SGM8140
Low Power, Vibration Sensor and PIR Sensor Analog Front End (AFE)

GENERAL DESCRIPTION

The SGM8140 is a PIR sensor and vibration sensor analog front end which consists of 2 independent building block circuits. One is a dual rail-to-rail input and output operational amplifier, and the other is an ultra-low power comparator. Both the operational amplifier and the comparator have been specifically designed to operate over a wide range of voltages from 1.4V to 5.5V. The SGM8140 only consumes 1.1μA working current, so it is ideal for use in a variety of battery-powered applications.

The operational amplifier is unity-gain stable and features a 5kHz gain-bandwidth product. It is suitable for low frequency systems in the case of monitoring battery current and conditioning sensor signal.

The comparator has a push-pull output, which drive resistive or capacitive with absolute lowest power consumption.

The SGM8140 is available in a Green TQFN-4×4-16L package. It is specified for the -40℃ to +85℃ industrial temperature range.

FEATURES

- **Ultra-Low Power: 1.1μA (TYP) at V_S = 5V**
- **Wide Supply Voltage Range: 1.4V to 5.5V**
- **Rail-to-Rail Input and Output Amplifier**
- **Amplifier Gain-Bandwidth Product: 5kHz (TYP) at V_S = 5V**
- **Amplifier is Unity-Gain Stable**
- **Comparator Propagation Delay: 6μs (TYP)**
- **Comparator Push-Pull Output Current Drive: 19mA (TYP) at V_S = 5V**
- **-40℃ to +85℃ Operating Temperature Range**
- **Available in a Green TQFN-4×4-16L Package**

APPLICATIONS

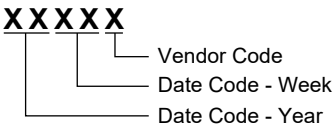
Toll Booth Tags
Wearable Products
Battery-Powered Systems
Temperature Measurements
Vibration Detectors
Alarm and Monitoring Circuits

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM8140	TQFN-4×4-16L	-40℃ to +85℃	SGM8140YTQE16G/TR	SGM8140 YTQE16 XXXXX	Tape and Reel, 3000

MARKING INFORMATION

NOTE: XXXXX = Date Code and Vendor Code.



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_{CC} 6V
Input Common Mode Voltage Range
..... $(-V_S)$ - 0.1V to $(+V_S)$ + 0.1V
Differential Input Voltage ..... $|(-V_S) - (+V_S)|$
Junction Temperature ..... +150℃
Storage Temperature Range ..... -65℃ to +150℃
Lead Temperature (Soldering, 10s) ..... +260℃
ESD Susceptibility
HBM 4000V
CDM 1000V

RECOMMENDED OPERATING CONDITIONS

Operating Temperature Range ..... -40℃ to +85℃

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.

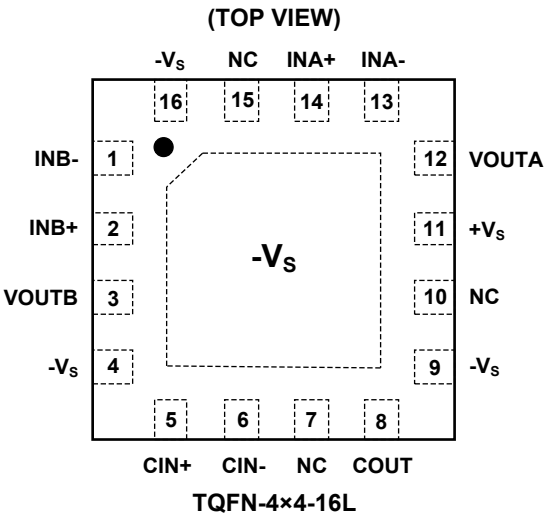
ESD SENSITIVITY CAUTION

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

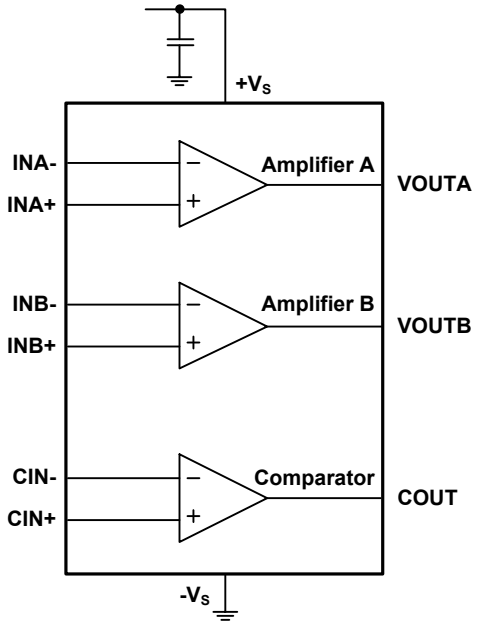
SG Micro Corp reserves the right to make any change in circuit design, or specifications without prior notice.

PIN CONFIGURATION



TQFN-4×4-16L

FUNCTIONAL BLOCK DIAGRAM



PIN DESCRIPTION

PIN	NAME	FUNCTION
1	INB-	Negative Input of Amplifier B.
2	INB+	Positive Input of Amplifier B.
3	VOUTB	Output of Amplifier B.
4	$-V_S$	Negative Supply. Always connect this pin to ground for single power supply application.
5	CIN+	Positive Input of Comparator.
6	CIN-	Negative Input of Comparator.
7	NC	No Connection.
8	COUT	Output of Comparator.
9	$-V_S$	Negative Supply. Always connect this pin to ground for single power supply application.
10	NC	No Connection.
11	$+V_S$	Positive Power Supply.
12	VOUTA	Output of Amplifier A.
13	INA-	Negative Input of Amplifier A.
14	INA+	Positive Input of Amplifier A.
15	NC	No Connection.
16	$-V_S$	Negative Supply. Always connect this pin to ground for single power supply pplication.

ELECTRICAL CHARACTERISTICS

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Quiescent Current	V_S = 5V, V_{CM} = 2.5V, T_A = +25℃		1.1	2.2	μA
	V_S = 1.4V, V_{CM} = 0.7V, T_A = +25℃		0.9		

Operational Amplifier Only

(V_S = 1.4V to 5V, -V_S = GND, T_A = +25℃, V_{CM} = V_S/2, V_{OUT} ≈ V_S/2 and R_L = 1MΩ to V_S/2, unless otherwise noted.)

