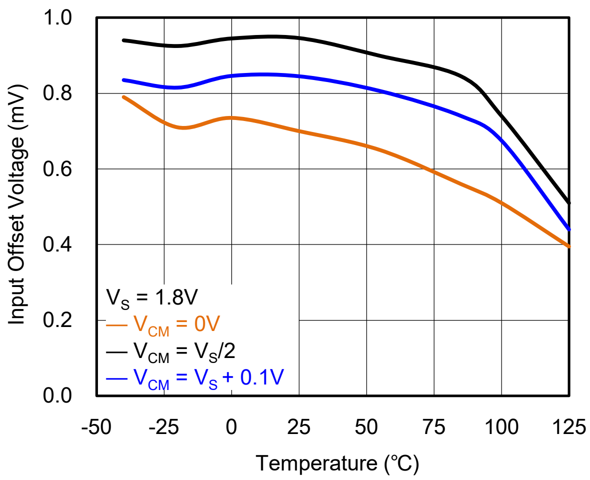
Quiescent Current vs. Input Common Mode Voltage



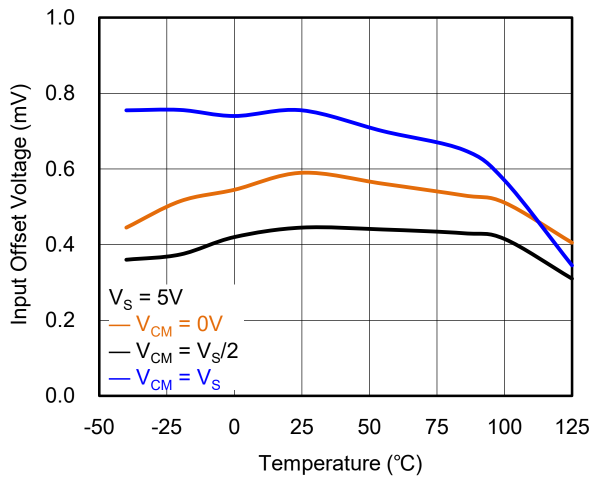
Input Bias Current vs. Temperature



Input Offset Voltage vs. Temperature



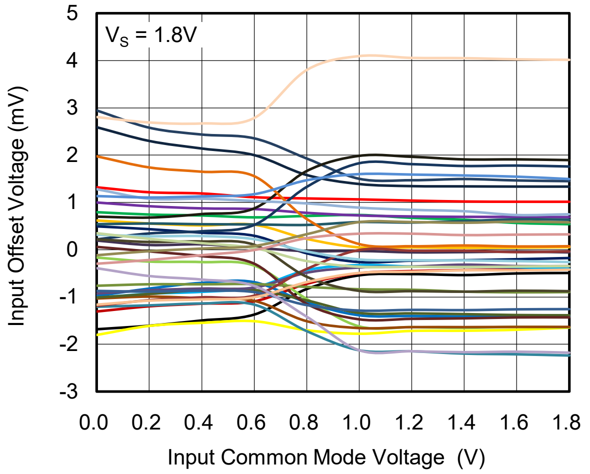
Input Offset Voltage vs. Temperature



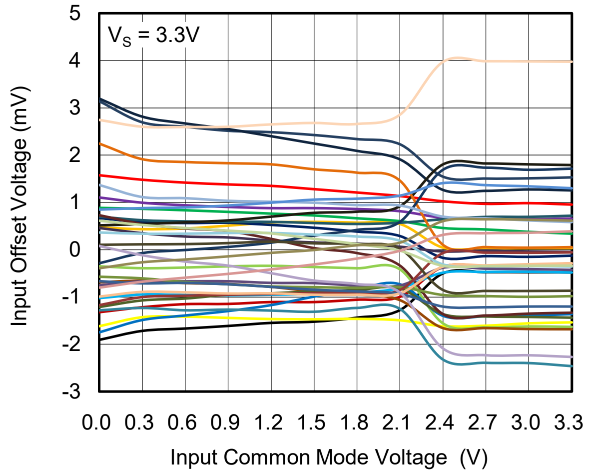
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A = +25℃, V_S = 5V, V_{CM} = V_S/2, unless otherwise noted.

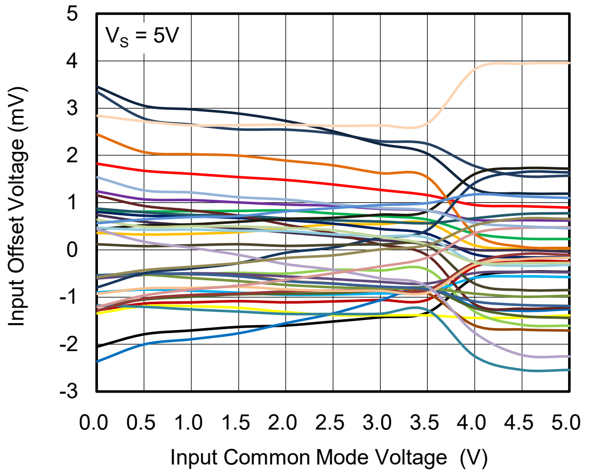
Input Offset Voltage vs. Input Common Mode Voltage



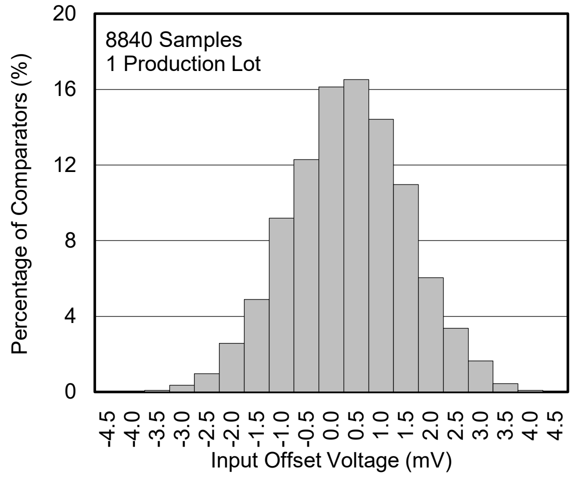
Input Offset Voltage vs. Input Common Mode Voltage



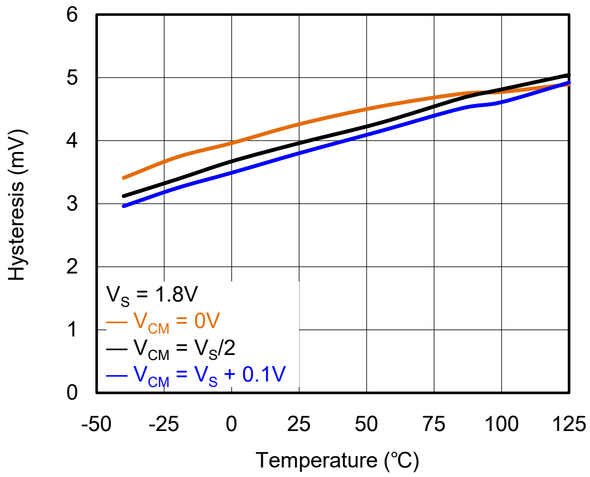
Input Offset Voltage vs. Input Common Mode Voltage



