

Features

- Supply Voltage: 3.3 V to 5.25 V
- High Gain Bandwidth Product: 8 GHz
- High Slew Rate: 2700 V/ μ s
- Offset Voltage: ± 1.2 mV at 25 °C (Max)
- Stable when Gain > 7 V/V
- Quiescent Current: 19 mA
- Overload Recovery: 2.8 ns
- Package: DFN2X2-8
- Operating Temperature Range: -40°C to 125°C
- AEC-Q100 Qualified for Automotive Applications, Grade 1: -40°C to $+125^{\circ}\text{C}$ T_A

Applications

- Automotive Lidar
- Lab Equipment
- Automated Test Equipment
- OTDR
- Laser Distance Meter

Description

The TPH2861Q is a high-speed, low-noise operational amplifier with high-speed BJT inputs, suitable for broadband cross resistance and voltage amplifier applications.

The device with 8-GHz GBP can achieve enough closed-loop bandwidth even when the transimpedance is about several tens of k Ω in the wideband trans-impedance (TIA) applications.

The TPH2861Q also has a large-signal bandwidth of 850 MHz (2 V_{PP}), a slew rate of 2750 V/ μ s, and only 2.8 ns for overload recovery, making it suitable for high-speed pulse applications.

The feedback pin (FB) of the TPH2861Q decreases the distance of feedback network connection between the input and output on PCB, which benefits the achievement of high close-loop bandwidth.

The DFN2X2-8 package with wettable flanks is provided for the TPH2861Q, making the solder yield easy to be checked during the SMT.

Typical Application Circuit

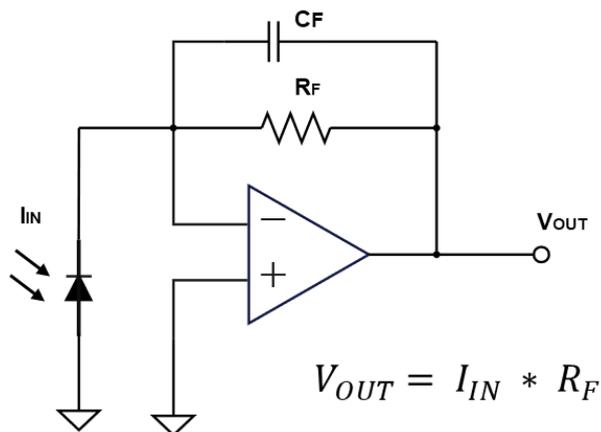


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Revision History

Date	Revision	Notes
2023-12-22	Rev.A.0	Initial version.
2023-12-29	Rev.A.1	The following updates are all about the new datasheet formats or typos, and the actual product remains unchanged. Updated HBM value.
2024-04-28	Rev.A.2	Modified the minimum spec of I_{SC} source in EC table from 45 to 55 mA. Added gain condition of Figure 2 in Typical Performance Characteristics.
2024-05-24	Rev.A.3	The following updates are all about the new datasheet formats or typos, and the actual product remains unchanged. Added PSRR specification in EC table. Updated the pin map.
2024-12-17	Rev.A.4	The following updates are all about the new datasheet formats or typos, and the actual product remains unchanged. <ul style="list-style-type: none">Updated the Tape and Reel Information.

Pin Configuration and Functions

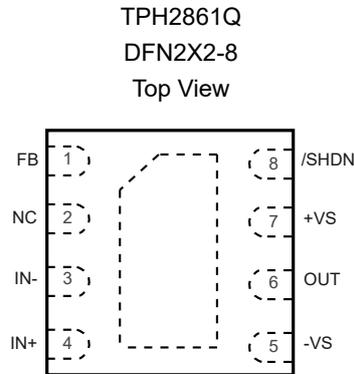


Table 1. Pin Functions: TPH2861Q

Pin No.	Name	I/O	Description
1	FB	I	Feedback connection to the output of the amplifier.
2	NC		No connection.
3	IN-	I	Inverting input.
4	IN+	I	Non-inverting input.
5	-V _S		Negative power supply.
6	OUT	O	Output.
7	+V _S		Positive power supply.
8	/SHDN	I	Shut down input. The device is shut down when the low-level input voltage is on the input; the device is active when the high-level input voltage is on the input. The device is active in default with an internal pull-up resistor.

Specifications

Absolute Maximum Ratings ⁽¹⁾

Parameter		Min	Max	Unit
	Supply Voltage, (+V _S) – (–V _S)		5.5	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: +I _N , –I _N ⁽²⁾	–1	1	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 are protected by ESD protection diodes to the 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 rating. This depends on the power dissipation of the application. Thermal resistance varies with the amount of PC board metal connected to the package.

