36-V, 1-MHz, 0.7-V/µs Operational Amplifiers

Features

- Supply Voltage: 4.5 V to 36 V
- Offset Voltage: ±300 µV (Max)
- Differential Input Voltage Range to Supply Rail, Can Work as Comparator
- Input Rail to $–V_S$, Rail-to-Rail Output
- Bandwidth: 1 MHz
- Slew Rate: 0.7 V/µs
- Excellent EMI Suppress Performance: 80 dB at 1 GHz
- Offset Voltage Temperature Drift: 2 µV/°C
- Low Noise: 30 nV/√Hz at 1 kHz
- 2-kV HBM, 1-kV CDM
- Operating Temperature Range: −40°C to 125°C

Applications

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

Description

The TP124x is a series of the newest high-supply voltage amplifiers with low offset, low power, and stable high-frequency response. The series incorporates the proprietary and patented design techniques of 3PEAK to achieve excellent AC performance with 1-MHz bandwidth, 0.7-V/µs slew rate, and low distortion while drawing only 150 µA of quiescent current per amplifier. The input common-mode voltage range extends to $−V_S$, and the outputs swing rail-to-rail. The TP124x series can be used as plug-in replacements for commercially available op amps to reduce power, extend input/output range, and improve performance. The combination of features makes the TP124x an ideal choice for industrial control and instrumentation.

Table of Contents

Revision History

Date	Revision	Notes
2020-12-10	Rev.A.0	Initial version.
2021-01-16	Rev.A.1	Updated overload recovery time: from 100 ns to 2 μs.
2021-04-15	Rev.A.2	Updated I_Q of the TP1241. Added TP1242L1-VR.
2023-11-03	Rev.A.3	The following updates are all about the new datasheet formats or typos, and the actual product remains unchanged. • Updated Marking Information of TP1242L1-SR: from "TP1242" to "1242". • Updated Tape and Reel Information. • Updated Package Outline Dimensions.
2024-12-30	Rev.A.4	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

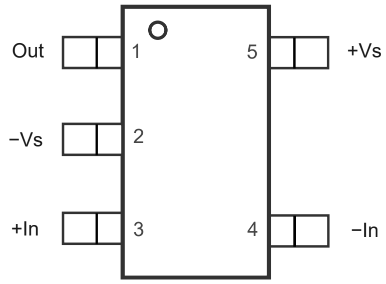


Table 1. Pin Functions: TP1241L1

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

TP1242L1
SOP8/MSOP8
Top View

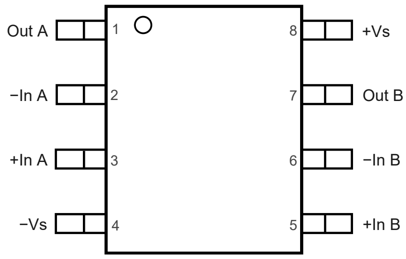


Table 2. Pin Functions: TP1242L1

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

Specifications

Absolute Maximum Ratings (1)

Symbol	Parameters	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
	Input Current: +IN, –IN (2)	−10	10	mA
	Output Short-Circuit Duration (3)		Infinite	
T_J	Maximum Junction Temperature		150	℃
T_A	Operating Temperature Range	−40	125	℃
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 are protected by ESD protection diodes to each power supply. If the input extends more than 300 mV beyond the 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. 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)	2	kV
CDM	Charged Device Model ESD	ANSI/ESDA/JEDEC JS-002 (2)	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_{JA}	θ_{JC}	Unit
SOT23-5	250	81	°C/W
SOP8	158	43	°C/W
MSOP8	210	45	°C/W