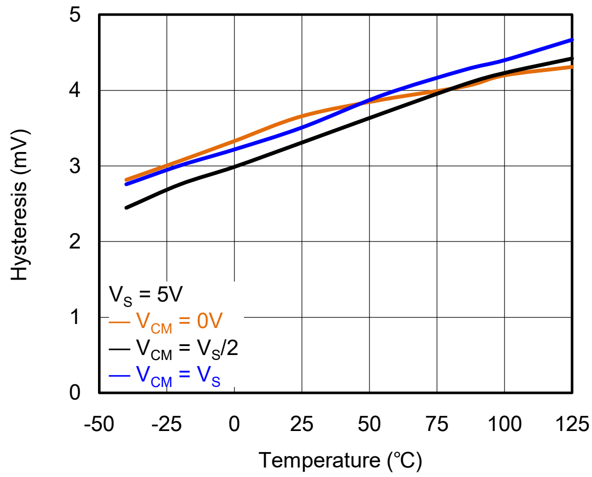
Input Offset Voltage Production Distribution



Hysteresis vs. Temperature



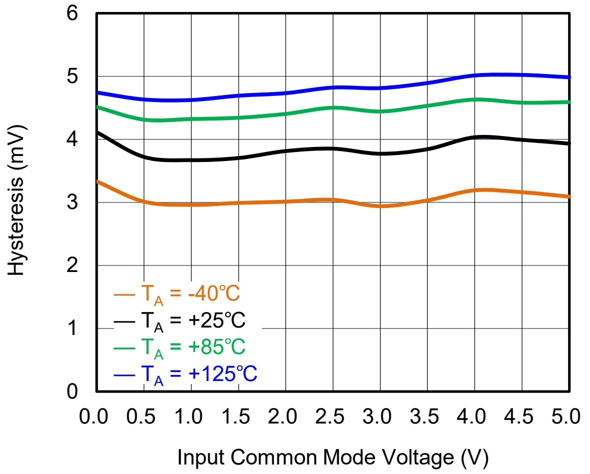
Hysteresis vs. Temperature



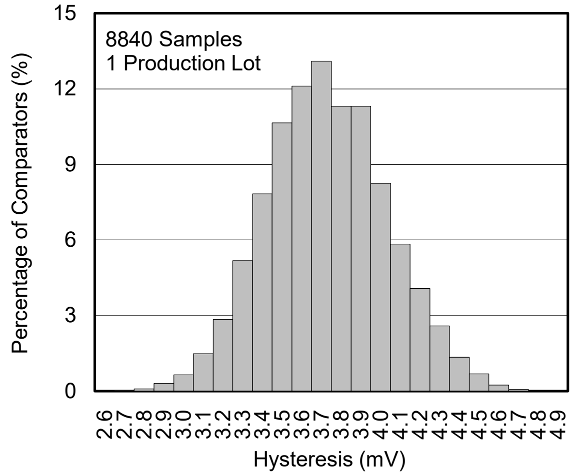
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A = +25℃, V_S = 5V, V_{CM} = V_S/2, unless otherwise noted.

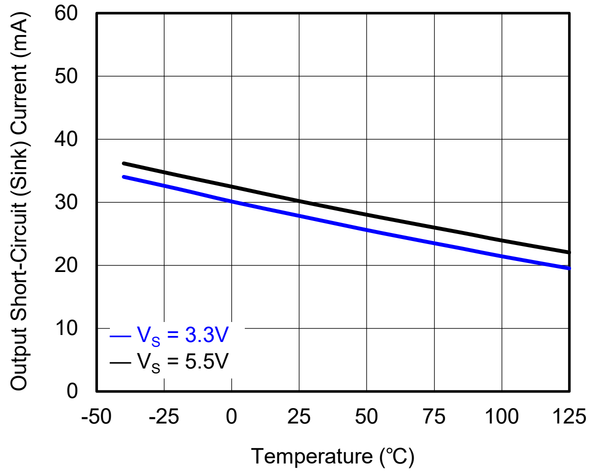
Hysteresis vs. Input Common Mode Voltage



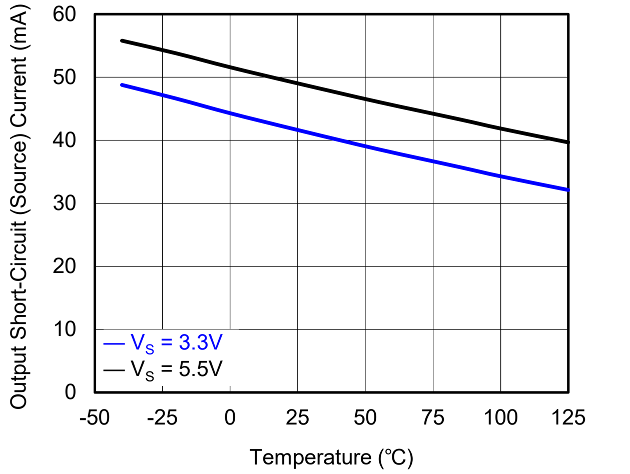
Hysteresis Production Distribution



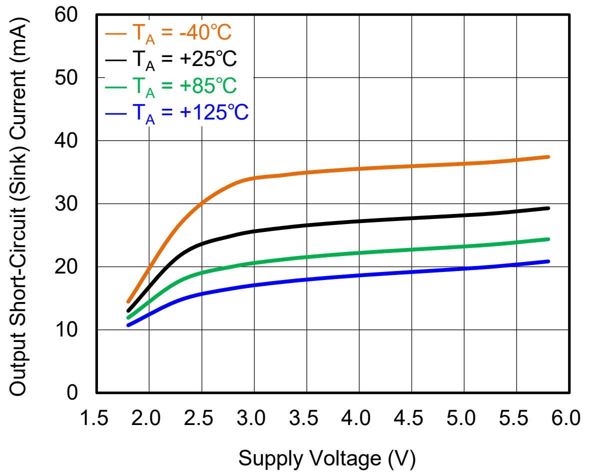
Output Short-Circuit (Sink) Current vs. Temperature



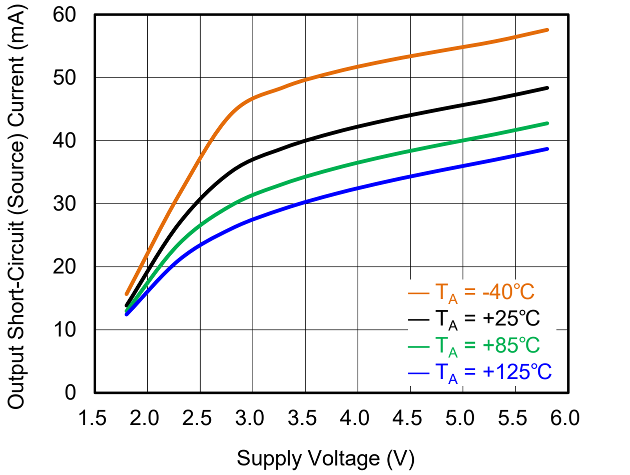
SGM8716B-1 Output Short-Circuit (Source) Current vs. Temperature



