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

Features

- Supply Voltage: 3.3 V to 5.25 V
- High Gain Bandwidth Product: 8 GHz
- High Slew Rate: 2700 V/μs
- 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°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 kΩ 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/μs, 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 the feedback network connection between the input and output on the PCB, which benefits the achievement of high closed-loop bandwidth.

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

Typical Application Circuit

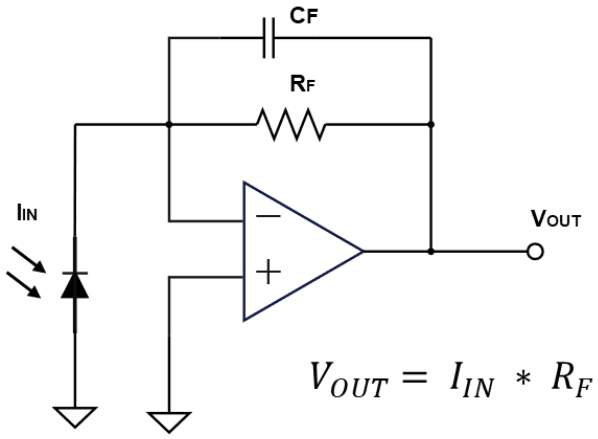


Table of Contents

Features 1
Applications 1
Description 1
Typical Application Circuit 1
Revision History 3
Pin Configuration and Functions 4
Specifications 5
Absolute Maximum Ratings (1) 5
ESD, Electrostatic Discharge Protection 5
Recommended Operating Conditions 5
Thermal Information 5
Electrical Characteristics 6
Electrical Characteristics (Continued) 7
Typical Performance Characteristics 9
Detailed Description 12
Overview 12
Functional Block Diagram 12
Feature Description 12
Application and Implementation 13
Application Information 13
Typical Application 14
Tape and Reel Information 15
Package Outline Dimensions 16
DFN2X2-8 16
Order Information 17
IMPORTANT NOTICE AND DISCLAIMER 18

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 the gain condition of Figure 2 in the 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 to the 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. • Updated the Tape and Reel Information.
2025-04-11	Rev.A.5	Modified the maximum spec of I_{OS} in EC table from −4 to 4 μA.
2025-11-27	Rev.A.6	Added the thermal pad description in the Pin Configuration and Functions. Corrected typos in Typical Performance Characteristics. The actual product remains unchanged.

Pin Configuration and Functions

TPH2861Q
DFN2X2-8
Top View

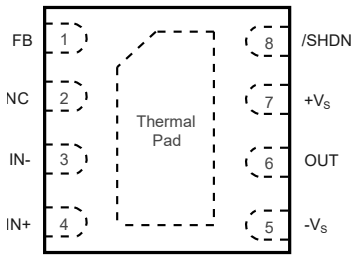


Table 1. Pin Functions: TPH2861Q

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 by default with an internal pull-up resistor.
	Thermal Pad		The thermal pad of the DFN2X2-8 is recommended to be left float or connected to $-V_S$.

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: +IN, –IN (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 V, V_{CM} = 2.5 V, T_A = 25°C, G = 7 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°C to 125°C			27	mA
PSRR+	Positive Power-Supply Rejection Ratio		80	87		dB
		T_A = −40°C to 125°C	72			dB
PSRR−	Negative Power-Supply Rejection Ratio		63	71		dB
		T_A = −40°C to 125°C	60			dB
Input Characteristics						
V_{OS}	Input Offset Voltage		−1.8	0.2	1.8	mV
		T_A = −40°C to 125°C	−2.5		2.5	mV
$V_{OS}TC$	Input Offset Voltage Drift	T_A = −40°C to 125°C		2		μV/°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		kΩ
		Common mode		0.3		MΩ
A_V	Open-Loop Voltage Gain		64	70		dB
V_{IH}	Common-Mode Input Range (High)		4.4	4.6		V
		T_A = −40°C to 125°C		4.3		V
V_{IL}	Common-Mode Input Range (Low)			1.1	1.3	V
		T_A = −40°C to 125°C		1.3		V
CMRR	Common-Mode Rejection Ratio	V_{CM} = ±0.5 V referred to midsupply	75	123		dB

Electrical Characteristics (Continued)

