SGM8606
1.8V, Micro-Power, Precision, RRIO, CMOS Zero-Drift Operational Amplifier with Comparator and Voltage Reference

GENERAL DESCRIPTION

The SGM8606 is a low power, high precision CMOS operational amplifier, integrated with one comparator and one low drift voltage reference. The device can operate from 1.8V to 5.5V single supply or from ±0.9V to ±2.75V dual power supplies, while consuming only 20μA quiescent current. The amplifier supports rail-to-rail input and output operation. Its input common mode voltage range is 100mV beyond the rails, and the output swings within 14mV of the rails. The device is suitable for low voltage operation, such as battery-powered applications.

The amplifier features high impedance inputs, a 50μV maximum input offset voltage and zero-drift over time and temperature. It is designed to provide optimal performance in low voltage and low power systems. These specifications make the device appropriate for a wide range of applications requiring high precision, such as driving ADCs without reducing differential linearity.

The comparator's input common mode voltage range is 200mV beyond the rails and the integrated voltage reference provides precise threshold in application.

The internal 1.2V series voltage reference features a low 42μV/℃ drift. It is stable for capacitive load up to 10nF, and can provide output current up to 2mA (TYP).

The SGM8606 fits in a tiny package with low power. It is well suited for mobile phones and handheld electronic applications.

The SGM8606 is available in a Green TDFN-3×3-10L package. It is rated over the -40℃ to +85℃ temperature range.

FEATURES

- **Quiescent Current: 20μA (TYP)**
- **Supply Voltage Range: 1.8V to 5.5V**
- **-40℃ to +85℃ Operating Temperature Range**
- **Available in a Green TDFN-3×3-10L Package**

AMPLIFIER

- **Low Offset Voltage: 50μV (MAX)**
- **Low 0.1Hz to 10Hz Noise: 2μV_{P-P}**
- **Integrated RFI Filter**
- **Single-Supply Operation**
- **Rail-to-Rail Input and Output**

COMPARATOR

- **Comparator Push-Pull Output Current Drive: 18mA (TYP) at V_S = 5V**
- **Comparator Rail-to-Rail Input**

VOLTAGE REFERENCE

- **1.2V Voltage Reference**
- **Low 42μV/℃ Drift**
- **2mA Output Drive Ability**

APPLICATIONS

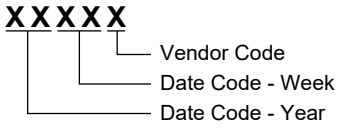
Temperature Measurements
Medical Instrumentation
Battery-Powered Instruments
IR Receivers
Alarm and Monitoring Circuits

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM8606	TDFN-3×3-10L	-40℃ to +85℃	SGM8606YTD10G/TR	SGM 8606D XXXXX	Tape and Reel, 4000

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 6V
V_{IN} Differential ..... $\pm(+V_S - (-V_S))$
Voltage at I/O Pins ..... $(-V_S)$ - 0.3V to $(+V_S)$ + 0.3V
Junction Temperature ..... +150℃
Storage Temperature Range ..... -65℃ to +150℃
Lead Temperature (Soldering, 10s) ..... +260℃
ESD Susceptibility
HBM 4000V
MM 400V
CDM 1000V

RECOMMENDED OPERATING CONDITIONS

Specified Voltage Range ..... 1.8V to 5.5V
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.

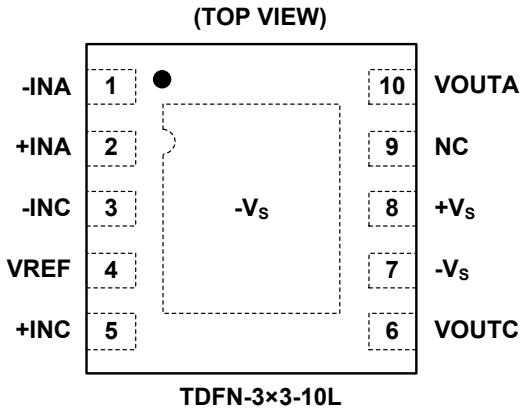
ESD SENSITIVITY CAUTION

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.

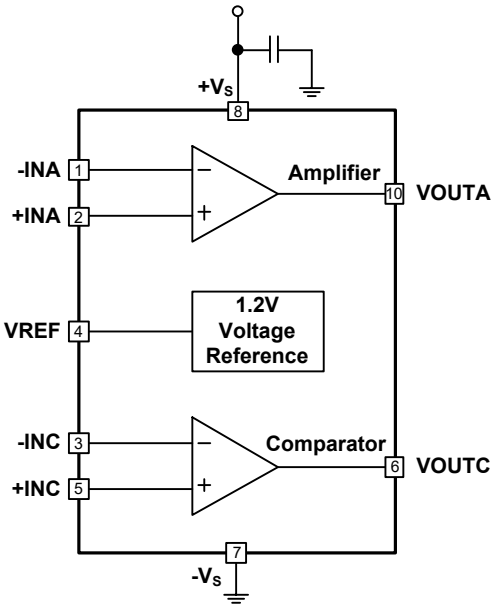
DISCLAIMER

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

PIN CONFIGURATION



FUNCTIONAL BLOCK DIAGRAM



PIN DESCRIPTION

PIN	NAME	FUNCTION
1	-INA	Negative Input of Amplifier.
2	+INA	Positive Input of Amplifier.
3	-INC	Negative Input of Comparator.
4	VREF	1.2V Voltage Reference Output.
5	+INC	Positive Input of Comparator.
6	VOUTC	Output of Comparator. Push-Pull output.
7	-V_S	Negative Supply. Always connect this pin to ground for single power supply application.
8	+V_S	Positive Power Supply.
9	NC	No Connection.
10	VOUTA	Output of Amplifier.
Exposed Pad	—	Exposed Paddle. Must be connected to -V_S or left floating.