Output Short-Circuit (Sink) Current vs. Supply Voltage

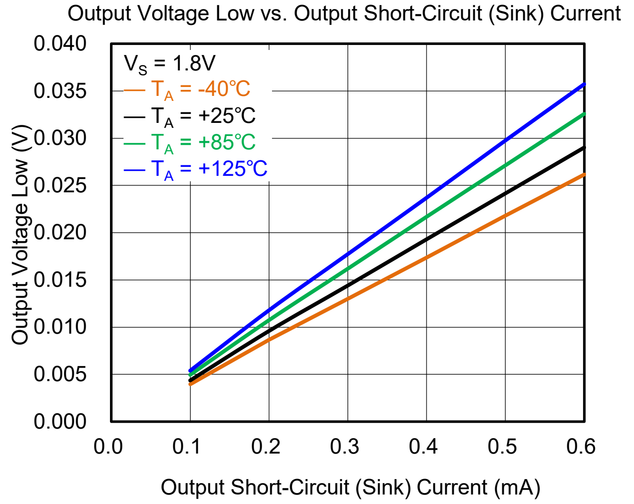


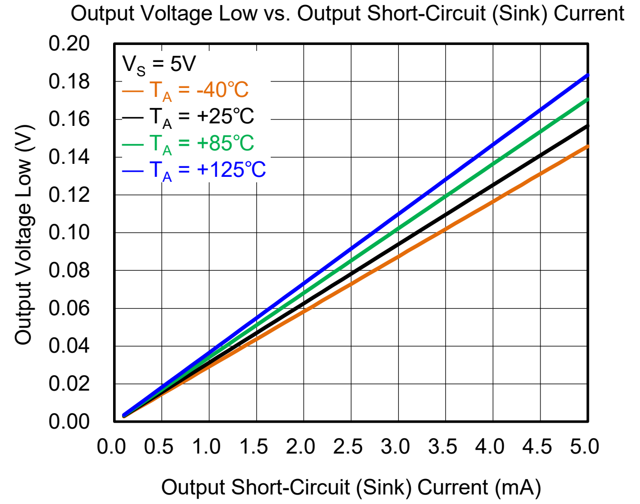
SGM8716B-1 Output Short-Circuit (Source) Current vs. Supply Voltage

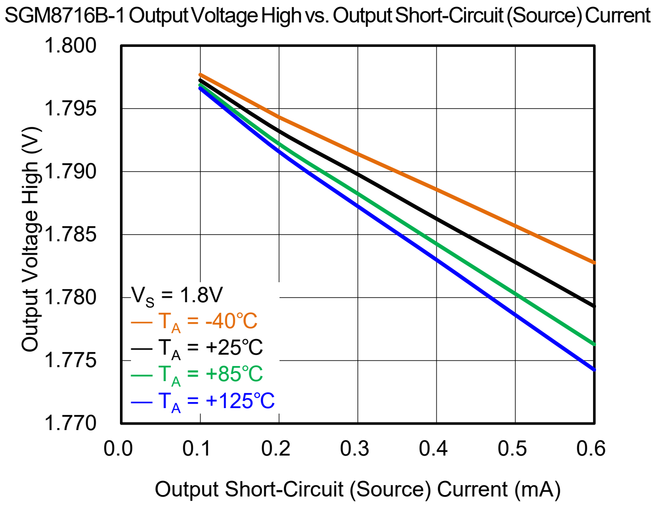


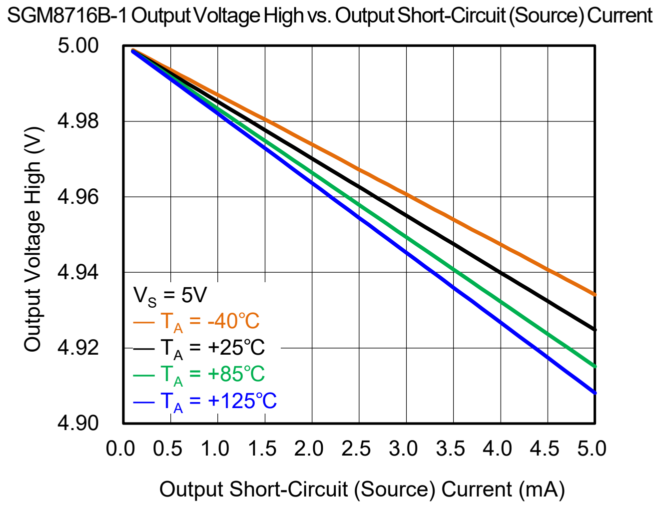
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

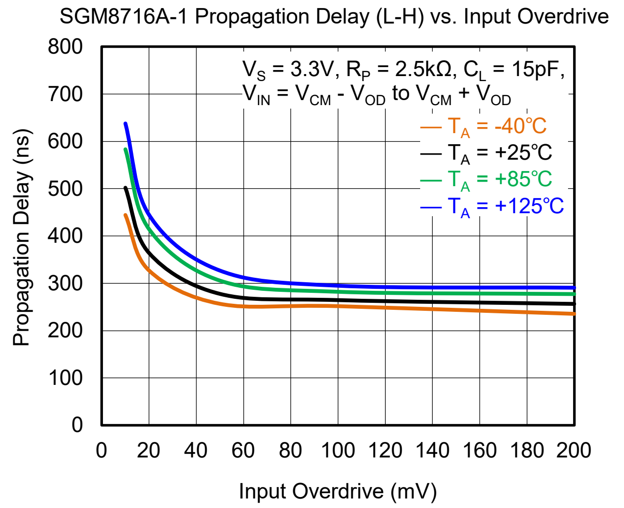
At T_A = +25℃, V_S = 5V, V_{CM} = V_S/2, unless otherwise noted.

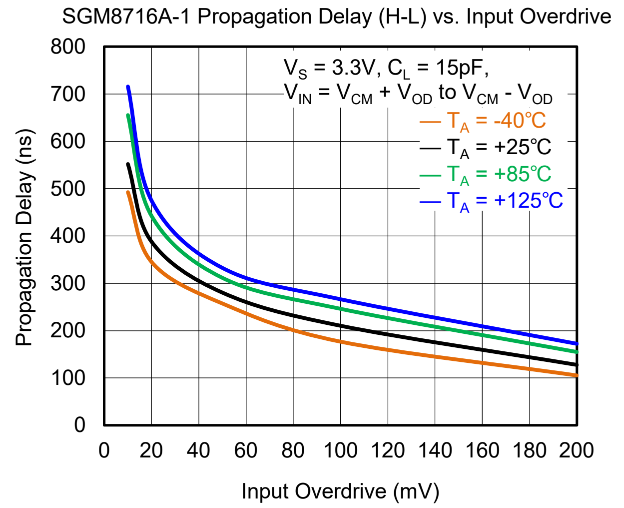








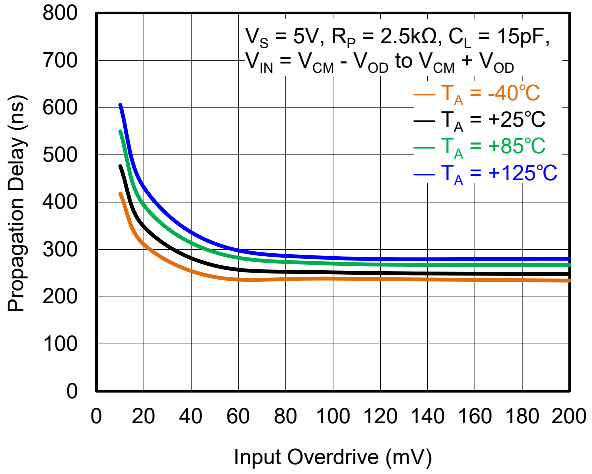




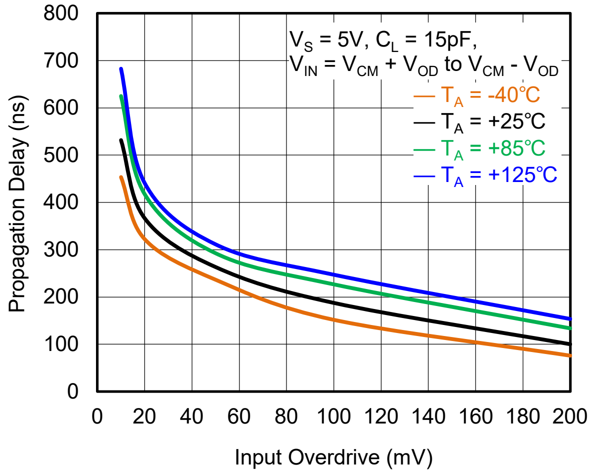
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A = +25℃, V_S = 5V, V_{CM} = V_S/2, unless otherwise noted.

