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 Maximum at 25 °C
- Stable when Gain > 7 V/V
- Quiescent Current: 19 mA
- Overload Recovery: 2.8 nS
- Package: 8-pin DFN
- –40°C to 125°C Operation Temperature Range

Applications

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

Description

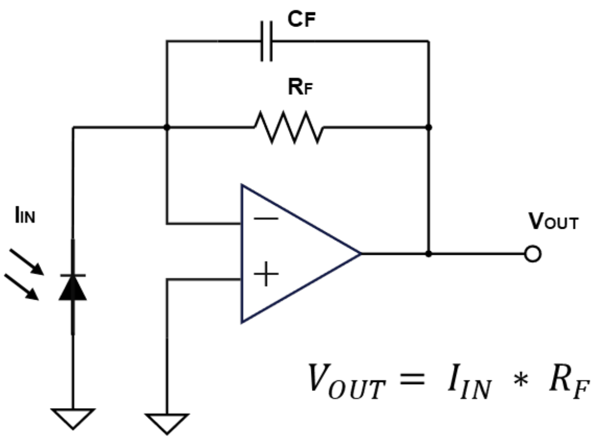
TPH2861 is a high-speed, low-noise operational amplifier with high-speed BJT inputs, suitable for broadband cross resistance and voltage amplifier applications.

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

The TPH2861 also has a large signal bandwidth of 850-MHz (2-VPP) , 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 TPH2861 decreases the distance of feedback network connection between the input and output on PCB, which benefits the achievement of high close-loop bandwidth.

Typical Application Circuit



$$V_{OUT} = I_{IN} * R_F$$

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Revision History

Date	Revision	Notes
2023-12-21	Rev.A.0	Initial version.

Pin Configuration and Functions

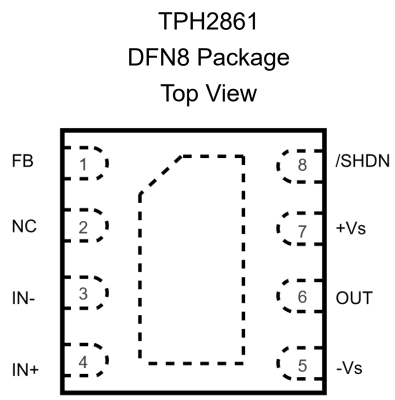


Table 1. Pin Functions: TPH2861

Pin No.	Name	I/O	Description
1	FB	Input	Feedback connection to output of amplifier
2	N/C		No connection
3	IN-	Input	Inverting input
4	IN+	Input	Noninverting input
5	$-V_S$		Negative power supply
6	Out	Output	Output
7	$+V_S$		Positive power supply
8	/SHDN	Input	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 a 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: +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 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	ANSI/ESDA/JEDEC JS-001 (1)	2	kV
CDM	Charged Device Model ESD	ANSI/ESDA/JEDEC JS-002 (2)	1.5	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.

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= 7V/V, input common-mode biased at mid-supply, unless otherwise noted.

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
Av	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.

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	45	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

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.