ESD, Electrostatic Discharge Protection

Parameter		Condition	Level	Unit
HBM	Human Body Model ESD	AEC-Q100-002	2	kV
CDM	Charged Device Model ESD	AEC-Q100-011	1.5	kV

Recommended Operating Conditions

Parameter		Min	Typ	Max	Unit
V _S	Supply Voltage, (+V _S) – (–V _S)	3.3 (±1.65)		5.25 (±2.625)	V
T _A	Operating Temperature Range	–40		125	°C

Thermal Information

Package Type	θ _{JA}	θ _{Jc}	Unit
DFN2X2-8	100	60	°C/W

Electrical Characteristics

All test conditions: $V_S = 5\text{ V}$, $V_{CM} = 2.5\text{ V}$, $T_A = 25^\circ\text{C}$, $G = 7\text{ V/V}$, input common-mode biased at mid-supply, unless otherwise noted.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Power Supply						
V_S	Supply Voltage Range		3.3		5.25	V
I_Q	Quiescent Current per Amplifier			19	24	mA
		$T_A = -40^\circ\text{C to } 125^\circ\text{C}$			27	mA
PSRR+	Positive Power-Supply Rejection Ratio		80	87		dB
		$T_A = -40^\circ\text{C to } 125^\circ\text{C}$	72			dB
PSRR-	Negative Power-Supply Rejection Ratio		63	71		dB
		$T_A = -40^\circ\text{C to } 125^\circ\text{C}$	60			dB
Input Characteristics						
V_{OS}	Input Offset Voltage		-1.8	0.2	1.8	mV
		$T_A = -40^\circ\text{C to } 125^\circ\text{C}$	-2.5		2.5	mV
V_{OSTC}	Input Offset Voltage Drift	$T_A = -40^\circ\text{C to } 125^\circ\text{C}$		2		$\mu\text{V}/^\circ\text{C}$
I_B	Input Bias Current		-45	-23	-6	μA
I_{OS}	Input Offset Current		-4	-1	-4	μA
C_{IN}	Input Capacitance	Differential mode		0.5		pF
		Common mode		0.6		pF
R_{IN}	Input Resistance	Differential mode		4		k Ω
		Common mode		0.3		M Ω
A_V	Open-Loop Voltage Gain		64	70		dB
V_{IH}	Common-Mode Input Range (High)		4.4	4.6		V
		$T_A = -40^\circ\text{C to } 125^\circ\text{C}$		4.3		V
V_{IL}	Common-Mode Input Range (Low)			1.1	1.3	V
		$T_A = -40^\circ\text{C to } 125^\circ\text{C}$		1.3		V
CMRR	Common-Mode Rejection Ratio	$V_{CM} = \pm 0.5\text{ V}$ referred to midsupply	75	123		dB

5-V, G = 7 Stable, 8-GHz, High-Speed Op Amp
Electrical Characteristics (Continued)

 All test conditions: $V_S = 5\text{ V}$, $T_A = 25^\circ\text{C}$, $R_L = 10\text{ k}\Omega$, unless otherwise noted.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Output Characteristics						
	Output Voltage Swing from Positive Rail	$I_{OUT} = 10\text{ mA}$		0.9	1.1	V
		$I_{OUT} = 10\text{ mA}$, $T_A = -40^\circ\text{C}$ to 125°C			1.2	V
		$V_S = 3.3\text{ V}$, $I_{OUT} = 10\text{ mA}$		0.9	1.1	V
		$V_S = 3.3\text{ V}$, $I_{OUT} = 10\text{ mA}$, $T_A = -40^\circ\text{C}$ to 125°C			1.2	V
	Output Voltage Swing from Negative Rail	$I_{OUT} = 10\text{ mA}$		1.05	1.15	V
		$I_{OUT} = 10\text{ mA}$, $T_A = -40^\circ\text{C}$ to 125°C			1.2	V
		$V_S = 3.3\text{ V}$, $I_{OUT} = 10\text{ mA}$		1.05	1.15	V
		$V_S = 3.3\text{ V}$, $I_{OUT} = 10\text{ mA}$, $T_A = -40^\circ\text{C}$ to 125°C			1.2	V
I_{SC}	Output Short-Circuit Current	$V_S = 5\text{ V}$, source	55	85		mA
		$V_S = 5\text{ V}$, sink	55	120		mA
AC Specifications						
SSBW	Small-Signal Bandwidth	$V_{OUT} = 100\text{ mV}_{PP}$		2.3		GHz
LSBW	Large-Signal Bandwidth	$V_{OUT} = 2\text{ V}_{PP}$		866		MHz
GBW	Gain-Bandwidth Product			8		GHz
SR	Slew Rate	$V_{OUT} = 3\text{-V step}$		2700		V/ μs
t_{OR}	Overload Recovery	2x output overdrive		2.8		ns
t_s	Settling Time, 0.1%			3.2		ns
	Settling Time, 0.001%			2600		ns
Noise Performance						
e_N	Input Voltage Noise Density	$f = 1\text{ MHz}$, $V_{CM} = 1\text{ V}$		1.1		nV/ $\sqrt{\text{Hz}}$
i_N	Input Current Noise	$f = 1\text{ MHz}$		3.1		pA/ $\sqrt{\text{Hz}}$
HD2	Second-Order Harmonic Distortion	$f = 10\text{ MHz}$, $V_{OUT} = 2\text{ V}_{PP}$		83		dBc
		$f = 100\text{ MHz}$, $V_{OUT} = 2\text{ V}_{PP}$		65		dBc
HD3	Third-Order Harmonic Distortion	$f = 10\text{ MHz}$, $V_{OUT} = 2\text{ V}_{PP}$		86		dBc
		$f = 100\text{ MHz}$, $V_{OUT} = 2\text{ V}_{PP}$		74		dBc
PD Performance						
	Disable Voltage Threshold	Amplifier OFF below this voltage	0.8	0.9		V
		Amplifier OFF below this voltage, $T_A = -40^\circ\text{C}$ to 125°C	0.7			V
	Enable Voltage Threshold	Amplifier ON above this voltage		1.1	1.2	V

