

Features

- Supply Voltage: 4.5 V to 36 V
- Offset Voltage: ±150 μV Maximum
- Differential Input Voltage Range to Supply Rail, can Work as Comparator
- Input Rail to –Vs, Rail to Rail Output
- Bandwidth: 7 MHz
- Slew Rate: 20 V/μs
- Excellent EMI Suppress Performance: 45 dB at 1 GHz
- Over-Temperature Protection
- Low Noise: 25 nV/√Hz at 1kHz
- 4 kV HBM, 2 kV CDM, 400 mA Latch Up
- –40°C to 125°C Operation Temperature Range

Applications

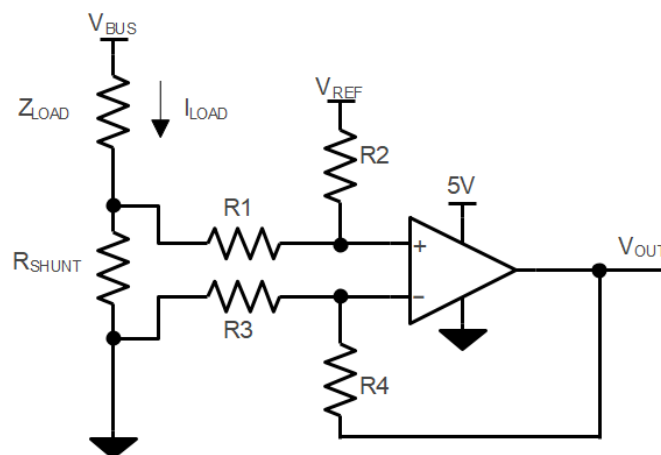
- Instrumentation
- Active Filters, ASIC Input or Output Amplifier
- Sensor Interface
- Motor Control
- Industrial Control

Description

The TP128X family amplifiers are the newest high supply voltage amplifiers with low offset, low power, and stable high-frequency response. They incorporate 3PEAK’s proprietary and patented design techniques to achieve very good AC performance with 7MHz bandwidth, 20 V/μs slew rate, and low distortion while drawing only 1600 μA of quiescent current per amplifier. The input common-mode voltage range extends to V–, and the outputs swing rail-to-rail. The TP128X family can be used as plug-in replacements for many commercially available op-amps to reduce power and improve input/output range and performance.

The TP128X has an over-temperature protection feature to guarantee chip safety. The output of TP128X will enter high impedance when the die temperature reaches around 170°C and will recover the function when the die temperature is down to around 150°C.

Typical Application Circuit



$$V_{OUT} = (I_{LOAD} \times R_{SHUNT}) \times (R_2 / R_1) + V_{REF}$$

$$\text{When } R_3 = R_1, R_2 = R_4, R_{SHUNT} \ll R_1$$

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Revision History

Date	Revision	Notes
2018/10/20	Rev.0	Initial Version
2021/3/10	Rev.A.0	Added New Part Number: TP1284-TR
2022/4/29	Rev.A.1	Updated order information
2022/7/17	Rev.A.2	Removed TP1284L1-SR, Add TP1284-SR

Pin Configuration and Functions

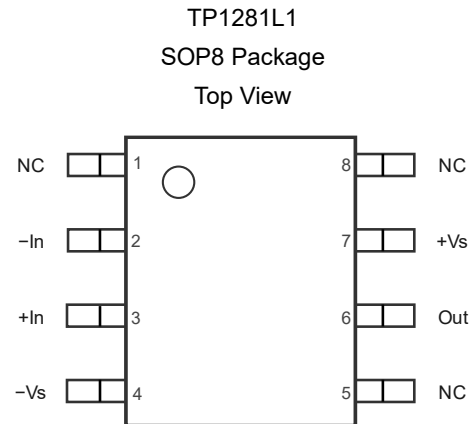
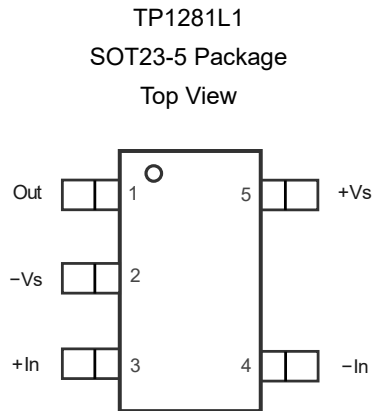


Table 6-1. Pin Functions: TP1281L1

Pin		Name	I/O	Description
SOT23-5	SOP8			
1	6	Out	Output	Output
2	4	-Vs		Negative power supply
3	3	+In	Input	Noninverting input
4	2	-In	Input	Inverting input
5	7	+Vs		Positive power supply
	1	NC		Not connected
	5	NC		Not connected
	8	NC		Not connected

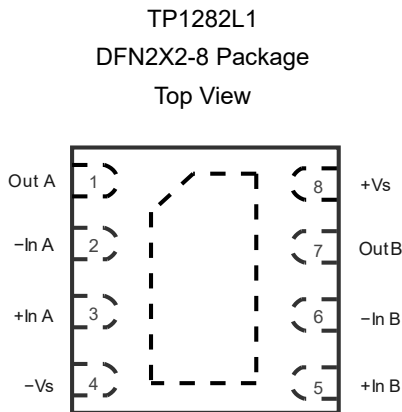
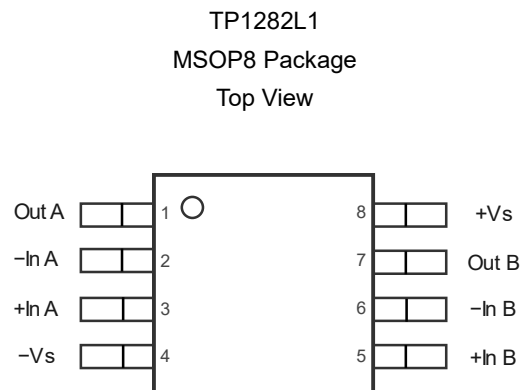
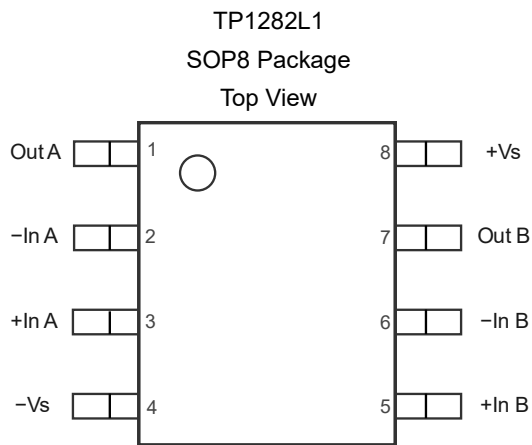


Table 6-2. Pin Functions: TP1281L1/TP1282L1

Pin	Name	I/O	Description
1	Out A	Output	Output
2	-In A	Input	Inverting input
3	+In A	Input	Noninverting input
4	-Vs		Negative power supply
5	+In B	Input	Noninverting input
6	-In B	Input	Inverting input
7	Out B	Output	Output
8	+Vs		Positive power supply

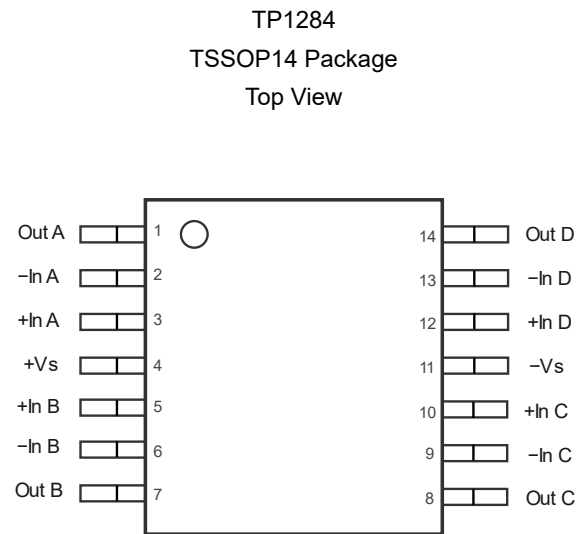
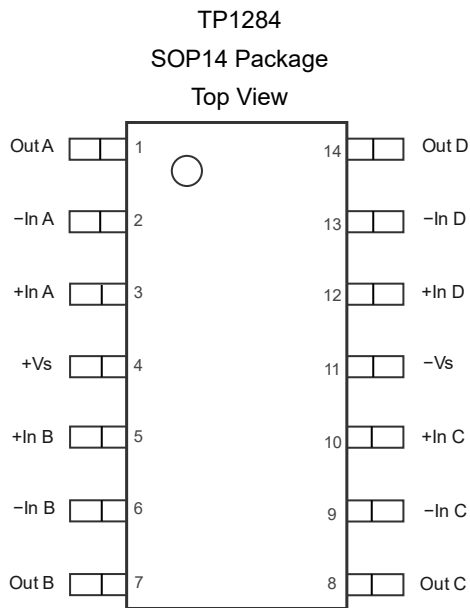