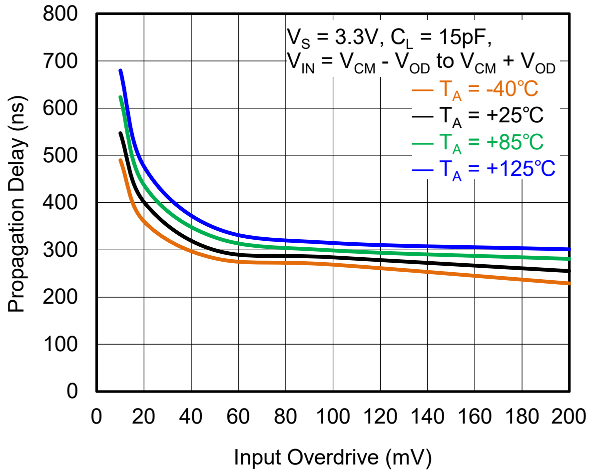
SGM8716A-1 Propagation Delay (L-H) vs. Input Overdrive



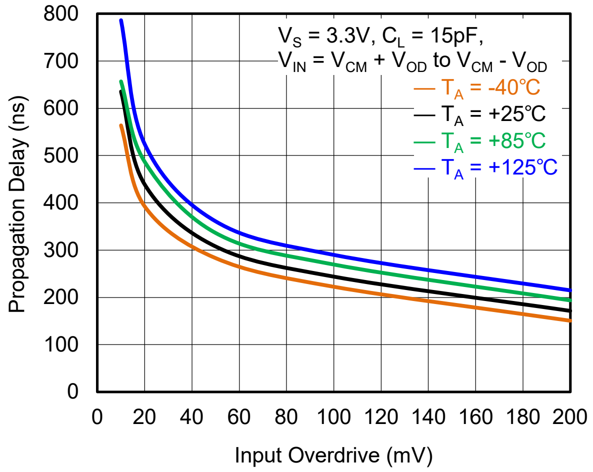
SGM8716A-1 Propagation Delay (H-L) vs. Input Overdrive



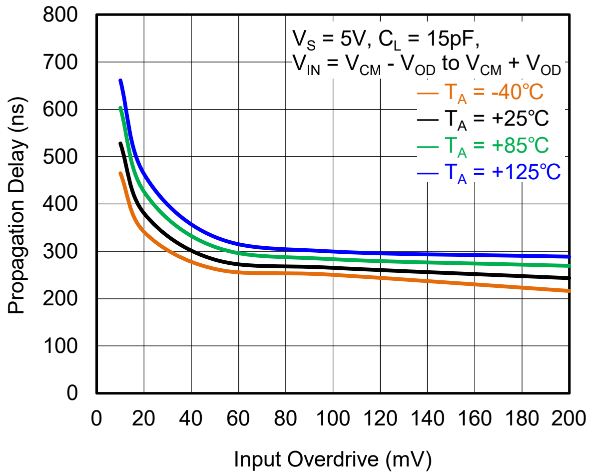
SGM8716B-1 Propagation Delay (L-H) vs. Input Overdrive



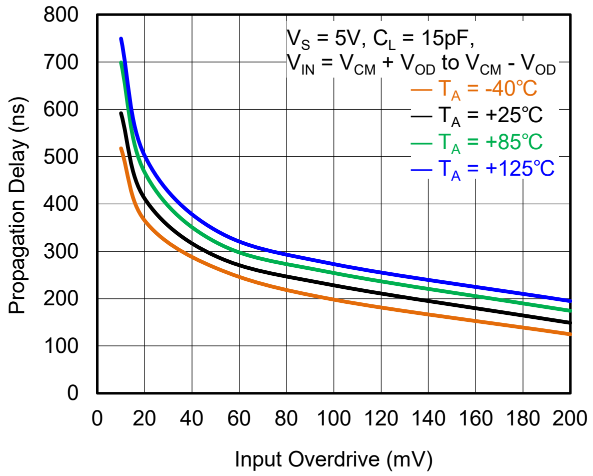
SGM8716B-1 Propagation Delay (H-L) vs. Input Overdrive



SGM8716B-1 Propagation Delay (L-H) vs. Input Overdrive



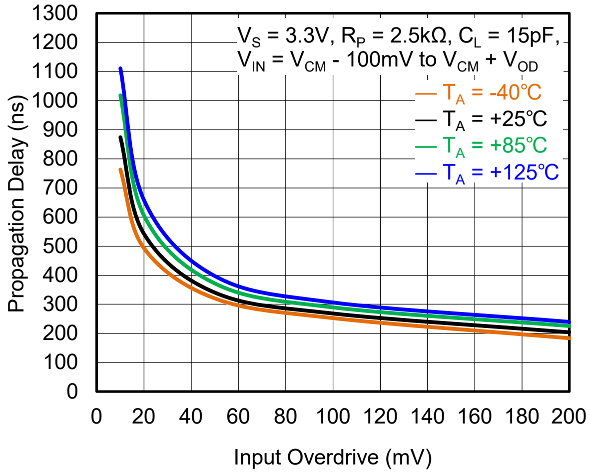
SGM8716B-1 Propagation Delay (H-L) vs. Input Overdrive



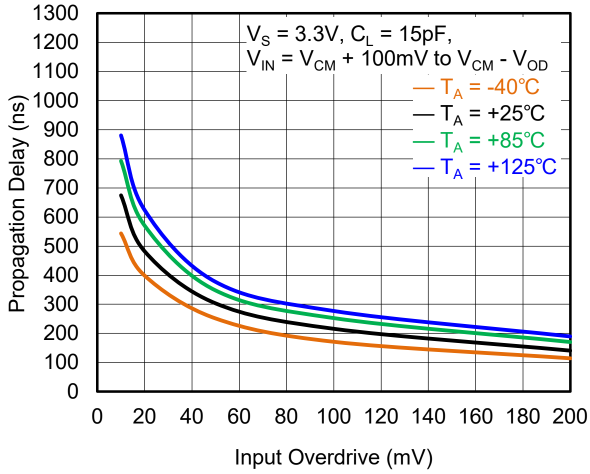
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A = +25℃, V_S = 5V, V_{CM} = V_S/2, unless otherwise noted.