All test conditions: V_S = 5 V, T_A = 25°C, R_L = 10 kΩ, unless otherwise noted.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Output Characteristics						
	Output Voltage Swing from Positive Rail	I_{OUT} = 10 mA		0.9	1.1	V
		I_{OUT} = 10 mA, T_A = −40°C to 125°C			1.2	V
		V_S = 3.3 V, I_{OUT} = 10 mA		0.9	1.1	V
		V_S = 3.3 V, I_{OUT} = 10 mA, T_A = −40°C to 125°C			1.2	V
	Output Voltage Swing from Negative Rail	I_{OUT} = 10 mA		1.05	1.15	V
		I_{OUT} = 10 mA, T_A = −40°C to 125°C			1.2	V
		V_S = 3.3 V, I_{OUT} = 10 mA		1.05	1.15	V
		V_S = 3.3 V, I_{OUT} = 10 mA, T_A = −40°C to 125°C			1.2	V
I_{SC}	Output Short-Circuit Current	V_S = 5 V, source	55	85		mA
		V_S = 5 V, sink	55	120		mA
AC Specifications						
SSBW	Small-Signal Bandwidth	V_{OUT} = 100 mV_{PP}		2.3		GHz
LSBW	Large-Signal Bandwidth	V_{OUT} = 2 V_{PP}		866		MHz
GBW	Gain-Bandwidth Product			8		GHz
SR	Slew Rate	V_{OUT} = 3-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 MHz, V_{CM} = 1 V		1.1		nV/√Hz
i_N	Input Current Noise	f = 1 MHz		3.1		pA/√Hz
HD2	Second-Order Harmonic Distortion	f = 10 MHz, V_{OUT} = 2 V_{PP}		83		dBc
		f = 100 MHz, V_{OUT} = 2 V_{PP}		65		dBc
HD3	Third-Order Harmonic Distortion	f = 10 MHz, V_{OUT} = 2 V_{PP}		86		dBc
		f = 100 MHz, V_{OUT} = 2 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°C to 125°C	0.7			V
	Enable Voltage Threshold	Amplifier ON above this voltage		1.1	1.2	V

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

Typical Performance Characteristics

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

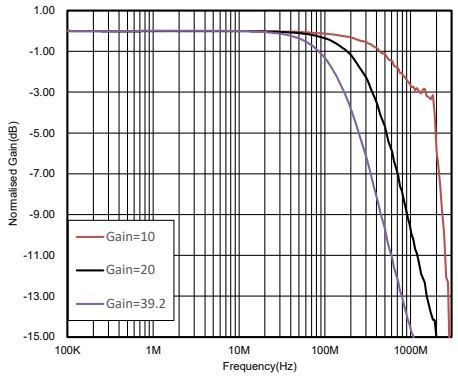
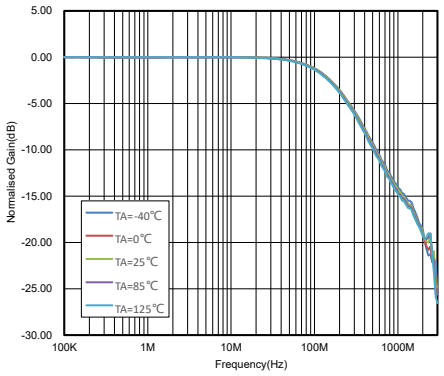