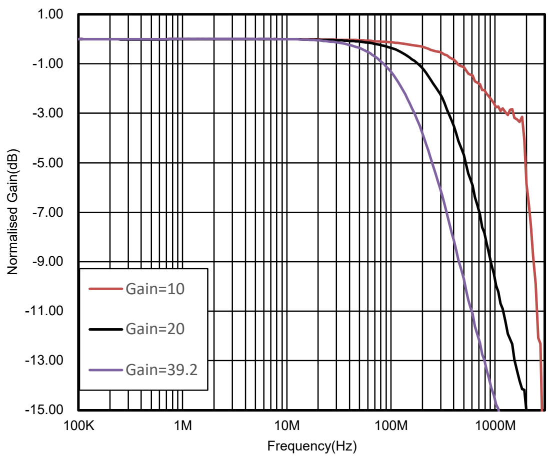


Figure 1. Small-Signal Frequency Response vs Gain

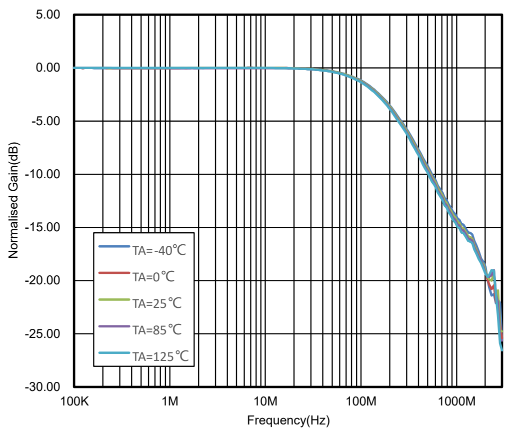


Figure 2. Small-Signal Frequency Response vs Ambient Temperature

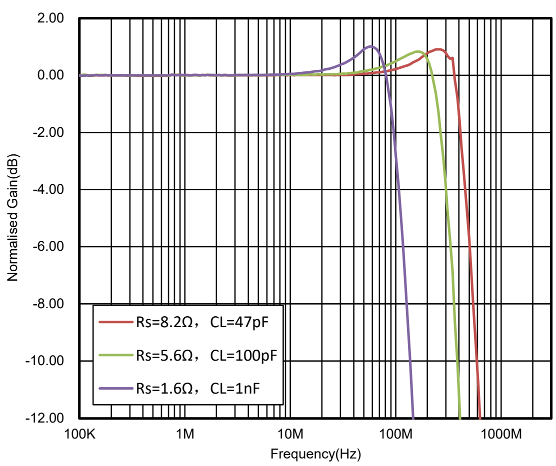


Figure 3. Small-Signal Frequency Response vs Capacitive Load

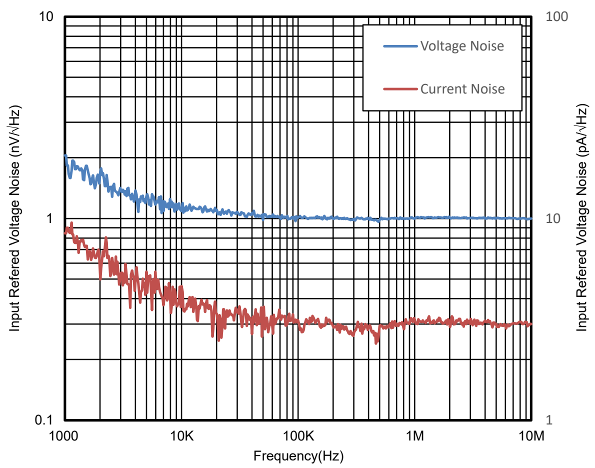


Figure 4. Voltage and Current Noise Density vs Frequency

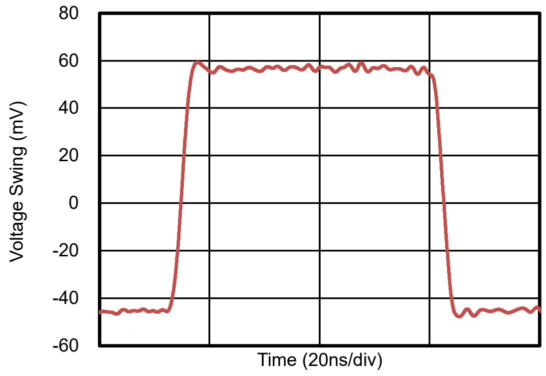


Figure 5. Small-Signal Transient Response

