36-V, 6-MHz, 50-μV V_{OS} Operational Amplifiers

Features

- Supply Voltage: 4.5 V to 36 V
- Offset Voltage: ±50 μV (Max)
- Differential Input Voltage Range to Supply Rail, can Work as Comparator
- Input Rail to $-V_S$, Rail-to-Rail Output
- Drive any Capacitive Load
- Bandwidth: 6 MHz, Slew Rate: 5 V/μs
- Excellent EMI Suppress Performance: 85 dB at 1 GHz
- Over-Temperature Protection
- Low Noise: 8 nV/√Hz at 1 kHz
- 2-kV HBM, 1-kV CDM, 500-mA Latch Up
- Operating Temperature Range: −40°C to 125°C

Applications

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

Description

The TP27 is a series of the newest high supply voltage amplifiers with low offset, low power, and stable high-frequency response. The series incorporates 3PEAK's proprietary and patented design techniques to achieve excellent AC performance with 6-MHz bandwidth, 5-V/μs slew rate, and low distortion. The input common-mode voltage range extends to $-V_S$, and the outputs swing rail-to-rail. The TP27 can be used as plug-in replacements for commercially available op amps to reduce power consumption, extend the input/output range, and improve performance.

The combination of features makes the TP27 an ideal choice for industrial control and instrumentation.

	TP07A	TP17	TP27	Unit
V_{OS}, 25°C	±150	±100	±50	μV
V_{OS}, −40 to 85°C	±500	±400	±70	μV
GBW	1	6	6	MHz
I_Q	1.5	2	1.6	mA

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Revision History

Date	Revision	Notes
2018-12-21	Rev.Pre.0	Pre-released version.
2019-09-11	Rev.A.0	Initial version.
2020-08-01	Rev.A.1	Corrected the typo in the header: from 5 MHz to 6 MHz. Added the test figure.
2021-07-07	Rev.A.2	Updated the Absolute Maximum Ratings: • Input Voltage: ($-V_S$) − 0.3 to ($+V_S$) + 0.3 → ($-V_S$) − 0.3 to 40 V ; • Differential Input Voltage : ($+V_S$) − ($-V_S$) → ($-V_S$) − ($+V_S$) to ($+V_S$) − ($-V_S$) .
2024-12-17	Rev.A.3	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 the Package Outline Dimensions. • Updated the Tape and Reel Information.

Pin Configuration and Functions

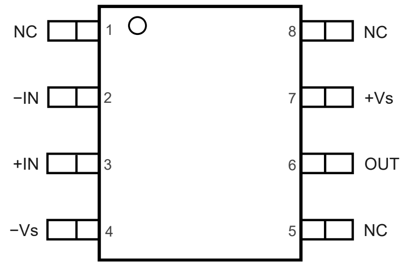


Table 1. Pin Functions: TP27

Pin No.	Name	I/O	Description
1	NC	-	Not connect
2	−IN	I	Inverting input
3	+IN	I	Non-inverting input
4	$-V_S$	-	Negative power supply
5	NC	-	Not connect
6	OUT	O	Output
7	$+V_S$	-	Positive power supply
8	NC	-	Not connect

Specifications

Absolute Maximum Ratings (1)