PARAMETER		CONDITIONS	MIN	TYP	MAX	UNITS
DC Electrical Characteristics						
Input Offset Voltage (V_{OS})		V_{CM} = V_S/2		0.4	2.5	mV
Input Offset Voltage Drift ($\Delta V_{OS}/\Delta T$)		V_{CM} = V_S/2		2		μV/°C
Power Supply Rejection Ratio (PSRR)		V_S = 1.4V to 5.5V	69	80		dB
Input Common Mode Voltage Range (V_{CMR})			(-V_S) - 0.1		(+V_S) + 0.1	V
Common Mode Rejection Ratio (CMRR)		V_S = 5V, V_{CM} = -0.1V to 5.1V	68	83		dB
		V_S = 5V, V_{CM} = 2.5V to 5.1V	67	82		
		V_S = 5V, V_{CM} = -0.1V to 2.5V	62	77		
Large-Signal Voltage Gain (A_{VO})		V_S = 1.4V, R_L = 50kΩ, V_{OUT} = (+V_S) - 0.1V	75	80		dB
		V_S = 5V, R_L = 50kΩ, V_{OUT} = (+V_S) - 0.1V	87	93		
Input Bias Current (I_B)				1		pA
Input Offset Current (I_{OS})				1		pA
Maximum Output Voltage Swing	V_{OH}	V_S = 1.4V, R_L = 50kΩ		5	12	mV
		V_S = 5V, R_L = 50kΩ		4	12	
	V_{OL}	V_S = 1.4V, R_L = 50kΩ		4.6	12	
		V_S = 5V, R_L = 50kΩ		3.6	12	
Short-Circuit Current (I_{SC})		V_S = 5V, source	20	24		mA
		V_S = 5V, sink	20	24		
Supply Voltage			1.4		5.5	V
AC Electrical Characteristics (C_L = 60pF)						
Gain-Bandwidth Product (GBP)		V_S = 1.4V		4.3		kHz
		V_S = 5V		5		
Slew Rate (SR)		V_S = 1.4V, V_{OUT} = 1V step		1.3		V/ms
		V_S = 5V, V_{OUT} = 2V step		1.6		
Phase Margin (PM)		V_S = 1.4V to 5.5V		60		°
Input Voltage Noise (e_n p-p)		V_S = 1.4V, f = 0.1Hz to 10Hz		4.4		μV_{P-P}
		V_S = 5V, f = 0.1Hz to 10Hz		4.0		
Input Voltage Noise Density (e_n)		V_S = 1.4V, f = 1kHz		135		$nV/\sqrt{HZ}$
		V_S = 5V, f = 1kHz		130		

ELECTRICAL CHARACTERISTICS (continued)

Comparator Only

(T_A = +25℃, V_S = 1.4V, -V_S = 0V, V_{CM} = V_S/2 and V_{OUT} = -V_S, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage	V_{OS}	V_{CM} = 0V		0.5	3.3	mV
		V_{CM} = 1.4V		0.5	3.2	
Input Offset Average Drift				2		μV/℃
Common Mode Rejection Ratio	CMRR	V_{CM} stepped from 0V to 0.3V		65		dB
		V_{CM} stepped from 0.8V to 1.4V		75		
		V_{CM} stepped from 0V to 1.4V		75		
Power Supply Rejection Ratio	PSRR	V_S = 1.8V to 5.5V, V_{CM} = 0V	65	95		dB
Large-Signal Voltage Gain	A_{VO}			100		dB
Output Swing High	V_{OH}	V_S = 1.8V, I_{OUT} = 500μA		131	202	mV
		-40℃ ≤ T_A ≤ +85℃			219	
		V_S = 1.8V, I_{OUT} = 1mA		292	476	
		-40℃ ≤ T_A ≤ +85℃			512	
Output Swing Low	V_{OL}	V_S = 1.8V, I_{OUT} = -500μA		82	112	mV
		-40℃ ≤ T_A ≤ +85℃			127	
		V_S = 1.8V, I_{OUT} = -1mA		167	225	
		-40℃ ≤ T_A ≤ +85℃			253	
Output Current	I_{OUT}	Source		0.7		mA
		Sink		2.0		
Propagation Delay (High to Low)		Overdrive = 10mV		12		μs
		Overdrive = 100mV		6		
Propagation Delay (Low to High)		Overdrive = 10mV		26		μs
		Overdrive = 100mV		17		
Rise Time	t_{Rise}	Overdrive = 10mV, C_L = 30pF, R_L = 1MΩ		220		ns
		Overdrive = 100mV, C_L = 30pF, R_L = 1MΩ		220		
Fall Time	t_{Fall}	Overdrive = 10mV, C_L = 30pF, R_L = 1MΩ		155		ns
		Overdrive = 100mV, C_L = 30pF, R_L = 1MΩ		155		

ELECTRICAL CHARACTERISTICS (continued)

Comparator Only (continued)

(T_A = +25℃, V_S = 5V, $-V_S$ = 0V, V_{CM} = V_S/2 and V_{OUT} = $-V_S$, unless otherwise noted.)