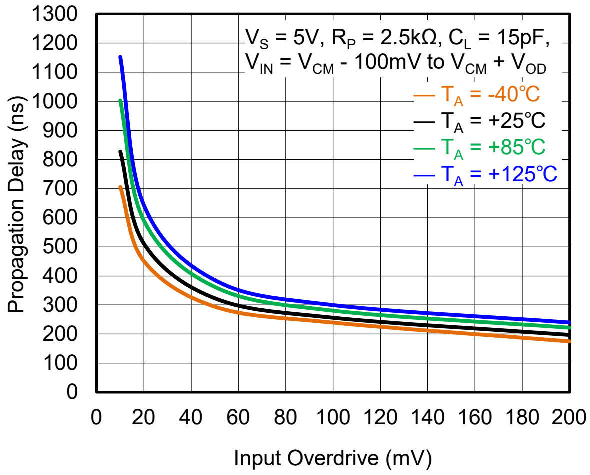
SGM8716A-1 Propagation Delay (L-H) vs. Input Overdrive



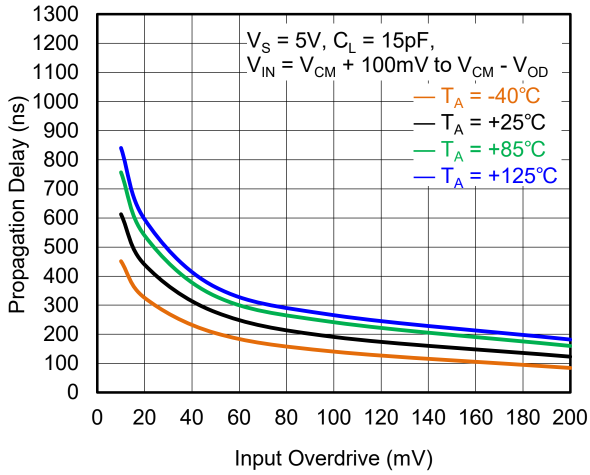
SGM8716A-1 Propagation Delay (H-L) vs. Input Overdrive



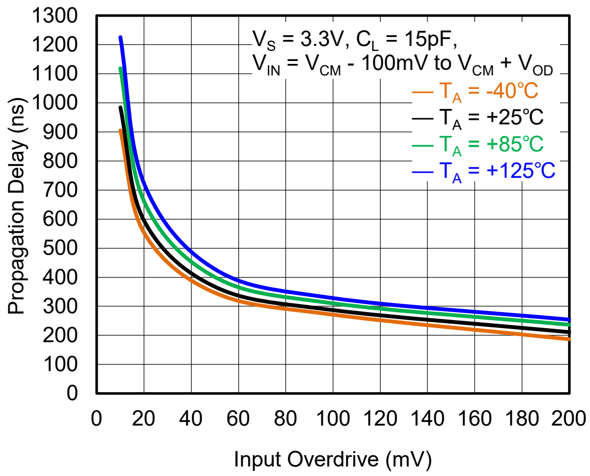
SGM8716A-1 Propagation Delay (L-H) vs. Input Overdrive



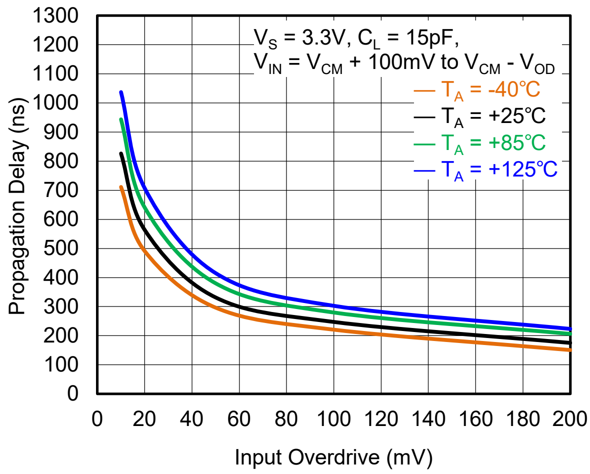
SGM8716A-1 Propagation Delay (H-L) vs. Input Overdrive



SGM8716B-1 Propagation Delay (L-H) vs. Input Overdrive



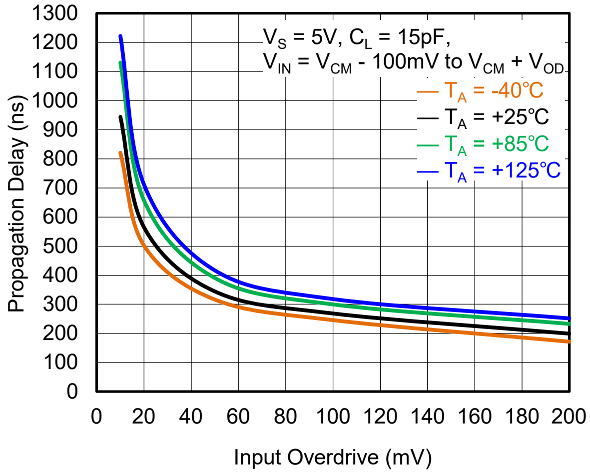
SGM8716B-1 Propagation Delay (H-L) vs. Input Overdrive



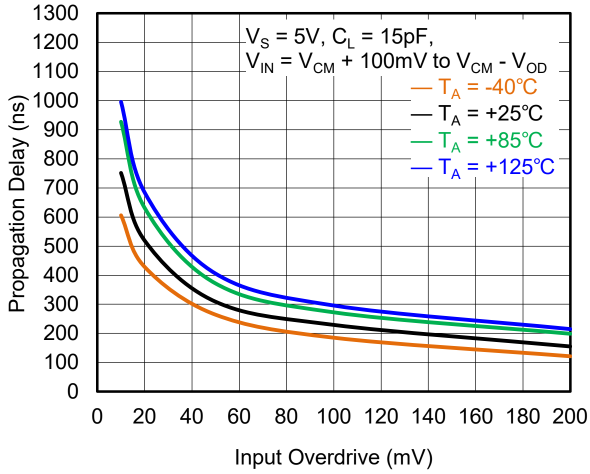
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A = +25℃, V_S = 5V, V_{CM} = V_S/2, unless otherwise noted.

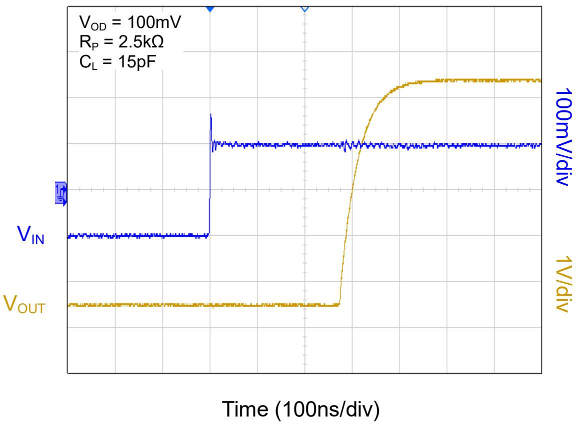
SGM8716B-1 Propagation Delay (L-H) vs. Input Overdrive



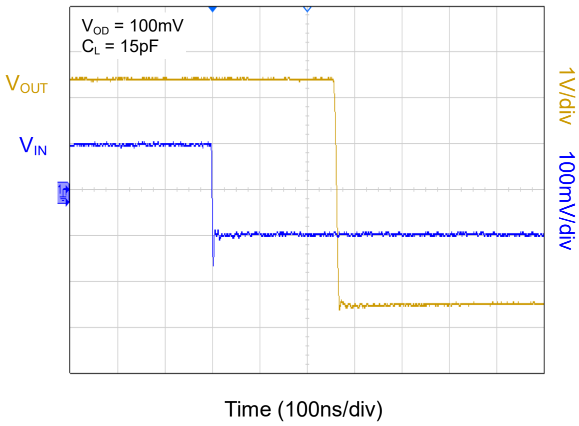
SGM8716B-1 Propagation Delay (H-L) vs. Input Overdrive



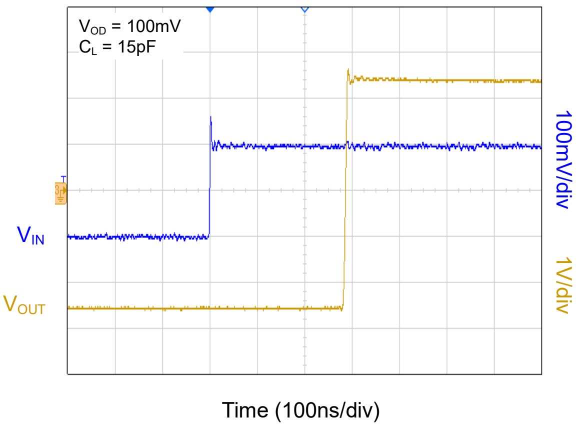
SGM8716A-1 Propagation Delay (L-H)