	Parameter	Min	Max	Unit
	Supply Voltage: $(+V_S) – (−V_S)$		40	V
	Input Voltage	$(−V_S) – 0.3$	40	V
	Differential Input Voltage	$(−V_S) – (+V_S)$	$(+V_S) − (−V_S)$	V
	Input Current: +IN, −IN (2)	−10	10	mA
	Output Voltage	$(−V_S) – 0.3$	$(+V_S) + 0.3$	V
	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 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 (1)	2	kV
CDM	Charged Device Model ESD	ANSI/ESDA/JEDEC JS-002 (2)	1	kV
LU	Latch Up	JESD 78, 25°C	500	mA
		JESD 78, 125°C	250	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
SOP8	158	43	°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			1.4	1.6	mA
			−40°C to 125°C			1.8	mA
		V_S = 5 V			1.2	1.5	mA
			−40°C to 125°C			1.7	mA
PSRR	Power Supply Rejection Ratio	V_S = 4.5 V to 36 V		125	140		dB
			−40°C to 125°C	120			dB
Input Characteristics							
V_{OS}	Input Offset Voltage	V_S = 30 V, V_{CM} = 15 V		−50		50	µV
			−40°C to 125°C	−70		70	µV
		V_S = 5 V, V_{CM} = 2.5 V		−50		50	µV
			−40°C to 125°C	−70		70	µV
V_{OS} TC	Input Offset Voltage Drift		−40°C to 125°C		0.01	0.2	µV/°C
I_B	Input Bias Current				100		pA
			−40°C to 125°C		100		pA
I_{OS}	Input Offset Current				100		pA
I_{IN}	Different Input Current	V_S = 36 V, V_{ID} = 36 V			10	100	µA
			−40°C to 125°C			120	µA
C_{IN}	Input Capacitance	Differential mode			5		pF
		Common mode			2.5		pF
A_V	Open-Loop Voltage Gain	R_{LOAD} = 10 kΩ, V_{OUT} = 0.5 V to 29.5 V		130	140		dB
			−40°C to 125°C	125			dB
V_{CMR}	Common-Mode Input Voltage Range			($-V_S$)		($+V_S$) – 1.5	V
CMRR	Common-Mode Rejection Ratio	V_{CM} = 0 V to 28.5 V		125	140		dB
			−40°C to 125°C	120			dB
Output Characteristics							
	Output Swing from Positive Rail	R_{LOAD} = 100 kΩ to V_S / 2			10	15	mV
			−40°C to 125°C			30	mV
		R_{LOAD} = 10 kΩ to V_S / 2			75	100	mV
			−40°C to 125°C			180	mV
		R_{LOAD} = 2 kΩ to V_S / 2			400	500	mV
			−40°C to 125°C			750	mV

Symbol	Parameter	Conditions	T_A	Min	Typ	Max	Unit
	Output Swing from Negative Rail	R_{LOAD} = 100 kΩ to V_S / 2			3	5	mV
			−40°C to 125°C			10	mV
		R_{LOAD} = 10 kΩ to V_S / 2			25	35	mV
			−40°C to 125°C			60	mV
		R_{LOAD} = 2 kΩ to V_S / 2			130	150	mV
			−40°C to 125°C			300	mV
I_{SC}	Output Short-Circuit Current	Source		60	95		mA
			−40°C to 85°C	40			mA
			−40°C to 125°C	35			mA
		Sink		130	150		mA
			−40°C to 85°C	100			mA
			−40°C to 125°C	85			mA
	Capacitive Load Drive				1		nF
AC Specifications							
GBW	Gain-Bandwidth Product				6		MHz
SR	Slew Rate	G = 1, 10-V step		3	5		V/µs
			−40°C to 125°C	2.2			V/µs
t_{OR}	Overload Recovery				500		ns
t_S	Settling Time, 0.1%	G = 1, 10-V step			7		µs
	Settling Time, 0.01%				12		µs
PM	Phase Margin	R_L = 10 kΩ, C_L = 100 pF			70		°
GM	Gain Margin	R_L = 10 kΩ, C_L = 100 pF			15		dB
Noise Performance							
E_N	Input Voltage Noise	f = 0.1 Hz to 10 Hz			0.1		µV_{PP}
e_N	Input Voltage Noise Density	f = 0.1 kHz			8		nV/√Hz
		f = 1 kHz			8		nV/√Hz
		f = 10 kHz			10		nV/√Hz
		f = 100 kHz			20		nV/√Hz
i_N	Input Current Noise	f = 10 kHz			200		fA/√Hz
THD+N	Total Harmonic Distortion and Noise	f = 1 kHz, G = 1, R_L = 10 kΩ, V_{OUT} = 6 V_{RMS}			0.0005		%