Figure 1. Small-Signal Frequency Response vs. Gain



Gain = 39.2 V/V

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

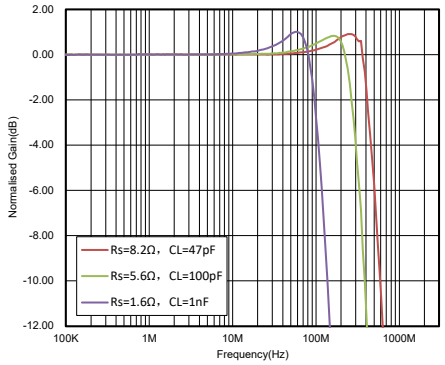


Figure 3. Small-Signal Frequency Response vs. Capacitive Load

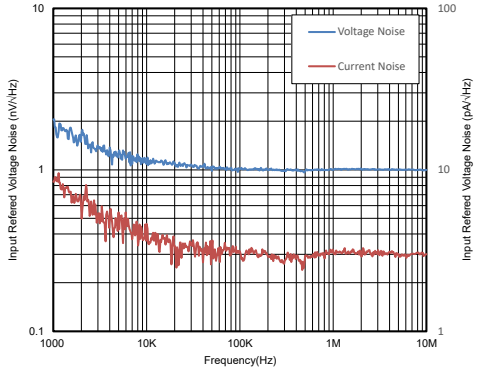


Figure 4. Voltage and Current Noise Density vs. Frequency

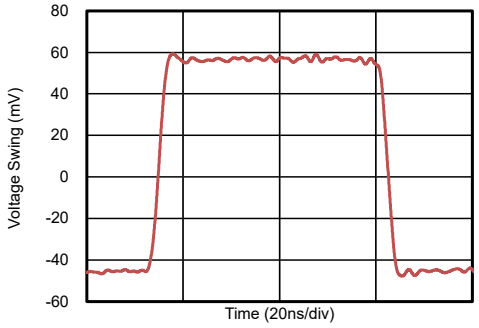


Figure 5. Small-Signal Transient Response

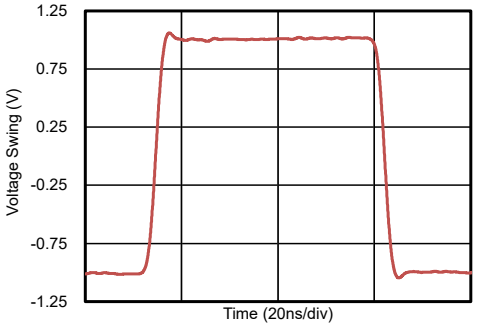


Figure 6. Large-Signal Transient Response

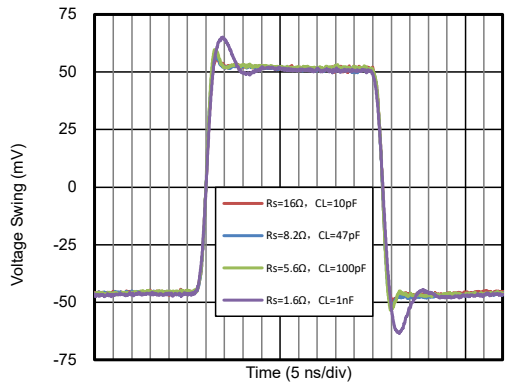


Figure 7. Small-Signal Transient Response vs. Capacitive Load

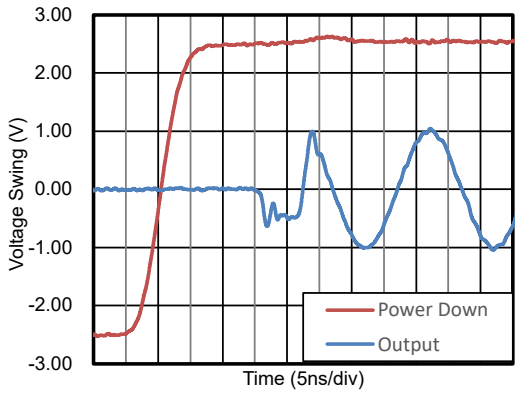


Figure 8. Turn-on Transient Response

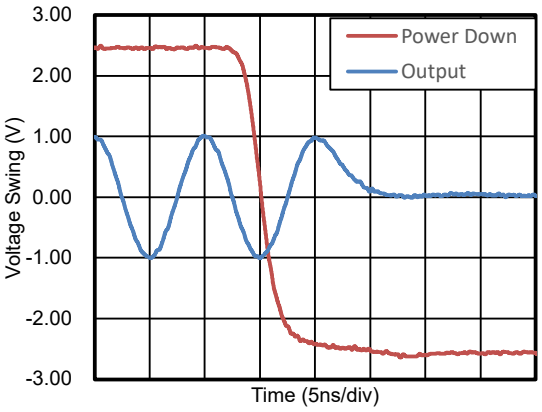