Table 6-3. Pin Functions: TP1284

Pin	Name	I/O	Description
1	Out A	Output	Output
2	-In A	Input	Inverting input
3	+In A	Input	Noninverting input
4	+Vs		Positive power supply
5	+In B	Input	Noninverting input
6	-In B	Input	Inverting input
7	Out B	Output	Output
8	Out C	Output	Output
9	-In C	Input	Inverting input
10	+In C	Input	Noninverting input
11	-Vs		Negative power supply
12	+In D	Input	Noninverting input
13	-In D	Input	Inverting input
14	Out D	Output	Output

Specifications

Absolute Maximum Ratings⁽¹⁾

Parameter		Min	Max	Unit
	Supply Voltage: (+V _S) – (–V _S)		40	V
	Input Voltage	(–V _S) – 0.3	(+V _S) + 0.3	V
	Differential Input Voltage	(–V _S) – (+V _S)	(+V _S) – (–V _S)	V
	Input Current: +IN, –IN ⁽²⁾	–10	+10	mA
	Output Short-Circuit Duration ⁽³⁾		Infinite	
T _J	Maximum Junction Temperature		150	°C
T _A	Operating Temperature Range	–40	125	°C
T _{STG}	Storage Temperature Range	–65	150	°C
T _L	Lead Temperature (Soldering 10 sec)		260	°C

(1) Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

(2) The inputs and outputs are protected by ESD protection diodes to negative power supply. If the input or output extends more than 500 mV beyond the negative power supply, the current should be limited to less than 10 mA.

(3) A heat sink may be required to keep the junction temperature below the absolute maximum. This depends on the power supply voltage and how many comparators are shorted. Thermal resistance varies with the amount of PC board metal connected to the package. The specified values are for short traces connected to the leads.

ESD, Electrostatic Discharge Protection

Symbol	Parameter	Condition	Minimum Level	Unit
HBM	Human Body Model ESD	ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	4	kV
CDM	Charged Device Model ESD	ANSI/ESDA/JEDEC JS-002 ⁽²⁾	2	kV
LU	Latch Up	JESD 78, 25°C	400	mA
		JESD 78, 125°C	300	mA

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

Thermal Information

Package Type	θ _{JA}	θ _{Jc}	Unit
SOT23-5	250	81	°C/W
SOP8	158	43	°C/W
MSOP8	210	45	°C/W
DFN2X2-8	100	60	°C/W
SOP14	120	36	°C/W
TSSOP14	180	35	°C/W

Electrical Characteristics

All test condition is $V_S = 30\text{ V}$, $T_A = 25^\circ\text{C}$, $R_L = 10\text{ k}\Omega$, unless otherwise noted.

Symbol	Parameter	Conditions	T_A	Min	Typ	Max	Unit
Power Supply							
V_S	Supply Voltage Range			4.5		36	V
I_Q	Quiescent Current per Amplifier	$V_S = 30\text{ V}$, TP1281			1.5	2	mA
			-40°C to 125°C			3	mA
		$V_S = 30\text{ V}$, TP1282/TP1284			1	1.6	mA
			-40°C to 125°C			2.5	mA
PSRR	Power Supply Rejection Ratio	$V_S = 4.5\text{ V to }36\text{ V}$		105	130		dB
			-40°C to 125°C	100			dB
Input Characteristics							
V_{OS}	Input Offset Voltage	$V_S = 30\text{ V}$, $V_{CM} = 15\text{ V}$, TP1281/TP1282		-100	50	100	μV
			-40°C to 85°C	-400		400	μV
			-40°C to 125°C	-600		600	μV
		$V_S = 25\text{ V}$, $V_{CM} = 12.5\text{ V}$, TP1281/TP1282		-100	50	100	μV
			-40°C to 85°C	-400		400	μV
			-40°C to 125°C	-600		600	μV
		$V_S = 5\text{ V}$, $V_{CM} = 2.5\text{ V}$, TP1281/TP1282		-150	50	150	μV
			-40°C to 85°C	-500		500	μV
			-40°C to 125°C	-600		600	μV
V_{OS}	Input Offset Voltage	$V_S = 30\text{ V}$, $V_{CM} = 15\text{ V}$, TP1284		-150	50	150	μV
			-40°C to 85°C	-450		450	μV
			-40°C to 125°C	-650		650	μV
		$V_S = 25\text{ V}$, $V_{CM} = 12.5\text{ V}$, TP1284		-150	50	150	μV
			-40°C to 85°C	-450		450	μV
			-40°C to 125°C	-650		650	μV
		$V_S = 5\text{ V}$, $V_{CM} = 2.5\text{ V}$, TP1284		-200	50	200	μV
			-40°C to 85°C	-550		550	μV
			-40°C to 125°C	-650		650	μV
$V_{OS\ TC}$	Input Offset Voltage Drift		-40°C to 125°C		1		$\mu\text{V}/^\circ\text{C}$
I_B	Input Bias Current				25		μA
		-40°C to 85°C			80		μA
		-40°C to 125°C			1000		μA
I_{OS}	Input Offset Current				25		μA
I_{IN}	Different Input Current	$V_S = 36\text{ V}$, $V_{ID} = 36\text{ V}$			10	100	nA
			-40°C to 125°C			100	300

Electrical Characteristics (Continued)

Symbol	Parameter	Conditions	T _A	Min	Typ	Max	Unit		
C _{IN}	Input Capacitance	Differential Mode			5		pF		
		Common Mode			2.5		pF		
A _V	Open-loop Voltage Gain	V _S = 30 V, V _{OUT} = 0.5 V to 29.5 V		120	130		dB		
			-40°C to 125°C	105			dB		
V _{CMR}	Common-mode Input Voltage Range			(V-)		(V+) – 1.5	V		
CMRR	Common Mode Rejection Ratio	V _{CM} = 0.5 V to 28.5 V		100	125		dB		
			-40°C to 125°C	95			dB		
Output Characteristics									
V _{OH}	Output Swing from Positive Rail	R _{LOAD} = 100 k Ω to V _S /2			5	15	mV		
			-40°C to 85°C				30	mV	
			-40°C to 125°C					40	mV
		R _{LOAD} = 10 k Ω to V _S /2			50	80		mV	
			-40°C to 85°C					120	mV
			-40°C to 125°C					130	mV
V _{OL}	Output Swing from Negative Rail	R _{LOAD} = 100 k Ω to V _S /2			5	10	mV		
			-40°C to 85°C				20	mV	
			-40°C to 125°C					25	mV
		R _{LOAD} = 10 k Ω to V _S /2			40	50		mV	
			-40°C to 85°C					80	mV
			-40°C to 125°C					100	mV
I _{SC}	Output Short-Circuit Current	Source Current		20	32		mA		
		Sink Current		15	25		mA		
AC Specifications									
GBW	Gain-Bandwidth Product				7		MHz		
SR	Slew Rate	G = 1, 10 V step		13	20		V/ μ s		
			-40°C to 125°C	10			V/ μ s		
t _{OR}	Overload Recovery				100		ns		
t _S	Settling Time, 0.1%	G = -1, 10 V step			0.5		μ s		
	Settling Time, 0.01%				0.8		μ s		
PM	Phase Margin	V _S = 36 V, R _L = 10 K, C _L = 100pF			60		°		
GM	Gain Margin	V _S = 36 V, R _L = 10 K, C _L = 100 pF			10		dB		

Electrical Characteristics (Continued)

Symbol	Parameter	Conditions	T _A	Min	Typ	Max	Unit
Noise Performance							
E _N	Input Voltage Noise	f = 0.1 Hz to 10 Hz			2		μ V _{RMS}
e _N	Input Voltage Noise Density	f = 1 kHz			25		nV/ \sqrt Hz
i _N	Input Current Noise	f = 1 kHz			2		fA/ \sqrt Hz
THD+N	Total Harmonic Distortion and Noise	f = 1 kHz, G = 1, R _L = 10 k Ω , V _{OUT} = 6 V _{RMS}			0.0005		%
Thermal Shutdown							
	Thermal Shutdown Temperature				170		$^{\circ}$ C
	Recover Temperature				150		$^{\circ}$ C

Typical Performance Characteristics

$V_S = \pm 15\text{ V}$, $V_{CM} = 0\text{ V}$, $R_L = 10\text{ k}\Omega$, unless otherwise specified.