5-V, G = 7 Stable, 8-GHz, High-Speed Op Amp

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
		Amplifier ON above this voltage, $T_A = -40^{\circ}\text{C}$ to 125°C			1.3	V
	Power-down Quiescent Current			224	255	μA
	Input PD bias Current			67	77	μA
		$T_A = -40^{\circ}\text{C}$ to 125°C			82	μA
	Turn-on Time Delay	Time to $V_{\text{OUT}} = 90\%$ of final value		17		ns
	Turn-off Time Delay			86		ns

5-V, G = 7 Stable, 8-GHz, High-Speed Op Amp

Typical Performance Characteristics

All test conditions: $T_A = 25^\circ\text{C}$, $+V_S = 2.5\text{ V}$, $-V_S = -2.5\text{ V}$, $V_{IN+} = 0\text{ V}$, $R_F = 453\ \Omega$, Gain = 7 V/V, $R_L = 200\ \Omega$, and output load referenced to midsupply, unless otherwise noted.

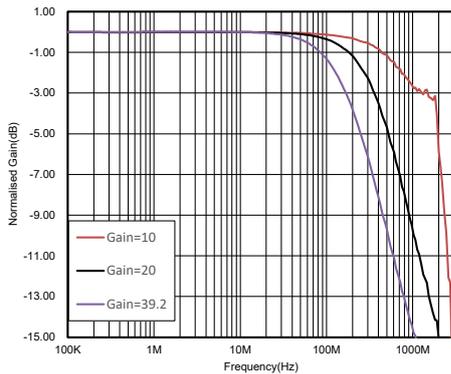
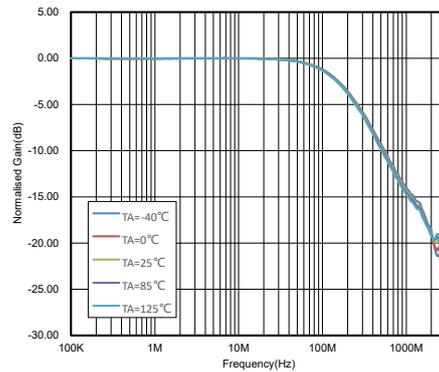