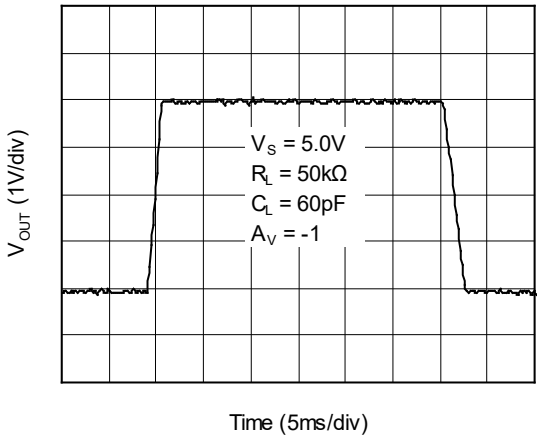
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage	V_{OS}	V_{CM} = 0V		0.5	3.3	mV
		V_{CM} = 5V		0.5	3.2	
Input Offset Average Drift				2		μV/℃
Common Mode Rejection Ratio	CMRR	V_{CM} stepped from 0V to 3.9V		85		dB
		V_{CM} stepped from 4.4V to 5V		85		
		V_{CM} stepped from 0V to 5V		85		
Power Supply Rejection Ratio	PSRR	V_S = 1.8V to 5.5V, V_{CM} = 0V	65	95		dB
Large-Signal Voltage Gain	A_{VO}			105		dB
Output Swing High	V_{OH}	I_{OUT} = 500μA		48	77	mV
		-40℃ ≤ T_A ≤ +85℃			84	
		I_{OUT} = 1mA		96	136	
		-40℃ ≤ T_A ≤ +85℃			152	
Output Swing Low	V_{OL}	I_{OUT} = -500μA		52	80	mV
		-40℃ ≤ T_A ≤ +85℃			90	
		I_{OUT} = -1mA		104	130	
		-40℃ ≤ T_A ≤ +85℃			143	
Output Current	I_{OUT}	Source	13.5	18		mA
		-40℃ ≤ T_A ≤ +85℃	11.5			
		Sink	15	19		
		-40℃ ≤ T_A ≤ +85℃	12.9			
Propagation Delay (High to Low)		Overdrive = 10mV		13		μs
		Overdrive = 100mV		6		
Propagation Delay (Low to High)		Overdrive = 10mV		42		μs
		Overdrive = 100mV		33		
Rise Time	t_{Rise}	Overdrive = 10mV, C_L = 30pF, R_L = 1MΩ		85		ns
		Overdrive = 100mV, C_L = 30pF, R_L = 1MΩ		85		
Fall Time	t_{Fall}	Overdrive = 10mV, C_L = 30pF, R_L = 1MΩ		70		ns
		Overdrive = 100mV, C_L = 30pF, R_L = 1MΩ		60		

TYPICAL PERFORMANCE CHARACTERISTICS

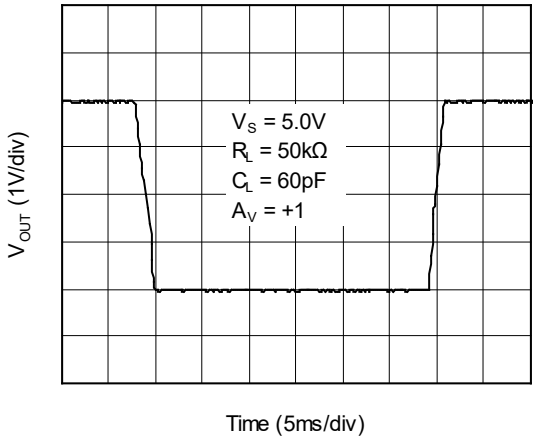
Operational Amplifier Only

T_A = +25℃, V_S = 1.4V to 5V, -V_S = GND, V_{CM} = V_S/2, V_{OUT} ≈ V_S/2 and R_L = 1MΩ to V_S/2, C_L = 60pF, unless otherwise noted.

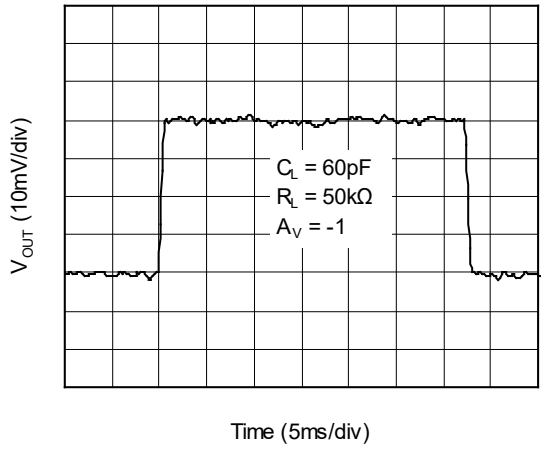
Large Signal Inverting Pulse Response



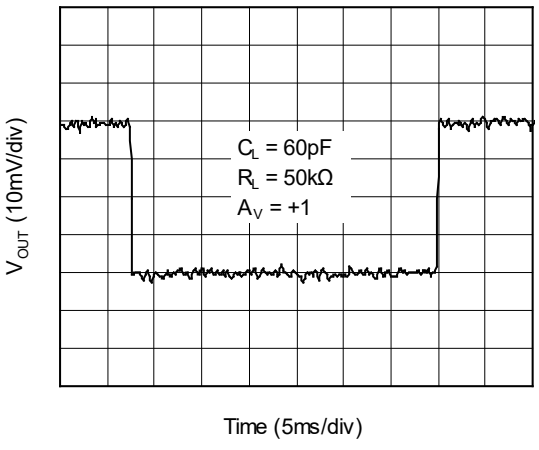
Large Signal Non-Inverting Pulse Response



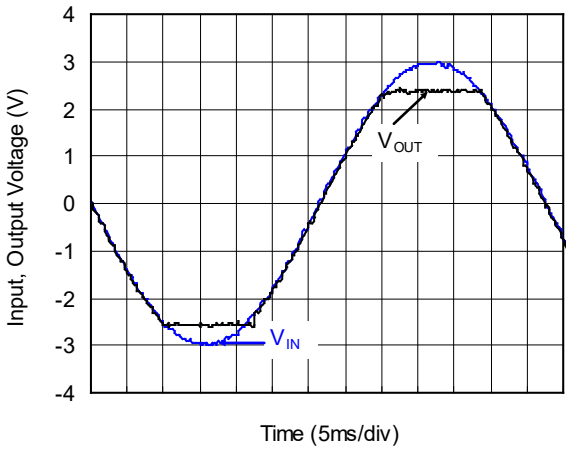
Small Signal Inverting Pulse Response



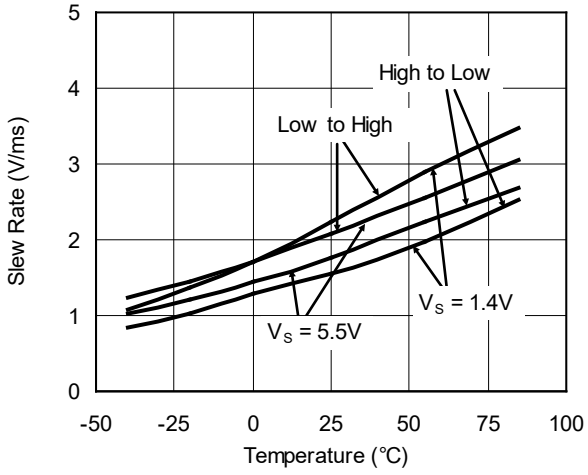
Small Signal Non-Inverting Pulse Response