ELECTRICAL CHARACTERISTICS

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Power Supply						
Power Supply Range	V_S		1.8		5.5	V
Quiescent Current	I_Q	I_{OUT} = 0		20	37	μA
		-40℃ ≤ T_A ≤ +85℃			48	

Operational Amplifier Only

(At T_A = +25℃, V_S = 5V, V_{CM} = +V_S/2, V_{OUT} = +V_S/2, and R_L = 10kΩ to +V_S/2, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Characteristics						
Input Offset Voltage	V_{OS}	V_S = 5V		22	50	μV
		-40℃ ≤ T_A ≤ +85℃			83	
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	-40℃ ≤ T_A ≤ +85℃		0.08		μV/℃
Input Bias Current	I_B			130		pA
Input Common Mode Voltage Range	V_{CM}		(-V_S) - 0.1		(+V_S) + 0.1	V
Common Mode Rejection Ratio	CMRR	(-V_S) - 0.1V < V_{CM} < (+V_S) + 0.1V	89	100		dB
		-40℃ ≤ T_A ≤ +85℃	85			
Open-Loop Voltage Gain	A_{OL}	(-V_S) + 0.1V < V_{OUT} < (+V_S) - 0.1V, R_L = 10kΩ	95	121		dB
		-40℃ ≤ T_A ≤ +85℃	94			
Input Impedance						
Differential				10^9		Ω
Common Mode				10^9		Ω
Output Characteristics						
Output Voltage Swing from Rail		R_L = 10kΩ		14	25	mV
		-40℃ ≤ T_A ≤ +85℃			27	
Short-Circuit Current	I_{SC}	V_S = 5V		60		mA
Open-Loop Output Impedance		f = 350kHz, I_{OUT} = 0		1		kΩ
Power Supply						
Specified Voltage Range	V_S		1.8		5.5	V
Power Supply Rejection Ratio	PSRR	V_S = 1.8V to 5.5V		4	20	μV/V
		-40℃ ≤ T_A ≤ +85℃			25	
Turn-On Time		V_S = 5V		220		μs
Dynamic Performance						
Gain-Bandwidth Product	GBP	C_L = 100pF		350		kHz
Slew Rate	SR	G = +1		0.18		V/μs
Noise						
Input Voltage Noise		f = 0.1Hz to 10Hz		2		μV_{P-P}

ELECTRICAL CHARACTERISTICS (continued)

Comparator and Voltage Reference (V_S = 1.8V)

(At T_A = +25℃, $+V_S$ = 1.8V, $-V_S$ = 0V, V_{CM} = $+V_S$/2, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage	V_{OS}	V_{CM} = 0V		0.5	3	mV
		V_{CM} = 1.8V		0.5	3	
Input Offset Average Drift				2		μV/℃
Common Mode Rejection Ratio	CMRR	V_{CM} = 0V to 1.8V	55	68		dB
Power Supply Rejection Ratio	PSRR	V_S = 1.8V to 5.5V, V_{CM} = 0V	74	102		dB
Power Supply Ramp-Up Rate (1)			5			V/s
Large-Signal Voltage Gain	A_{VO}			100		dB
Output Swing High	V_{OH}	I_{OUT} = 1mA	1.412	1.525		V
		I_{OUT} = 1mA, -40℃ ≤ T_A ≤ +85℃	1.330			
Output Swing Low	V_{OL}	I_{OUT} = -1mA		173	249	mV
		I_{OUT} = -1mA, -40℃ ≤ T_A ≤ +85℃			347	
Output Current	I_{OUT}	Source	1.15	2		mA
		Source, -40℃ ≤ T_A ≤ +85℃	1.0			
		Sink		-3.5	-2.0	
		Sink, -40℃ ≤ T_A ≤ +85℃			-1.4	
Propagation Delay (High to Low)		Overdrive = 10mV		11.7		μs
		Overdrive = 100mV		5.6		
Propagation Delay (Low to High)		Overdrive = 10mV		24.2		μs
		Overdrive = 100mV		14.7		
Rise Time	t_{RISE}	Overdrive = 10mV, C_L = 30pF, R_L = 1MΩ		168		ns
		Overdrive = 100mV, C_L = 30pF, R_L = 1MΩ		174		
Fall Time	t_{FALL}	Overdrive = 10mV, C_L = 30pF, R_L = 1MΩ		75		ns
		Overdrive = 100mV, C_L = 30pF, R_L = 1MΩ		50		
Noise of V_{REF}		f = 0.1Hz to 10Hz		0.3		mV_{P-P}
Voltage Reference						
Reference Voltage	V_{REF}	I_{REF} = 0mA	1.176	1.200	1.224	V
Reference Voltage Drift				42		μV/℃
Reference Output Current (Source)				2		mA

NOTE: 1. If the power supply ramp-up rate is lower than 5V/s, the reference voltage output is not guaranteed to start up.

ELECTRICAL CHARACTERISTICS (continued)

Comparator and Voltage Reference (V_S = 5V)

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

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage	V_{OS}	V_{CM} = 0V		0.5	3	mV
		V_{CM} = 5V		0.5	3	
Input Offset Average Drift				2		μV/℃
Common Mode Rejection Ratio	CMRR	V_{CM} = 0V to 5V	63	76		dB
Power Supply Rejection Ratio	PSRR	V_S = 1.8V to 5.5V, V_{CM} = 0V	74	102		dB
Power Supply Ramp-Up Rate (1)			5			V/s
Large-Signal Voltage Gain	A_{VO}			110		dB
Output Swing High	V_{OH}	I_{OUT} = 1mA	4.874	4.904		V
		I_{OUT} = 1mA, -40℃ ≤ T_A ≤ +85℃	4.855			
Output Swing Low	V_{OL}	I_{OUT} = -1mA		106	140	mV
		I_{OUT} = -1mA, -40℃ ≤ T_A ≤ +85℃			154	
Output Current	I_{OUT}	Source	14.0	18		mA
		Source, -40℃ ≤ T_A ≤ +85℃	10.5			
		Sink		-18	-15.5	
		Sink, -40℃ ≤ T_A ≤ +85℃			-12.5	
Propagation Delay (High to Low)		Overdrive = 10mV		12.7		μs
		Overdrive = 100mV		5.6		
Propagation Delay (Low to High)		Overdrive = 10mV		38.1		μs
		Overdrive = 100mV		29.5		
Rise Time	t_{RISE}	Overdrive = 10mV, C_L = 30pF, R_L = 1MΩ		39		ns
		Overdrive = 100mV, C_L = 30pF, R_L = 1MΩ		40		
Fall Time	t_{FALL}	Overdrive = 10mV, C_L = 30pF, R_L = 1MΩ		33		ns
		Overdrive = 100mV, C_L = 30pF, R_L = 1MΩ		30		
Noise of V_{REF}		f = 0.1Hz to 10Hz		0.32		mV_{P-P}
Voltage Reference						
Reference Voltage	V_{REF}	I_{REF} = 0mA	1.176	1.200	1.224	V
Reference Voltage Drift				41		μV/℃
Reference Output Current (Source)				2		mA

