

## Features

- Supply Voltage: 3 V to 36 V
- Offset Voltage:  $\pm 3$  mV (Max)
- Differential Input Voltage Range to Supply Rail, can Work as Comparator
- Bandwidth: 1.5 MHz, Slew Rate: 0.5 V/ $\mu$ s
- Input Rail to  $-V_s$ , No Internal ESD Diode to  $+V_s$
- Low 1/f Noise: 50 nV/Hz at 10 Hz
- High PSRR+: 60 dB at 100 KHz
- No Significant Output Glitch during Power-on and Power-off
- Operating Temperature Range:  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$
- Qualified for Automotive Applications with AEC-Q100 Reliability Test

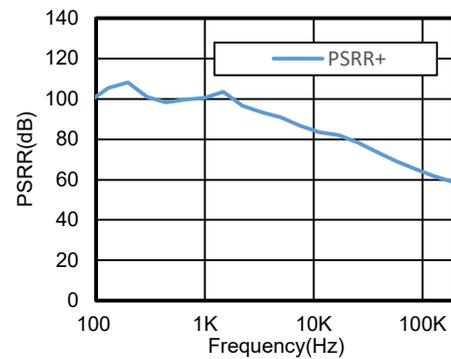
## Applications

- Instrumentation
- Sensor Interface
- Motor Control
- Industrial Control

## Description

The TPA264x is a series of the newest high supply voltage amplifiers with 2-mV offset, low noise, and immunity to high-frequency noise from the power supply. It incorporates 3PEAK's proprietary and patented design techniques to achieve excellent AC performance with a 1.5-MHz bandwidth, a 0.5-V/ $\mu$ s slew rate, and low distortion while drawing a quiescent current of only 550  $\mu$ A per amplifier.

The input common-mode voltage range extends to  $-V_s$ , and there is no internal ESD diode between the input and  $+V_s$ . This feature can block the current path from the input to  $+V_s$  during power-down, but the signal is still in the input pin. It's usual in battery-related applications.



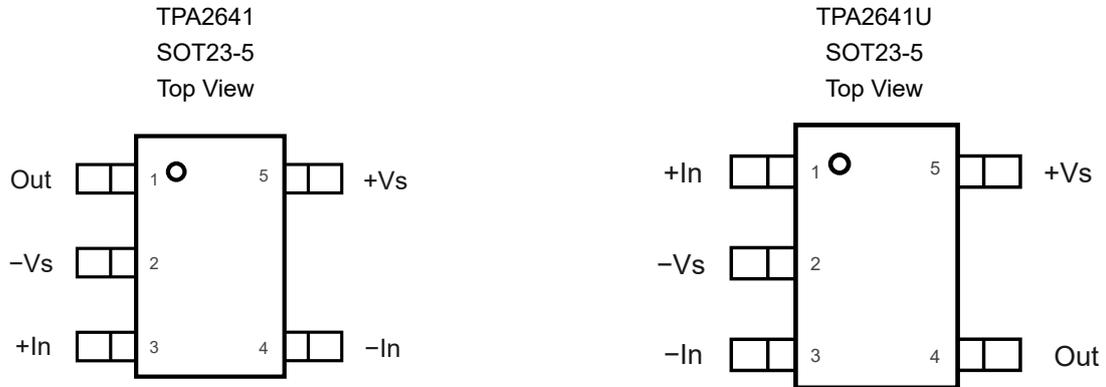
## Table of Contents

<b>Features</b> .....	<b>1</b>
<b>Applications</b> .....	<b>1</b>
<b>Description</b> .....	<b>1</b>
<b>Revision History</b> .....	<b>3</b>
<b>Pin Configuration and Functions</b> .....	<b>4</b>
<b>Specifications</b> .....	<b>8</b>
Absolute Maximum Ratings <sup>(1)</sup> .....	8
ESD, Electrostatic Discharge Protection.....	8
Thermal Information.....	8
Electrical Characteristics.....	9
Typical Performance Characteristics.....	11
Typical Performance Characteristics (Continued).....	14
Typical Performance Characteristics (Continued).....	15
<b>Tape and Reel Information</b> .....	<b>16</b>
<b>Package Outline Dimensions</b> .....	<b>17</b>
SOT23-5.....	17
SOP8.....	18
TSSOP8.....	19
MSOP8.....	20
SOP14.....	21
TSSOP14.....	22
<b>Order Information</b> .....	<b>23</b>
<b>IMPORTANT NOTICE AND DISCLAIMER</b> .....	<b>24</b>

## Revision History

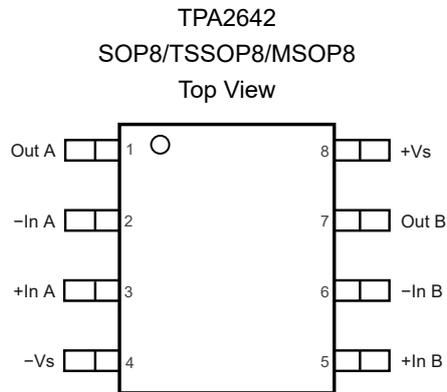
Date	Revision	Notes
2023-11-16	Rev.A.0	Initial version
2024-12-18	Rev.A.1	The following updates are all about the new datasheet formats or typos, and the actual product remains unchanged. Updated to a new datasheet format. Updated to a new format of Package Outline Dimensions. Updated the Tape and Reel Information.

## Pin Configuration and Functions



**Table 1. Pin Functions: TPA2641, TPA2641U**

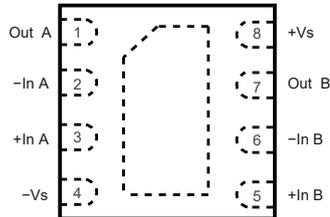
Pin No.		Name	I/O	Description
TPA2641	TPA2641U			
1	4	Out	O	Output
2	2	-Vs	-	Negative power supply
3	1	+In	I	Non-inverting input
4	3	-In	I	Inverting input
5	5	+Vs	-	Positive power supply



**Table 2. Pin Functions: TPA2642**

Pin No.	Name	I/O	Description
1	Out A	O	Output
2	-In A	I	Inverting input
3	+In A	I	Non-inverting input
4	-Vs	-	Negative power supply
5	+In B	I	Non-inverting input
6	-In B	I	Inverting input
7	Out B	O	Output
8	+Vs	-	Positive power supply

TPA2642  
 DFN2X2-8  
 Top View

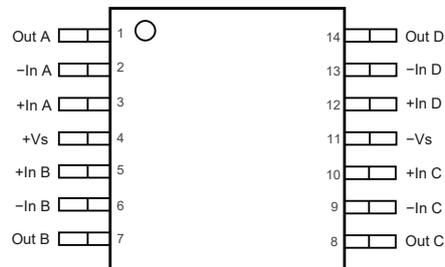


The thermal pad of the DFN2X2-8 package is recommended to be left float or connected to  $-V_S$ .