Typical Performance Characteristics

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

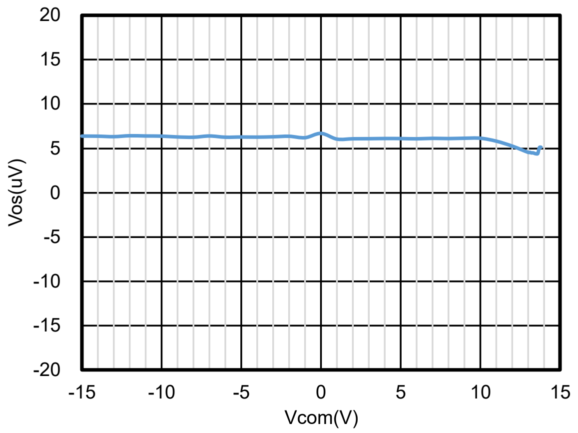


Figure 1. Offset Voltage vs. Common-Mode Voltage

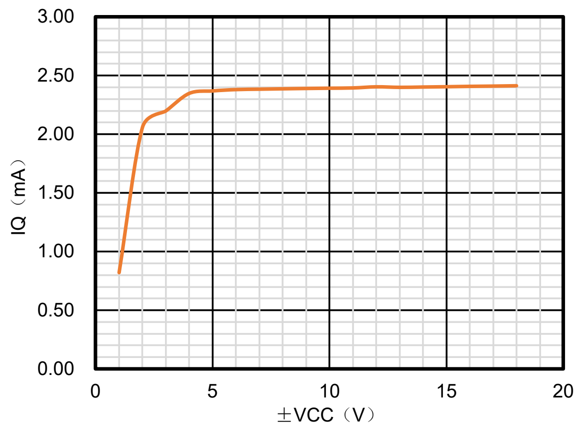


Figure 2. I_Q vs. Supply Voltage

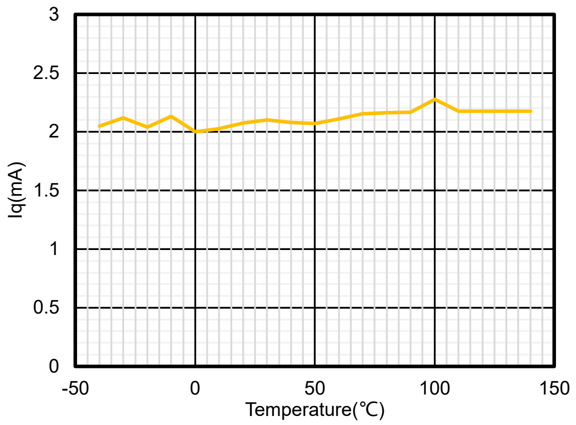


Figure 3. I_Q vs. Temperature, ±2.5-V Supply

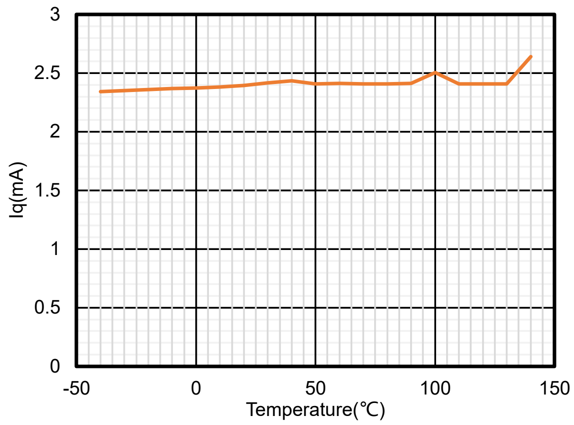