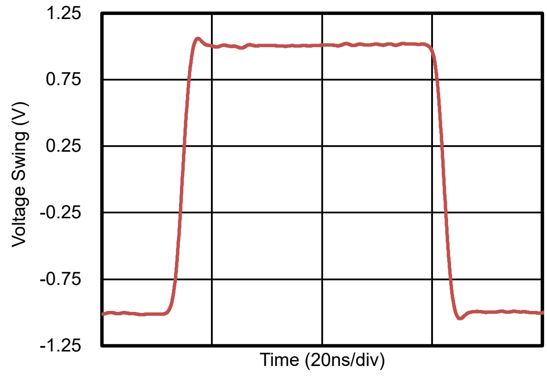


Figure 6. Large-Signal Transient Response

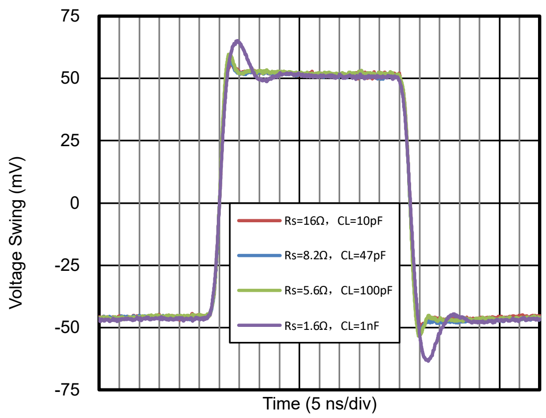


Figure 7. Small-Signal Transient Response vs Capacitive Load

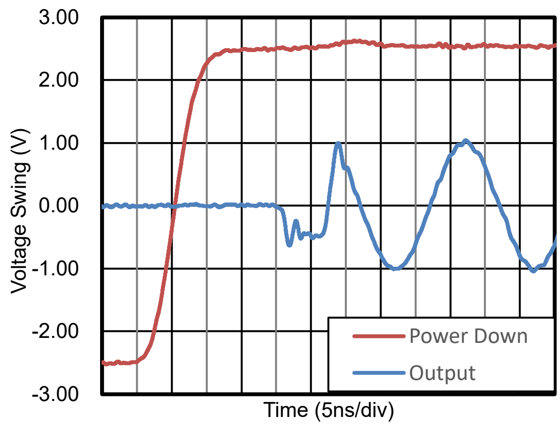


Figure 8. Turn-on Transient Response

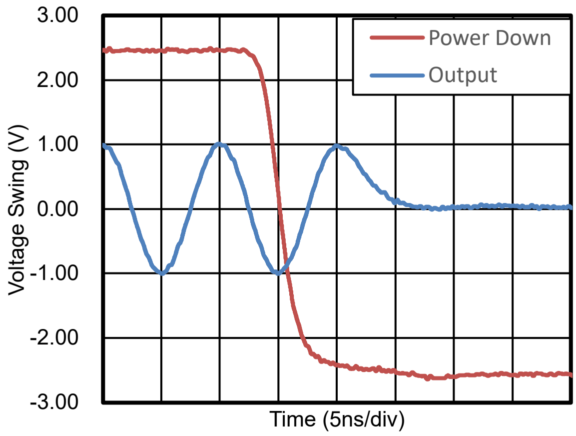


Figure 9. Turn-off Transient Response

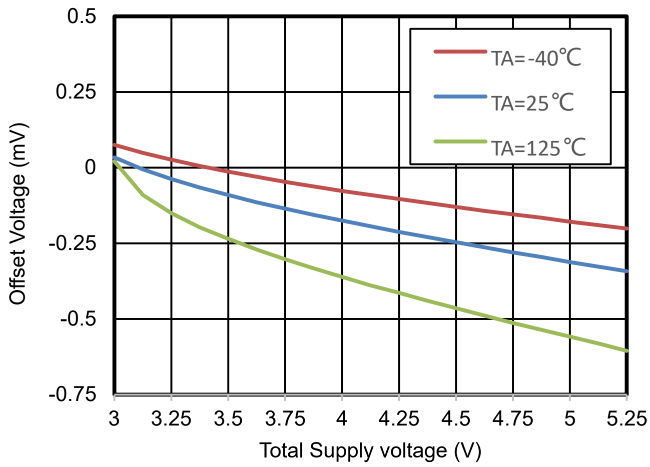


Figure 10. Offset Voltage vs Supply Voltage

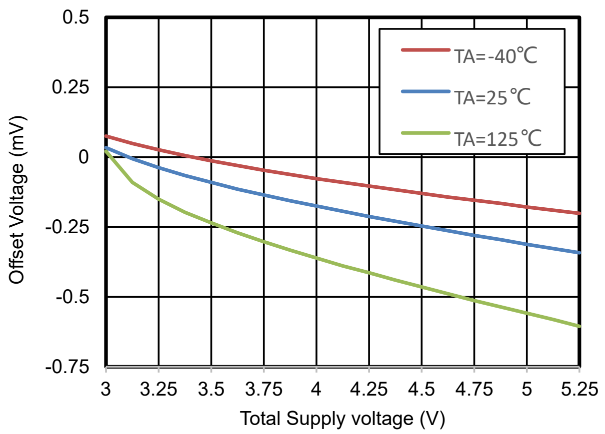