Electrical Characteristics

All test conditions: V_S = 30 V, T_A = 25°C, R_L = 10 kΩ, 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 V, TP1241L1			250	500	µA
			−40°C to 125°C			700	µA
		V_S = 30 V, TP1242L1			150	350	µA
			−40°C to 125°C			500	µA
PSRR	Power Supply Rejection Ratio	V_S = 4.5 V to 36 V		100	120		dB
			−40°C to 125°C	95			dB
Input Characteristics							
V_{OS}	Input Offset Voltage	V_S = 30 V, V_{CM} = 15 V		−300	50	300	µV
			−40°C to 125°C	−800		800	µV
		V_S = 5 V, V_{CM} = 2.5 V		−300	50	300	µV
			−40°C to 125°C	−800		800	µV
		V_S = 5 V, V_{CM} = 0 V		−500	100	500	µV
			−40°C to 85°C	−1000		1000	µV
			−40°C to 125°C	−3000		3000	µV
$V_{OS}TC$	Input Offset Voltage Drift		−40°C to 125°C		2		µV/°C
I_B	Input Bias Current				25		pA
			−40°C to 85°C		80		pA
			−40°C to 125°C		1000		pA
I_{OS}	Input Offset Current				25		pA
I_{IN}	Different Input Current	V_S = 36 V, V_{ID} = 36 V			10	200	nA
			−40°C to 125°C			300	nA
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		110	130		dB
			−40°C to 125°C	90			dB
V_{CMR}	Common-Mode Input Voltage Range			($-V_S$)		($+V_S$) – 1.5	V
CMRR	Common-Mode Rejection Ratio	V_{CM} = 0.5 V to 28.5 V		100	120		dB
			−40°C to 125°C	95			dB

Symbol	Parameter	Conditions	T_A	Min	Typ	Max	Unit
Output Characteristics							
V_{OH}	Output Swing from Positive Rail	R_{LOAD} = 100 kΩ to V_S / 2			15	30	mV
			−40°C to 125°C			50	mV
		R_{LOAD} = 10 kΩ to V_S / 2			60	90	mV
			−40°C to 125°C			140	mV
V_{OL}	Output Swing from Negative Rail	R_{LOAD} = 100 kΩ to V_S / 2			10	20	mV
			−40°C to 125°C			30	mV
		R_{LOAD} = 10 kΩ to V_S / 2			35	50	mV
			−40°C to 125°C			90	mV
		No load to $-V_S$			5	10	mV
			−40°C to 125°C			15	mV
I_{SC}	Output Short-Circuit Current	Source			70		mA
		Sink			120		
AC Specifications							
GBW	Gain-Bandwidth Product				1		MHz
SR	Slew Rate	G = 1		0.3	0.7		V/µs
			−40°C to 125°C	0.1			V/µs
t_{OR}	Overload Recovery				2		µs
t_S	Settling Time, 0.1%	G = −1, 10-V step			15		µs
	Settling Time, 0.01%				20		µs
PM	Phase Margin	V_S = 36 V, R_L = 10 kΩ, C_L = 100 pF			60		°
GM	Gain Margin	V_S = 36 V, R_L = 10 kΩ, C_L = 100 pF			10		dB
Noise Performance							
E_N	Input Voltage Noise	f = 0.1 Hz to 10 Hz			2		μV_{RMS}
e_N	Input Voltage Noise Density	f = 1 kHz			30		nV/√Hz
i_N	Input Current Noise	f = 1 kHz			2		fA/√Hz

Typical Performance Characteristics

All test conditions: V_S = ±15 V, V_{CM} = 0 V, R_L = 10 kΩ, unless otherwise specified.