Figure 4. I_Q vs. Temperature, ±15-V Supply

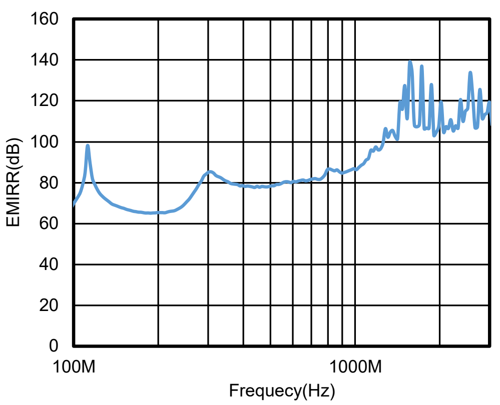


Figure 5. EMIRR vs. Frequency

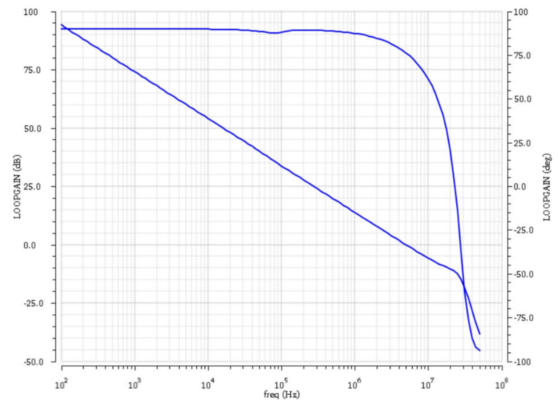


Figure 6. Open-Loop Gain and Phase vs. Frequency

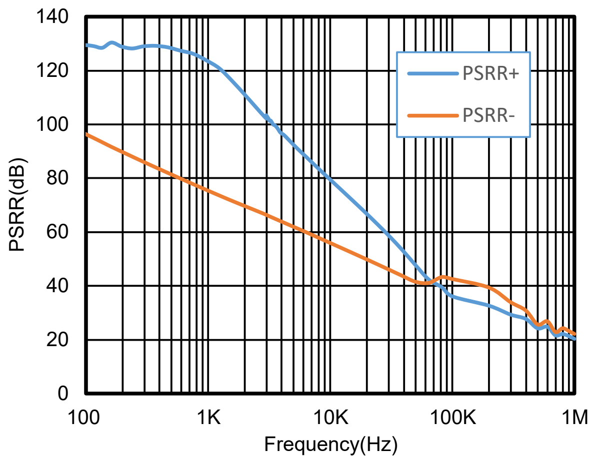


Figure 7. PSRR vs. Frequency

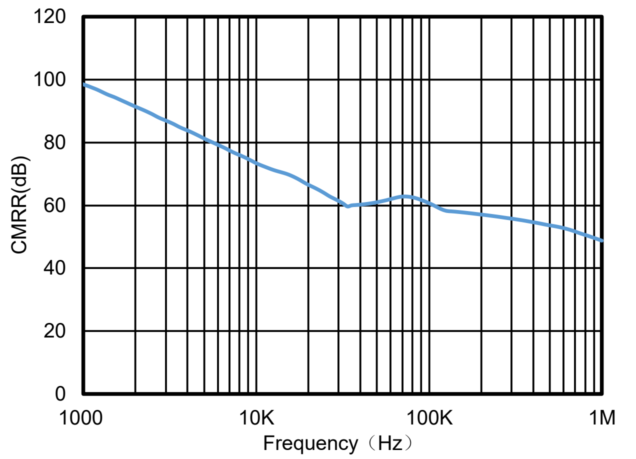
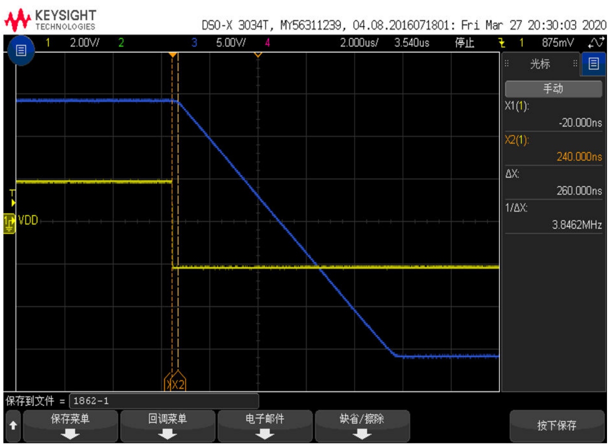


