12-V, Ultra-Wideband, Current-Feedback Operational Amplifier

Features

- Wide Bandwidth:
  - 1350 MHz (G = +1 V/V)
  - 330 MHz (G = +8 V/V)
- Large-signal Bandwidth (4 V_{PP}): 310 MHz
- Output Voltage Swing: ±4 V
- Ultra-high Slew Rate: 4000 V/μs
- Input Voltage Noise: 2.9 nV/√Hz
- High Output Current: ±280 mA
- Supply Voltage: 5 V to 12 V
- Supply Current: 16 mA (Typ)
- Shutdown Current: 120 μA (Typ)
- Package: SOP8

Applications

- Very Wideband ADC Drivers
- Low-cost Precision IF Amplifiers
- Broadband Video Line Drivers
- Portable Instruments
- Active Filters
- Arbitrary Waveform Generators
- Current DAC Drivers

Description

The TPH1021 is a high-bandwidth, current-feedback operational amplifier that combines an exceptional 4000 V/μs slew rate and low input voltage noise to deliver a precision, low-distortion, high dynamic range amplifier for use as intermediate gain stages in high-speed instrumentation systems. The TPH1021 is optimized for high-gain operation. Typical uses include current-DAC output interfacing, gain stages in high-speed digitizers, and cable-modem upstream line drivers requiring high output power at low distortion.

The TPH1021 features a low supply current of 16 mA (at 25°C). System power can be further reduced using the optional disable control pin. Leaving this pin open, or holding this pin high, gives normal operation. If pulled low, the TPH1021 supply current drops to less than 160 μA. This power-saving feature, along with exceptional single 5 V operation, makes the TPH1021 an excellent choice for portable applications.

The TPH1021 is specified over the temperature range of −40°C to +125°C. The device is offered in an SOP8 package.

Device Table

Device	Package	Body Size
TPH1021N-SO1R	SOP8	4.9 mm × 3.9 mm

Typical Application Circuit

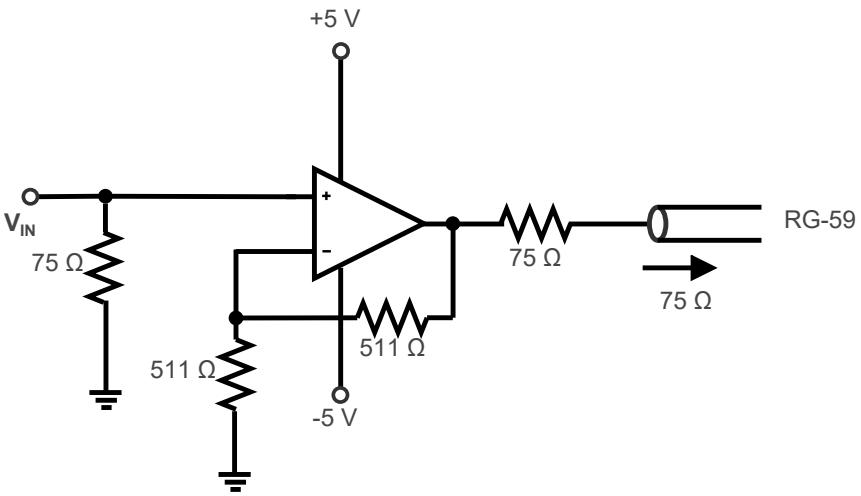


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Revision History

Date	Revision	Notes
2026-05-25	Rev.A.0	Initial version.

Pin Configuration and Functions

TPH1021
SOP8
Top View

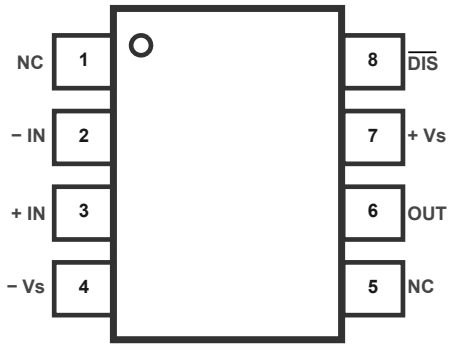


Table 1. Pin Functions: TPH1021

Pin No.	Pin Name	I/O	Description
1	NC		Not connected.
2	–IN	I	Inverting input.
3	+IN	I	Non-inverting input.
4	$-V_S$		Negative supply.
5	NC		Not connected.
6	OUT	O	Output.
7	$+V_S$		Positive supply.
8	$\overline{DIS}$	I	Not disable (enable).