No Phase Reversal



Slew Rate vs. Temperature

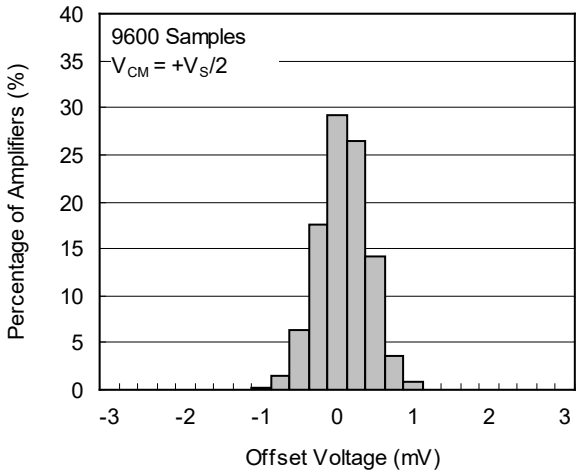


TYPICAL PERFORMANCE CHARACTERISTICS (continued)

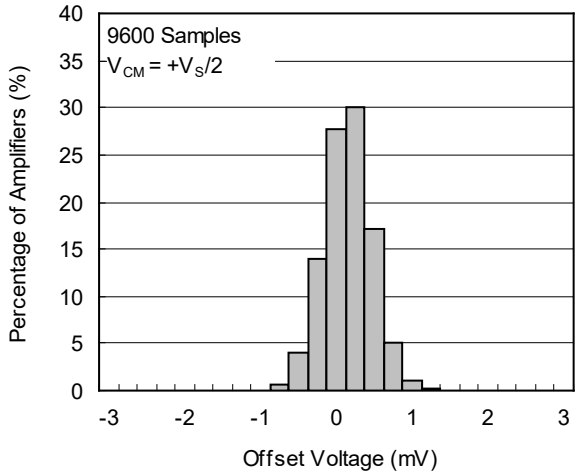
Operational Amplifier Only (continued)

T_A = +25℃, V_S = 1.4V to 5V, -V_S = GND, V_{CM} = V_S/2, V_{OUT} ≈ V_S/2 and R_L = 1MΩ to V_S/2, C_L = 60pF, unless otherwise noted.

Offset Voltage Production Distribution at +1.4V

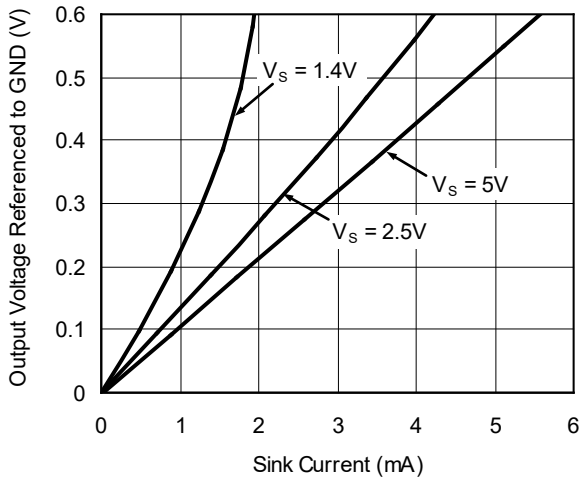


Offset Voltage Production Distribution at +5V

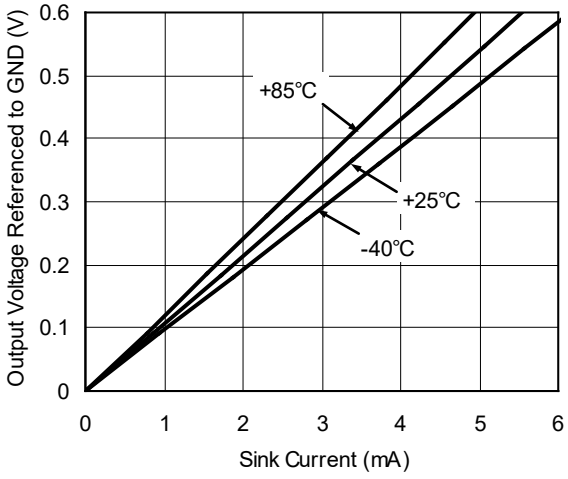


Comparator Only

Output Voltage Low vs. Sink Current



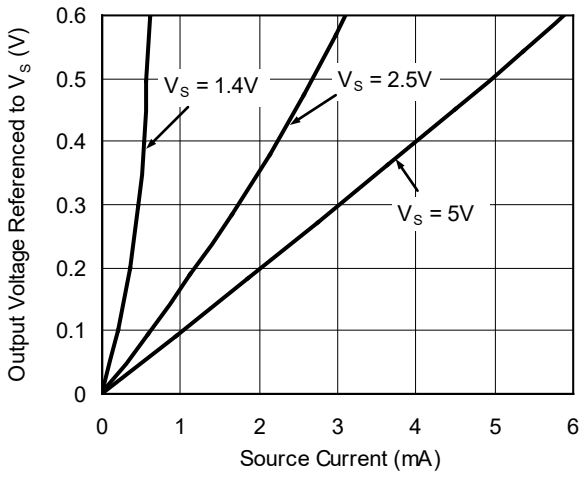
Output Voltage Low vs. Sink Current



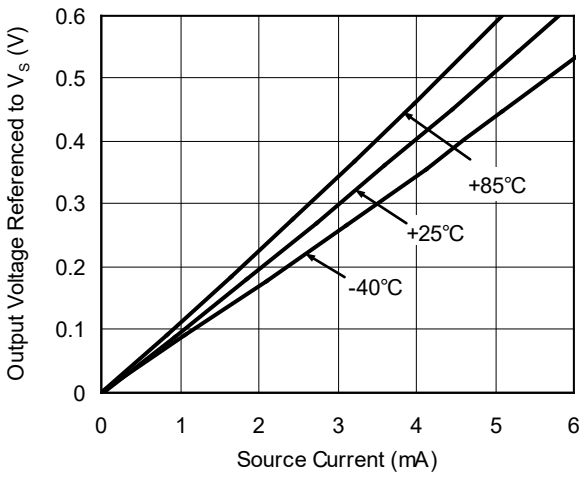
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Comparator Only (continued)