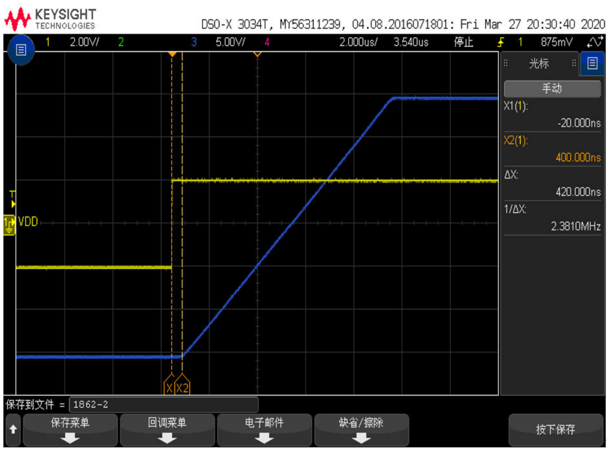
Figure 8. CMRR vs. Frequency



Time: 2 µs/div, Measure Time: 260 ns

R_L = 2 kΩ, C_L = 100 pF, G = 10

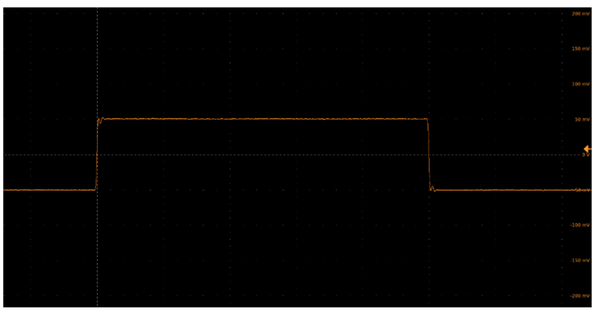
Figure 9. Positive Overload Recovery



Time: 2 µs/div, Measure Time: 420 ns

R_L = 2 kΩ, C_L = 100 pF, G = 10

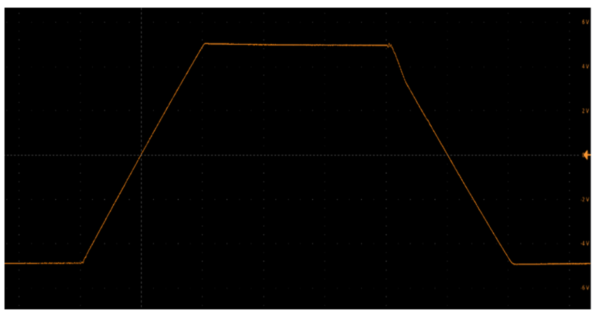
Figure 10. Negative Overload Recovery



Voltage: 50 mV/div, Time: 2 µs/div

R_L = 2 kΩ, C_L = 100 pF, G = 1

Figure 11. 100-mV Signal Step Response