Figure 11. Offset Voltage vs Input Common-Mode Voltage

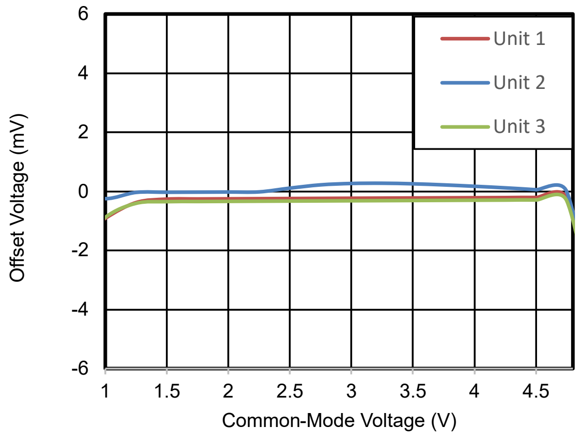


Figure 12. Offset Voltage vs Input Common-Mode Voltage

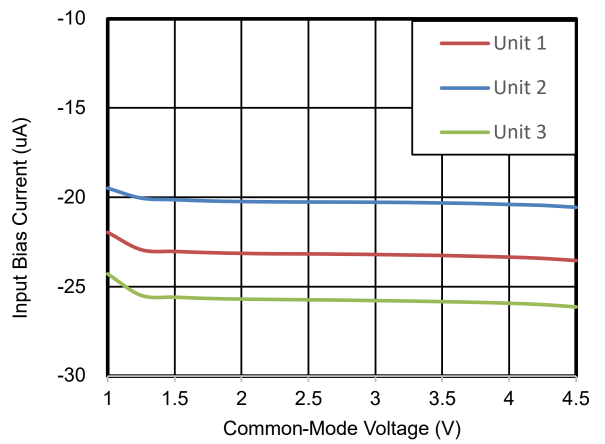


Figure 13. Input Bias Current vs Input-Common Mode Voltage

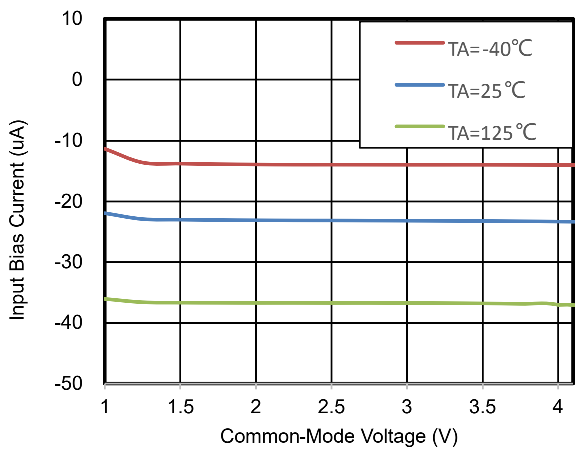


Figure 14. Input Bias Current vs Input-Common Mode Voltage

Detailed Description

Overview

The TPH2861 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, 2700-V/μs