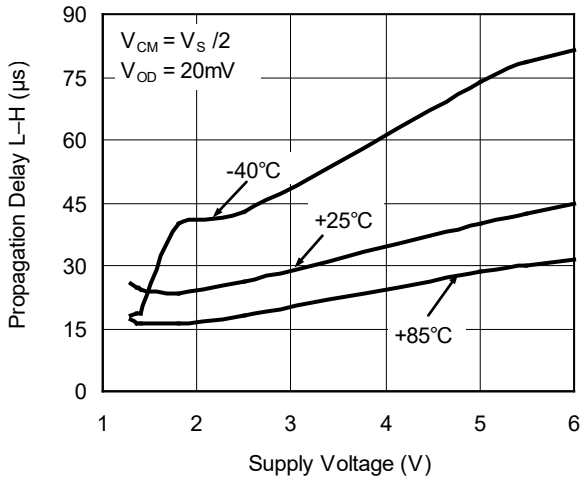
Output Voltage High vs. Source Current



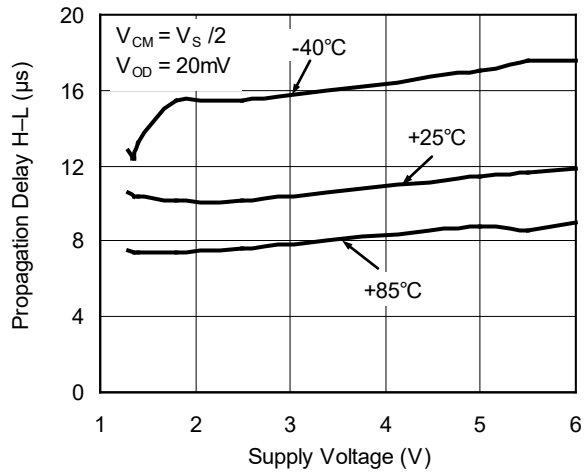
Output Voltage High vs. Source Current



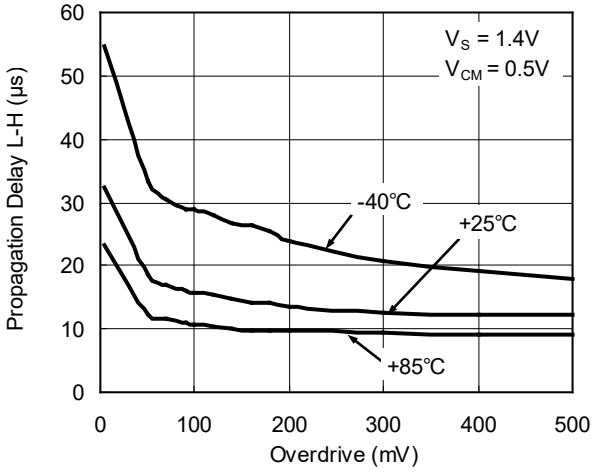
Propagation Delay vs. Supply Voltage



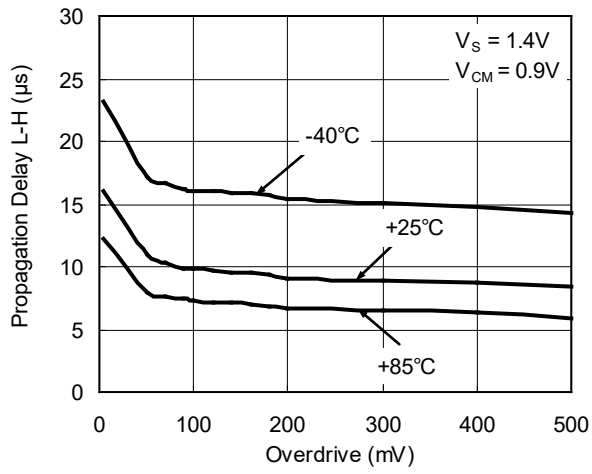
Propagation Delay vs. Supply Voltage



Propagation Delay vs. Overdrive



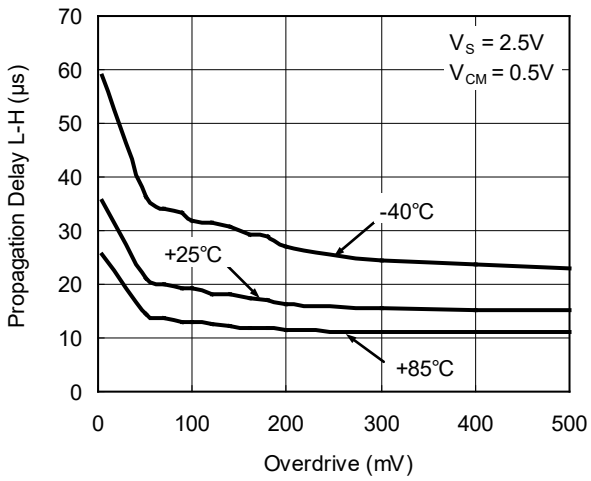
Propagation Delay vs. Overdrive



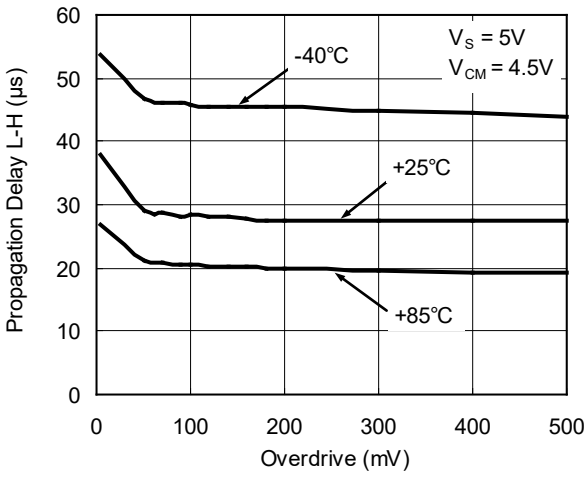
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Comparator Only (continued)