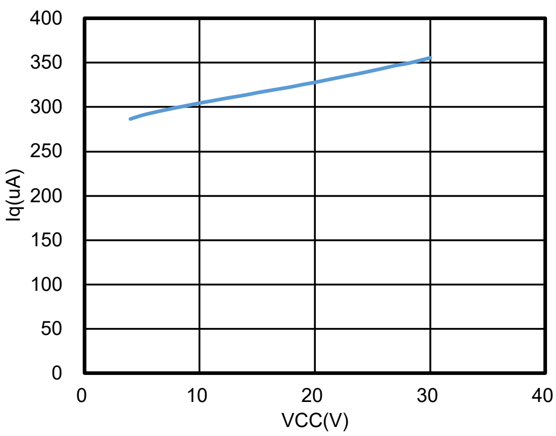


Figure 1. I_Q vs. V_{CC}, TP1242L1

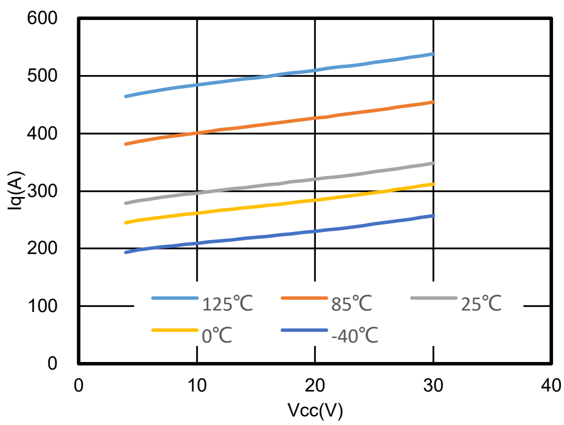


Figure 2. I_Q vs. V_{CC} in Different Temperature, TP1242L1

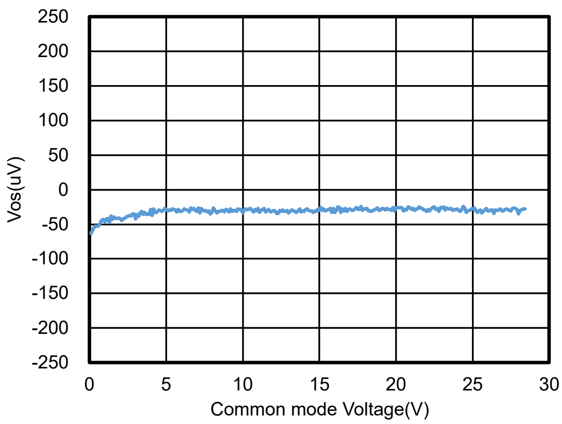


Figure 3. Offset Voltage vs. Common-Mode Voltage

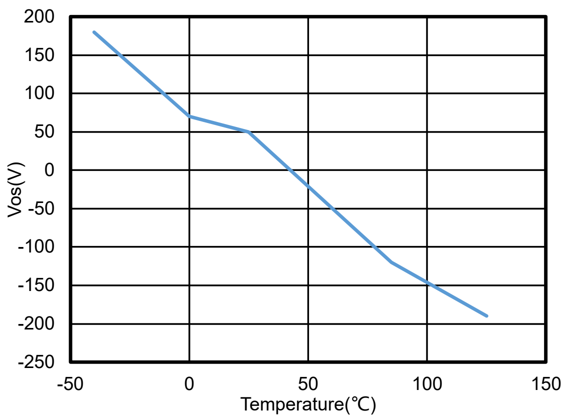


Figure 4. V_{OS} vs. Temperature

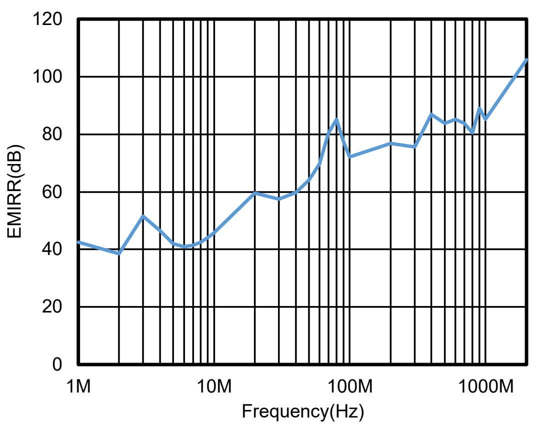


Figure 5. EMIRR vs. Frequency

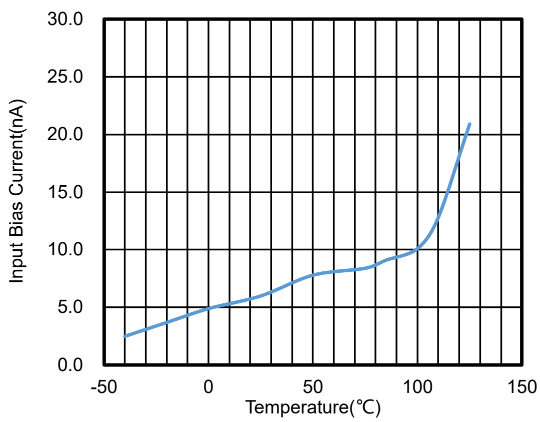


Figure 6. Input Current in Large V_{DM} vs. Temperature

Typical Performance Characteristics (Continued)