**Table 3. Pin Functions: TPA2642**

Pin No.	Name	I/O	Description
1	Out A	O	Output
2	-In A	I	Inverting input
3	+In A	I	Non-inverting input
4	$-V_S$	-	Negative power supply
5	+In B	I	Non-inverting input
6	-In B	I	Inverting input
7	Out B	O	Output
8	$+V_S$	-	Positive power supply

TPA2644  
SOP14/TSSOP14  
Top View



**Table 4. Pin Functions: TPA2644**

Pin No.	Name	I/O	Description
1	Out A	O	Output
2	-In A	I	Inverting input
3	+In A	I	Non-inverting input
4	+Vs	-	Positive power supply
5	+In B	I	Non-inverting input
6	-In B	I	Inverting input
7	Out B	O	Output power supply
8	Out C	O	Output power supply
9	-In C	I	Inverting input
10	+In C	I	Non-inverting input
11	-Vs	-	Negative power supply
12	+In D	I	Non-inverting input
13	-In D	I	Inverting input
14	Out D	O	Output

## Specifications

### Absolute Maximum Ratings <sup>(1)</sup>

	Parameter	Min	Max	Unit
	Supply Voltage, (+V <sub>S</sub> ) – (–V <sub>S</sub> )		40	V
	Input Voltage	(–V <sub>S</sub> ) – 0.3	40	V
	Input Current: +IN, –IN <sup>(2)</sup>	–10	10	mA
	Output Voltage	(–V <sub>S</sub> ) – 0.3	(+V <sub>S</sub> ) + 0.3	V
	Output Short-Circuit Duration <sup>(3)</sup>		Infinite	
T <sub>J</sub>	Maximum Junction Temperature		150	°C
T <sub>A</sub>	Operating Temperature Range	–40	125	°C
T <sub>STG</sub>	Storage Temperature Range	–65	150	°C
T <sub>L</sub>	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 are protected by ESD-protection diodes to the negative power supply. If the input extends more than 300 mV beyond the negative power supply, the input 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 amplifiers are shorted. The 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 <sup>(1)</sup>	2	kV
CDM	Charged Device Model ESD	ANSI/ESDA/JEDEC JS-002 <sup>(2)</sup>	1	kV

(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 <sub>JA</sub>	θ <sub>JC</sub>	Unit
SOT23-5	250	81	°C/W
SOP8	158	43	°C/W
MSOP8	210	45	°C/W
TSSOP8	191	44	°C/W
DFN2X2-8	100	60	°C/W
SOP14	120	36	°C/W
TSSOP14	180	35	°C/W

## Electrical Characteristics

All test conditions:  $T_A = 25^\circ\text{C}$ ,  $R_L = 10\text{ k}\Omega$ ,  $C_L = 100\text{ pF}$ , unless otherwise noted.

Symbol	Parameter	Conditions	$T_A$	Min	Typ	Max	Unit
<b>Power Supply</b>							
$V_S$	Supply Voltage Range			3		36	V
$I_Q$	Quiescent Current per Amplifier	$V_S = 5\text{ V to }36\text{ V}$			350	550	$\mu\text{A}$
			$-40^\circ\text{C to }125^\circ\text{C}$			700	$\mu\text{A}$
PSRR	Power Supply Rejection Ratio	$V_S = 5\text{ V to }36\text{ V}$		90	120		dB
			$-40^\circ\text{C to }125^\circ\text{C}$	80			dB
<b>Input Characteristics</b>							
$V_{OS}$	Input Offset Voltage	$V_S = 36\text{ V}, V_{CM} = 0\text{ V to }28\text{ V}$		-3	0.5	3	mV
			$-40^\circ\text{C to }125^\circ\text{C}$	-5		5	mV
		$V_S = 5\text{ V}, V_{CM} = 2.5\text{ V}$		-3	0.5	3	mV
			$-40^\circ\text{C to }125^\circ\text{C}$	-5		5	mV
$V_{OS\text{ TC}}$	Input Offset Voltage Drift		$-40^\circ\text{C to }125^\circ\text{C}$		5		$\mu\text{V}/^\circ\text{C}$
$I_B$	Input Bias Current	$V_S = 36\text{ V}, V_{CM} = 18\text{ V}$			15	30	nA
			$-40^\circ\text{C to }125^\circ\text{C}$			50	nA
$I_{OS}$	Input Offset Current	$V_S = 36\text{ V}, V_{CM} = 18\text{ V}$			1	10	nA
			$-40^\circ\text{C to }125^\circ\text{C}$			30	nA
$I_B$	Input Bias Current	$V_S = 36\text{ V}, V_{CM} = 0\text{ V}$			20	50	nA
			$-40^\circ\text{C to }125^\circ\text{C}$			100	nA
$I_{OS}$	Input Offset Current	$V_S = 36\text{ V}, V_{CM} = 0\text{ V}$			1	30	nA
			$-40^\circ\text{C to }125^\circ\text{C}$			50	nA
$I_{IN}$	Different Input Current	$V_S = 36\text{ V}, V_{ID} = 36\text{ V}$		-300	50	300	nA
			$-40^\circ\text{C to }125^\circ\text{C}$	-500		500	nA
$C_{IN}$	Input Capacitance	Differential mode			5		pF
		Common mode			5		pF
$A_V$	Open-Loop Voltage Gain			100	130		dB
		$-40^\circ\text{C to }125^\circ\text{C}$		90			dB
$V_{CMR}$	Common-Mode Input Voltage Range		$-40^\circ\text{C to }125^\circ\text{C}$	$(-V_S)$		$(+V_S) - 2$	V
CMRR	Common-Mode Rejection Ratio	$V_{CM} = 0\text{ V to }28\text{ V}$		80	110		dB
			$-40^\circ\text{C to }125^\circ\text{C}$	75			dB
<b>Output Characteristics</b>							
	Output Voltage Swing from Positive Rail	$I_{LOAD} = 50\text{ }\mu\text{A to }V_S / 2$			1.1	1.2	V
			$-40^\circ\text{C to }125^\circ\text{C}$			1.4	V
		$I_{LOAD} = 1\text{ mA to }V_S / 2$			1.3	1.5	V