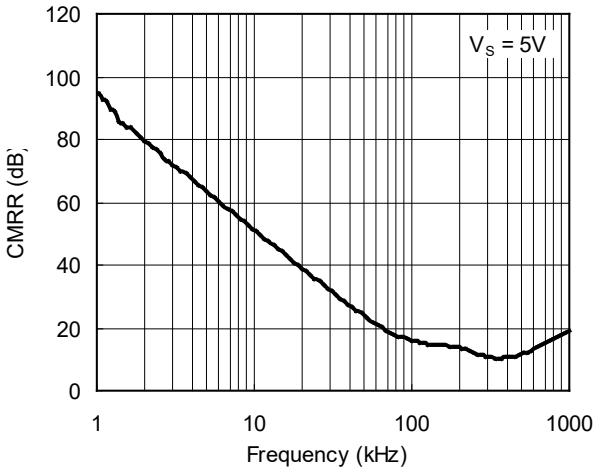
NOTE: 1. If the power supply ramp-up rate is lower than 5V/s, the reference voltage output is not guaranteed to start up.

TYPICAL PERFORMANCE CHARACTERISTICS

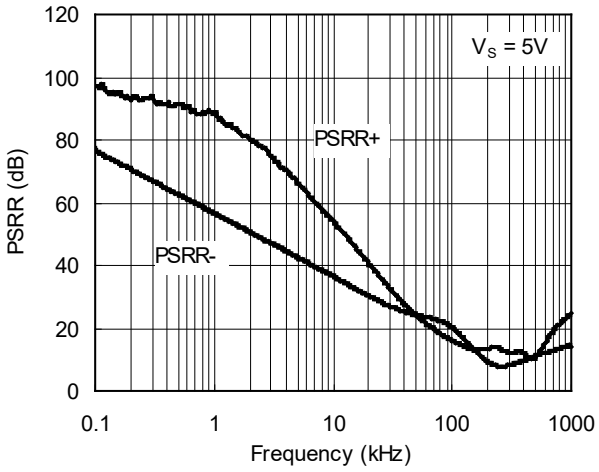
Operational Amplifier Only

At T_A = +25℃, V_S = 5V, and C_L = 0pF, unless otherwise noted.

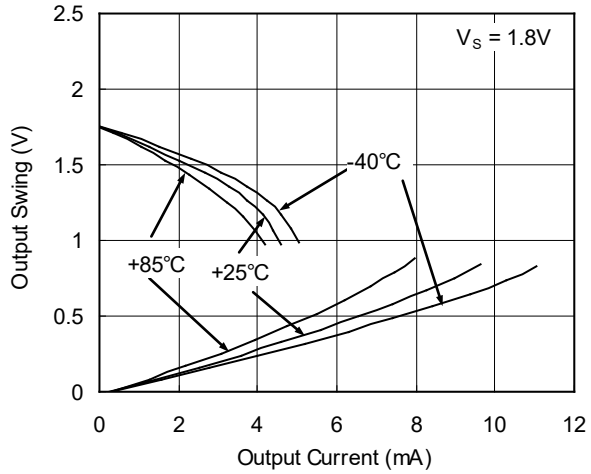
Common Mode Rejection Ratio vs. Frequency



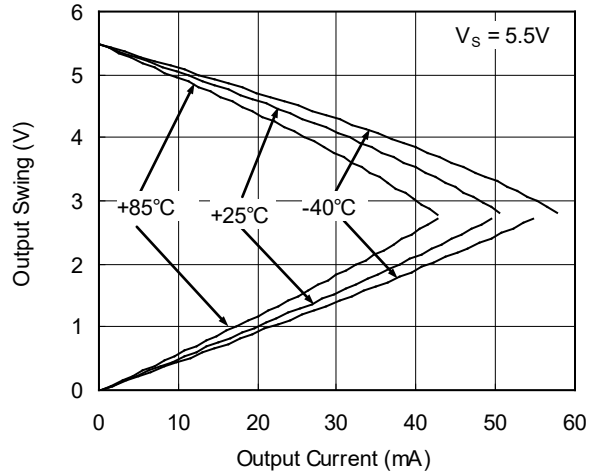
Power Supply Rejection Ratio vs. Frequency