Voltage: 2 V/div, Time: 2 µs/div

R_L = 2 kΩ, C_L = 100 pF, G = 1

Figure 12. 10-V Signal Step Response

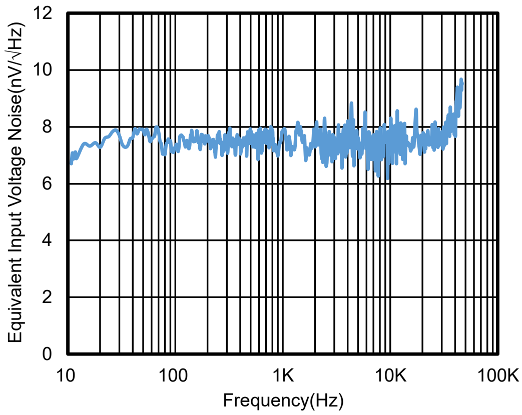


Figure 13. Voltage Noise Density vs. Frequency

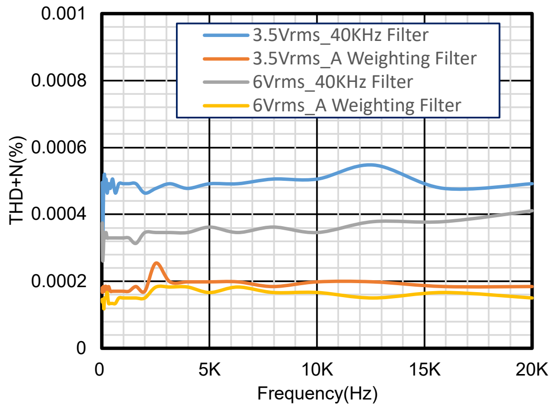


Figure 14. THD vs. Frequency, G = 1

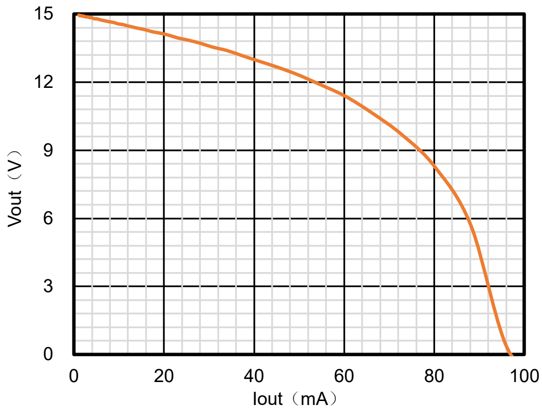


Figure 15. V_{OUT} vs. I_{OUT}, Source

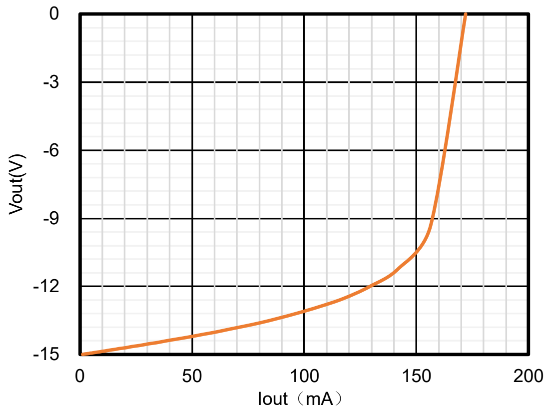
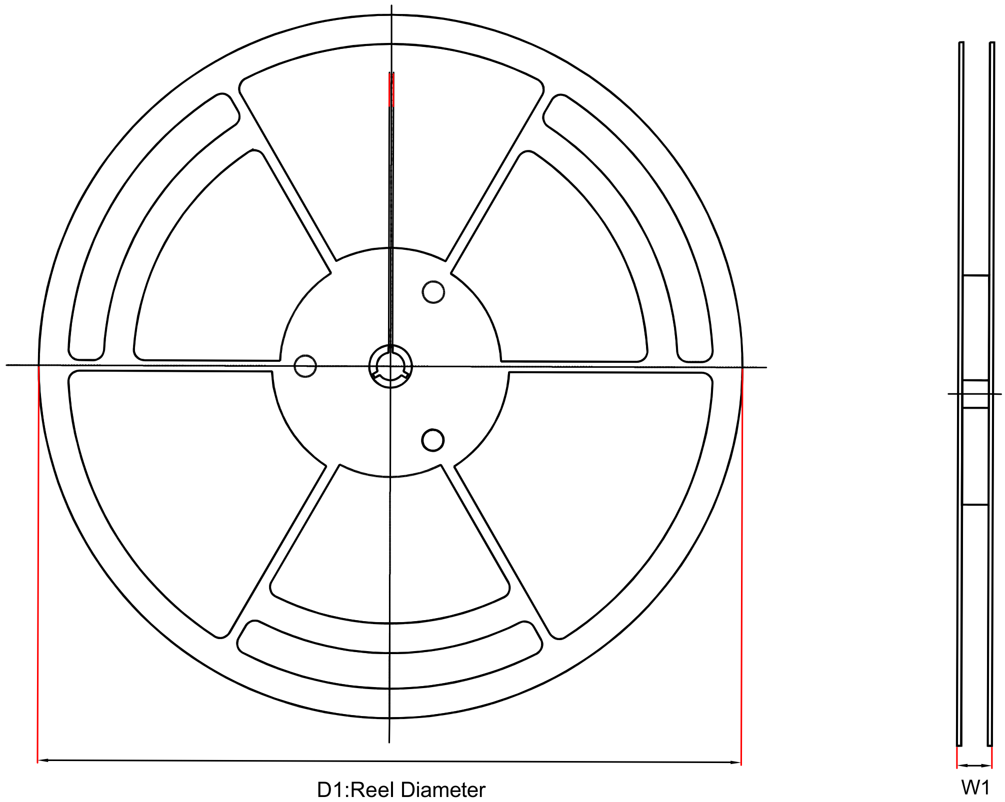
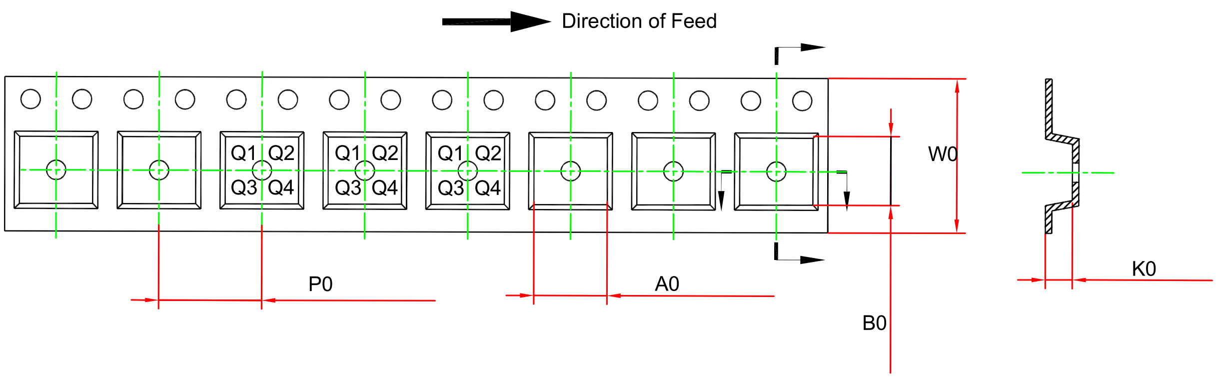