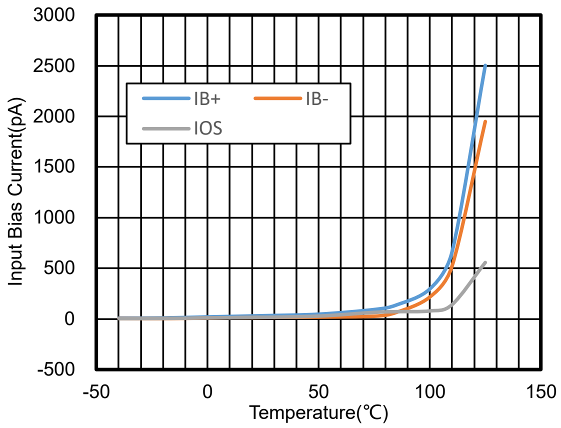


Figure 7. I_B vs. Temperature, −40°C to 125°C

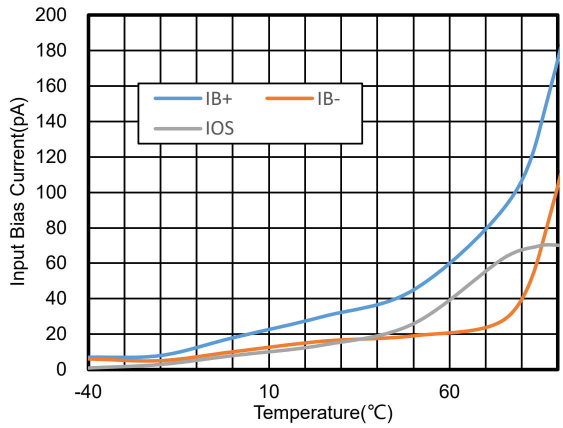


Figure 8. I_B vs. Temperature, −40°C to 90°C

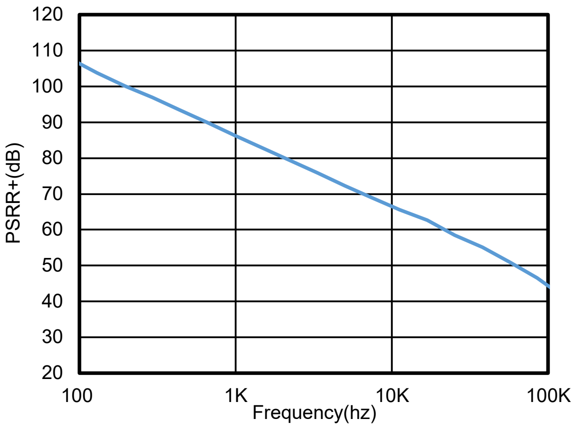


Figure 9. PSRR+ vs. Frequency

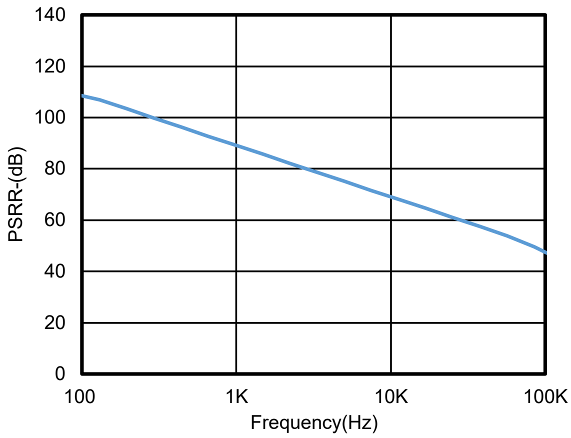


Figure 10. PSRR− vs. Frequency

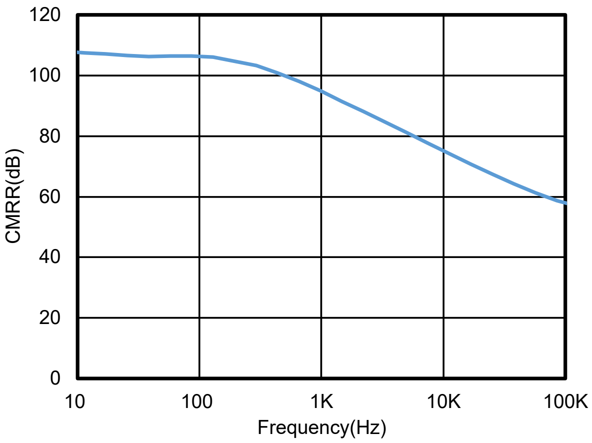


Figure 11. CMRR vs. Frequency

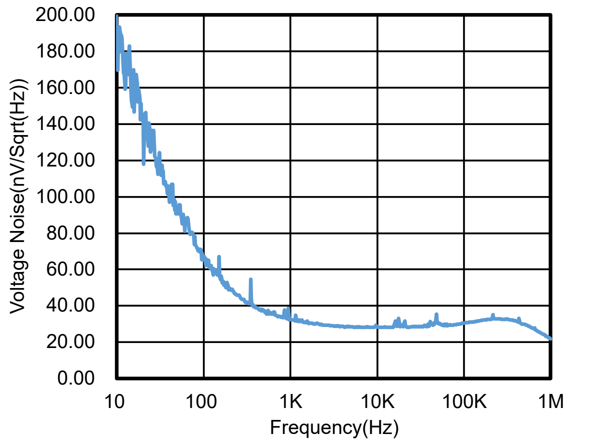