Specifications

Absolute Maximum Ratings (1)

Symbol	Parameter	Min	Max	Unit
V_S	Supply Voltage, $V_S = (V_{S+}) – (V_{S-})$		13	V
V_{ID}	Differential Input Voltage		±1.2	V
V_I	Input Common-Mode Voltage		$±V_S$	V
	Continuous Input Current		±10	mA
T_J	Maximum Junction Temperature		150	°C
T_{STG}	Storage Temperature Range	−65	150	°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.

ESD, Electrostatic Discharge Protection

Parameter		Condition	Minimum Level	Unit
HBM	Human Body Model ESD	ANSI/ESDA/JEDEC JS-001 (1)	7	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.

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	Total supply Voltage, $(V_{S+}) – (V_{S-})$	5		12	V
T_A	Operating Free-Air Temperature	−40		125	°C

Thermal Information

Package Type	θ_{JA}	θ_{JC}	Unit
SOP8	158	43	°C/W

Electrical Characteristics V_S = ±5 V

All test conditions: T_A = 25°C, V_S = ±5 V, G = +5.7 V/V, RF = 4.7 kΩ, and RL = 100 Ω to V_S / 2, unless otherwise noted.

Parameter		Conditions		Min	Typ	Max	Unit
AC Performance							
SSBW	Small-Signal Bandwidth	V_O = 0.5 V_{PP}	G = +1 V/V, RF = 523 Ω		1350		MHz
			G = +2 V/V, RF = 511 Ω		1300		MHz
			G = +8 V/V, RF = 402 Ω		330		MHz
			G = +16 V/V, RF = 249 Ω		230		MHz
	Bandwidth for 0.2-dB Gain Flatness	V_O = 0.5 V_{PP}, G = +2 V/V, RF = 511 Ω			32		MHz
	Peaking at G = +1 V/V	V_O = 0.5 V_{PP}, RF = 523 Ω			6.5		dB
LSBW	Large-Signal Bandwidth	V_O = 4 V_{PP}, G = +8 V/V			310		MHz
SR	Slew Rate (20% to 80%)	V_O = 4 V step	G = −8 V/V		4700		V/µs
			G = +8 V/V		4000		V/µs
	Rise and Fall Time (10% to 90%)	G = +8 V/V	V_O = 0.5 V step		0.8		ns
			V_O = 4 V step		0.8		ns
	Settling Time	To 0.5%, V_O = 2 V step, G = +8 V/V			8		ns
HD2	2nd-order Harmonic Distortion (1)	f = 10 MHz	V_O = 2 Vpp, RL = 100 Ω		77.7		dBc
			V_O = 2 Vpp, RL = 500 Ω		75.5		dBc
HD3	3rd-order Harmonic Distortion (1)	f = 10 MHz	V_O = 2 Vpp, RL = 100 Ω		81.2		dBc
			V_O = 2 Vpp, RL = 500 Ω		78		dBc
e_n	Input Voltage Noise	f > 1 MHz			2.9		nV/√Hz
i_{n+}	Noninverting Input Current Noise	f > 1 MHz			4		pA/√Hz
i_{n-}	Inverting Input Current Noise	f > 1 MHz			21		pA/√Hz
DC Performance							
Z_{OL}	Open-Loop Transimpedance Gain			45	120		kΩ
		T_A = −40°C to 125°C		41			
V_{OS}	Input Offset Voltage	V_{CM} = 0 V		−4	±0.7	+4	mV
			T_A= −40°C to 125°C	−5.3		+5.3	
V_{OS} TC	Input Offset Voltage Drift	V_{CM} = 0 V, T_A = −40°C to 125°C			−5		µV/°C
	Noninverting Input Bias Current	V_{CM} = 0 V		−30	−6	+30	µA
			T_A= −40°C to 125°C	−41		+41	
	Average Noninverting Input Bias Current Drift	V_{CM} = 0 V, T_A = −40°C to 125°C			25		nA/°C
	Inverting Input Bias Current	V_{CM} = 0 V		−60	−8	60	µA