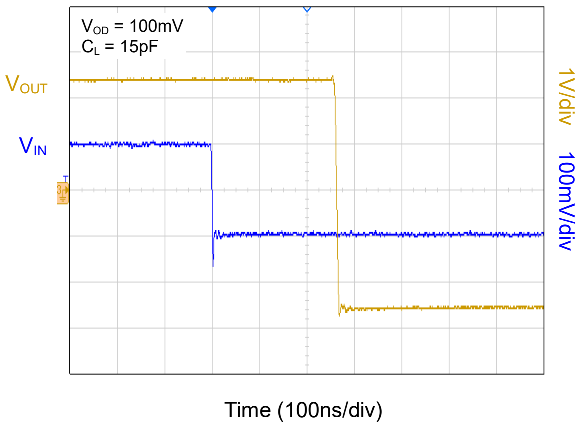
SGM8716A-1 Propagation Delay (H-L)



SGM8716B-1 Propagation Delay (L-H)

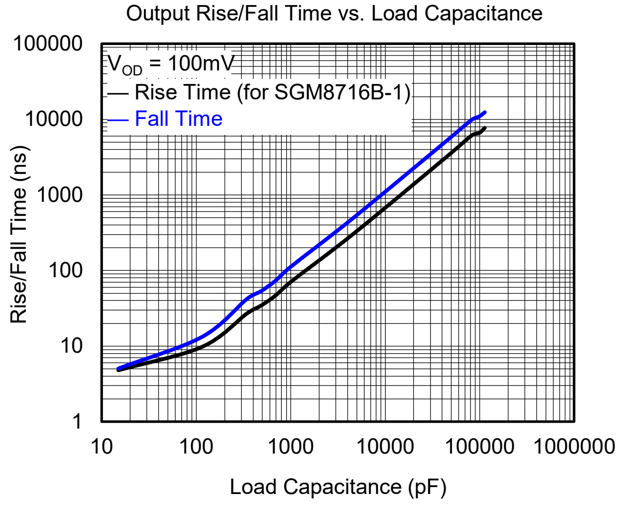


SGM8716B-1 Propagation Delay (H-L)



TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A = +25℃, V_S = 5V, V_{CM} = V_S/2, unless otherwise noted.



FUNCTIONAL BLOCK DIAGRAM

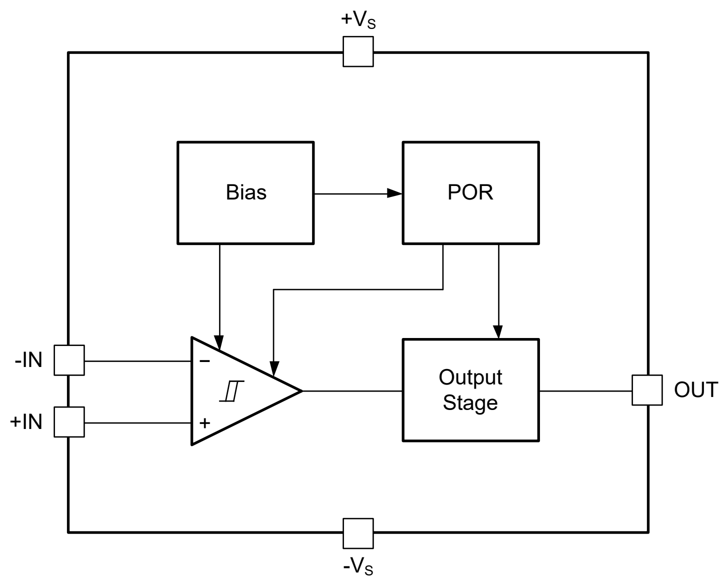


Figure 3. Block Diagram

DETAILED DESCRIPTION

The SGM8716A-1 and SGM8716B-1 are single, micro-power, rail-to-rail input and small size comparators. They are optimized for low voltage operation from 1.6V to 5.5V single supply, consuming only 5.5μA quiescent current. The output of SGM8716A-1 is open-drain and the output of SGM8716B-1 is push-pull. Both devices are packaged in space-saving packages.

The above advantages make these comparators operate well in the battery-powered system. Also, the input rail-to-rail stage can manage the input signal which is higher than the positive power supply with the internal hysteresis. The positive feedback should be taken into account for the applications of higher hysteresis.

The ability of open-drain for SGM8716A-1 is suitable for the condition of level shifting and wire-ORing. The power-budget can be reduced by the structure of push-pull for SGM8716B-1.

POR Function

The SGM8716A-1 and SGM8716B-1 integrate a power-on-reset (POR) circuit that becomes active during the rising or falling ramp of the power supply ($+V_S$). Upon activation, the POR circuit of SGM8716B-1 maintains a low output ($-V_S$). Conversely, the SGM8716A-1 maintains a high output.

Inputs

The maximum input common mode voltage range of the comparator is from $-V_S$ to $(+V_S) + 0.1V$. These comparators can operate at any differential input voltage within these limits.

To protect the inputs of the comparator from going out of range, the internal diode connected to $-V_S$ is taken into account. To explain, the internal diode will be forward biased if the input voltage is below $-V_S$ and the input bias current of the comparator will increase exponentially in this situation.

Output

The SGM8716A-1 provides the output of open-drain, and the SGM8716B-1 provides the output stage of push-pull.

When the power supply voltage is within the normal operating range, the output of the comparator is related to the differential input (V_{ID}).

Internal Hysteresis

Both SGM8716A-1 and SGM8716B-1 have 4.2mV hysteresis (V_{HYST}), which helps improve the noise immunity. Figure 4 shows the relationship among V_{TH}, V_{OS}, and V_{HYST}. V_{TH} is the trip voltage or set voltage of the comparator. V_{OS} is defined as the input offset voltage between V_{IN+} and V_{IN-}. V_{OS} is considered into the influence of the hysteresis which can affect the response of the output.

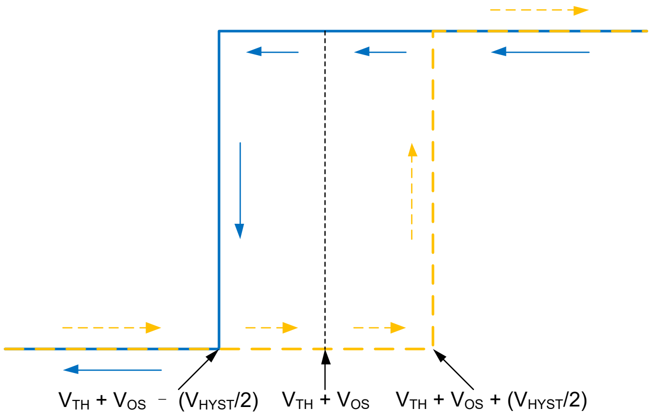


Figure 4. Hysteresis Transfer Curve

APPLICATION INFORMATION

Typical Application

Adding External Hysteresis

The effect of significant input noise is an issue that has to be taken into consideration for applications with slow moving or noisy input signals. The output will switch as the result of the input noise, although there is 4.2mV internal hysteresis.

Figure 5 illustrates the SGM8716B-1 inverting circuit with the external hysteresis.