Figure 12. Voltage Noise Spectral Density vs. Frequency

Typical Performance Characteristics (Continued)

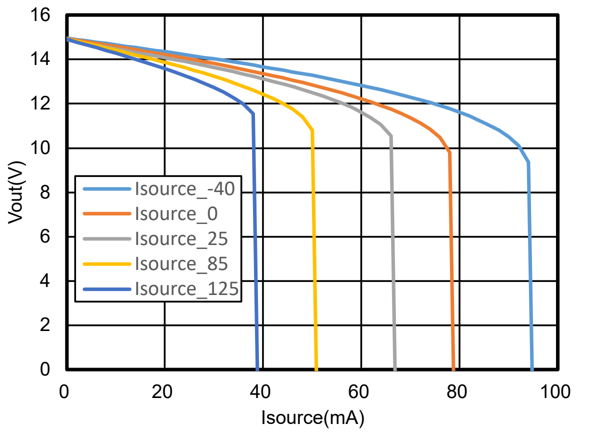


Figure 13. Positive Output Voltage vs. Output Current

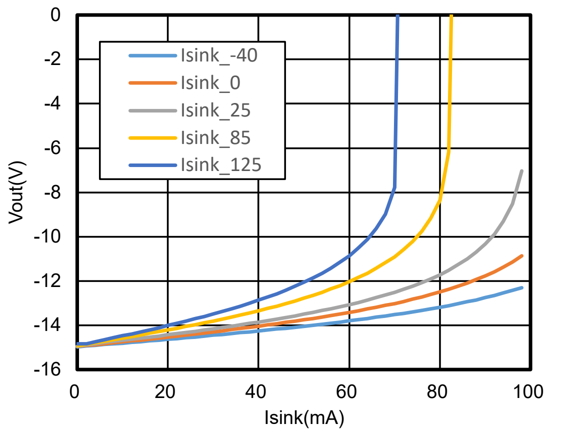


Figure 14. Negative Output Voltage vs. Output Current

Voltage: 5 V/div for output, Time: 10 µs/div

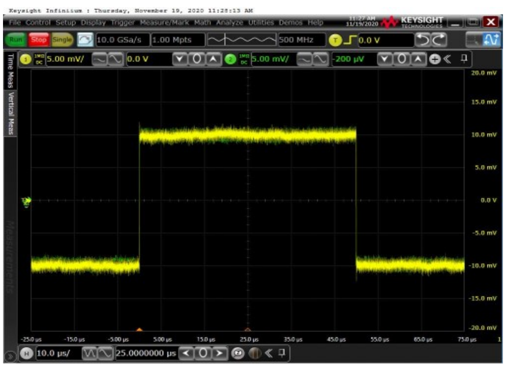
G = 10, V_{REF} = GND; V_{IN} = 5 V_{PP}