Parameter		Conditions		Min	Typ	Max	Unit
			T_A= −40°C to 125°C	−70		70	
	Average Inverting Input Bias Current Drift	V_{CM} = 0 V, T_A = −40°C to 125°C			150		nA/°C
Input Characteristics							
CMIR	Common Mode Input Range			±2.5	±2.6		V
		T_A= −40°C to 125°C		±2.5			
CMRR	Common Mode Rejection Ratio	V_{CM} = 0 V		51	53		dB
			T_A= −40°C to 125°C	48			
	Noninverting Input Resistance (1)				498 || 2.9		kΩ || pF
	Inverting Input Resistance	Open-Loop			45		Ω
V_O	Output Voltage Swing	No Load		±3.93	±4		V
			T_A= −40°C to 125°C	±3.85			
		RL = 100 Ω		±3.63	±3.64		V
			T_A= −40°C to 125°C	±3.55			
I_O	Output Current Sourcing (2)	V_O = 0 V		90	280		mA
			T_A= −40°C to 125°C	70			
	Output Current Sinking (2)	V_O = 0 V			−340	−90	mA
			T_A= −40°C to 125°C			−70	
Z_O	Closed-Loop Output Impedance (1)	G = +8 V/V, f = 100 kHz			0.02		Ω
Power Supply							
I_Q	Quiescent Current			11.7	16	20	mA
		T_A= −40°C to 125°C		10		30	
−PSRR	Negative Power-Supply Rejection Ratio			51	79		dB
		T_A= −40°C to 125°C		48			
Disable (Disabled Low)							
	Power-Down Quiescent Current	$V_{\overline{DIS}}$ = 0 V			120	200	µA
			T_A= −40°C to 125°C			210	
	Disable Time	V_{IN} = ±0.25 V_{DC}			1.5		µs
	Enable Time	V_{IN} = ±0.25 V_{DC}			180		ns
	Off Isolation	G = +8 V/V, f = 10 MHz			75		dB
	Output Capacitance in Disable (1)				16		pF
	Enable Voltage Threshold				3	3.5	V
		T_A= −40°C to 125°C				3.7	
	Disable Voltage Threshold			1.7	2.3		V
		T_A= −40°C to 125°C		1.5			

Parameter		Conditions		Min	Typ	Max	Unit
	$\overline{DIS}$ Control Pin Input Bias Current	$V_{\overline{DIS}}$ = 0 V		−50	−26		μA
			T_A= −40°C to 125°C	−60			

(1) Provided by bench test and design simulation.
(2) The sink or source current will be limited by junction temperature and 1-W internal power.

Electrical Characteristics V_s = 5 V

All test conditions: T_A = 25°C, V_S = 5 V, G = +5.7 V/V, RF = 4.7 kΩ, and RL = 100 Ω to V_S/2, unless otherwise noted.