Figure 9. Turn-off Transient Response

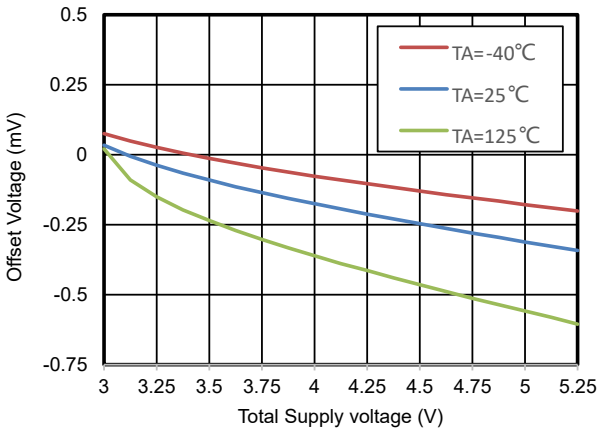


Figure 10. Offset Voltage vs. Supply Voltage

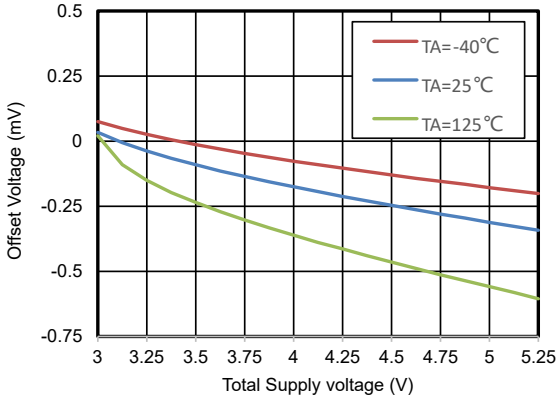


Figure 11. Offset Voltage vs. Total Supply Voltage

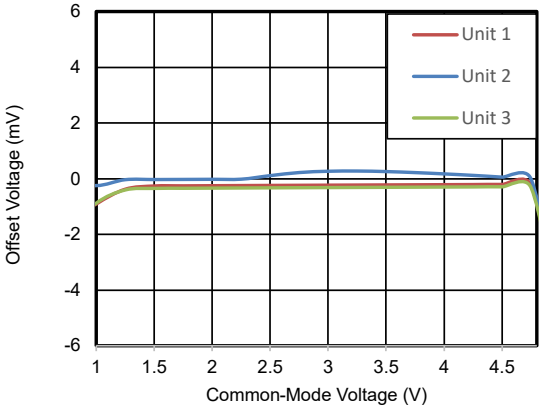


Figure 12. Offset Voltage vs. Input Common-Mode Voltage

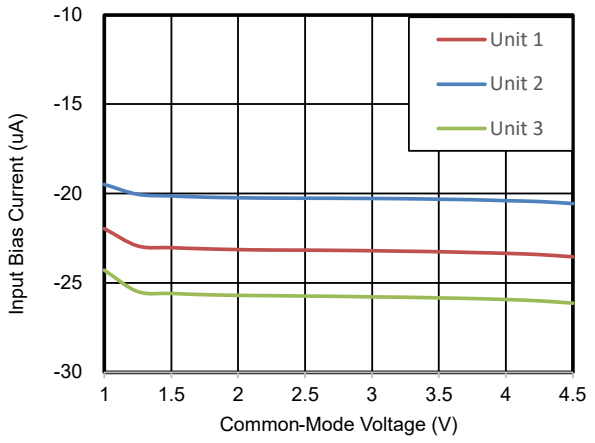


Figure 13. Input Bias Current vs. Input Common-Mode Voltage

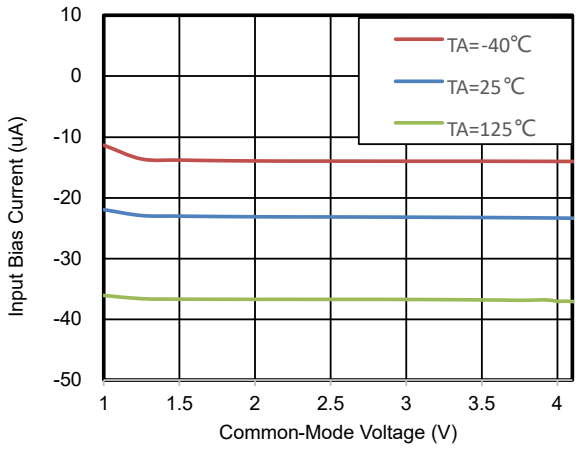


Figure 14. Input Bias Current vs. Input Common-Mode Voltage

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/μs slew rate, and a broad voltage noise of 1.1 nV/$\sqrt{Hz}$. 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