slew rate and broad voltage noise of 1.1 nV /√Hz, but it is not unity-gain stable and can be stable when the gain is larger than 7 V/V. The TPH2861 power-supply range of +3.3 V to +5.25 V (±1.65 V to ±2.625 V).

Functional Block Diagram

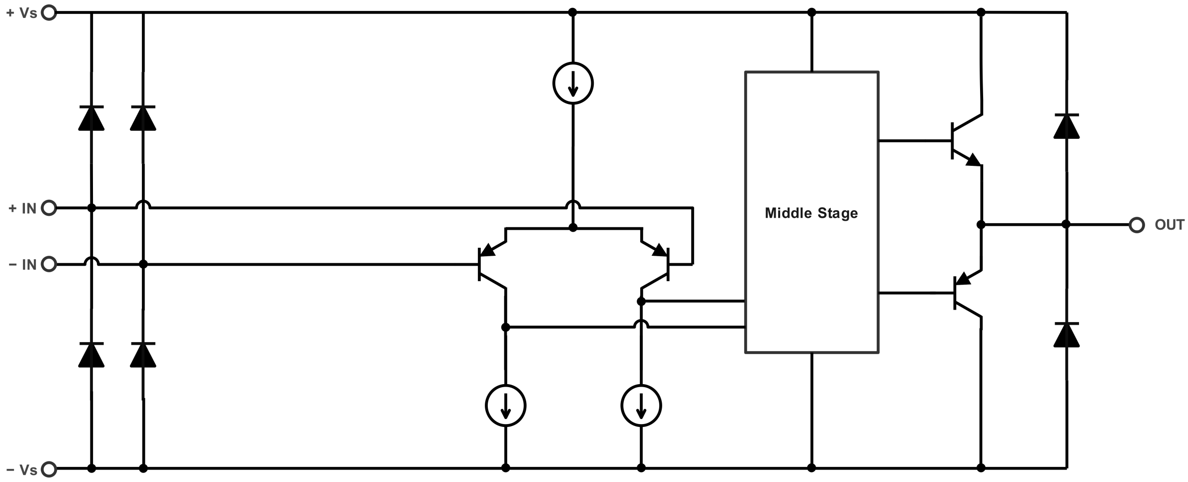


Figure 15. Functional Block Diagram

Feature Description

Operating Voltage

The TPH2861 is designed for single supply operation from 3.3 V to 5.25 V or dual supply operation from ±1.65 V to ±2.625 V.