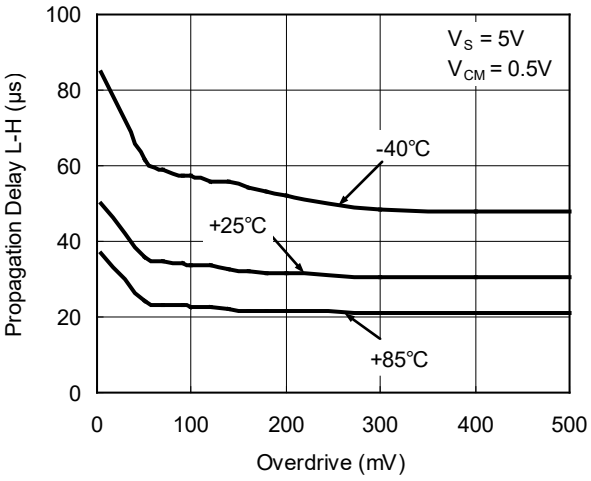
Propagation Delay vs. Overdrive



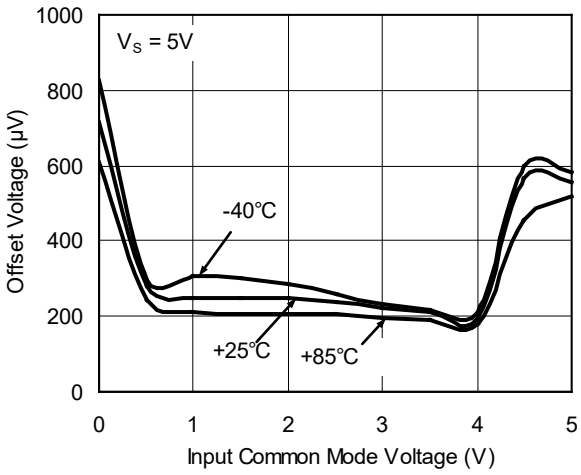
Propagation Delay vs. Overdrive



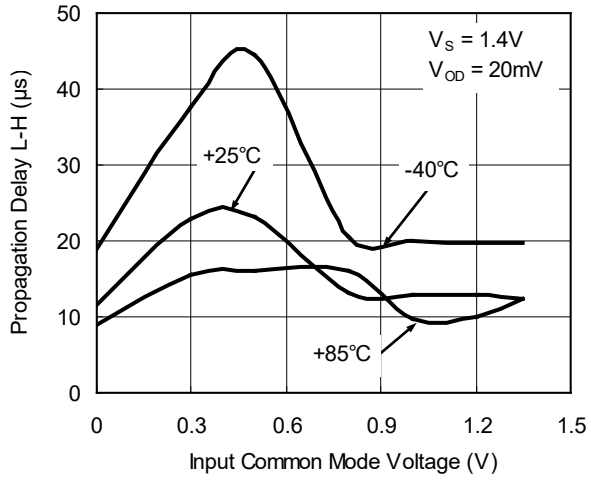
Propagation Delay vs. Overdrive



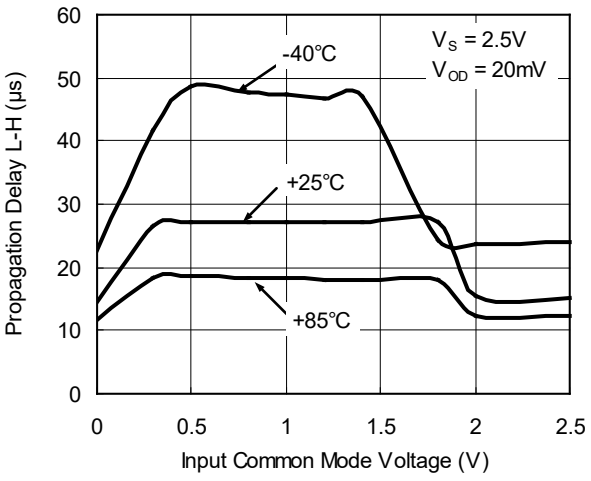
Offset Voltage vs. Input Common Mode Voltage



Propagation Delay vs. Input Common Mode Voltage



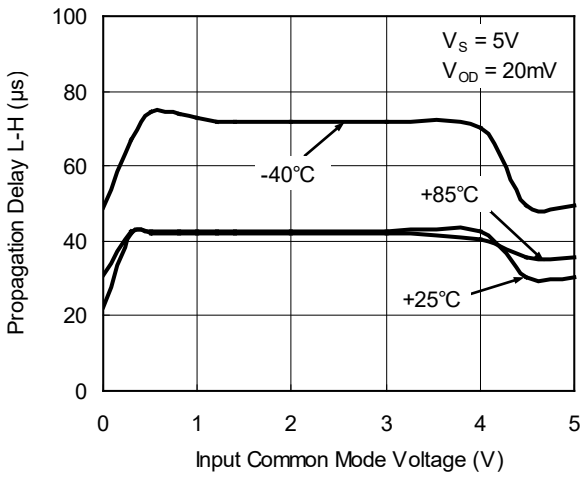
Propagation Delay vs. Input Common Mode Voltage



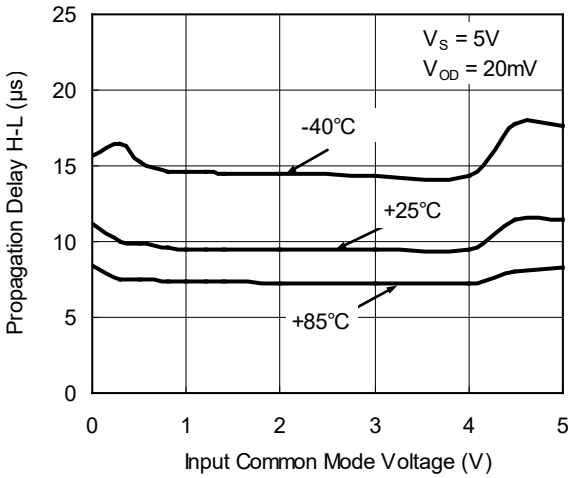
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Comparator Only (continued)

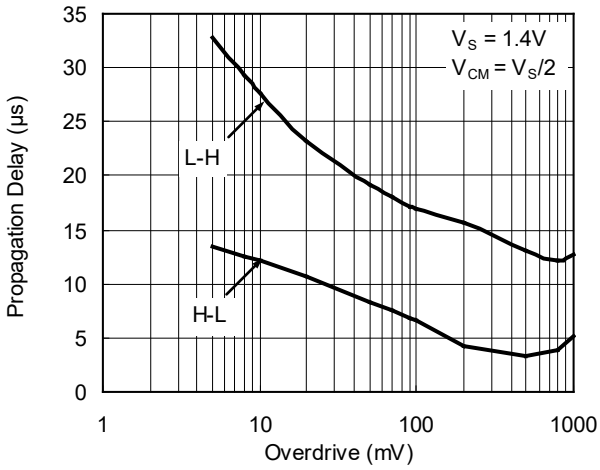
Propagation Delay vs. Input Common Mode Voltage