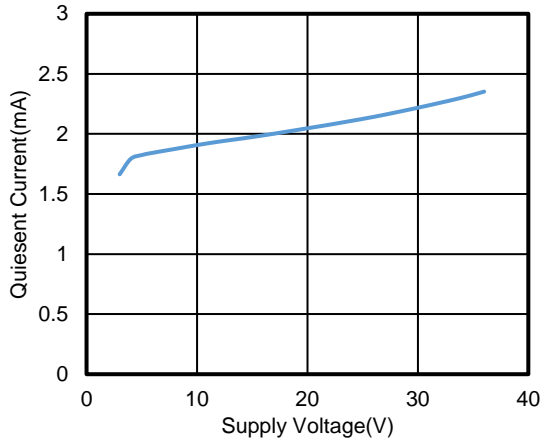


Figure 1. Quiescent Current vs. Supply Voltage, TP1282

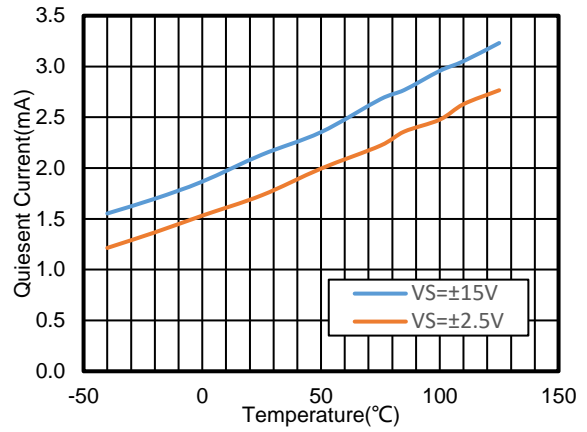


Figure 2. Quiescent Current vs. Temperature, TP1282

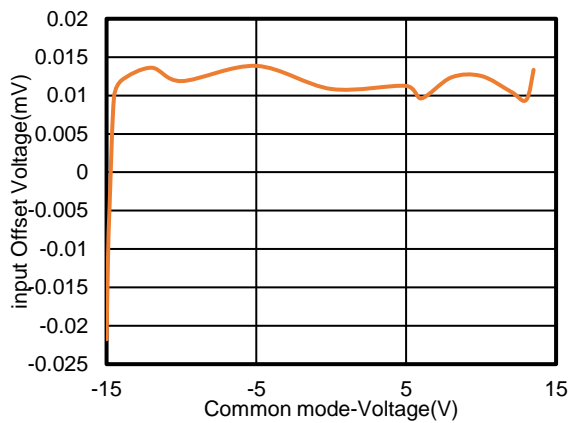


Figure 3. Offset Voltage vs. Common-Mode Voltage

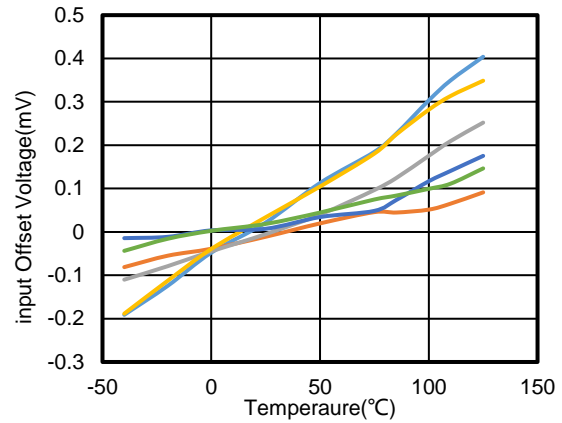


Figure 4. Vos vs. Temperature

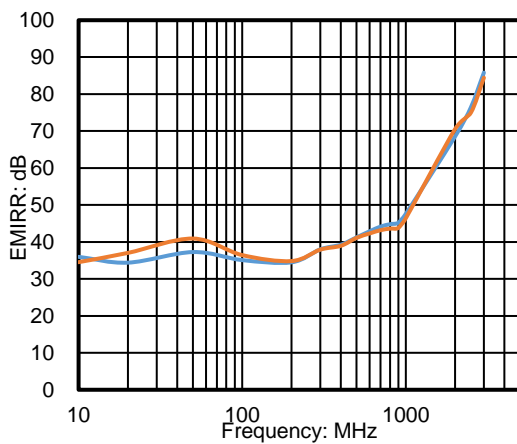


Figure 5. EMIRR vs. Frequency

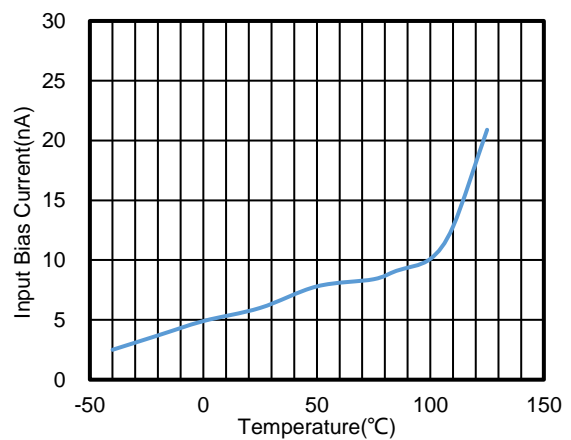


Figure 6. Input Current in Large Vdm vs. Temperature

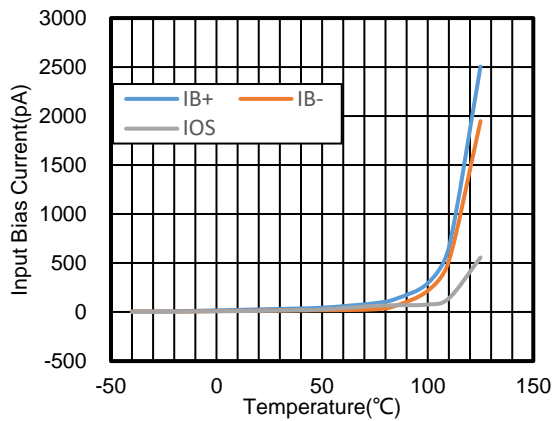


Figure 7. I_B vs. Temperature, -40 to 125°C

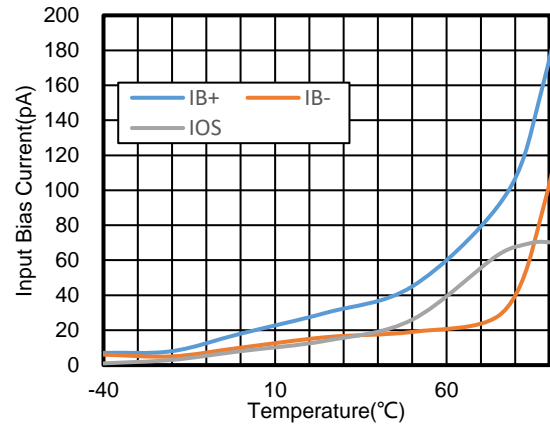


Figure 8. I_B vs. Temperature, -40 to 90°C

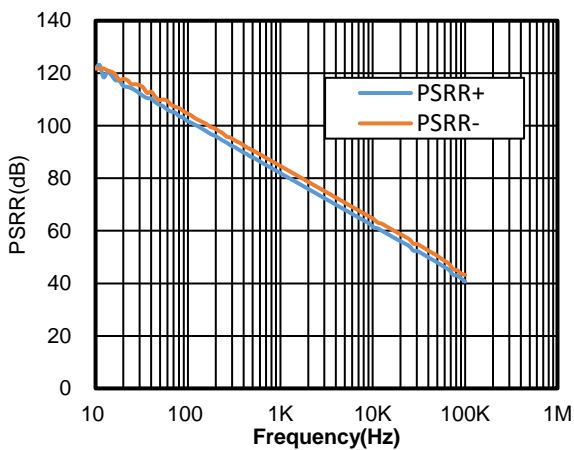


Figure 9. PSRR vs. Frequency

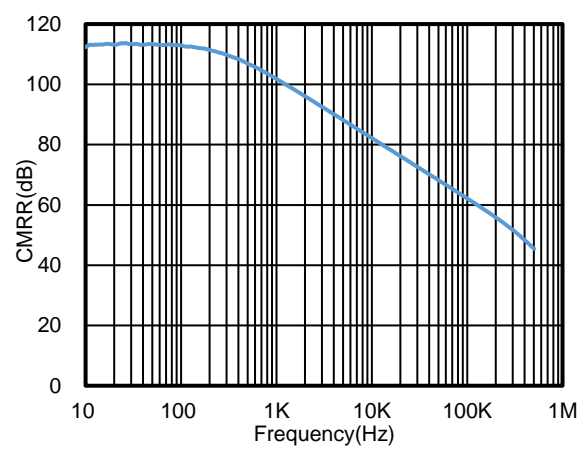


Figure 10. CMRR vs. Frequency

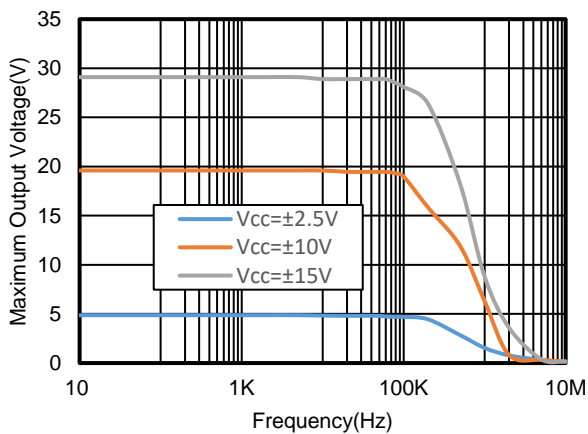


Figure 11. Maximum Output Voltage vs. Frequency

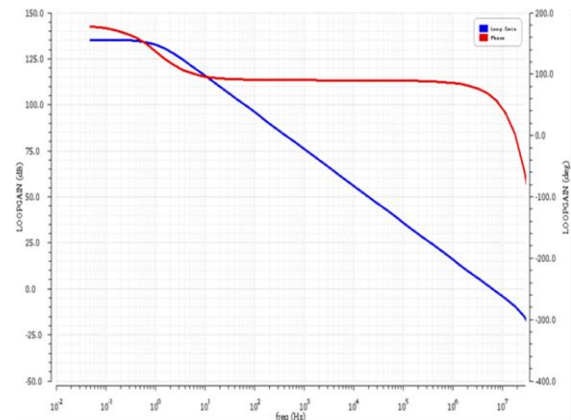


Figure 12. Open Loop Gain and Phase vs. Frequency

$R_{LOAD} = 10\text{ K}, C_{LOAD} = 100\text{ pF}$

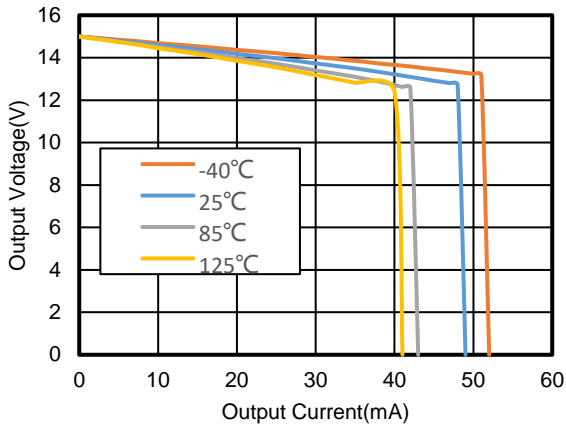


Figure 13. Positive Output Voltage vs. Output Current

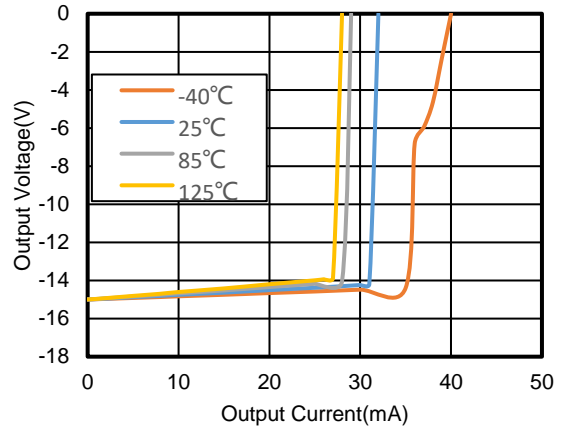