Symbol	Parameter	Conditions	T <sub>A</sub>	Min	Typ	Max	Unit
			-40°C to 125°C			1.7	V
		I <sub>LOAD</sub> = 5 mA to V <sub>S</sub> / 2	-40°C to 125°C		1.9	2.4	V
						2.5	V
	Output Voltage Swing from Negative Rail	I <sub>LOAD</sub> = 50 μA to V <sub>S</sub> / 2	-40°C to 125°C		70	100	mV
						150	mV
		I <sub>LOAD</sub> = 1 mA to V <sub>S</sub> / 2	-40°C to 125°C		0.9	1	V
						1.1	V
		I <sub>LOAD</sub> = 5 mA to V <sub>S</sub> / 2	-40°C to 125°C		1.2	1.5	V
						1.6	V
		V <sub>S</sub> = 5 V, R <sub>LOAD</sub> = 10 kΩ to 0 V	-40°C to 125°C		5	10	mV
						15	mV
I <sub>SC</sub>	Output Short-Circuit Current				50		mA
			-40°C to 125°C		30		mA
<b>AC Specifications</b>							
GBW	Gain-Bandwidth Product				1.5		MHz
SR	Slew Rate	G = 1, 2-V step			0.5		V/μs
t <sub>OR</sub>	Overload Recovery	From positive rail			1.5		μs
		From negative rail			8		μs
t <sub>S</sub>	Settling Time, 0.1%	G = 1, 2-V step			3		μs
	Settling Time, 0.01%				4		μs
PM	Phase Margin	R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 100 pF			60		°
GM	Gain Margin	R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 100 pF			15		dB
	Channel Separation	f = 100 kHz			120		dB
<b>Noise Performance</b>							
E <sub>N</sub>	Input Voltage Noise	f = 0.1 Hz to 10 Hz			1.6		μV <sub>PP</sub>
e <sub>N</sub>	Input Voltage Noise Density	f = 1 kHz			50		nV/√Hz
i <sub>N</sub>	Input Current Noise	f = 1 kHz			200		fA/√Hz
THD+N	Total Harmonic Distortion and Noise	f = 1 kHz, G = 1, R <sub>L</sub> = 10 kΩ, V <sub>OUT</sub> = 6 V <sub>RMS</sub>			0.01		%

### Typical Performance Characteristics

All test conditions:  $V_S = \pm 15\text{ V}$ ,  $V_{CM} = 0\text{ V}$ ,  $R_L = 10\text{ k}\Omega$ , unless otherwise noted.

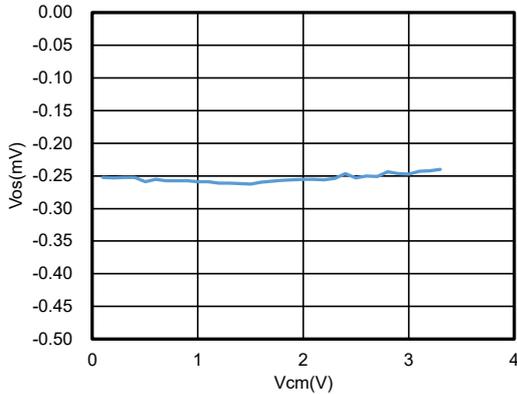


Figure 1. Offset Voltage vs. Common-Mode Voltage,  $V_S = 5\text{ V}$

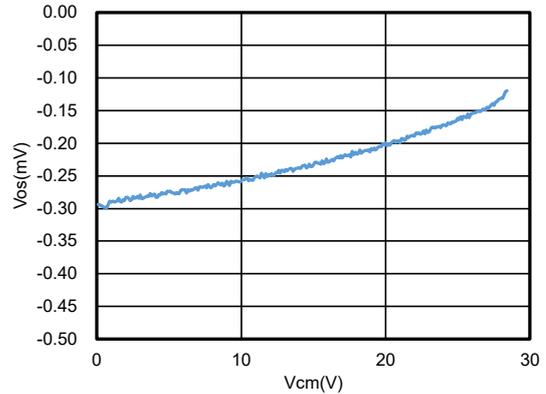


Figure 2. Offset Voltage vs. Common-Mode Voltage,  $V_S = 30\text{ V}$

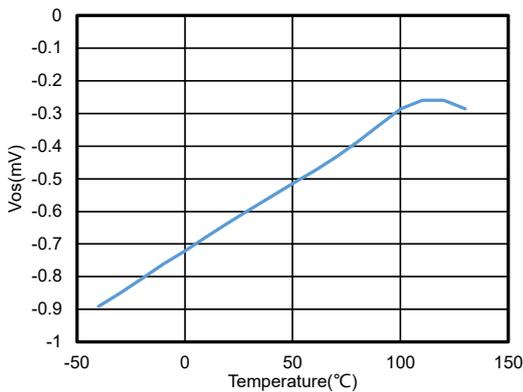


Figure 3. Offset Voltage vs. Temperature,  $V_S = 30\text{ V}$ ,  $V_{CM} = 15\text{ V}$

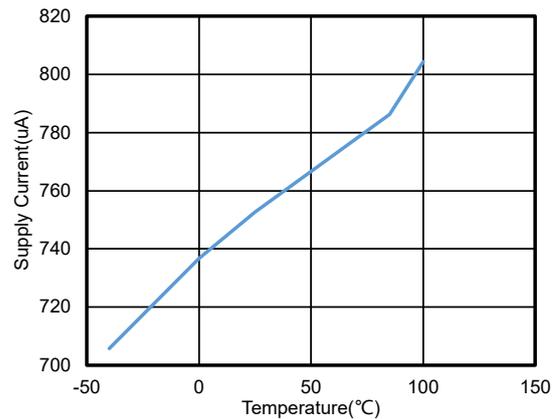


Figure 4.  $I_q$  vs. Temperature,  $\pm 15\text{-V}$  Supply, TPA2642

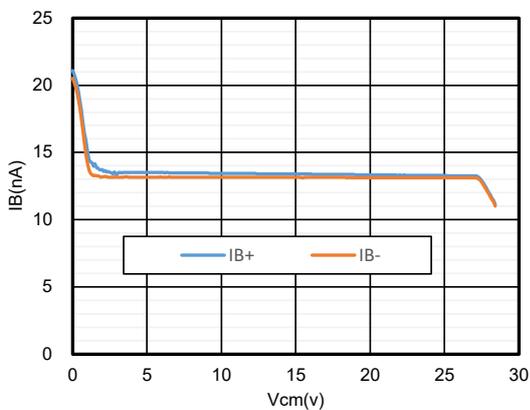


Figure 5.  $I_B$  vs. Common-Mode Voltage,  $V_S = 30\text{ V}$

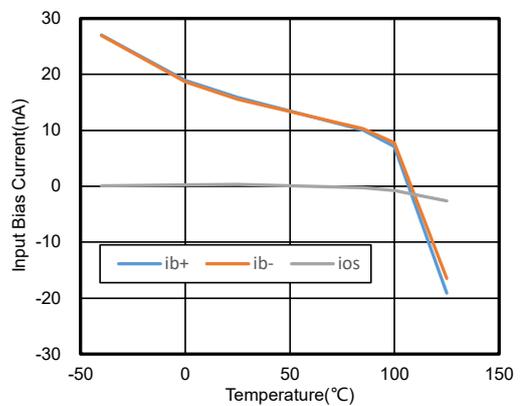


Figure 6.  $I_B$  and  $I_{OS}$  vs. Temperature,  $V_S = 30\text{ V}$ ,  $V_{CM} = 15\text{ V}$