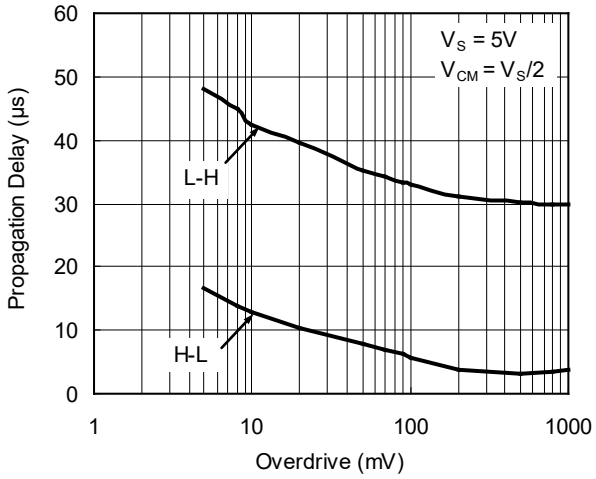
Propagation Delay vs. Input Common Mode Voltage



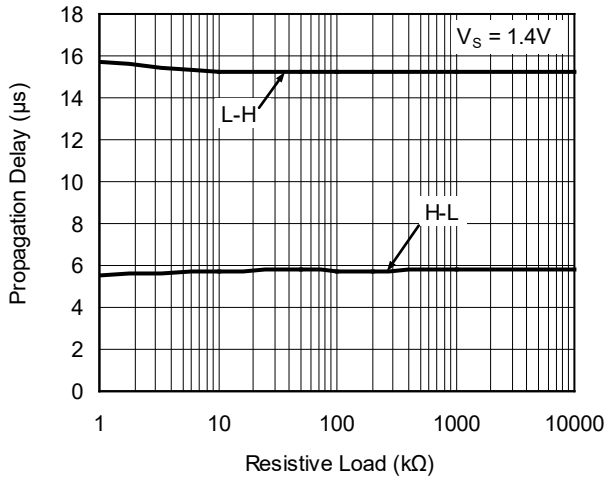
Propagation Delay vs. Overdrive



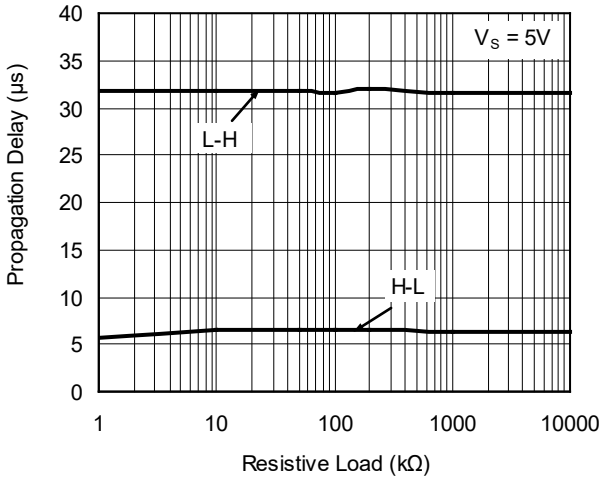
Propagation Delay vs. Overdrive



Propagation Delay vs. Resistive Load



Propagation Delay vs. Resistive Load



APPLICATION CIRCUIT

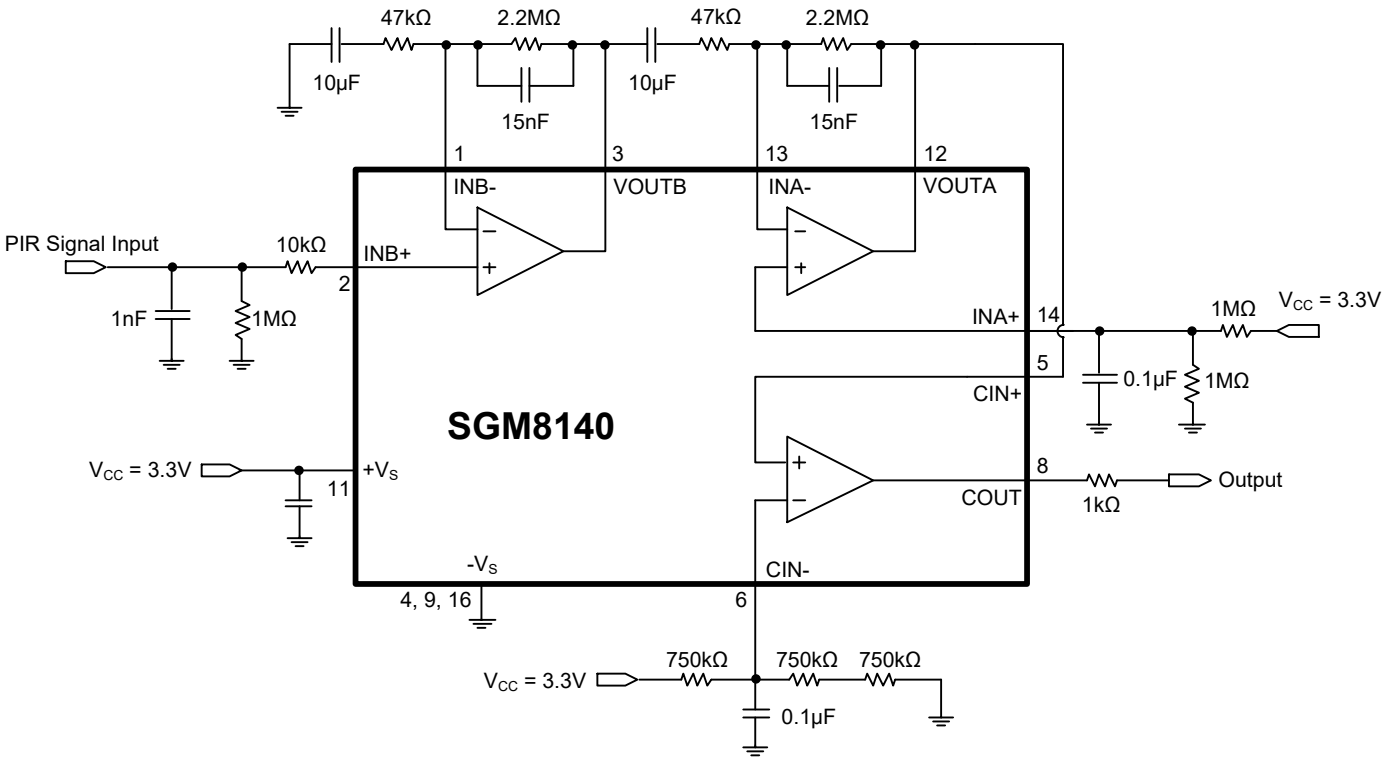


Figure 1. Application Circuit for PIR Sensor

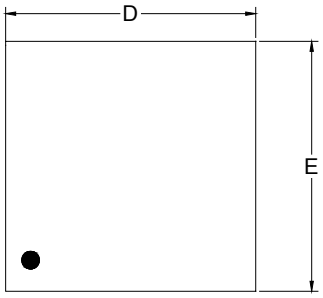
REVISION HISTORY

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

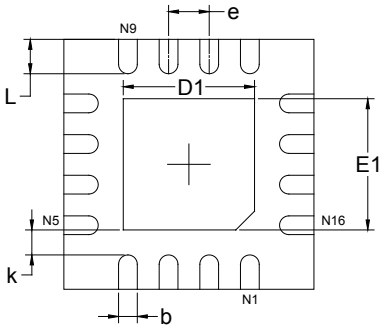
Changes from Original (NOVEMBER 2015) to REV.A	Page
Changed from product preview to production data	All

PACKAGE OUTLINE DIMENSIONS

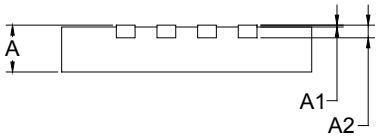
TQFN-4×4-16L



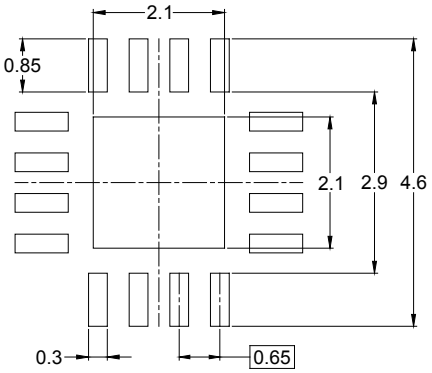
TOP VIEW