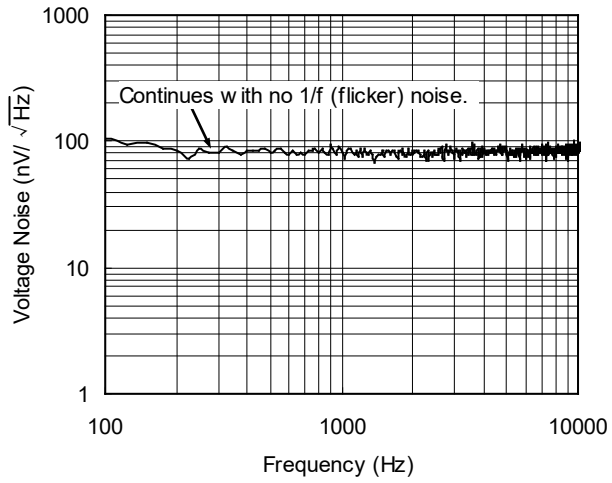
Output Voltage Swing vs. Output Current



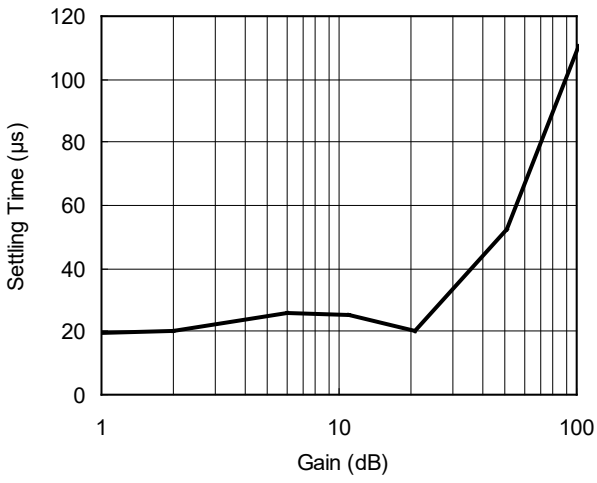
Output Voltage Swing vs. Output Current



Voltage Noise Spectral Density vs. Frequency



Settling Time vs. Closed-Loop Gain

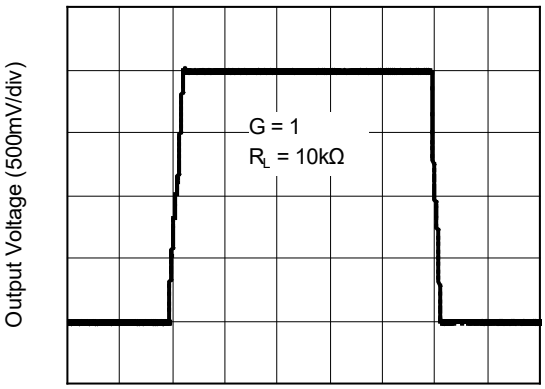


TYPICAL PERFORMANCE CHARACTERISTICS (continued)

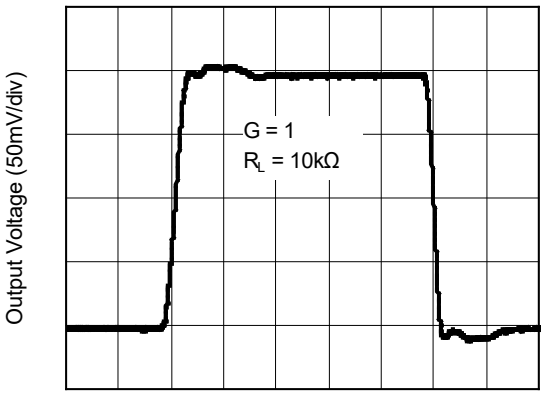
Operational Amplifier Only (continued)

At T_A = +25℃, V_S = 5V, and C_L = 0pF, unless otherwise noted.