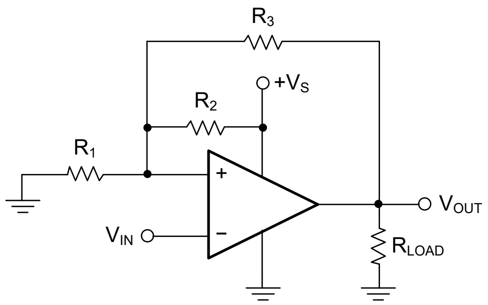


Figure 5. Inverting Configuration with Hysteresis of SGM8716B-1

The external hysteresis caused by the circuit is shown in Equation 1. In Equation 1, R_{F1} = (R_2//R_3) and R_{F2} = (R_1//R_3).

$$V_{HYS} = (+V_S)\left(\frac{R_1}{R_{F1}+R_1} - \frac{R_{F2}}{R_2+R_{F2}}\right) \quad (1)$$

Figure 6 illustrates the SGM8716B-1 non-inverting circuit with external hysteresis.

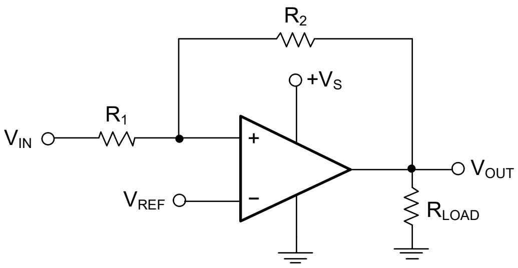


Figure 6. Non-Inverting Configuration with Hysteresis of SGM8716B-1

The external hysteresis of this circuit can be calculated using Equation 2.

$$V_{HYS} = (+V_S) \times \frac{R_1}{R_2} \quad (2)$$

Window Comparator

The application of window comparator with SGM8716A-1 is shown in Figure 7, and it is used for detecting the under-voltage or over-voltage situation. When the operating voltage of the circuit is 3.3V and R_1 = R_2 = R_3 = 10MΩ, V_{TH+} can be obtained as 2.2V and V_{TH-} as 1.1V.

As shown in Figure 8, if V_{SENSOR} < 1.1V or V_{SENSOR} > 2.2V, V_{OUT} is logic low. If 1.1V < V_{SENSOR} < 2.2V, V_{OUT} is logic high.

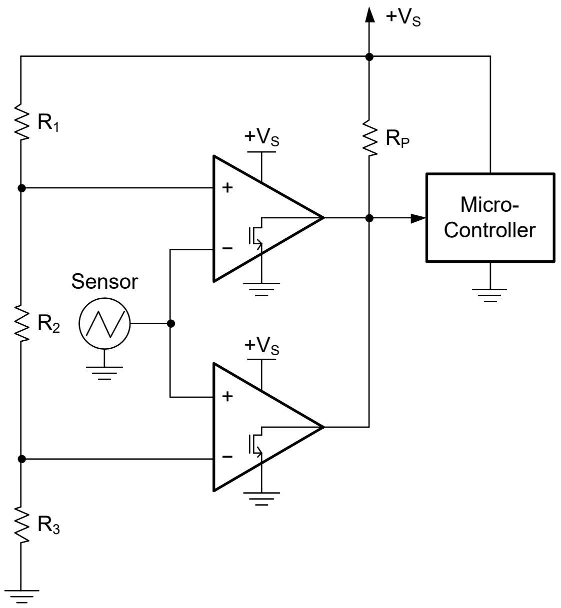


Figure 7. Window Comparator with SGM8716A-1

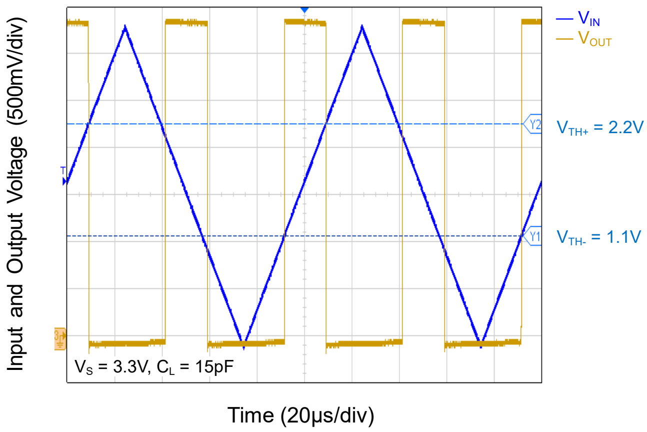


Figure 8. Window Comparator Results

APPLICATION INFORMATION (continued)

Square-Wave Oscillator

The following circuit is widely used for the applications of low-cost timing reference or clock source of the system.

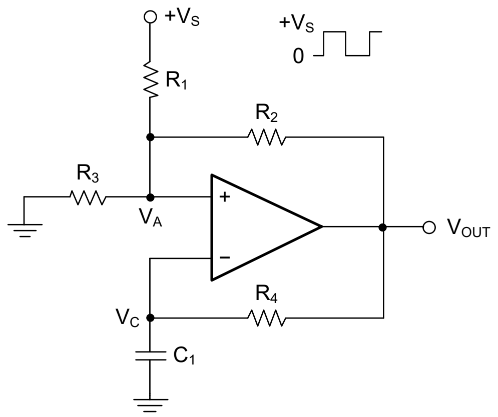


Figure 9. Square-Wave Oscillator

Design Requirements

For the circuit in Figure 9, the period of the square waveform is determined by the time constant R_4C_1. There are two parameters that limit the frequency of the square waveform, which are the propagation delay of the comparator and the capacitance of the load. For a specific oscillation frequency, the feedback resistor R_4 can be larger when considering using small capacitor as the extreme low bias current of the input.

Detailed Design Procedure

The time constant R_4C_1 determines the oscillated frequency of the circuit.

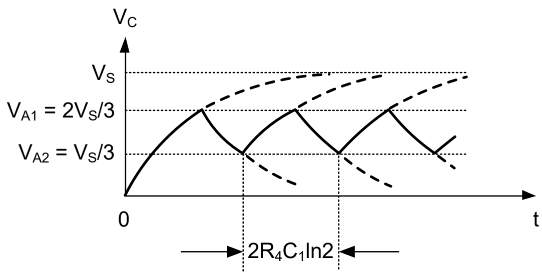


Figure 10. Square-Wave Oscillator Timing and Thresholds

To explain the operation of the circuit, first, it can be assumed that V_{OUT} is in high position. Then, the capacitor C_1 is charged by V_{OUT} at this stage until the value of V_C reaches the value of V_A. The following equation illustrates the threshold V_{A1} for the above case:

$$V_{A1} = \frac{V_S \times R_3}{R_3 + R_1 || R_2} \quad (3)$$

If $R_1 = R_2 = R_3$, then $V_{A1} = 2V_S/3$.

Once the value of $V_C > V_A$, the output of the comparator will be in low position (GND). The capacitor C_1 will discharge until the value of V_C reaches the threshold V_{A2}. The following equation illustrates the threshold V_{A2}:

$$V_{A2} = \frac{V_S \times (R_2 || R_3)}{R_1 + R_2 || R_3} \quad (4)$$

If $R_1 = R_2 = R_3$, then $V_{A2} = V_S/3$.

As the decreasing of V_C, the output will switch back to high position again. To calculate the period of oscillation, during which the value of V_C changes from $2V_S/3$ to $V_S/3$ and then goes back to $2V_S/3$ again, the equation is shown as below:

$$f = 1/(2 \times R_4 \times C_1 \times \ln 2) \quad (5)$$

Application Curve

The test outcomes of a tan oscillator are illustrated in Figure 11.