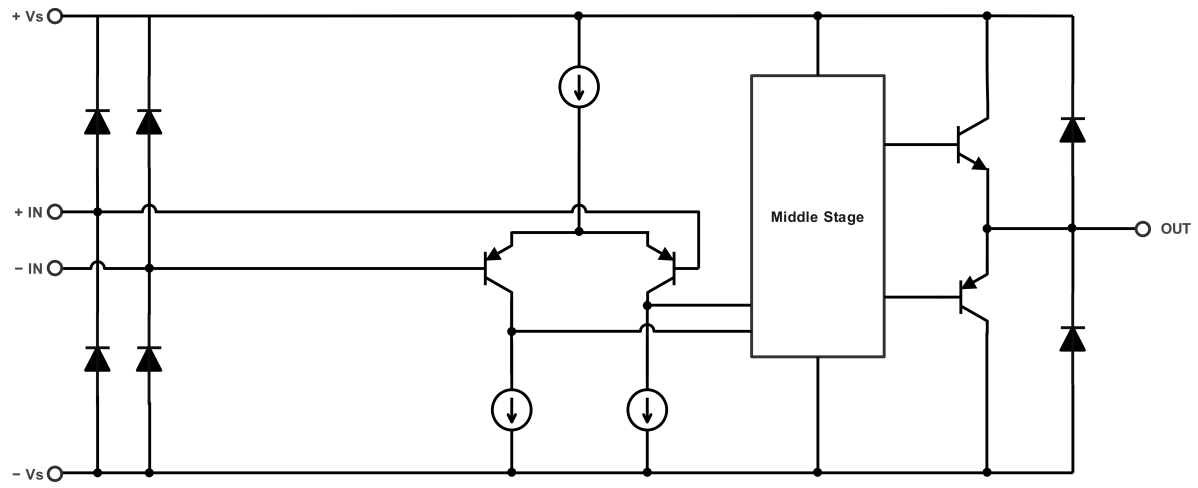


Figure 15. Functional Block Diagram

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 that 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.

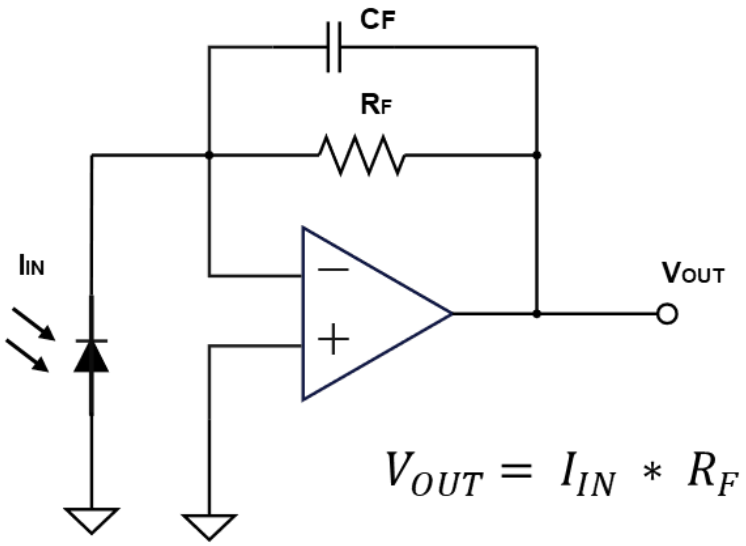


Figure 16. TIA (Trans-Impedance Amplifier) Application

Power Supply Recommendations

Place 0.1-μF bypass capacitors close to the power supply pins to reduce coupling errors from the noise or high-impedance power supplies.

Typical Application

Figure 17 shows the typical application schematic.