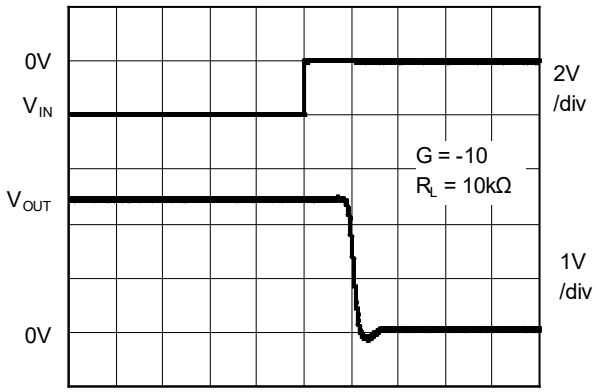
Large-Signal Step Response



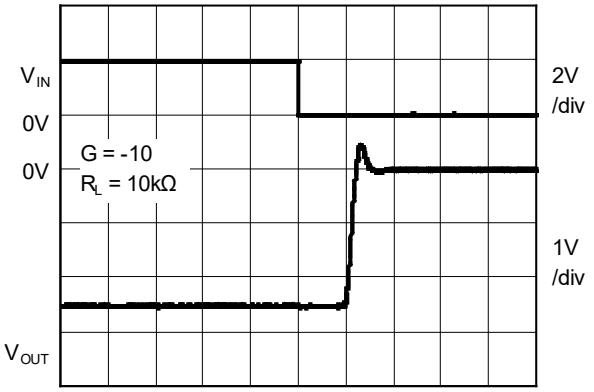
Small-Signal Step Response



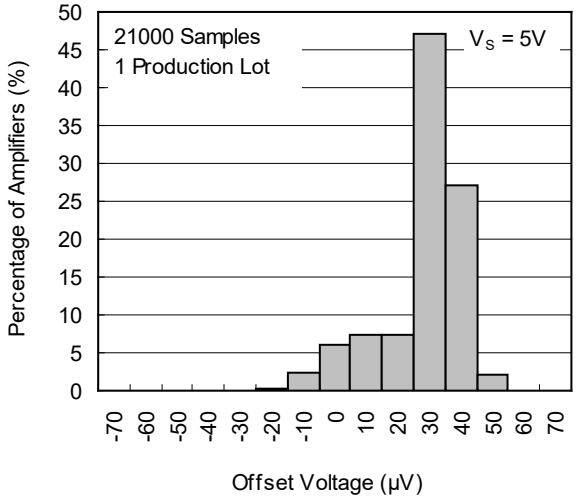
Positive Over-Voltage Recovery



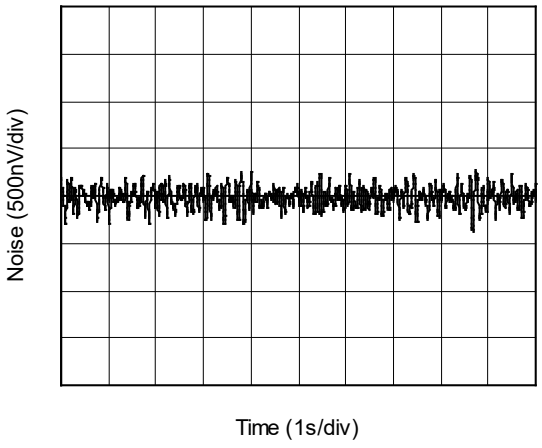
Negative Over-Voltage Recovery



Offset Voltage Production Distribution



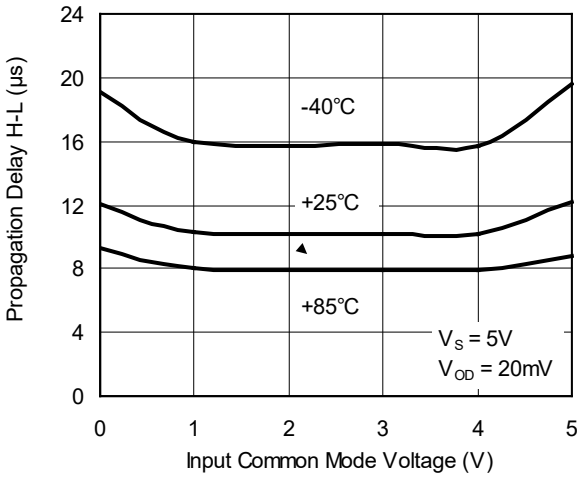
0.1Hz to 10Hz Noise



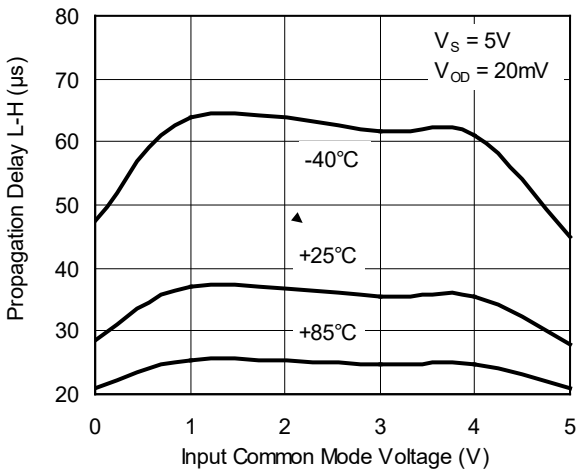
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Comparator Only

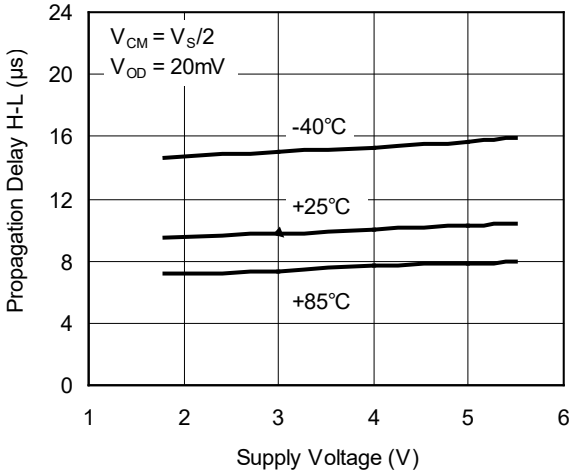
Propagation Delay vs. Input Common Mode Voltage



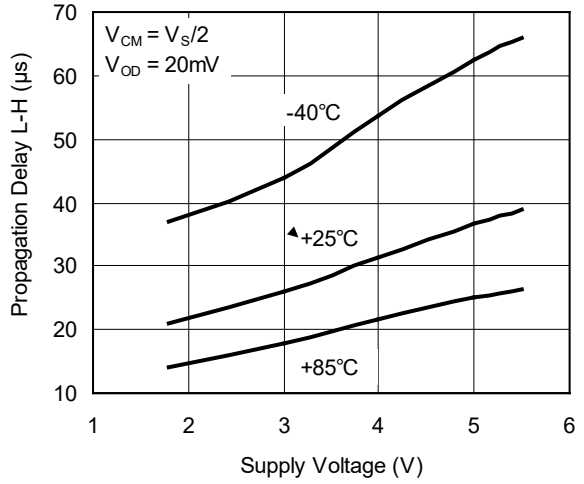
Propagation Delay vs. Input Common Mode Voltage



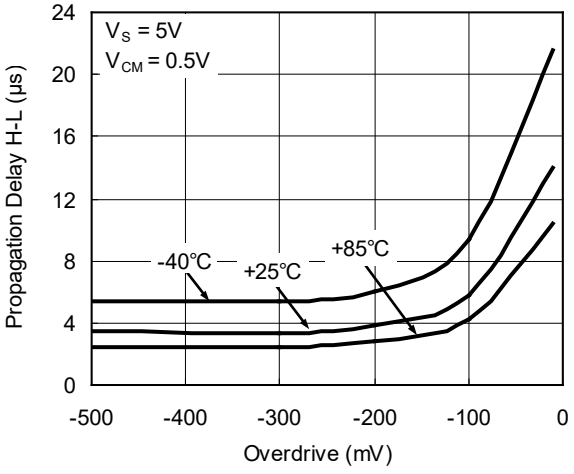
Propagation Delay vs. Supply Voltage



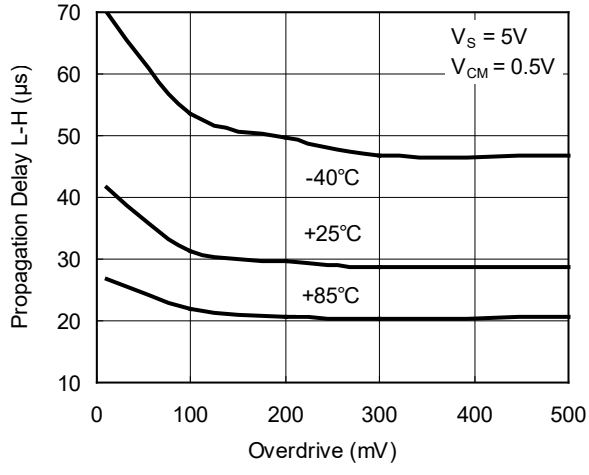
Propagation Delay vs. Supply Voltage



Propagation Delay vs. Overdrive



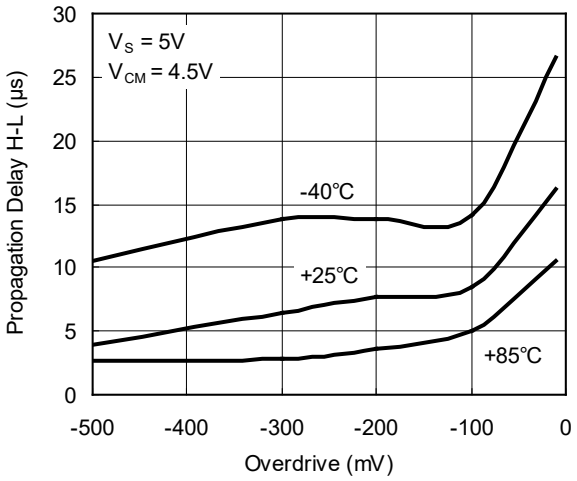
Propagation Delay vs. Overdrive



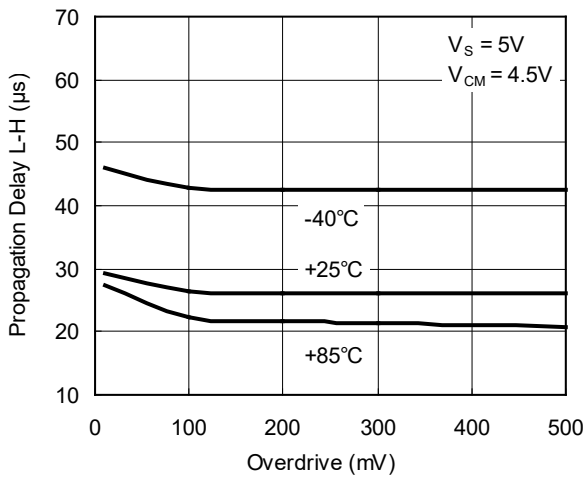
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Comparator Only (continued)