Figure 1. Small-Signal Frequency Response vs. Gain



Gain = 39.2 V/V

Figure 2. Small-Signal Frequency Response vs. Ambient Temperature

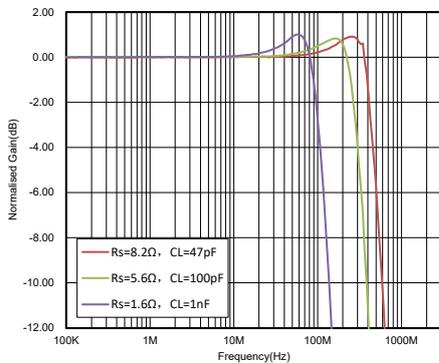


Figure 3. Small-Signal Frequency Response vs. Capacitive Load

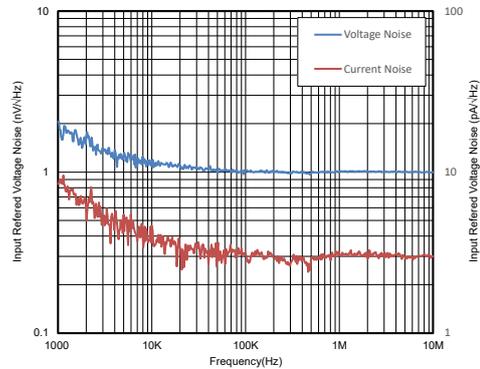


Figure 4. Voltage and Current Noise Density vs. Frequency

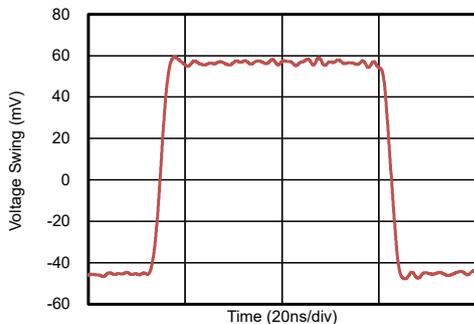


Figure 5. Small-Signal Transient Response

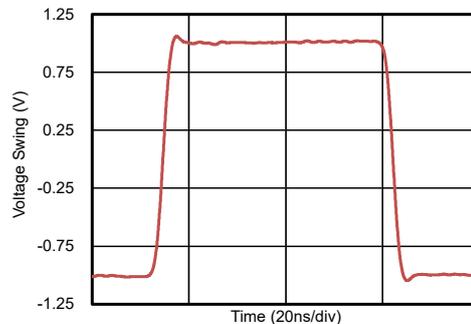


Figure 6. Large-Signal Transient Response

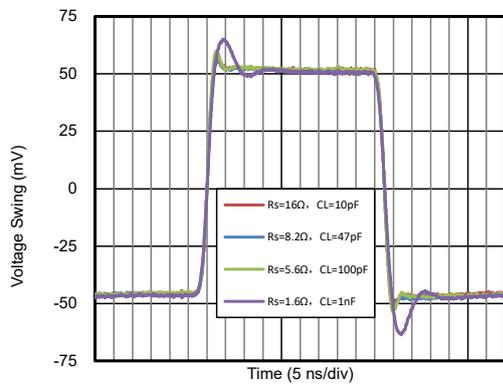


Figure 7. Small-Signal Transient Response vs. Capacitive Load

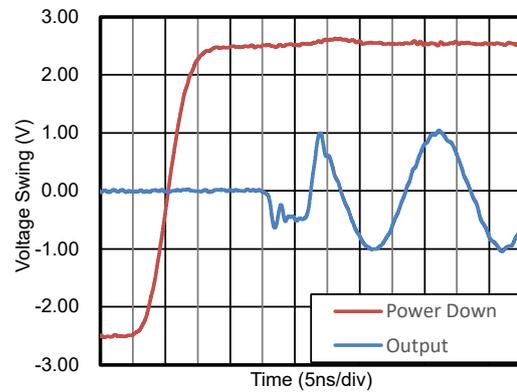


Figure 8. Turn-on Transient Response

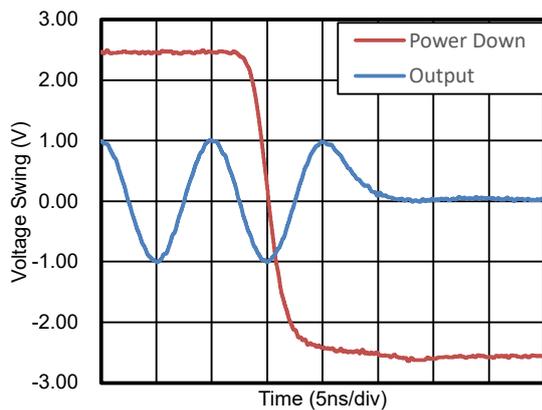


Figure 9. Turn-off Transient Response

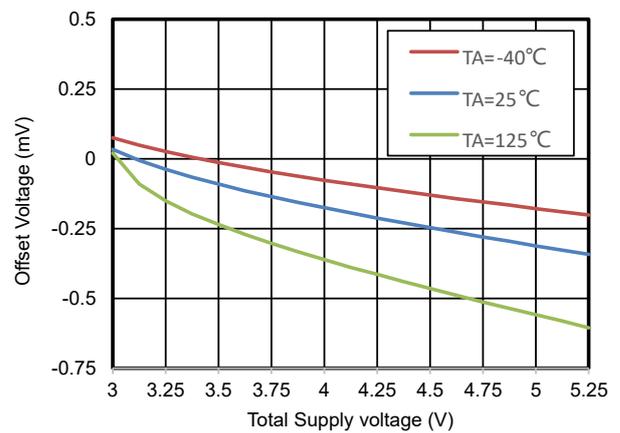


Figure 10. Offset Voltage vs. Supply Voltage

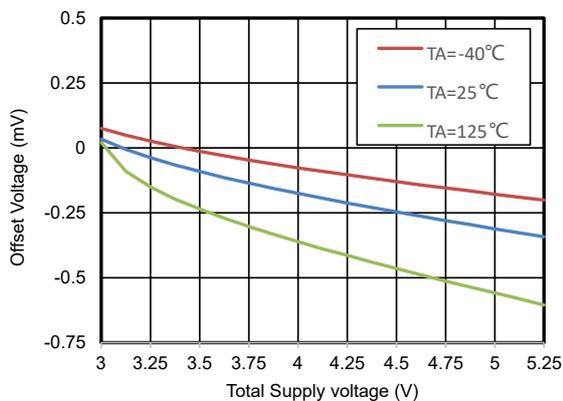