Parameter		Conditions		Min	Typ	Max	Unit
AC Performance							
SSBW	Small-Signal Bandwidth	V_O = 0.5 V_{PP}	G = +1 V/V, RF = 523 Ω		1300		MHz
			G = +2 V/V, RF = 511 Ω		700		MHz
			G = +8 V/V, RF = 402 Ω		300		MHz
			G = +16 V/V, RF = 249 Ω		210		MHz
	Bandwidth for 0.2-dB Gain Flatness	V_O = 0.5 V_{PP}, G = +2 V/V, RF = 511 Ω			28		MHz
	Peaking at G = +1 V/V	V_O = 0.5 V_{PP}, RF = 523 Ω			6.5		dB
LSBW	Large-Signal Bandwidth	V_O = 2 V_{PP}, G = +8 V/V			260		MHz
SR	Slew Rate (20% to 80%)	V_O = 2 V step	G = +8 V/V		1300		V/µs
	Rise and Fall Time (10% to 90%)	G = +8 V/V	V_O = 0.5 V step		1		ns
			V_O = 2 V step		1.2		ns
	Settling Time	To 0.5%, V_O = 2 V step, G = +8 V/V			8		ns
HD2	2nd-order Harmonic Distortion (1)	f = 10 MHz	V_O = 2 Vpp, RL = 100 Ω		77.7		dBc
			V_O = 2 Vpp, RL = 500 Ω		75.5		dBc
HD3	3rd-order Harmonic Distortion (1)	f = 10 MHz	V_O = 2 Vpp, RL = 100 Ω		81.2		dBc
			V_O = 2 Vpp, RL = 500 Ω		78		dBc
e_n	Input Voltage Noise	f > 1 MHz			2.9		nV/√Hz
i_{n+}	Noninverting Input Current Noise	f > 1 MHz			4		pA/√Hz
i_{n-}	Inverting Input Current Noise	f > 1 MHz			21		pA/√Hz
DC Performance							
Z_{OL}	Open-Loop Transimpedance Gain			25	48		kΩ
		T_A = −40°C to 125°C		12.5			
V_{OS}	Input Offset Voltage	V_{CM} = V_S/2		−4.6	±2.4	+4.6	mV
			T_A= −40°C to 125°C	−6.2		+6.2	
V_{OS} TC	Input Offset Voltage Drift	V_{CM} = V_S/2, T_A = −40°C to 125°C			−7		µV/°C
	Noninverting Input Bias Current	V_{CM} = V_S/2		−40	−4	+40	µA
			T_A= −40°C to 125°C	−50		+50	
	Average Noninverting Input Bias Current Drift	V_{CM} = V_S/2, T_A = −40°C to 125°C			25		nA/°C
	Inverting Input Bias Current	V_{CM} = V_S/2		−60	2	60	µA
			T_A= −40°C to 125°C	−70		70	

Parameter		Conditions		Min	Typ	Max	Unit
	Average Inverting Input Bias Current Drift	V_{CM} = V_S/2, T_A = −40°C to 125°C			100		nA/°C
Input Characteristics							
CMIR	Common Mode Input Range			V_S/2 ± 0.4	V_S/2 ± 0.6		V
		T_A= −40°C to 125°C		V_S/2 ± 0.4			
	Noninverting Input Resistance (1)				362|| 1.92		kΩ || pF
	Inverting Input Resistance	Open-Loop			48		Ω
V_O	Output Voltage Swing (most positive)	No Load		3.95	4.05		V
			T_A= −40°C to 125°C	3.75			
	Output Voltage Swing (least positive)	No Load			0.9	1.05	V
			T_A= −40°C to 125°C			1.25	
	Output Voltage Swing (most positive)	RL = 100 Ω		3.9	3.95		V
			T_A= −40°C to 125°C	3.7			
	Output Voltage Swing (least positive)	RL = 100 Ω			1.1	1.13	V
			T_A= −40°C to 125°C			1.3	
I_O	Output Current Sourcing (2)	V_O = V_S/2		70	120		mA
			T_A= −40°C to 125°C	60			
	Output Current Sinking (2)	V_O = V_S/2			−130	−70	mA
			T_A= −40°C to 125°C			−60	
Z_O	Closed-Loop Output Impedance (1)	G = +2 V/V, f = 100 kHz			0.029		Ω
Power Supply							
I_Q	Quiescent Current			10.9	15	19	mA
		T_A= −40°C to 125°C		9.1		20	
−PSRR	Negative Power-Supply Rejection Ratio				81		dB
Disable (Disabled Low)							
	Power-Down Quiescent Current	$V_{\overline{DIS}}$ = 0 V			116	160	µA
			T_A= −40°C to 125°C			180	
	Disable Time	V_{IN} = ±0.25 V_{DC}			1.5		µs
	Enable Time	V_{IN} = ±0.25 V_{DC}			500		ns
	Off Isolation	G = +8 V/V, f = 10 MHz			75		dB
	Output Capacitance in Disable (1)				5.8		pF
	Enable Voltage Threshold				3.1	3.5	V
		T_A= −40°C to 125°C				3.7	

Parameter		Conditions		Min	Typ	Max	Unit
	Disable Voltage Threshold			1.7	2.4		V
		T_A= −40°C to 125°C		1.5			
	$\overline{DIS}$ Control Pin Input Bias Current	$V_{\overline{DIS}}$ = 0 V		−50	−26		μA
			T_A= −40°C to 125°C	−60			

(1) Provided by bench test and design simulation.
(2) The sink or source current will be limited by junction temperature and 1-W internal power.