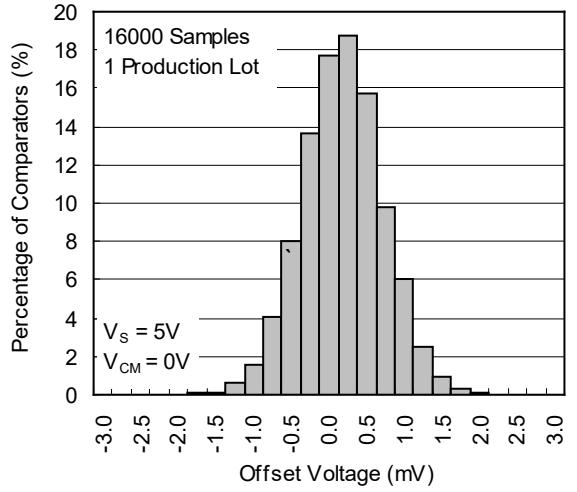
Propagation Delay vs. Overdrive



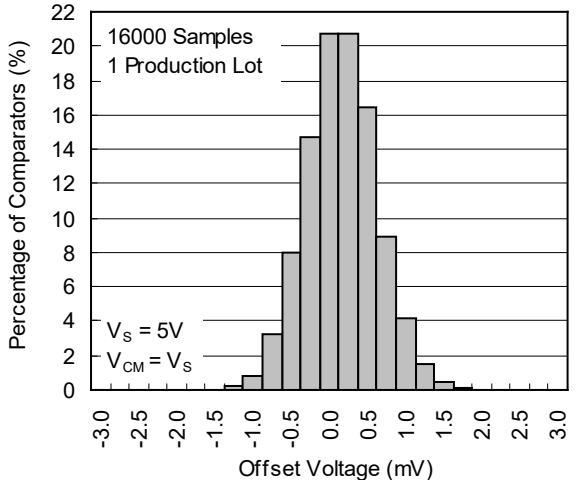
Propagation Delay vs. Overdrive



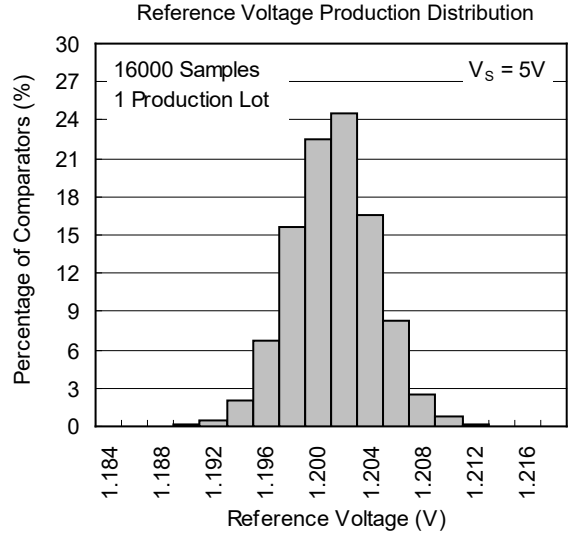
Offset Voltage Production Distribution



Offset Voltage Production Distribution



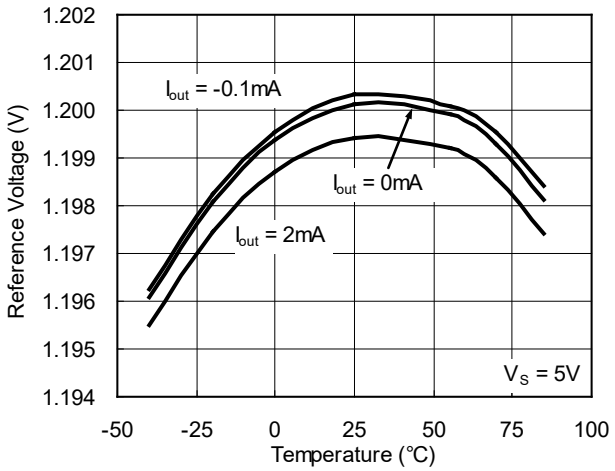
Reference Voltage Production Distribution



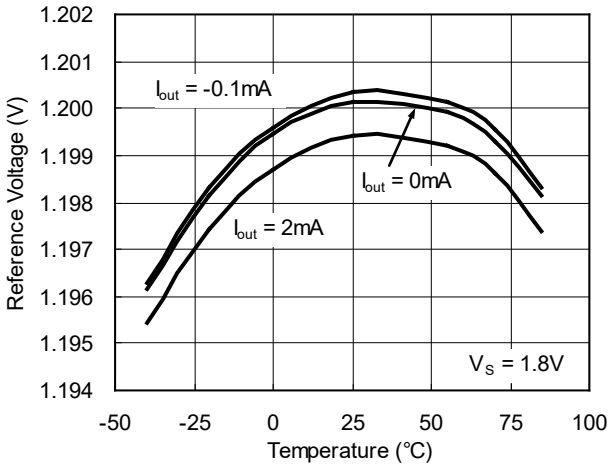
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Comparator Only (continued)