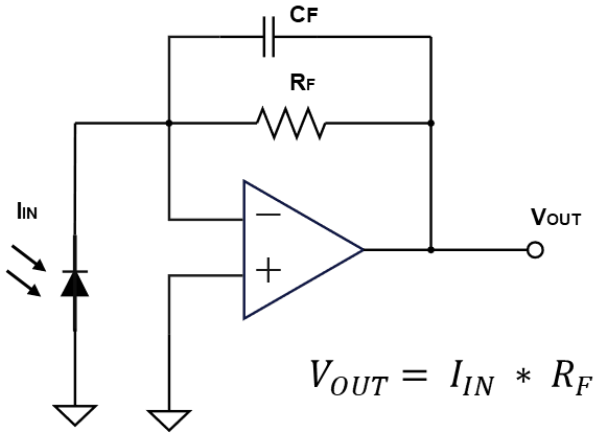
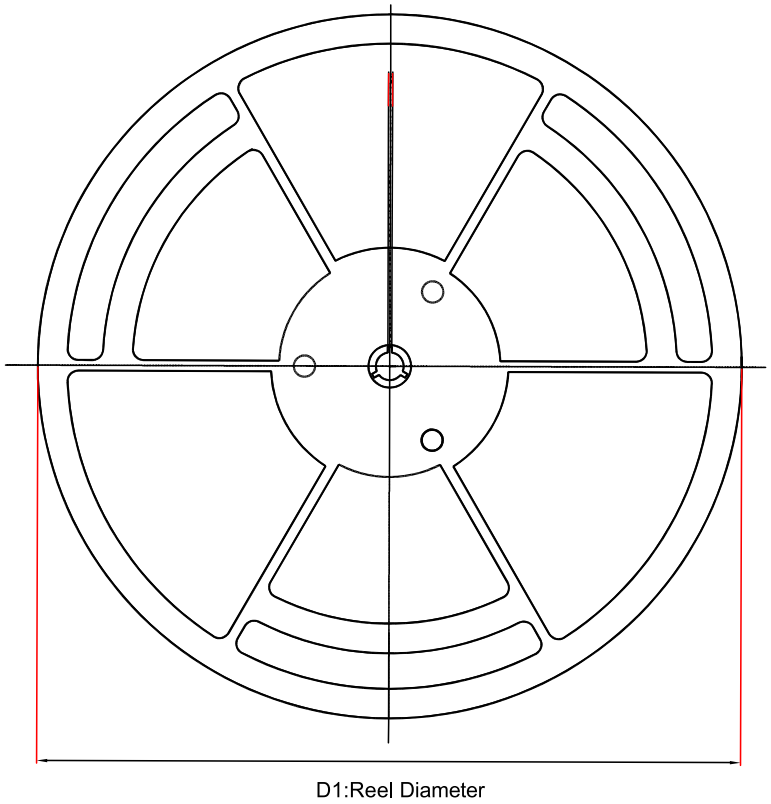
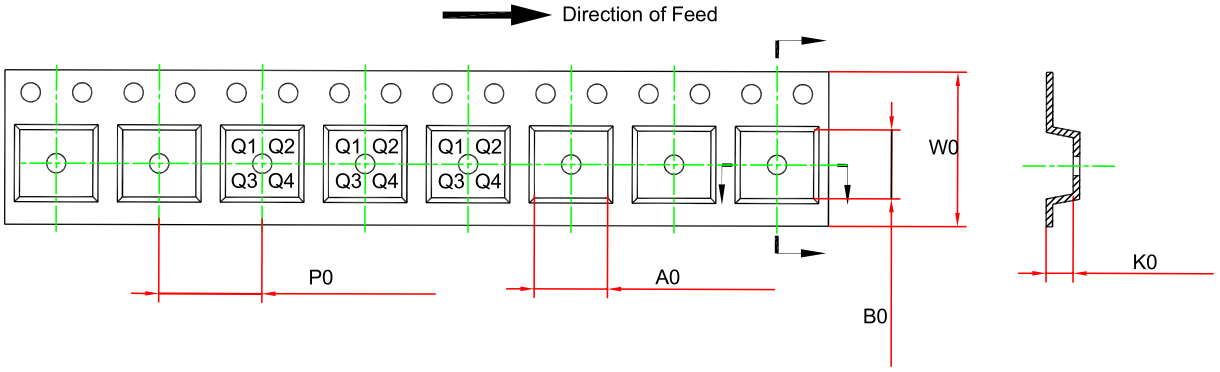