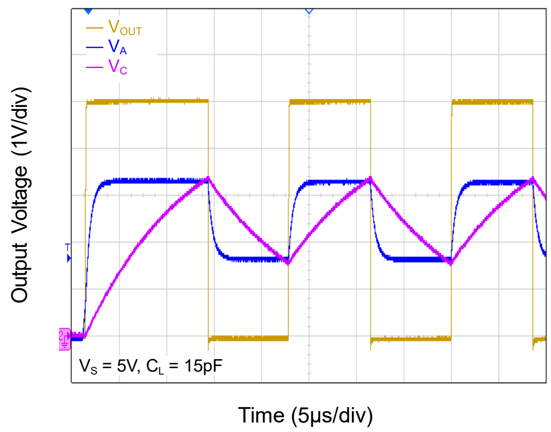


Figure 11. Square-Wave Oscillator Output Waveform

Power Supply Recommendations

The SGM8716A-1 and SGM8716B-1 can be used for both single and dual power supply modes. In Application, a 100nF bypass capacitor is recommended and should be placed as close as possible to $+V_S$ pin.

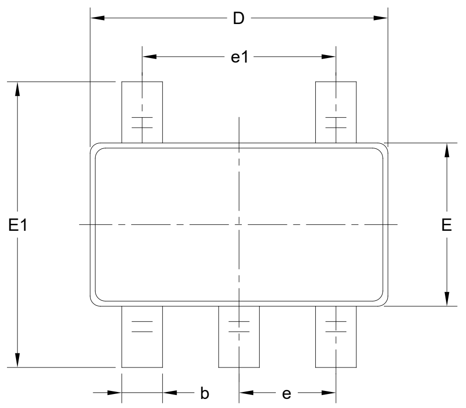
REVISION HISTORY

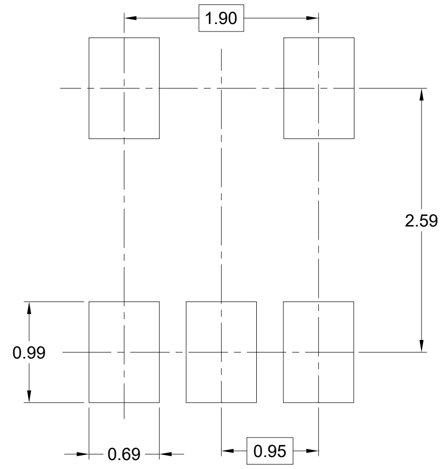
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Original to REV.A (JUNE 2025)	Page
Changed from product preview to production data	All

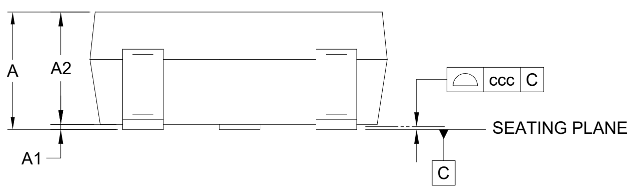
PACKAGE OUTLINE DIMENSIONS

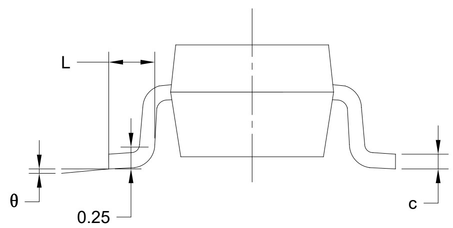
SOT-23-5





RECOMMENDED LAND PATTERN (Unit: mm)



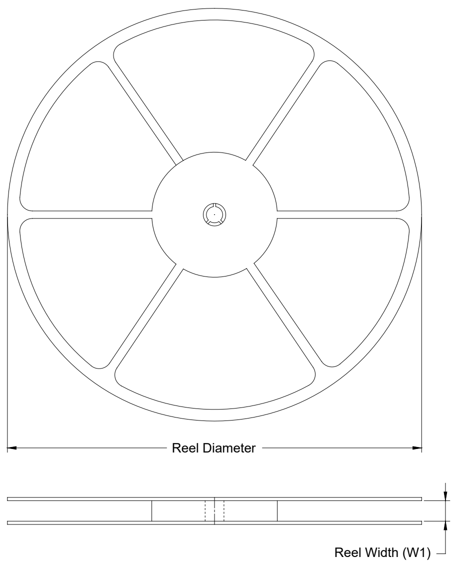


Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A	-	-	1.450
A1	0.000	-	0.150
A2	0.900	-	1.300
b	0.300	-	0.500
c	0.080	-	0.220
D	2.750	-	3.050
E	1.450	-	1.750
E1	2.600	-	3.000
e	0.950 BSC		
e1	1.900 BSC		
L	0.300	-	0.600
θ	0°	-	8°
ccc	0.100		

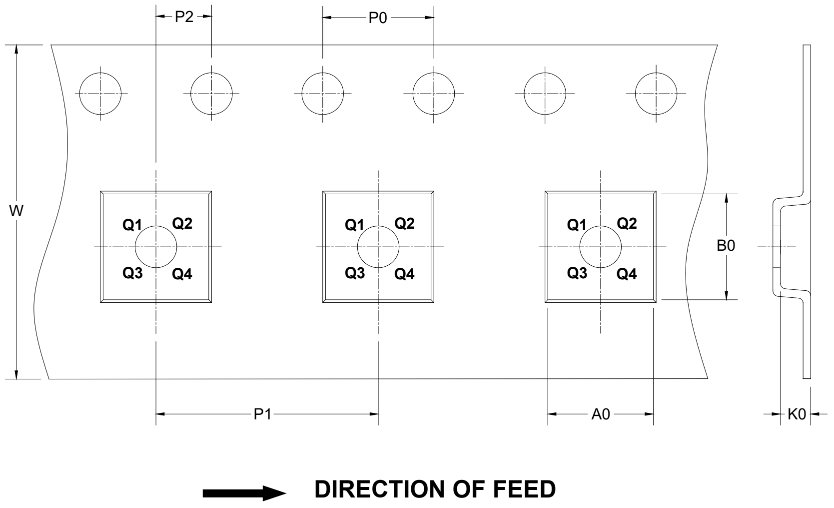
NOTES:
1. This drawing is subject to change without notice.
2. The dimensions do not include mold flashes, protrusions or gate burrs.
3. Reference JEDEC MO-178.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



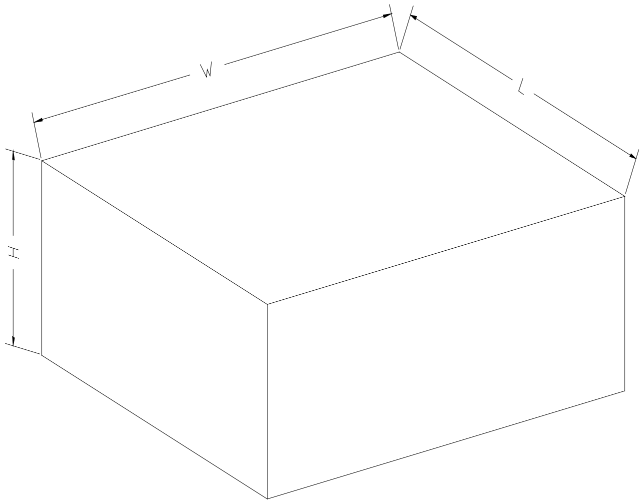
NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
SOT-23-5	7″	9.5	3.20	3.20	1.40	4.0	4.0	2.0	8.0	Q3

DD0001

CARTON BOX DIMENSIONS



NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF CARTON BOX

Reel Type	Length (mm)	Width (mm)	Height (mm)	Pizza/Carton
7″ (Option)	368	227	224	8
7″	442	410	224	18

DD0002