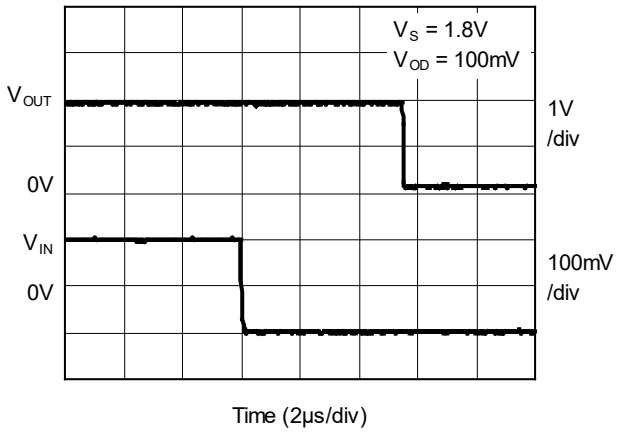
Reference Voltage vs. Temperature



Reference Voltage vs. Temperature

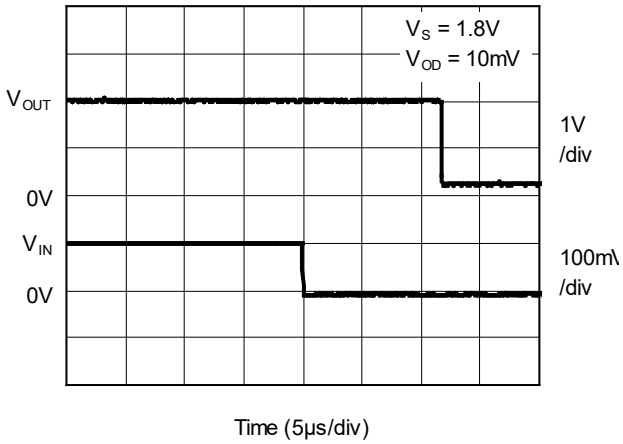


Propagation Delay (t_{PHL})



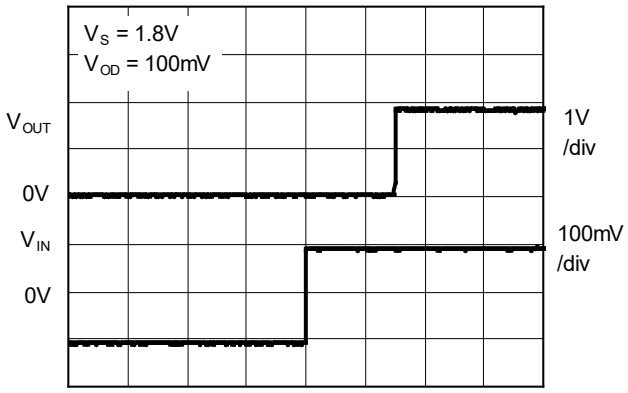
Time (2μs/div)

Propagation Delay (t_{PHL})



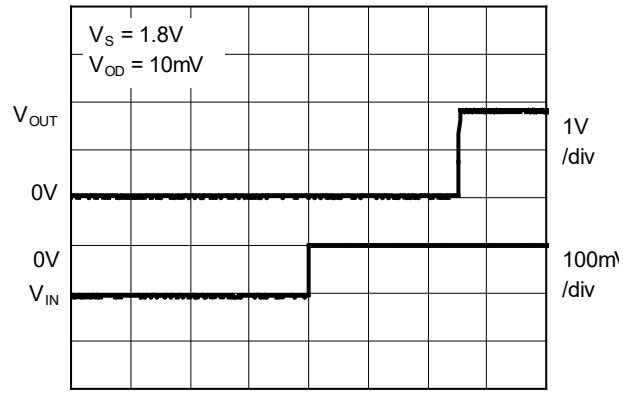
Time (5μs/div)

Propagation Delay (t_{PLH})



Time (10μs/div)

Propagation Delay (t_{PLH})

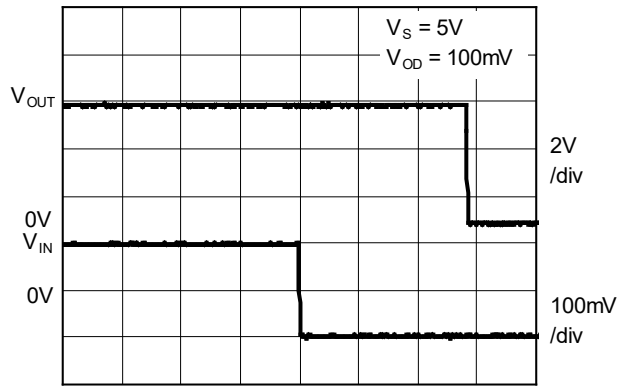


Time (10μs/div)

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

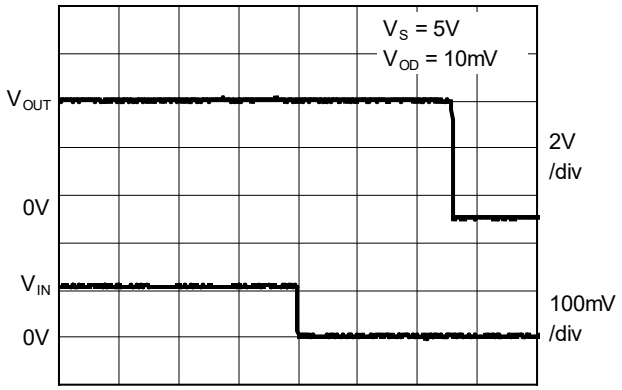
Comparator Only (continued)

Propagation Delay (t_{PHL})



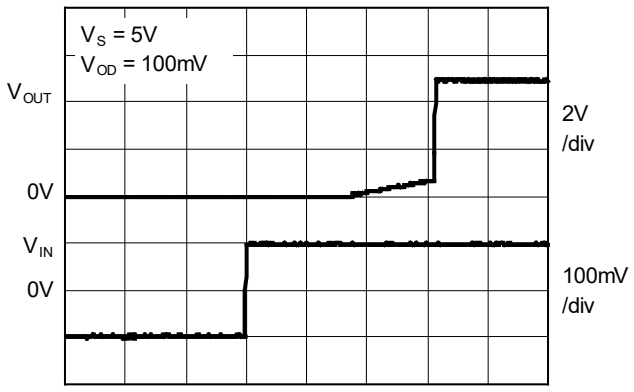
Time (2μs/div)

Propagation Delay (t_{PHL})



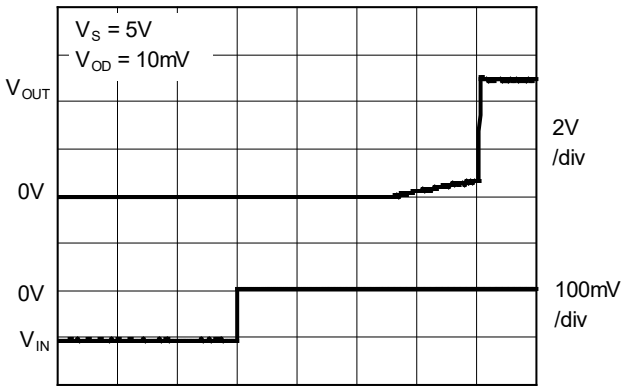
Time (5μs/div)