Figure 14. Negative Output Voltage vs. Output Current

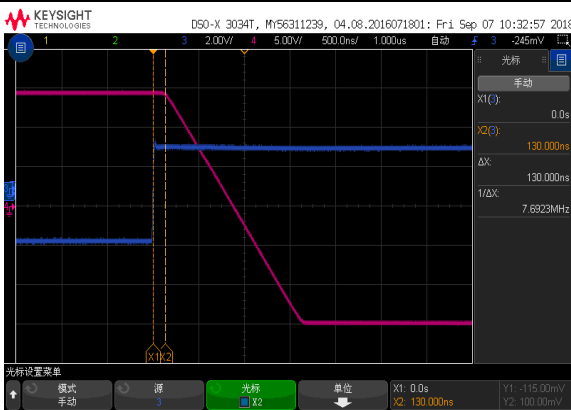


Figure 15. Positive Overload Recovery

Voltage: 5 V/div for Output, Time: 500 ns/div

$G = -10$, $V_{REF} = GND$; $V_{IN} = 5 V_{PP}$, $R = 2 K$, $C = 100 pF$

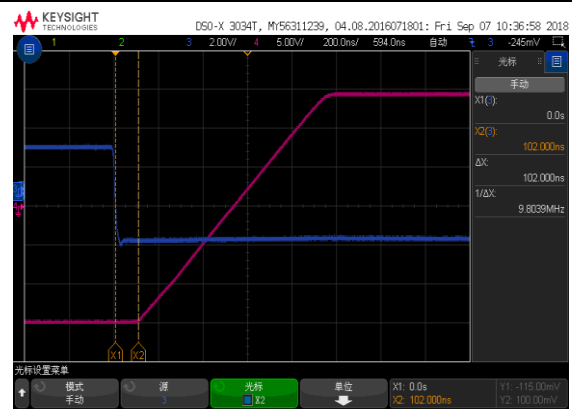


Figure 16. Negative Overload Recovery

Voltage: 5V/div for Output, Time: 500 ns/div

$G = -10$, $V_{REF} = GND$; $V_{IN} = 5 V_{PP}$, $R = 2 K$, $C = 100 pF$



Figure 17. 100mV Signal Step Response

Voltage: 50 mV/div, Time: 1 μ s/div

$R_L = 2 K$, $C_L = 100 pF$, $G = 1$



Figure 18. 10V Signal Step Response

Voltage: 5 V/div, Time: 1 μ s/div

$R_L = 2 K$, $C_L = 100 pF$, $G = 1$

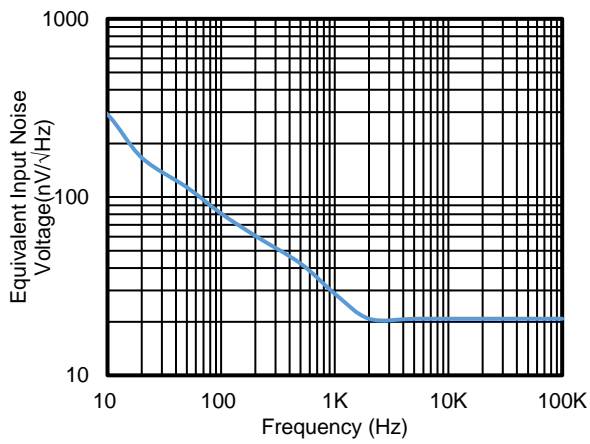


Figure 19. Voltage Noise Spectral Density vs. Frequency

$V_S = \pm 15\text{ V}, V_{CM} = 0\text{ V}$

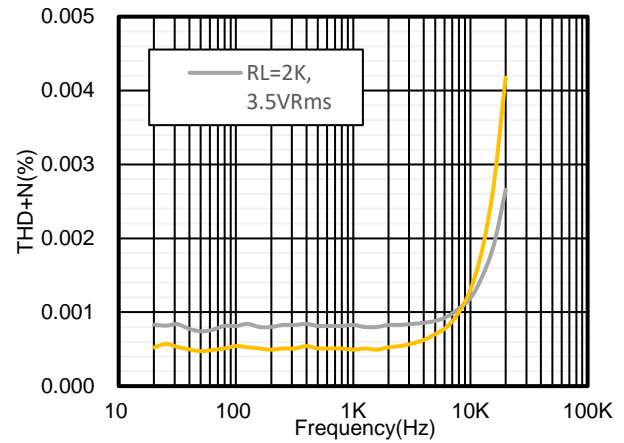


Figure 20. THD+N vs. Frequency

$V_S = \pm 15\text{ V}, V_{CM} = 0\text{ V}$

Detailed Description

Overview

The TP128X series is a new family of low-power, rail-to-rail output op amplifiers. These devices operate from 4.5 V to 36 V, are unity-gain stable and designed for a wide range of general-purpose applications.