Figure 11. Offset Voltage vs. Input Common-Mode Voltage

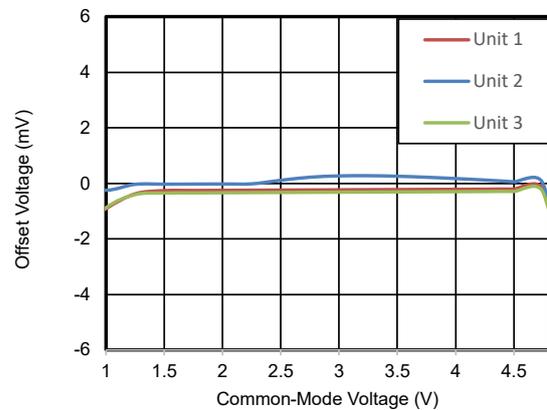


Figure 12. Offset Voltage vs. Input Common-Mode Voltage

5-V, G = 7 Stable, 8-GHz, High-Speed Op Amp

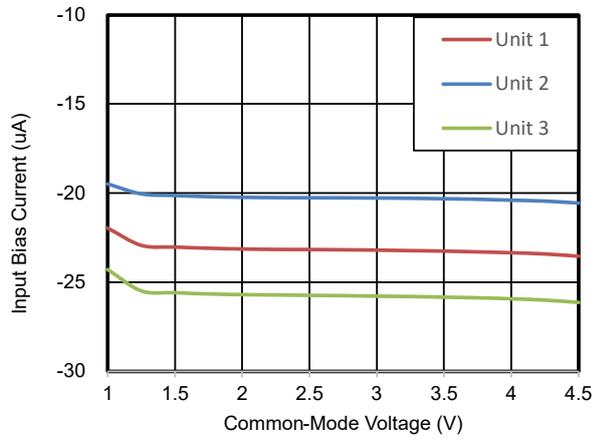


Figure 13. Input Bias Current vs. Input Common-Mode Voltage

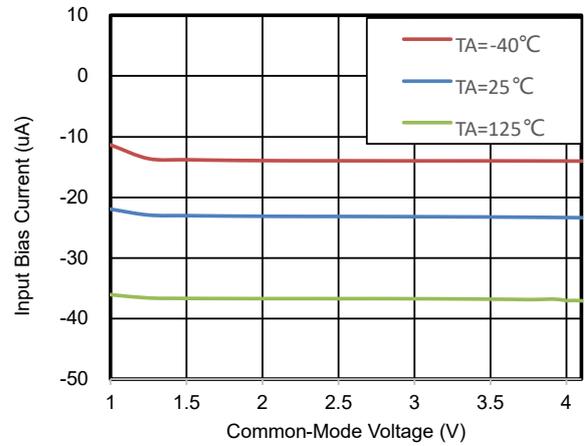


Figure 14. Input Bias Current vs. Input Common-Mode Voltage

Detailed Description

Overview

The TPH2861Q is a BJT, high-speed, voltage-feedback operational amplifier designed for high-speed pulse, high-speed data acquisition systems, and other applications. It is available as a single op amp. The amplifier features an 8-GHz gain bandwidth, a 2700-V/ μ s slew rate, and a broad voltage noise of 1.1 nV/ $\sqrt{\text{Hz}}$. Although it is not unity-gain stable, it can be stable when the gain is larger than 7 V/V. The TPH2861Q has a power-supply range from +3.3 V to +5.25 V (± 1.65 V to ± 2.625 V).