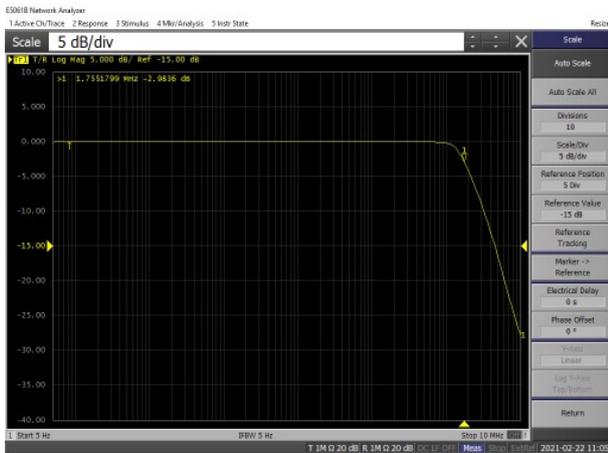


Figure 7. -3-dB Bandwidth, G = 1, V<sub>s</sub> = 30 V

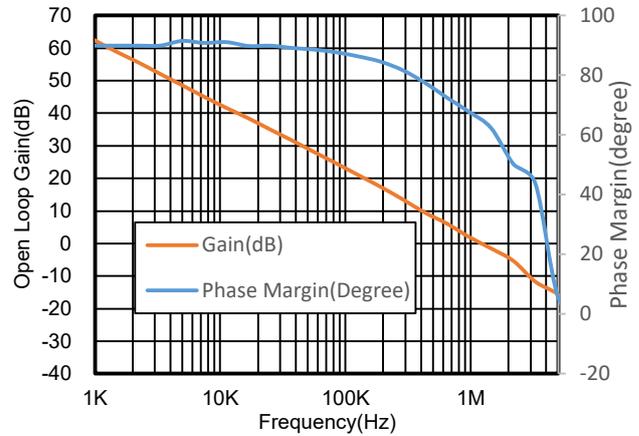


Figure 8. Open-Loop Gain and Phase vs. Frequency

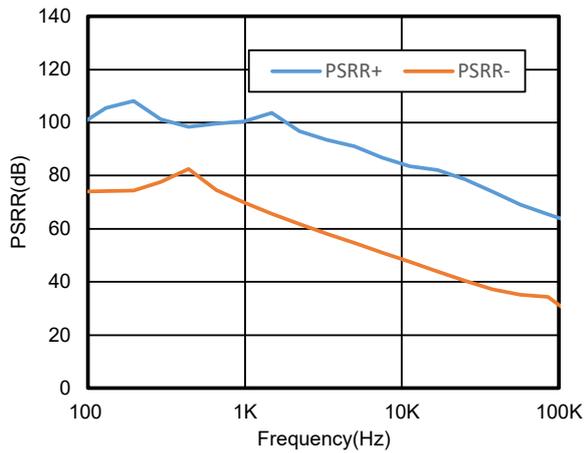


Figure 9. PSRR vs. Frequency

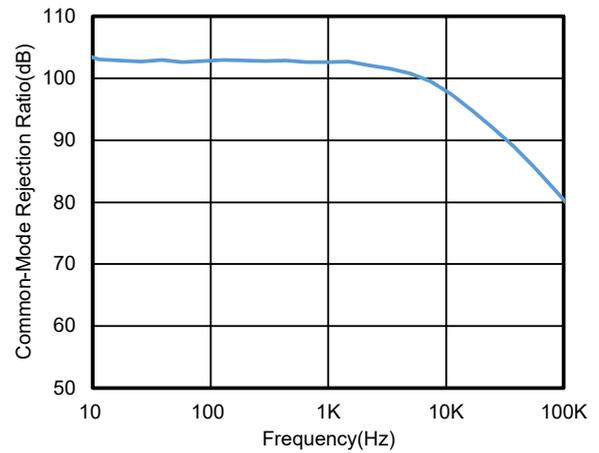


Figure 10. CMRR vs. Frequency



Time: 10  $\mu$ s/div, Measure Time: 1.4  $\mu$ s, G = 11

Figure 11. Positive Overload Recovery



Time: 10  $\mu$ s/div, Measure Time: 7.8  $\mu$ s, G = 11

Figure 12. Negative Overload Recovery



Voltage: 200 mV/div, Time: 5 µs/div

$R_L = 100\text{ k}\Omega$ ,  $C_L = 1\text{ nF}$ ,  $G = 1$

Figure 13. 1-V Signal Step Response



Voltage: 2 mV/div, Time: 5 µs/div

$C_L = 50\text{ pF}$ ,  $G = 1$

Figure 14. 10-mV Signal Step Response

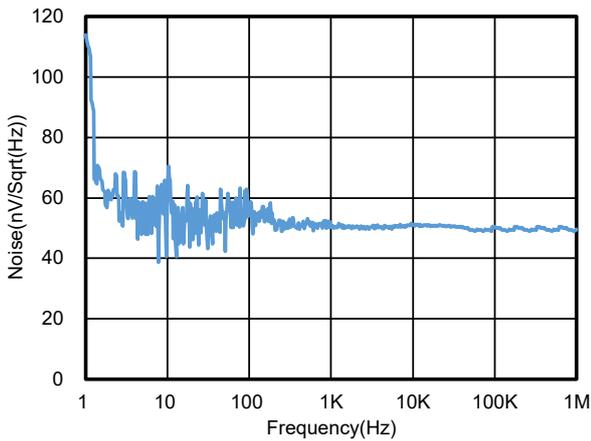


Figure 15. Voltage Noise Density vs. Frequency

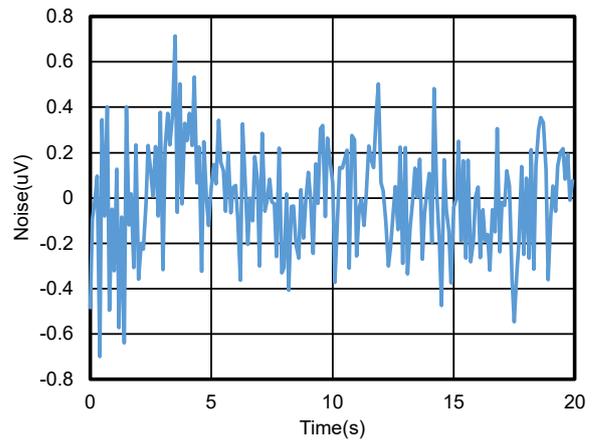


Figure 16. 0.1-Hz to 10-Hz Voltage Noise

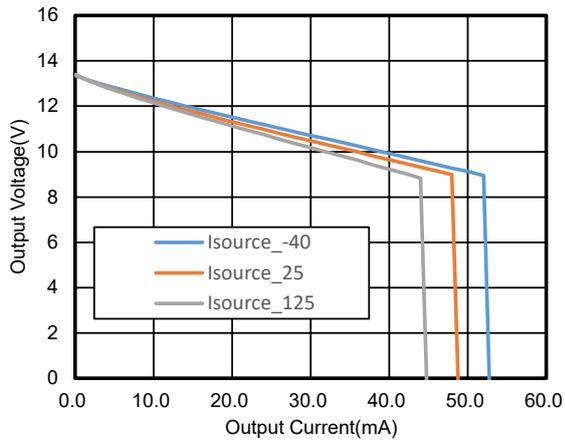