Functional Block Diagram

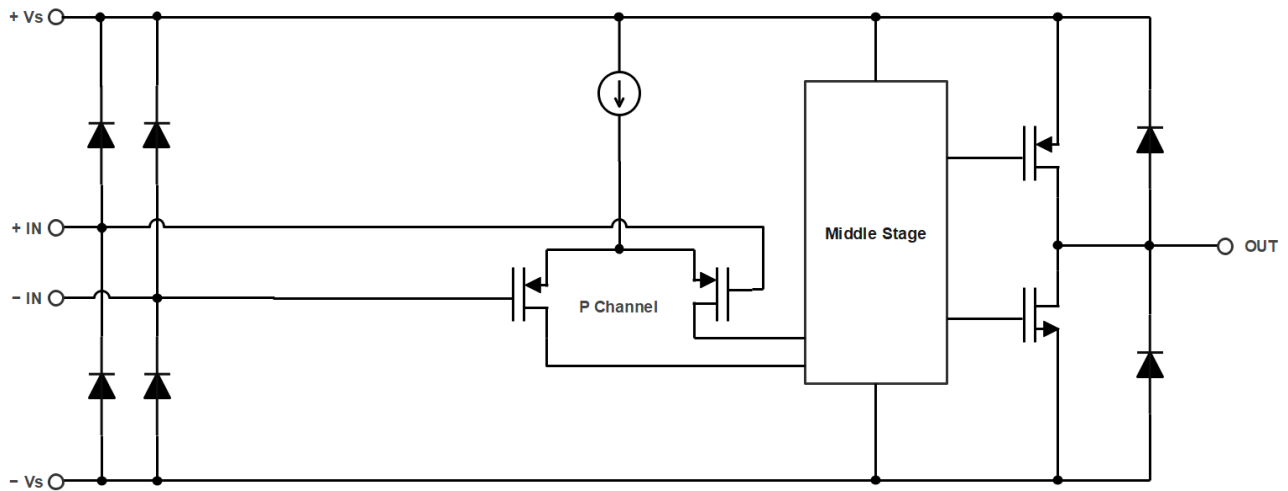
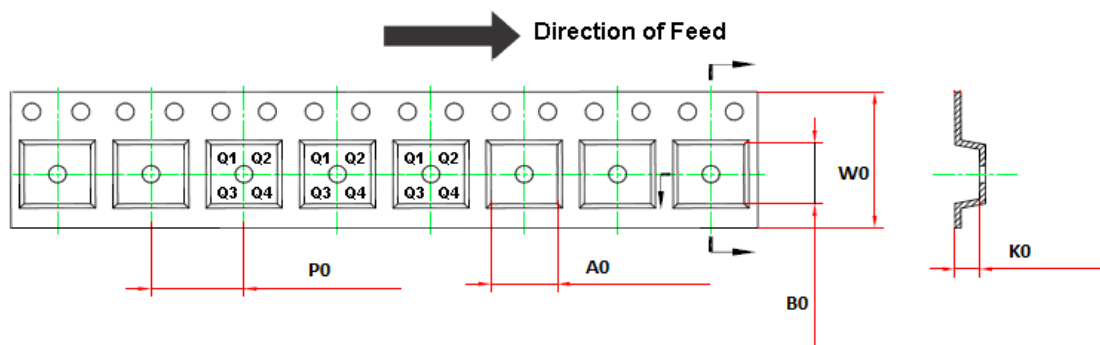
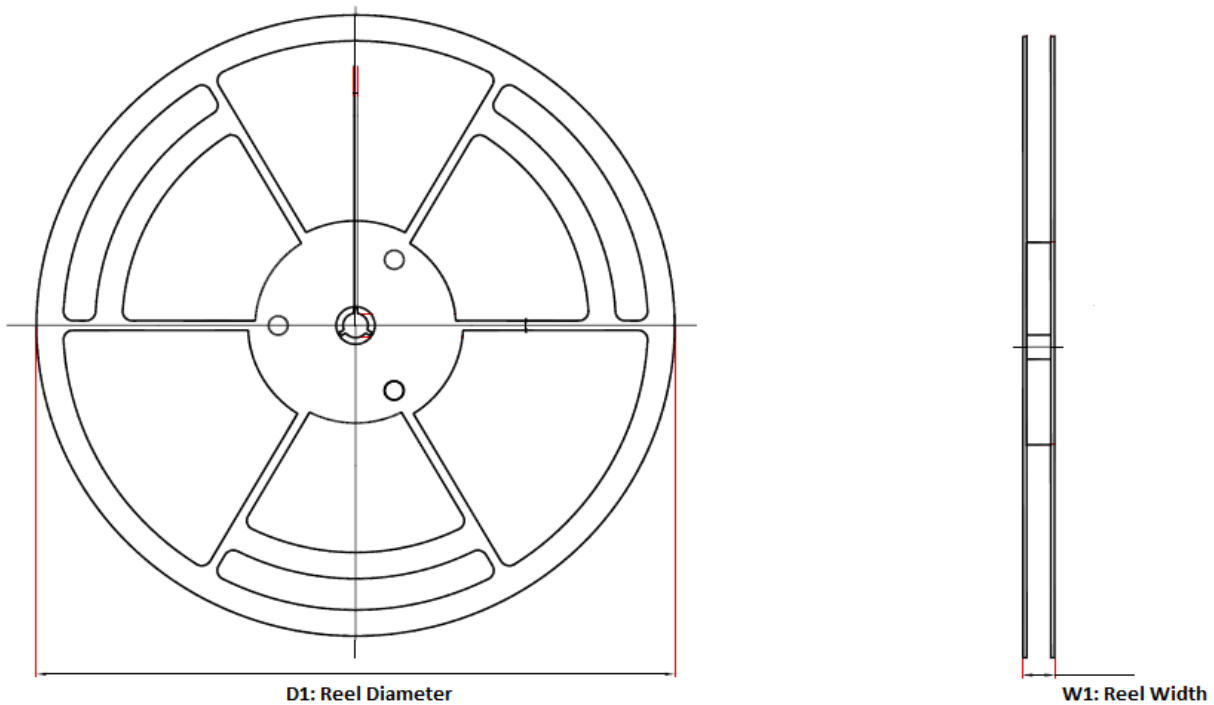