Functional Block Diagram

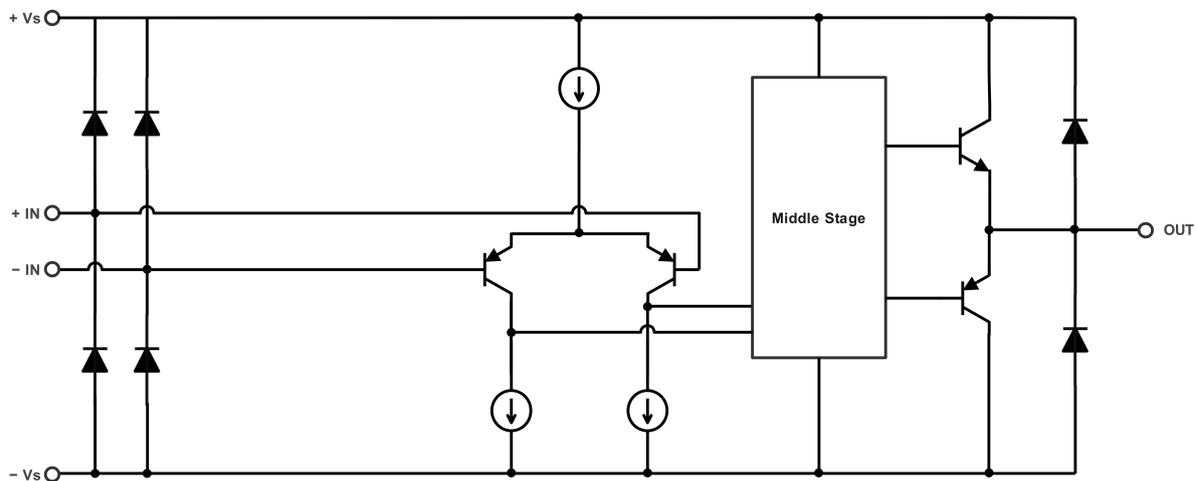


Figure 15. Functional Block Diagram

Feature Description

Operating Voltage

The TPH2861Q is designed for single-supply operation from 3.3 V to 5.25 V, and dual-supply operation from ± 1.65 V to ± 2.625 V.

Application and Implementation

Note

Information in the following application sections is not part of the 3PEAK's component specification and 3PEAK does not warrant its accuracy or completeness. 3PEAK's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

Application Information

Trans-Impedance Amplifier Application

Figure 16 shows the TPH2861Q is configured in a trans-impedance amplifier application. Trans-impedance amplifier (TIA) is a current-to-voltage converter. In the circuit shown in Figure 16, the current source (shown as a photodiode) is connected between ground and the inverting input of the op amp. The other input of the op amp is also connected to ground. This provides a low-impedance load for the photodiode, which keeps the photodiode voltage low. The current of the photodiode is equal to the feedback current through R_F due to the high gain of the op amp. The DC gain of a trans-impedance amplifier is determined by the equation shown in Figure 16. C_F is used to maintain the stability of the whole circuit via creating a zero.

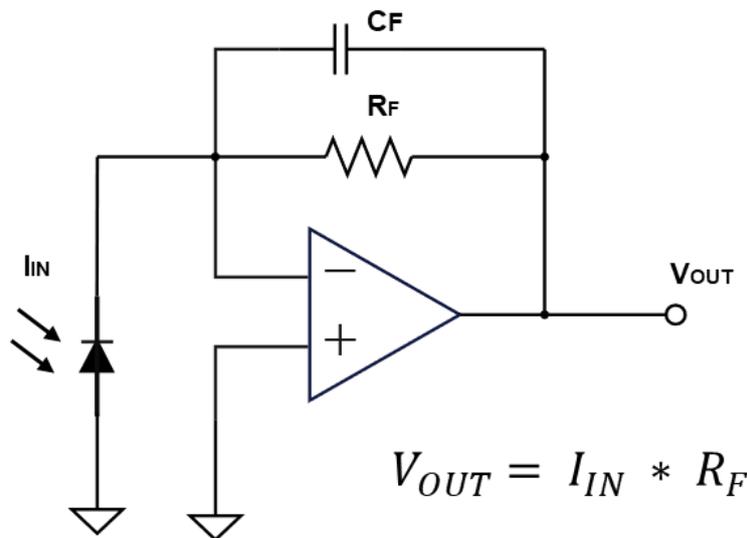


Figure 16. TIA (Trans-Impedance Amplifier) Application

Power Supply Recommendations

Place 0.1- μ F bypass capacitors close to the power supply pins for reducing coupling errors from the noise or high-impedance power supplies.

Typical Application

Figure 17 shows the typical application schematic.