BOTTOM VIEW



SIDE VIEW

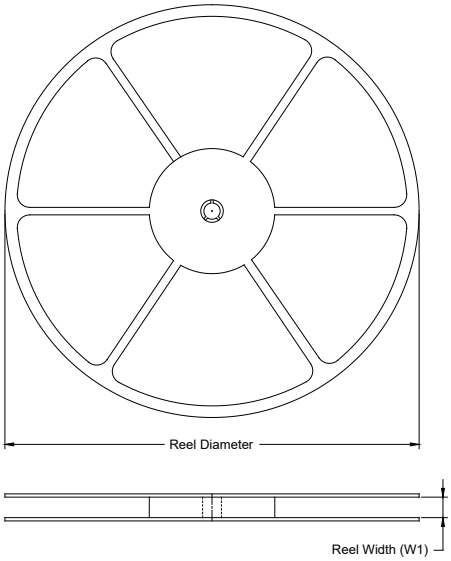


RECOMMENDED LAND PATTERN (Unit: mm)

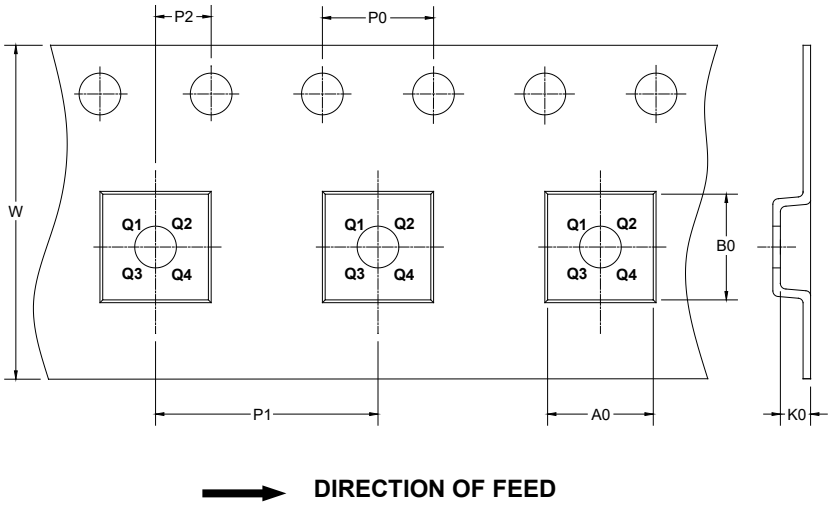
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A2	0.203 REF		0.008 REF	
D	3.900	4.100	0.154	0.161
D1	2.000	2.200	0.079	0.087
E	3.900	4.100	0.154	0.161
E1	2.000	2.200	0.079	0.087
k	0.200 MIN		0.008 MIN	
b	0.250	0.350	0.010	0.014
e	0.650 TYP		0.026 TYP	
L	0.450	0.650	0.018	0.026

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



DIRECTION OF FEED

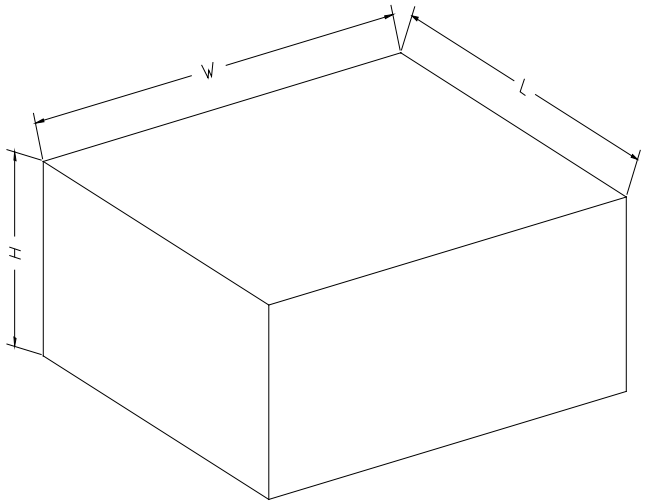
NOTE: The picture is only for reference. Please make the object as the standard.

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
TQFN-4×4-16L	13″	12.4	4.30	4.30	1.10	4.0	8.0	2.0	12.0	Q1

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
13″	386	280	370	5

DD0002