Figure 15. Positive Overload Recovery

Voltage: 5 V/div for output, Time: 10 µs/div

G = 10, V_{REF} = GND; V_{IN} = 5 V_{PP}

Figure 16. Negative Overload Recovery



Voltage: 5 mV/div, Time: 10 µs/div

R_L = 2 kΩ, C_L = 100 pF, G = 1

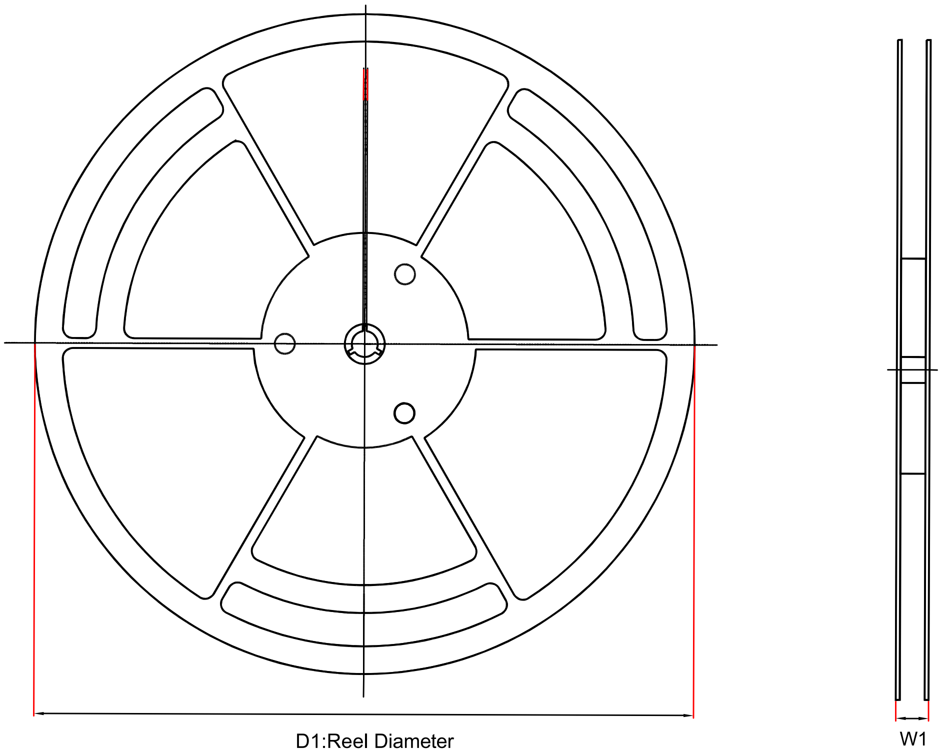
Figure 17. 20-mV Signal Step Response

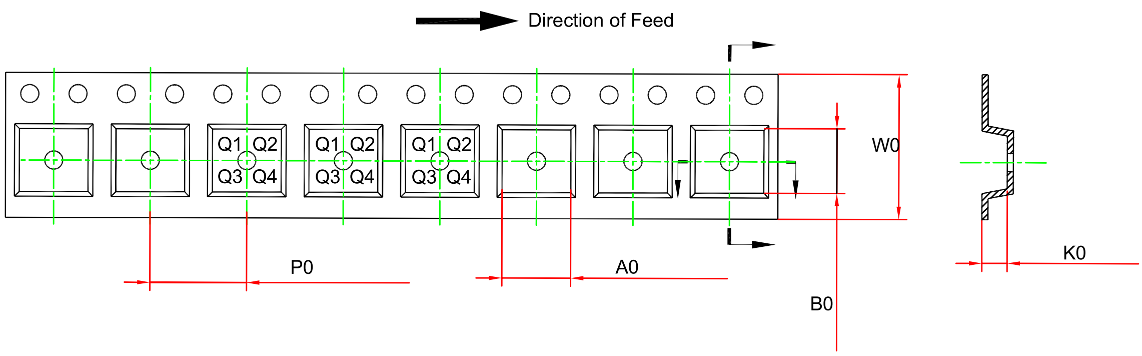
Voltage: 5 V/div, Time: 100 µs/div

R_L = 2 kΩ, C_L = 100 pF, G = 1

Figure 18. 10-V Signal Step Response

Tape and Reel Information





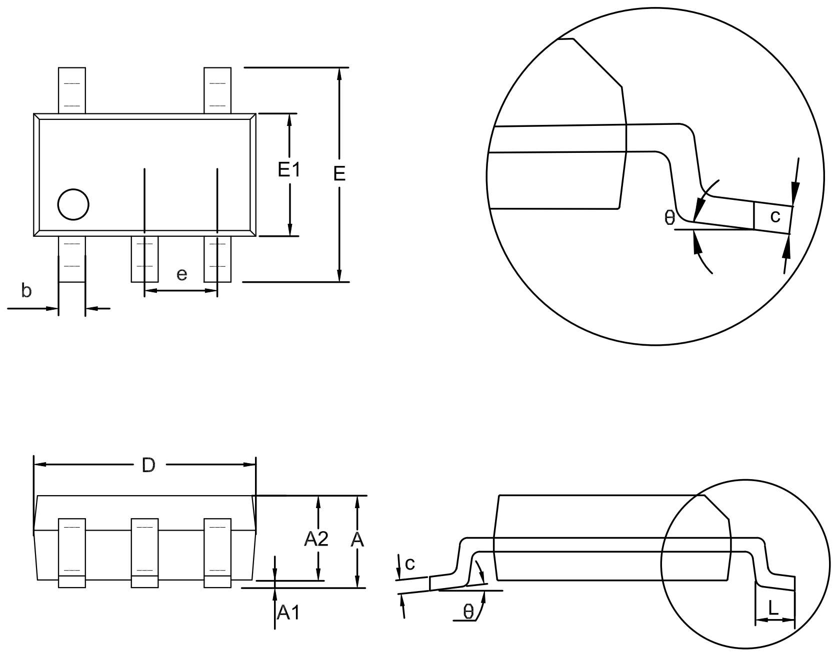
Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm) (1)	B0 (mm) (1)	K0 (mm) (1)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TP1241L1-TR	SOT23-5	179.0	12	3.3	3.25	1.4	4.0	8.0	Q3