Figure 17. Typical Application Circuit

Tape and Reel Information





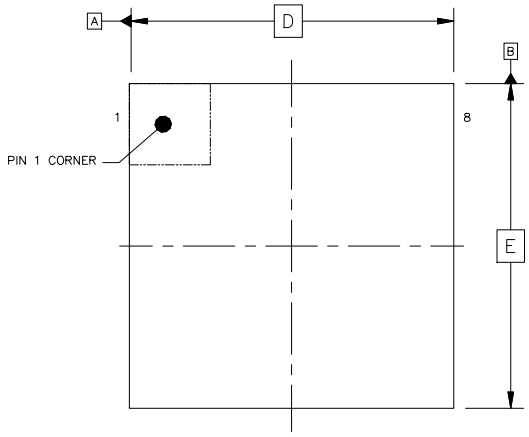
Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm) (1)	B0 (mm) (1)	K0 (mm) (1)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPH2861Q-DFVR-S	DFN2X2-8	180	12.5	2.3	2.3	1.1	4	8	Q2

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

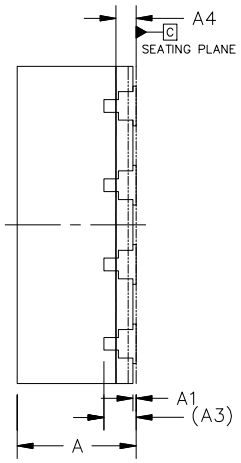
Package Outline Dimensions

DFN2X2-8

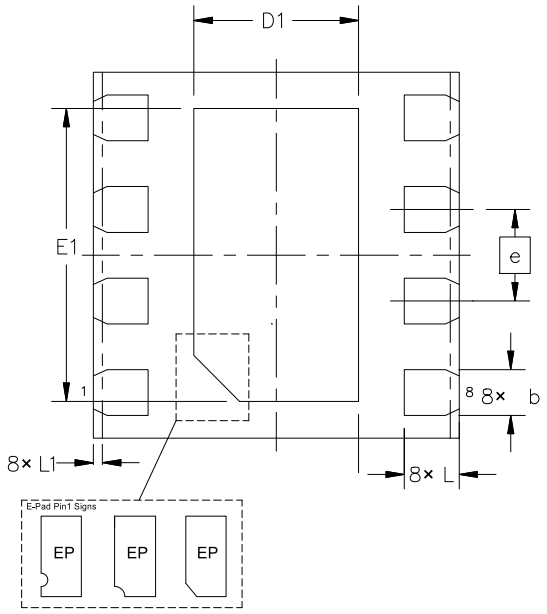
Package Outline Dimensions DFV(DFN2X2-8-WET-H)



Top View



Side View



Bottom View

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A3	0.203 REF		0.008 REF	
A4	0.080	0.180	0.003	0.007
b	0.200	0.300	0.008	0.012
D	2.000 BSC		0.079 BSC	
D1	0.800	1.000	0.031	0.039
E	2.000 BSC		0.079 BSC	
E1	1.500	1.700	0.059	0.067
e	0.500 BSC		0.020 BSC	
L	0.250	0.350	0.010	0.014
L1	0.010	0.090	0.000	0.004

NOTES

1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.
3. The many types of E-pad Pin1 signs may appear in the product.

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.

IMPORTANT NOTICE AND DISCLAIMER

Trademarks. Any of the 思瑞浦 or 3PEAK trade names, trademarks, graphic marks, and domain names contained in this document /material are the property of 3PEAK. You may NOT reproduce, modify, publish, transmit or distribute any Trademark without the prior written consent of 3PEAK.

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.

Disclaimer. 3PEAK provides technical and reliability data (including data sheets), design resources (including reference designs), application or other design recommendations, networking tools, security information and other resources "As Is". 3PEAK makes no warranty as to the absence of defects, and makes no warranties of any kind, express or implied, including without limitation, implied warranties as to merchantability, fitness for a particular purpose or non-infringement of any third-party's intellectual property rights. Unless otherwise specified in writing, products supplied by 3PEAK are not designed to be used in any life-threatening scenarios, including critical medical applications, automotive safety-critical systems, aviation, aerospace, or any situations where failure could result in bodily harm, loss of life, or significant property damage. 3PEAK disclaims all liability for any such unauthorized use.