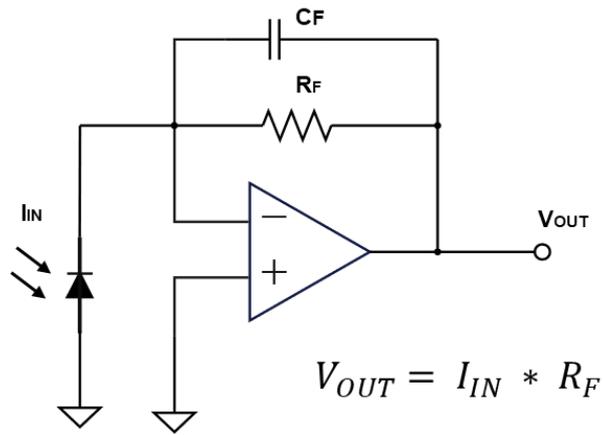
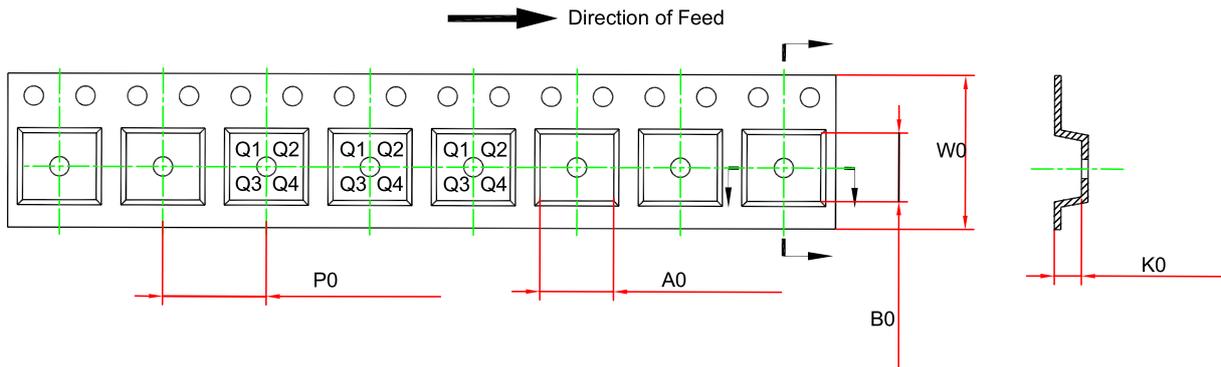
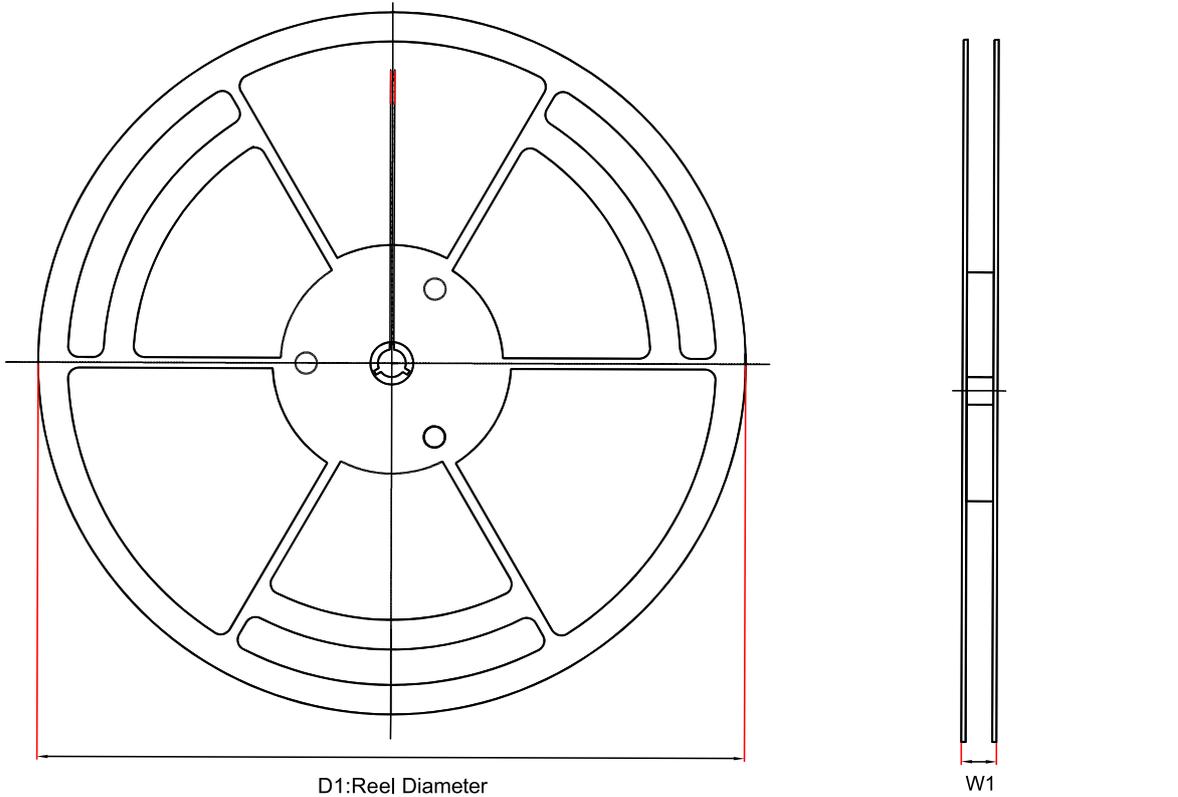