TP1242L1-SR	SOP8	330.0	17.6	6.5	5.4	2.0	8.0	12.0	Q1
TP1242L1-VR	MSOP8	330.0	17.6	5.4	3.3	1.3	8.0	12.0	Q1

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

Package Outline Dimensions

SOT23-5

Package Outline Dimensions S5T(SOT23-5-A)



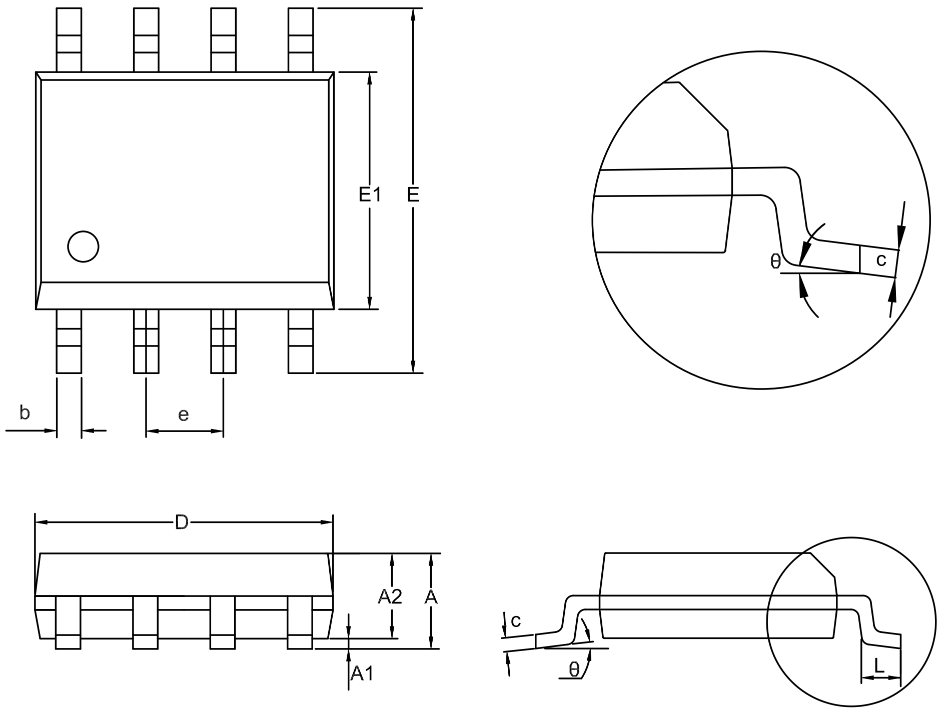
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.150	0.000	0.006
A2	1.000	1.200	0.039	0.047
b	0.280	0.500	0.011	0.020
c	0.100	0.230	0.004	0.009
D	2.820	3.020	0.111	0.119
E	2.600	3.000	0.102	0.118
E1	1.500	1.720	0.059	0.068
e	0.950 BSC		0.037 BSC	
L	0.300	0.600	0.012	0.024
θ	0	8°	0	8°