Figure 17.  $V_{OUT}$  vs.  $I_{OUT}$ , Source

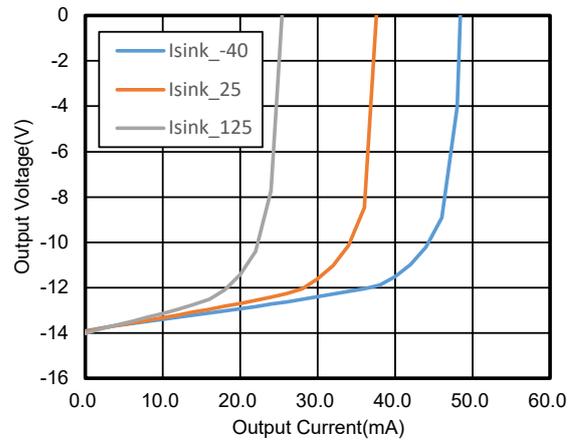


Figure 18.  $V_{OUT}$  vs.  $I_{OUT}$ , Sink

Typical Performance Characteristics (Continued)

All test conditions: power on and off behavior, 36-V single supply,  $G = 1$ , Input =  $V_s / 2$ , Yellow:  $V_s$ , Green: Output, unless otherwise noted.



Figure 19. 2-ms Power on and off Time



Figure 20. 10-ms Power on and off Time



Figure 21. 100-ms Power on and off Time

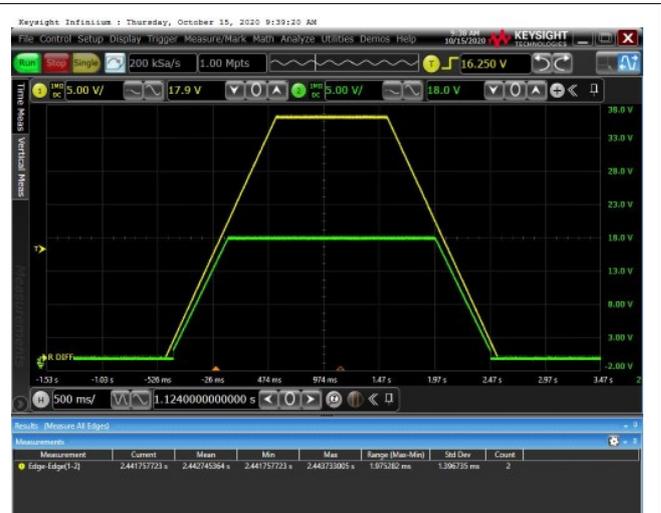


Figure 22. 1-s Power on and off Time

### Typical Performance Characteristics (Continued)

All test conditions: power on and off behavior, +18-V and -18-V dual supply, G = 1, Input = Ground, Green: +Vs, Red: -Vs, Yellow: Output, unless otherwise noted.

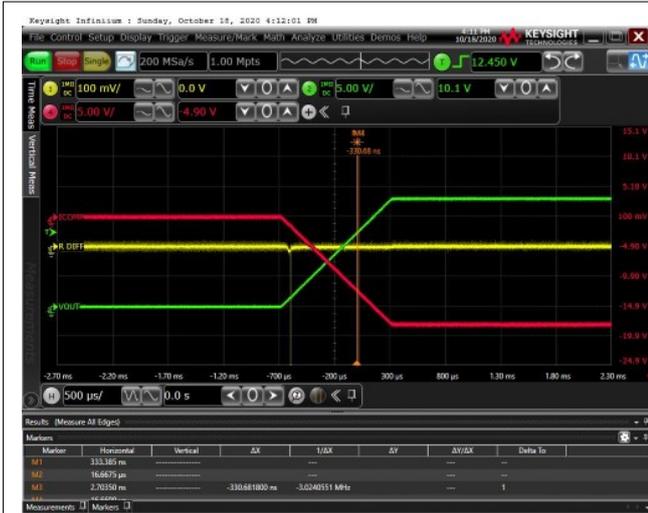


Figure 23. 1-ms Power on and off Time



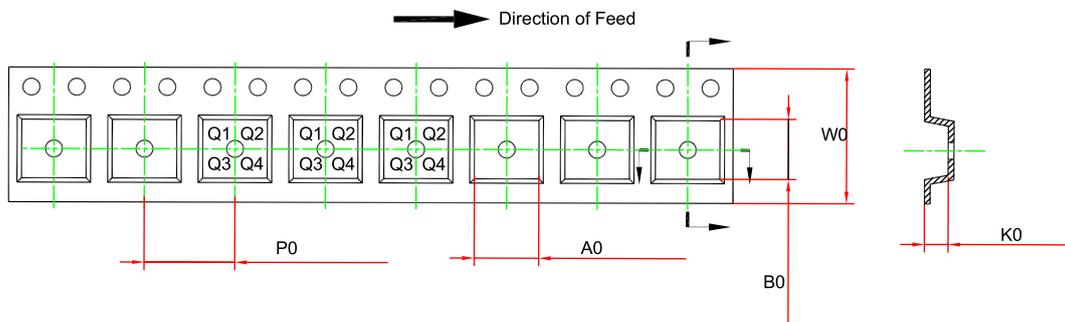
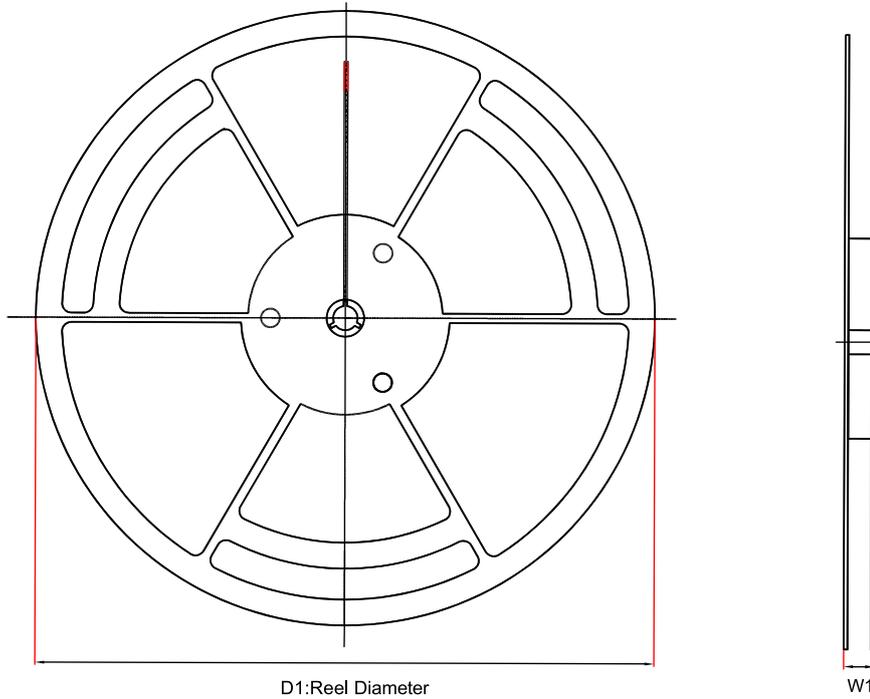
Figure 24. 10-ms Power on and off Time