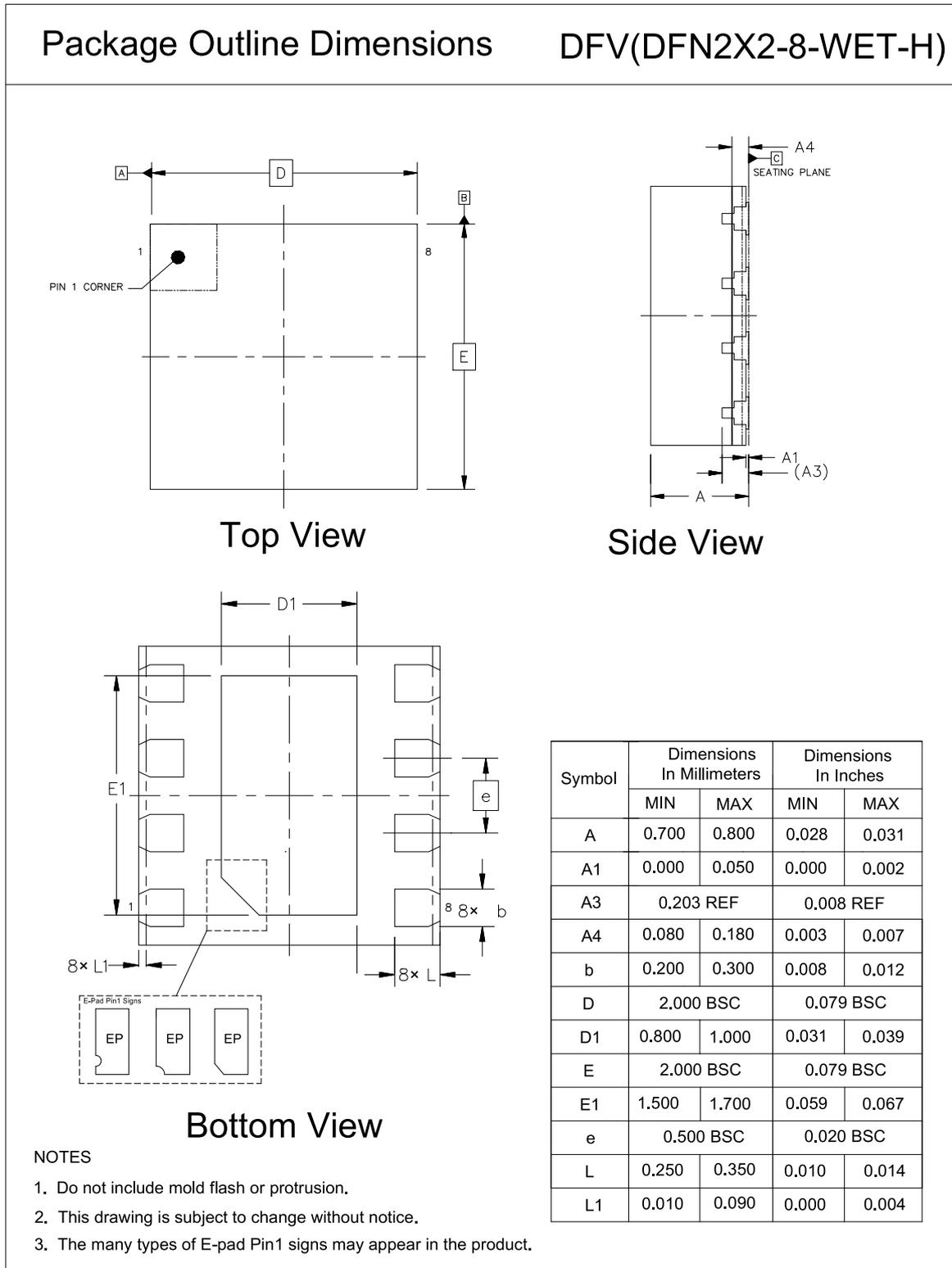
Figure 17. Typical Application Circuit

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
TPH2861Q-DFVR-S	DFN2X2-8	180	12.5	2.3	2.3	1.1	4	8	Q2

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

Package Outline Dimensions
DFN2X2-8


Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
TPH2861Q-DFVR-S	-40 to 125°C	DFN2X2-8	A28	2	Tape and Reel, 3000	Green

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

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