Application and Implementation

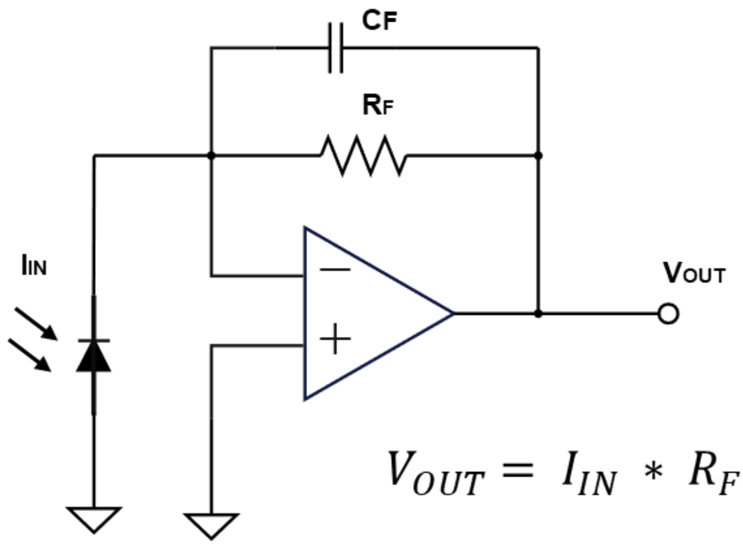
Note

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

Transimpedance Amplifier Application

Figure 16 shows the TPH2861 is configured in a Transimpedance amplifier application. Transimpedance amplifier (TIA) is a current to voltage converter. In the circuit shown in the following figure,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 transimpedance amplifier is determined by the equation shown in the Figure 16. The CF is used to maintain the stability of the whole circuit via creating a zero.