Figure 21. Functional Block Diagram

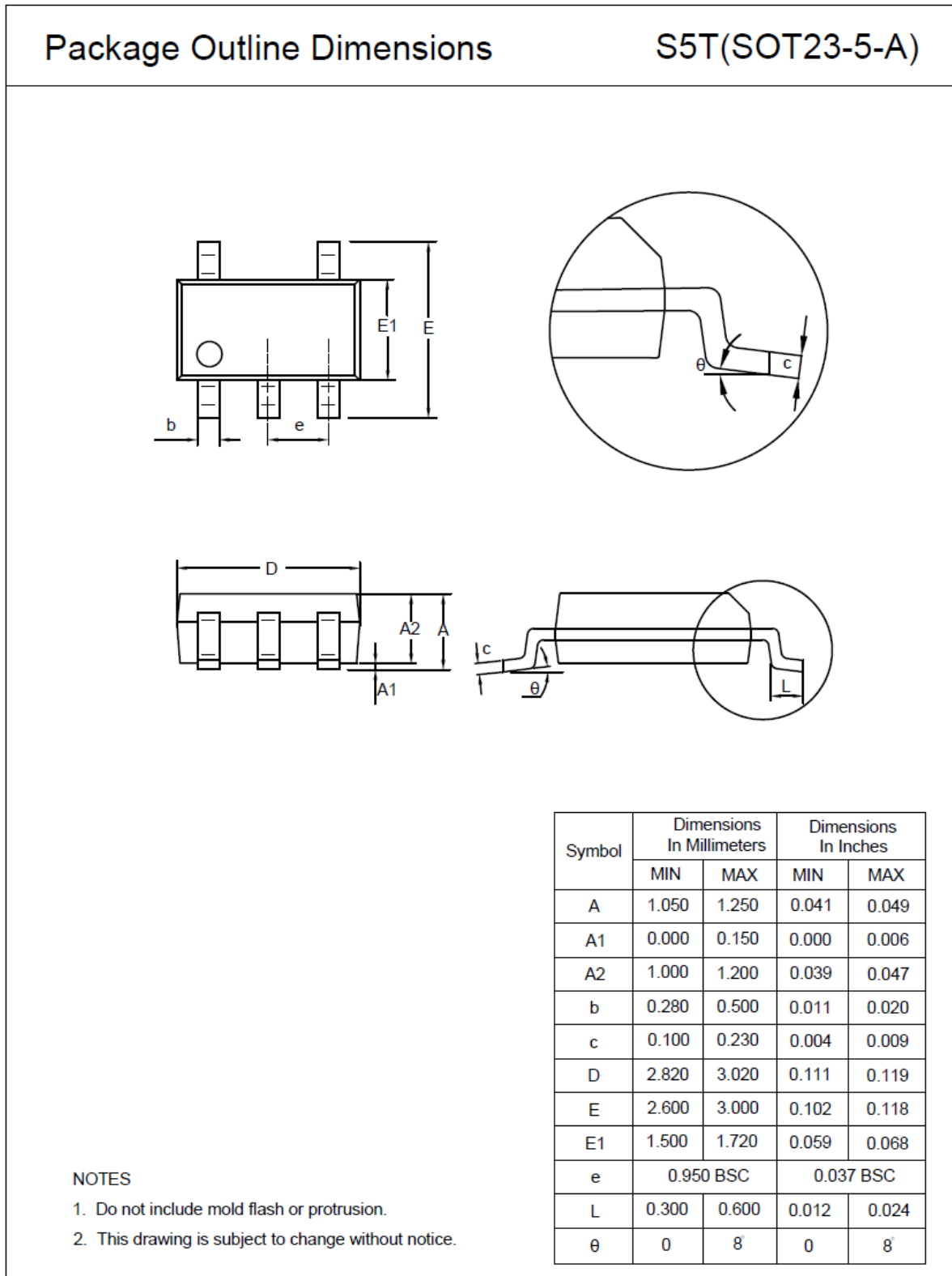
Tape and Reel Information



Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TP1281L1-TR	SOT23-5	180.0	13.1	3.2	3.2	1.4	4.0	8.0	Q3
TP1282L1-SR	SOP8	330.0	17.6	6.4	5.4	2.1	8.0	12.0	Q1
TP1282L1-VR	MSOP8	330.0	17.6	5.2	3.3	1.5	8.0	12.0	Q1
TP1282L1-FR	DFN2X2-8	180.0	13.1	2.3	2.3	1.1	4.0	8.0	Q1
TP1284-SR	SOP14	330.0	21.6	6.5	9.0	2.1	8.0	16.0	Q1
TP1284-TR	TSSOP14	330.0	17.6	6.8	5.4	1.2	8.0	12.0	Q1

Package Outline Dimensions

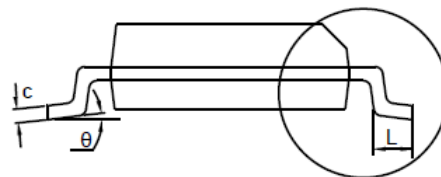
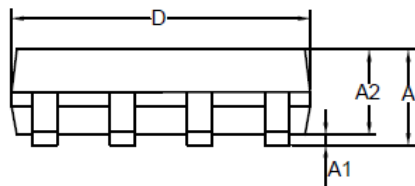
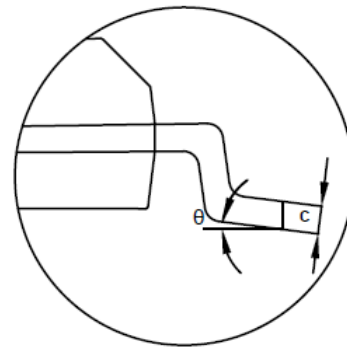
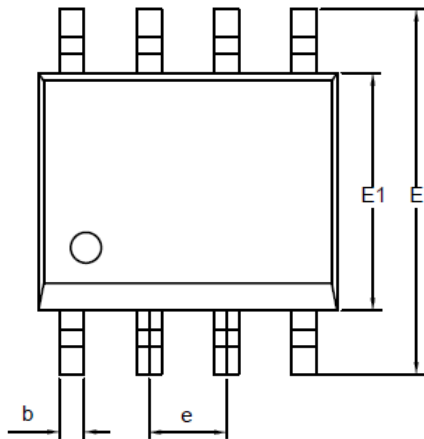
SOT23-5



SOP8

Package Outline Dimensions

SO1(SOP-8-A)

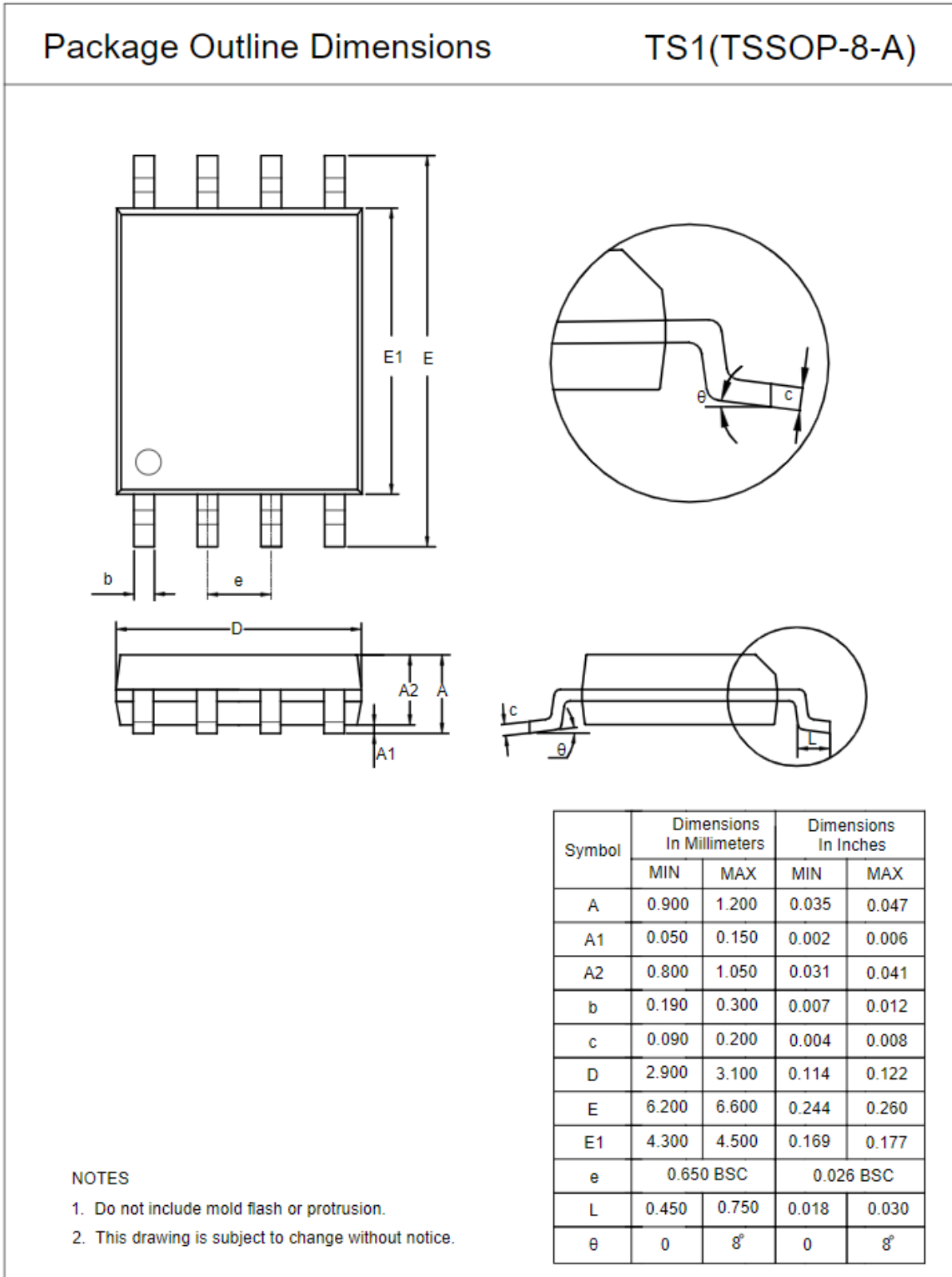


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.250	1.550	0.049	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	1.270 BSC		0.050 BSC	
L	0.400	1.000	0.016	0.039
θ	0	8	0	8