Figure 25. 100-ms Power on and off Time



Figure 26. 1-s Power on and off Time

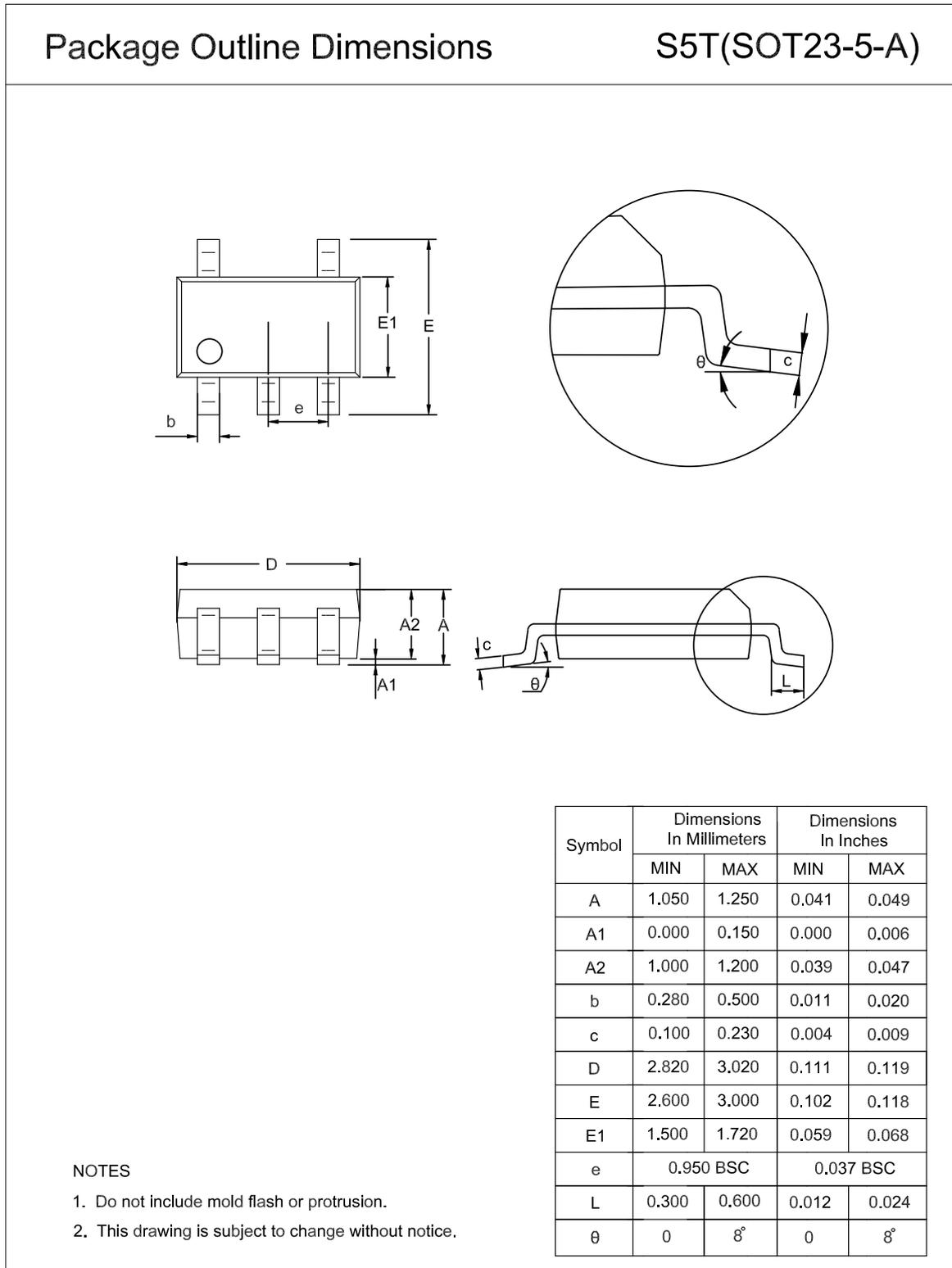
**Tape and Reel Information**


Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm) <sup>(1)</sup>	B0 (mm) <sup>(1)</sup>	K0 (mm) <sup>(1)</sup>	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPA2641-S5TR-S	SOT23-5	180.0	12.0	3.3	3.25	1.4	4.0	8.0	Q3
TPA2641U-S5TR-S	SOT23-5	180.0	12.0	3.3	3.25	1.4	4.0	8.0	Q3
TPA2642-SO1R-S	SOP8	330.0	17.6	6.5	5.4	2.0	8.0	12.0	Q1
TPA2642-TS1R-S	TSSOP8	330.0	17.6	6.8	3.4	1.7	8.0	12.0	Q1
TPA2642-VS1R-S	MSOP8	330.0	17.6	5.4	3.3	1.3	8.0	12.0	Q1
TPA2644-SO2R-S	SOP14	330.0	21.6	6.5	9.15	1.8	8.0	16.0	Q1
TPA2644-TS2R-S	TSSOP14	330.0	17.6	6.8	5.5	1.7	8.0	12.0	Q1

(1) The value is for reference only. Contact the 3PEAK factory for more information.