Propagation Delay (t_{PLH})



Time (10μs/div)

Propagation Delay (t_{PLH})



Time (10μs/div)

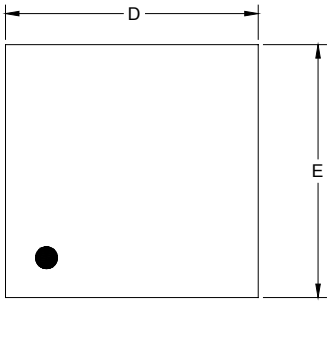
REVISION HISTORY

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

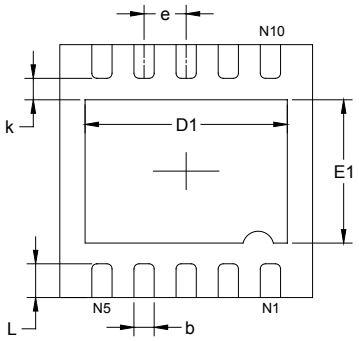
Changes from Original (DECEMBER 2015) to REV.A	Page
Changed from product preview to production data	All

PACKAGE OUTLINE DIMENSIONS

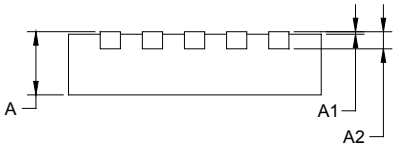
TDFN-3×3-10L



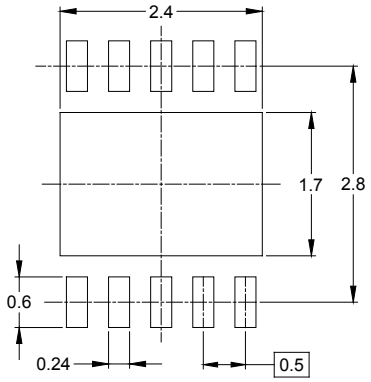
TOP VIEW



BOTTOM VIEW



SIDE VIEW

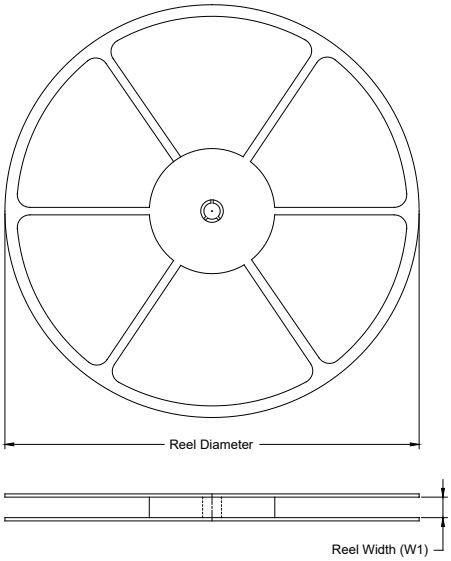


RECOMMENDED LAND PATTERN (Unit: mm)

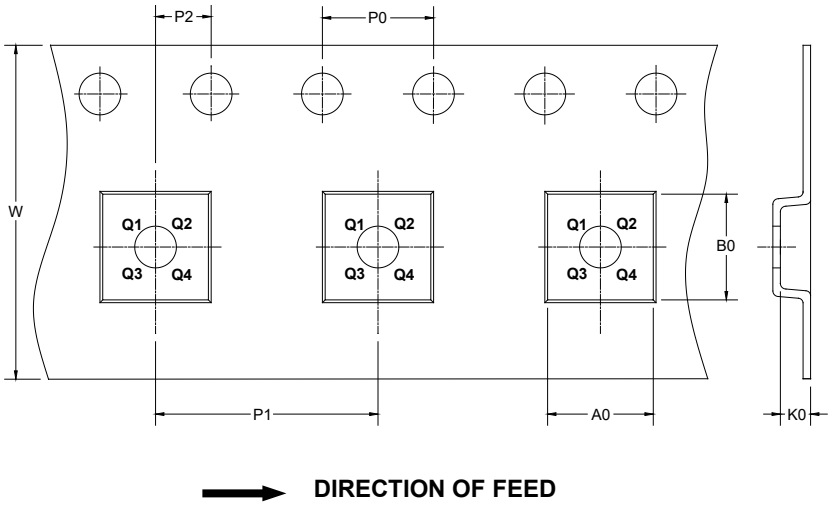
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A2	0.203 REF		0.008 REF	
D	2.900	3.100	0.114	0.122
D1	2.300	2.600	0.091	0.103
E	2.900	3.100	0.114	0.122
E1	1.500	1.800	0.059	0.071
k	0.200 MIN		0.008 MIN	
b	0.180	0.300	0.007	0.012
e	0.500 TYP		0.020 TYP	
L	0.300	0.500	0.012	0.020

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



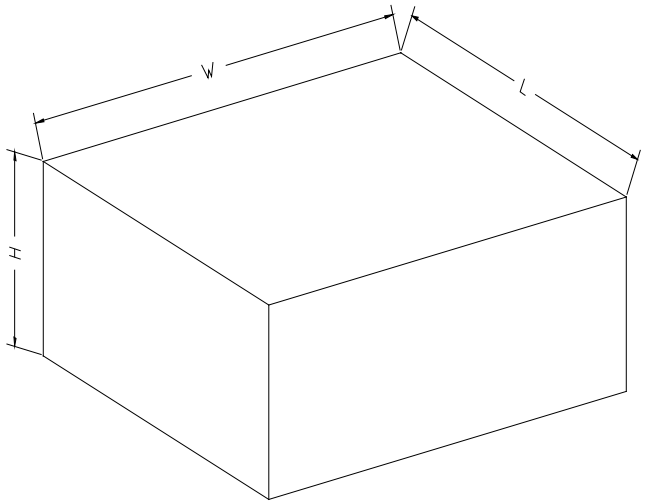
NOTE: The picture is only for reference. Please make the object as the standard.

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
TDFN-3×3-10L	13″	12.4	3.35	3.35	1.13	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