NOTES

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

SOP8

Package Outline Dimensions SO1(SOP-8-A)



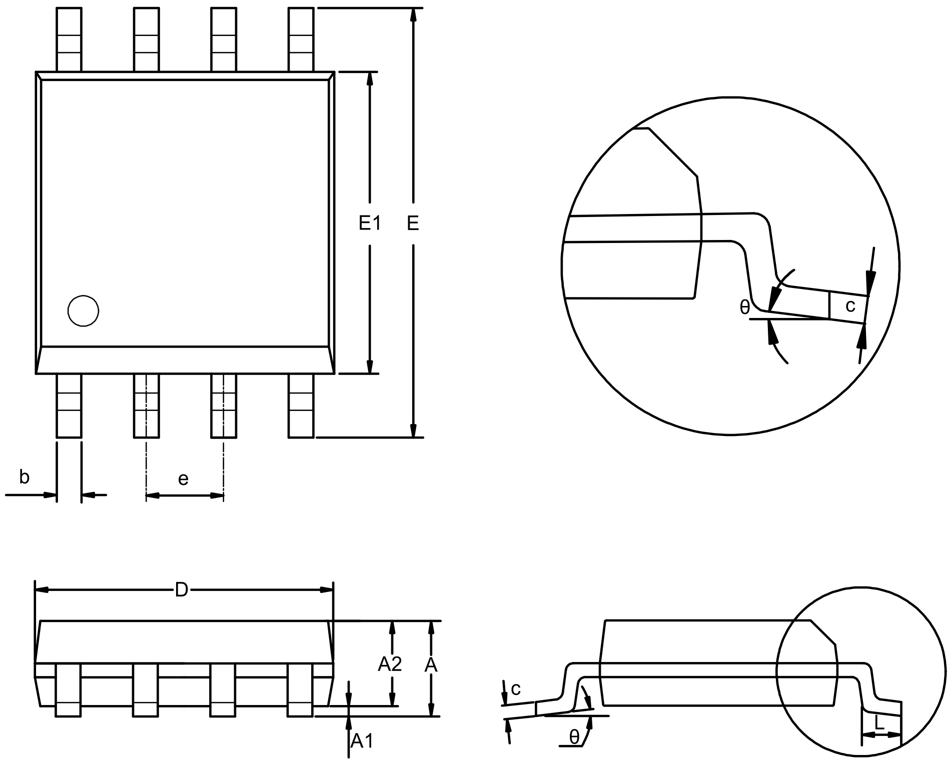
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.250	1.550	0.049	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	1.270 BSC		0.050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

MSOP-8

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
θ	0	8°	0	8°

NOTES

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

Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
TP1241L1-TR	−40 to 125°C	SOT23-5	124	1	Tape and Reel, 3000	Green
TP1242L1-SR	−40 to 125°C	SOP8	1242	1	Tape and Reel, 4000	Green
TP1242L1-VR	−40 to 125°C	MSOP8	TP1242	1	Tape and Reel, 3000	Green

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

IMPORTANT NOTICE AND DISCLAIMER

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