Package Outline Dimensions

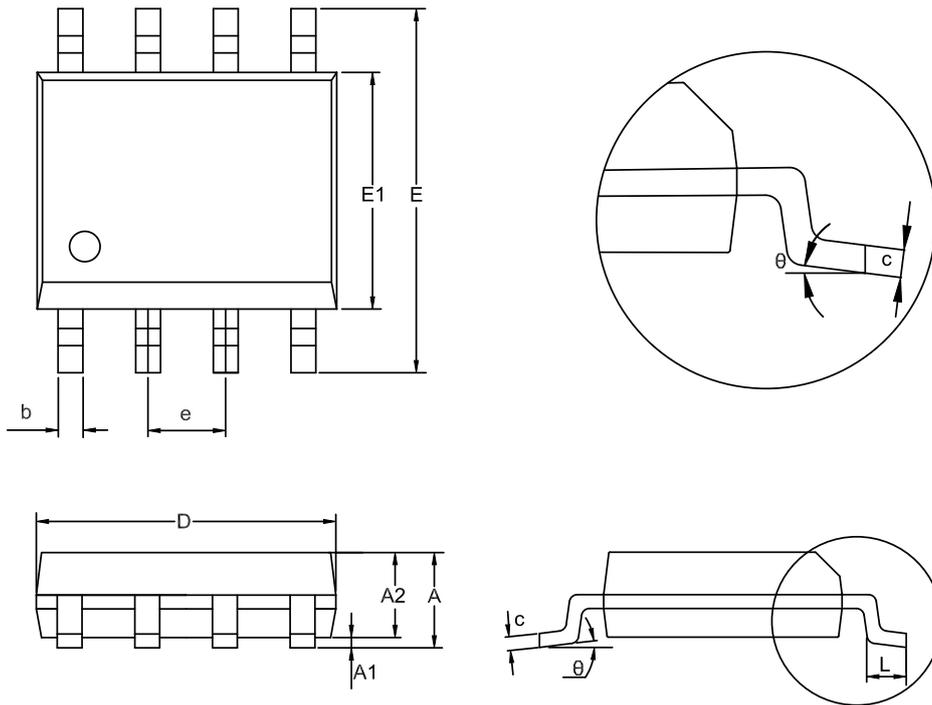
SOT23-5



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°

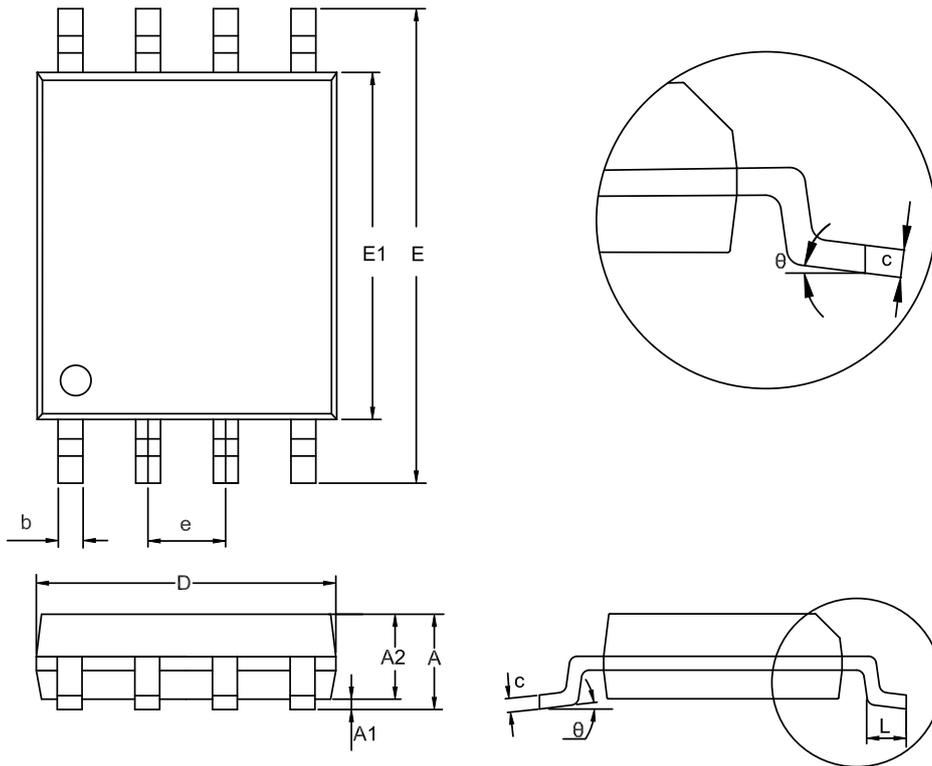
NOTES

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

**TSSOP8**

**Package Outline Dimensions**

**TS1(TSSOP-8-A)**



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.900	1.200	0.035	0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	2.900	3.100	0.114	0.122
E	6.200	6.600	0.244	0.260
E1	4.300	4.500	0.169	0.177
e	0.650 BSC		0.026 BSC	
L	0.450	0.750	0.018	0.030
θ	0	8°	0	8°

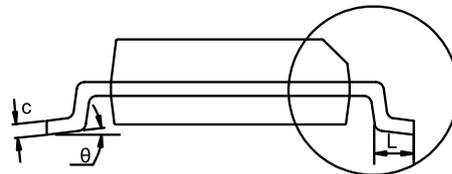
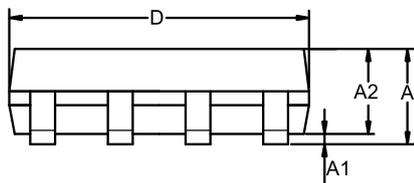
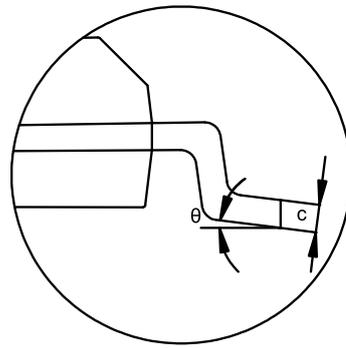
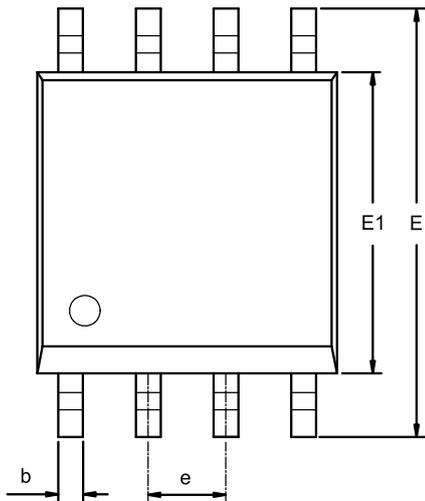
**NOTES**

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

**MSOP8**

**Package Outline Dimensions**

**VS1(MSOP-8-A)**



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.800	1.100	0.031	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	4.700	5.100	0.185	0.201
E1	2.900	3.100	0.114	0.122
e	0.650 BSC		0.026 BSC	
L	0.400	0.800	0.016	0.031
$\theta$	0	8°	0	8°