Figure 16. V_{OUT} vs. I_{OUT}, Sink

Tape and Reel Information





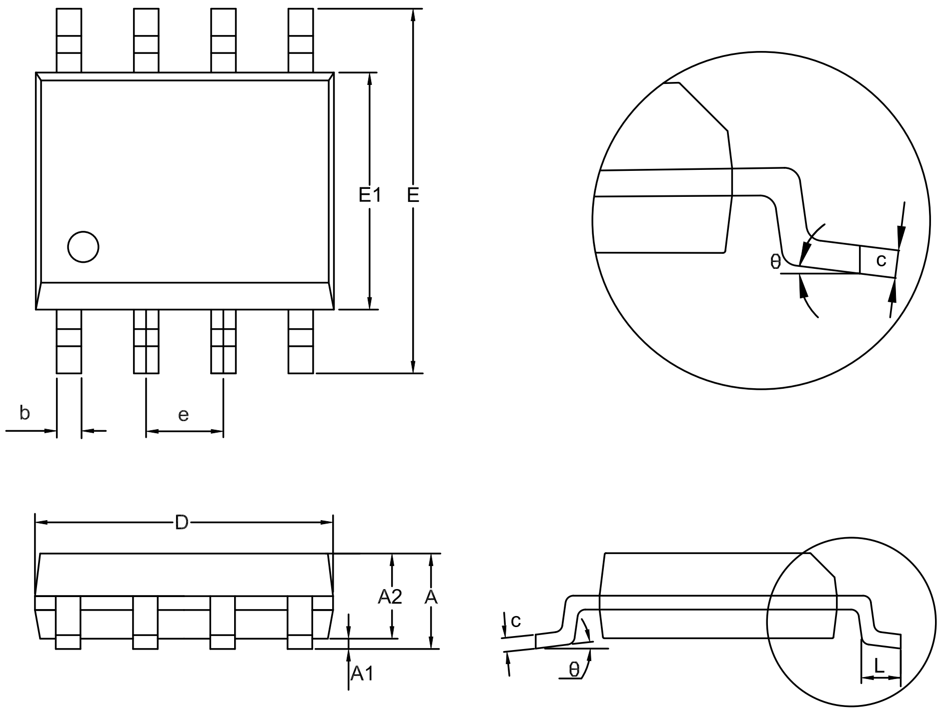
Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm) (1)	B0 (mm) (1)	K0 (mm) (1)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TP27-SR	SOP8	330.0	17.6	6.5	5.4	2.0	8.0	12.0	Q1

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

Package Outline Dimensions

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.

Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
TP27-SR	−40 to 125°C	SOP8	TP27	3	Tape and Reel, 4000	Green

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

IMPORTANT NOTICE AND DISCLAIMER

Performance Information. Performance tests or performance range contained in this document/material are either results of design simulation or actual tests conducted under designated testing environment. Any variation in testing environment or simulation environment, including but not limited to testing method, testing process or testing temperature, may affect actual performance of the product.

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