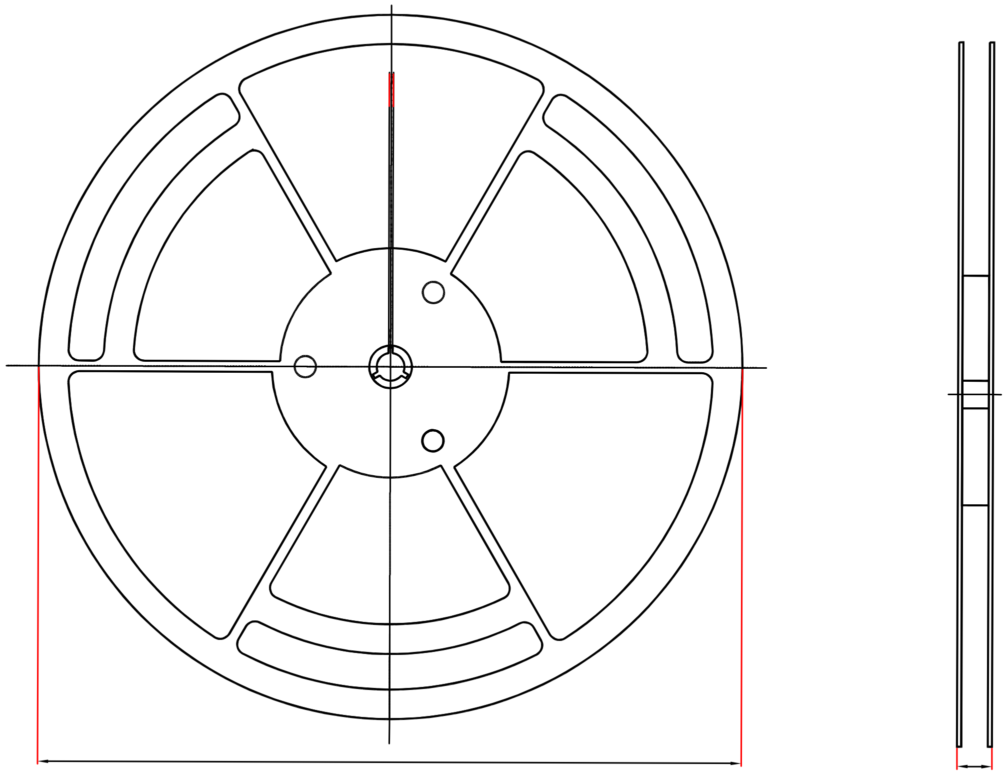
$$V_{OUT} = I_{IN} * R_F$$

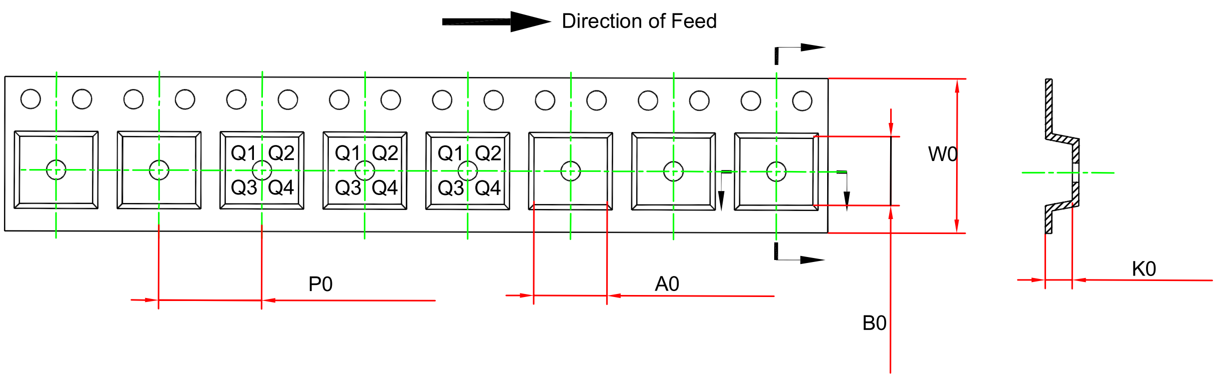
Figure 16. TIA(transimpedance amplifier) Application

Power Supply Recommendations

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

Tape and Reel Information



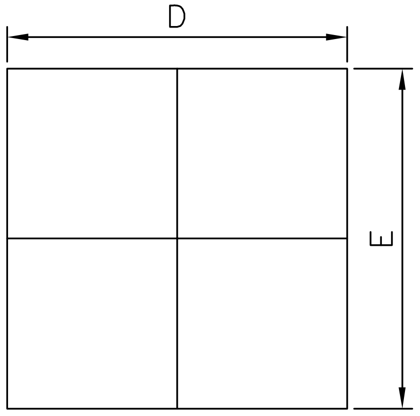


Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPH2861-DF4R-S	DFN2X2-8	180	12.5	2.3	2.3	1.1	4	8	Q2

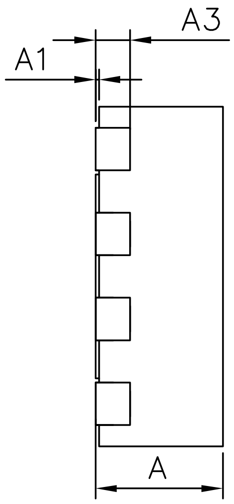
Package Outline Dimensions

DFN2X2-8-D

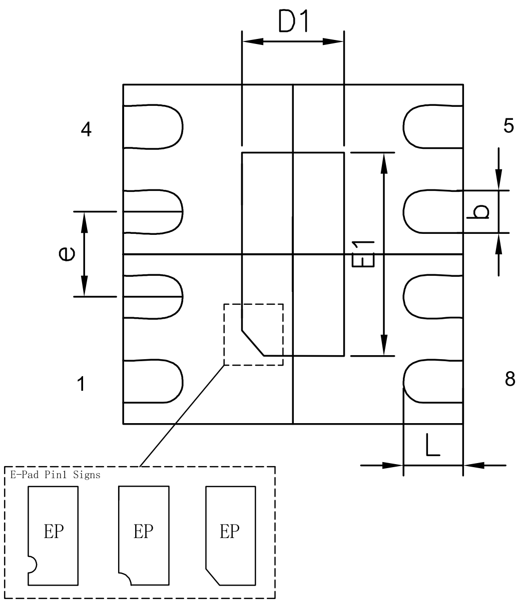
Package Outline Dimensions DF4(DFN2X2-8-D)



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
b	0.180	0.300	0.007	0.012
A3	0.150	0.250	0.006	0.010
D	1.900	2.100	0.075	0.083
D1	0.800	1.000	0.031	0.039
E	1.900	2.100	0.075	0.083
E1	1.500	1.700	0.059	0.067
e	0.500 BSC		0.020BSC	
L	0.250	0.350	0.010	0.014

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
TPH2861-DF4R-S	−40 to 125°C	DFN2X2-8	A25	MSL2	Tape and Reel,3000	Green

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

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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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