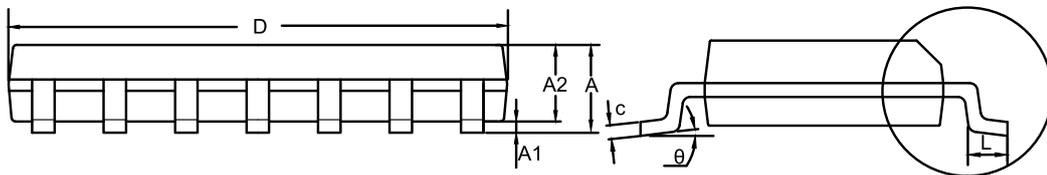
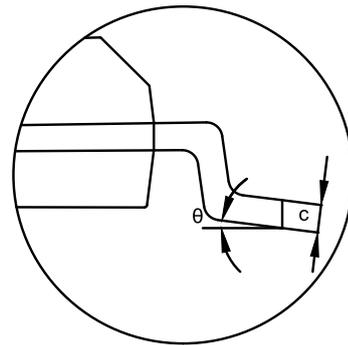
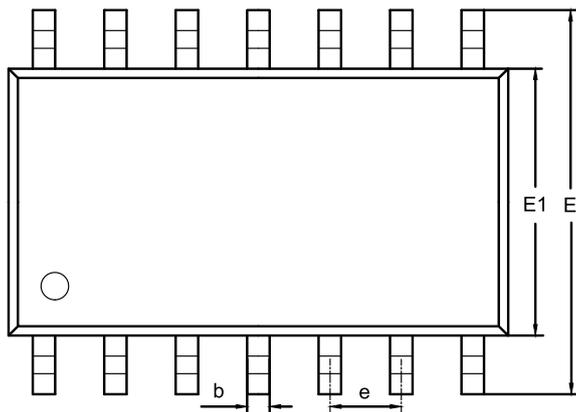
**NOTES**

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

SOP14

Package Outline Dimensions

SO2(SOP-14-A)

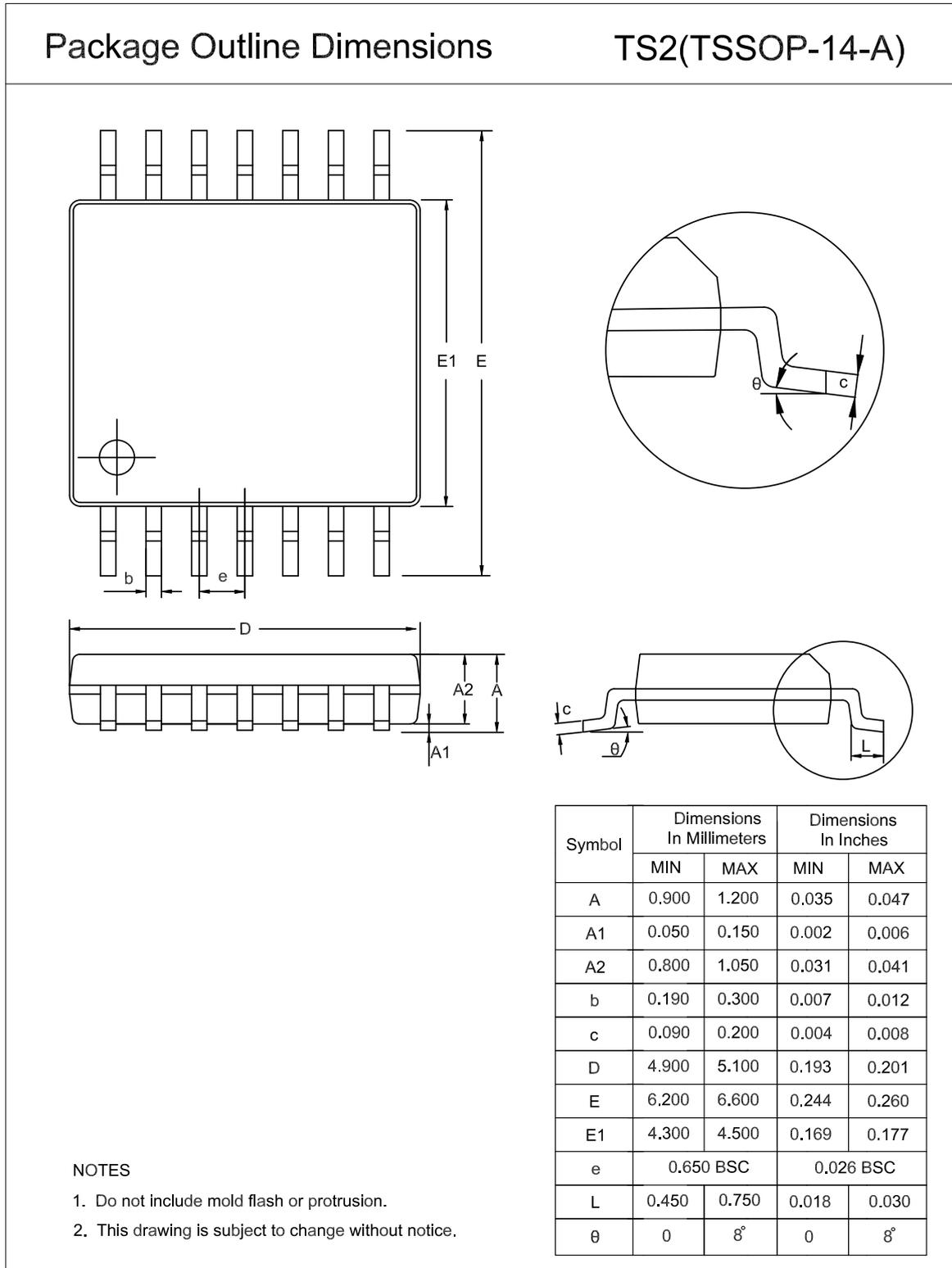


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.250	1.650	0.049	0.065
b	0.310	0.510	0.012	0.020
c	0.100	0.250	0.004	0.010
D	8.450	8.850	0.333	0.348
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	1.270 BSC		0.050 BSC	
L	0.400	1.270	0.016	0.050
θ	0	8°	0	8°

NOTES

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

**TSSOP14**



## Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
TPA2641-S5TR-S <sup>(1)</sup>	-40 to 125°C	SOT23-5	641	3	Tape and Reel, 3000	Green
TPA2641U-S5TR-S <sup>(1)</sup>	-40 to 125°C	SOT23-5	64U	3	Tape and Reel, 3000	Green
TPA2642-SO1R-S <sup>(1)</sup>	-40 to 125°C	SOP8	A2642	3	Tape and Reel, 4000	Green
TPA2642-TS1R-S <sup>(1)</sup>	-40 to 125°C	TSSOP8	A2642	3	Tape and Reel, 3000	Green
TPA2642-VS1R-S <sup>(1)</sup>	-40 to 125°C	MSOP8	A2642	3	Tape and Reel, 3000	Green
TPA2644-SO2R-S	-40 to 125°C	SOP14	A2644	3	Tape and Reel, 2500	Green
TPA2644-TS2R-S <sup>(1)</sup>	-40 to 125°C	TSSOP14	A2644	3	Tape and Reel, 3000	Green

(1) For future products, contact the 3PEAK factory for more information and samples.

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

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