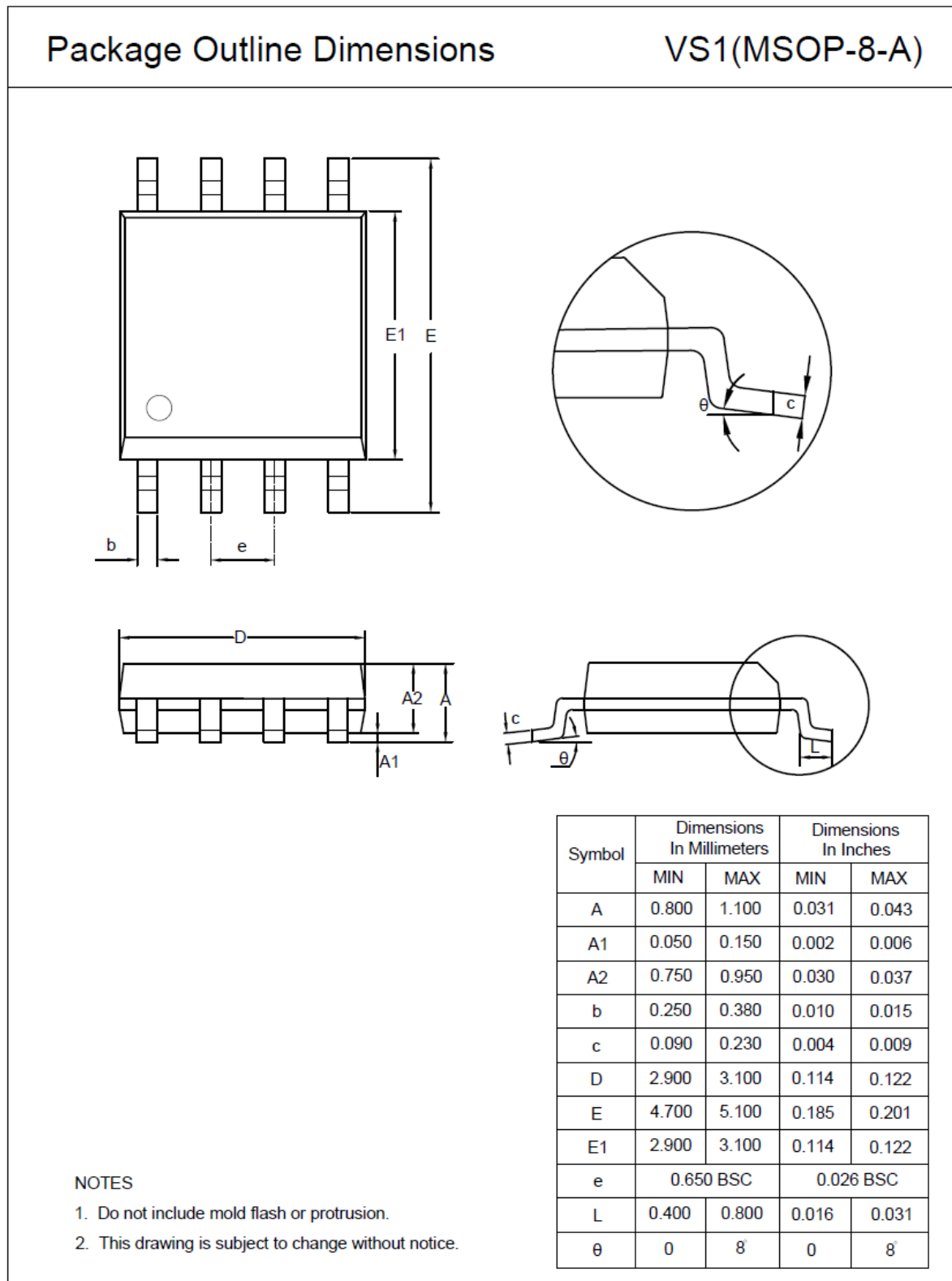
NOTES

1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

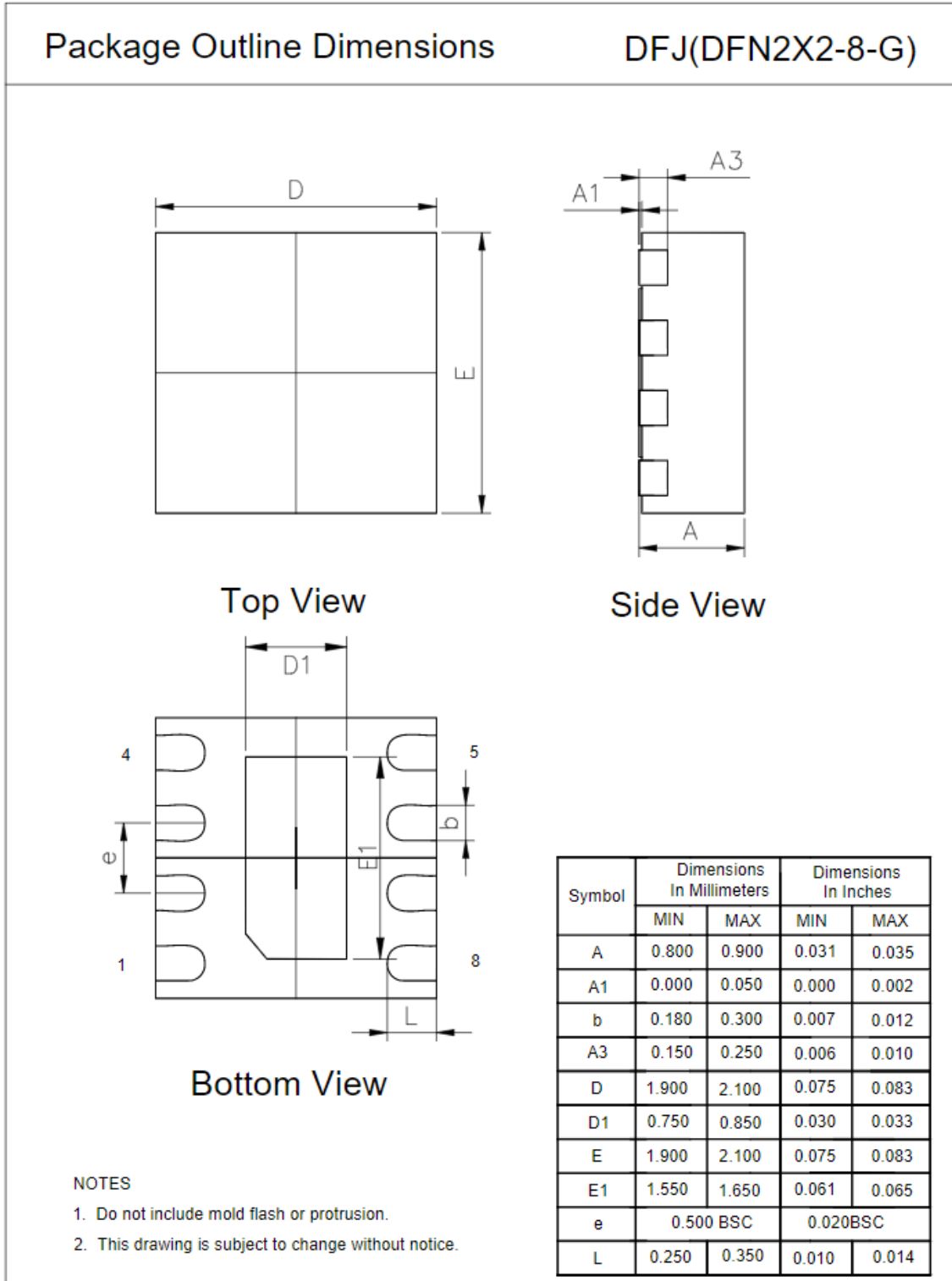
TSSOP8



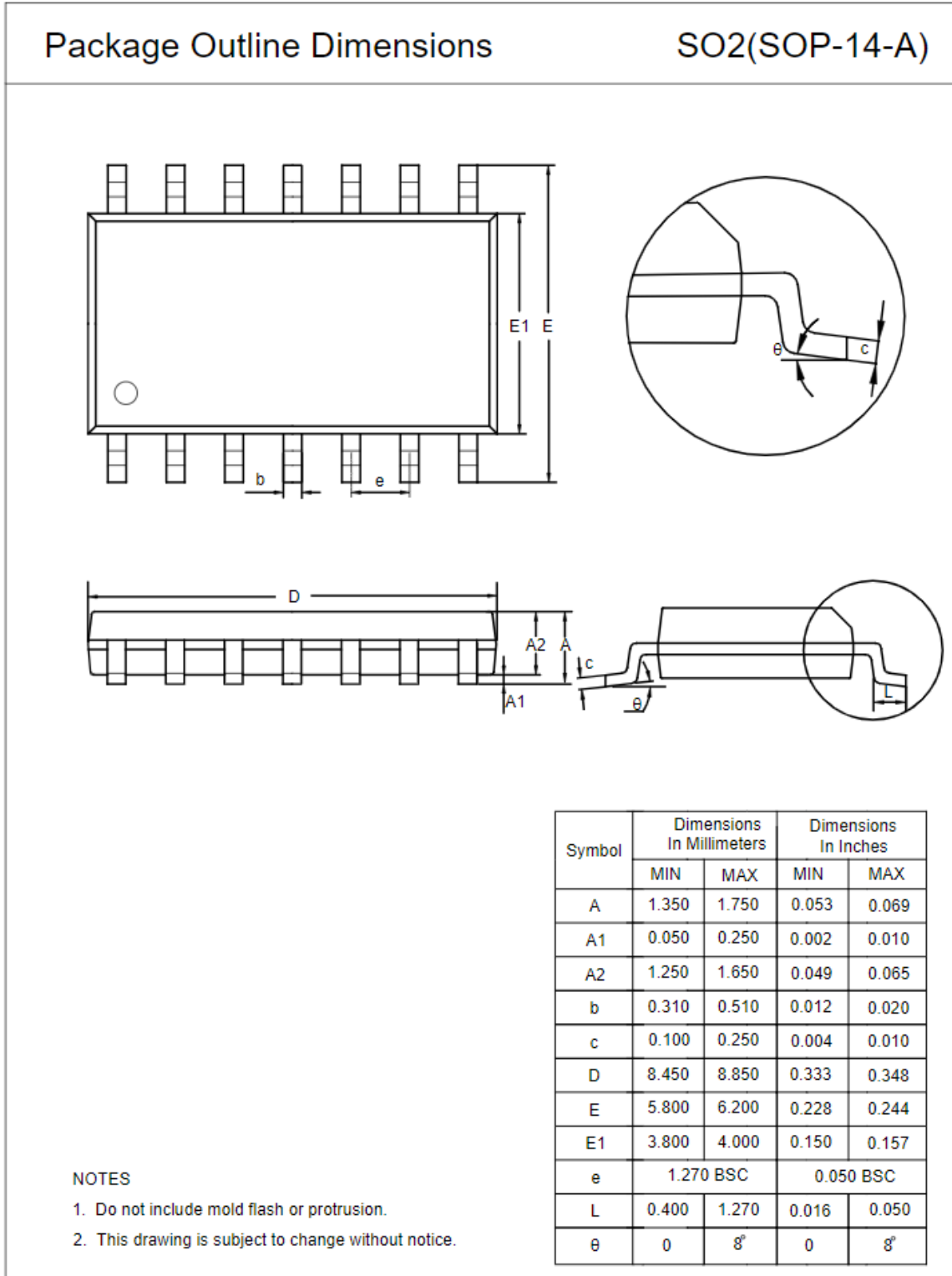
MSOP8



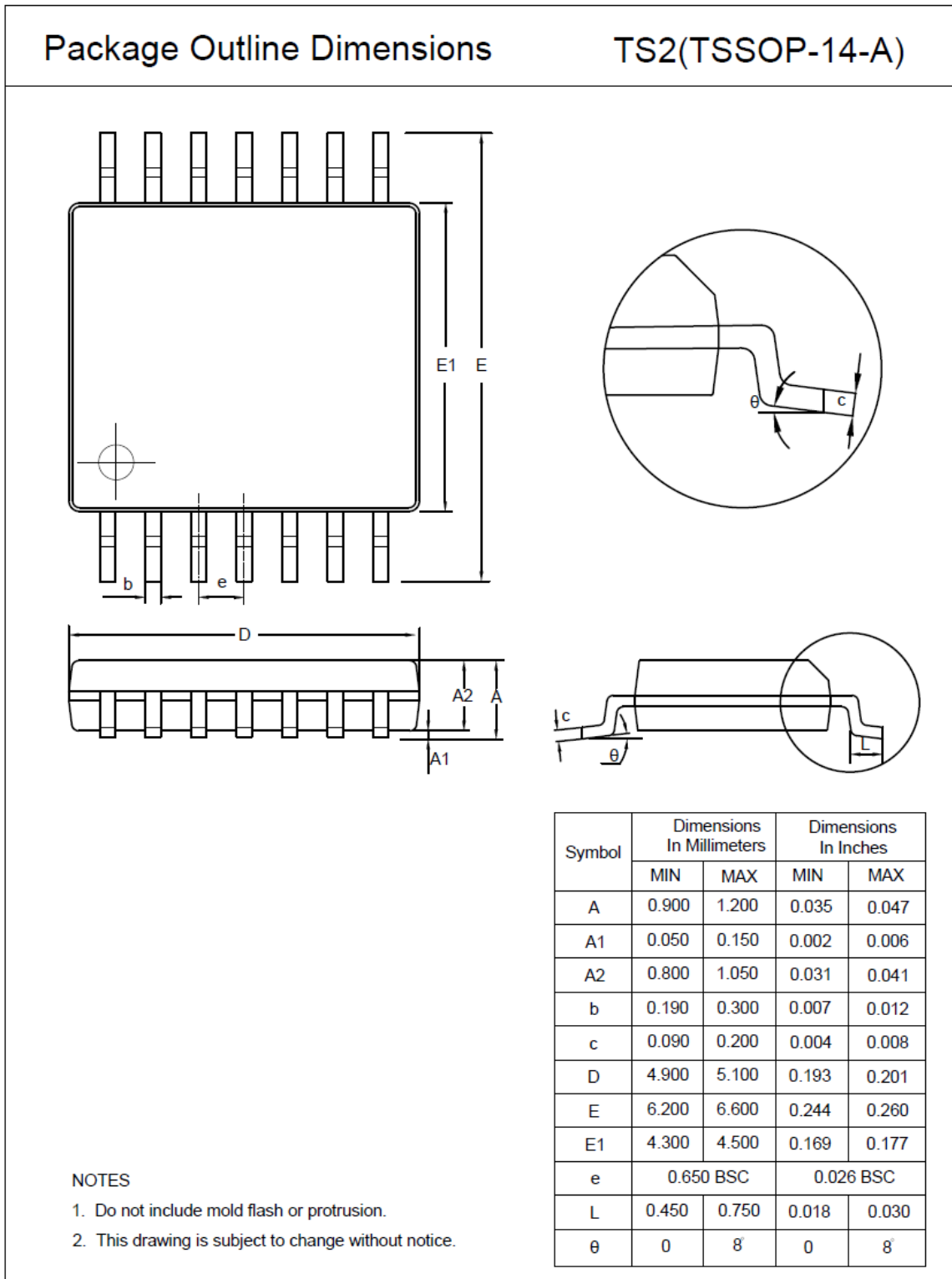
DFN2X2-8



SOP14



TSSOP14



Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
TP1281L1-SR	-40 to 125°C	SOP8	1281	1	Tape and Reel, 4000	Green
TP1281L1-TR	-40 to 125°C	SOT23-5	128	1	Tape and Reel, 3000	Green
TP1282L1-SR	-40 to 125°C	SOP8	1282	1	Tape and Reel, 4000	Green
TP1282L1-VR	-40 to 125°C	MSOP8	1282	1	Tape and Reel, 3000	Green
TP1282L1-FR ^{Note 1}	-40 to 125°C	DFN2X2-8	128	1	Tape and Reel, 3000	Green
TP1284-SR	-40 to 125°C	SOP14	1284	3	Tape and Reel, 2500	Green
TP1284-TR	-40 to 125°C	TSSOP14	1284	3	Tape and Reel, 3000	Green

(1) For Future product, contact 3PEAK factory for more information and sample.

Green: 3PEAK defines "Green" to mean RoHS compatible and free of halogen substances.

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