Typical Performance Characteristics

At T_A = 25°C, V_S = ±5 V, G = +8 V/V, RF = 402 Ω, and RL = 100 Ω to V_S / 2, unless otherwise noted.

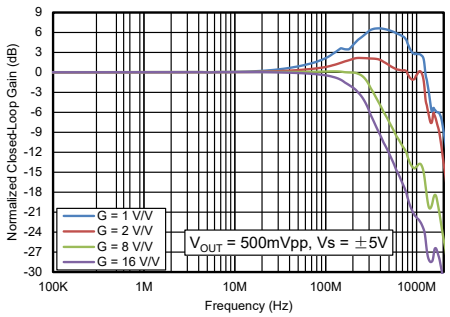


Figure 1. Noninverting Small-Signal Frequency Response (V_S = ±5 V)

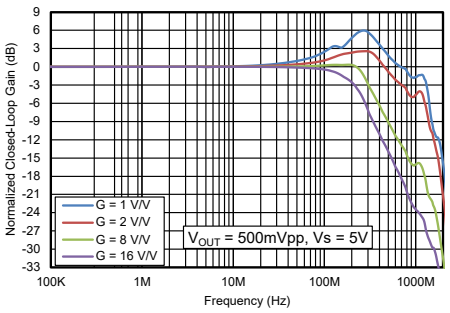


Figure 2. Noninverting Small-Signal Frequency Response (V_S = 5 V)

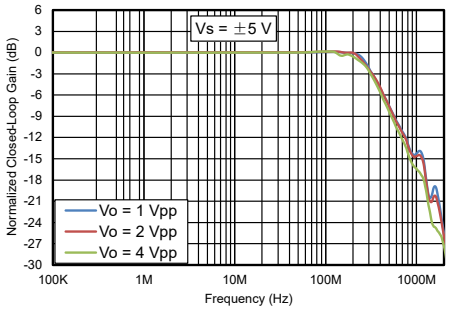


Figure 3. Noninverting Large-Signal Frequency Response (V_S = ±5 V)

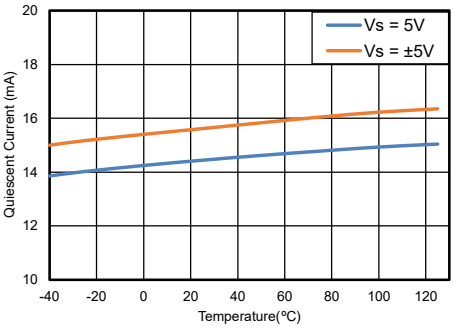


Figure 4. Quiescent Current vs. Temperature

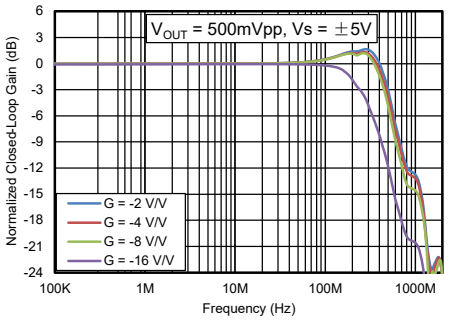


Figure 5. Inverting Small-Signal Frequency Response

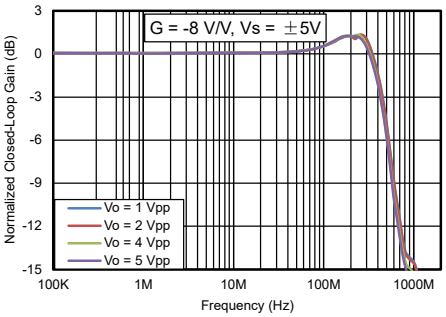


Figure 6. Inverting Large-Signal Frequency Response

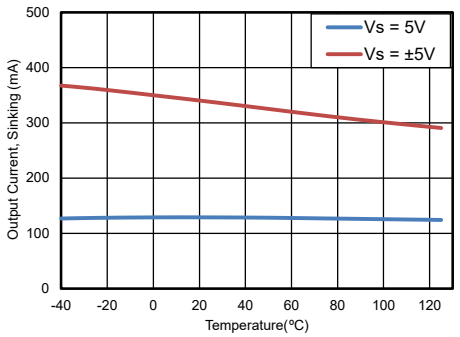


Figure 7. Sink Current vs. Temperature

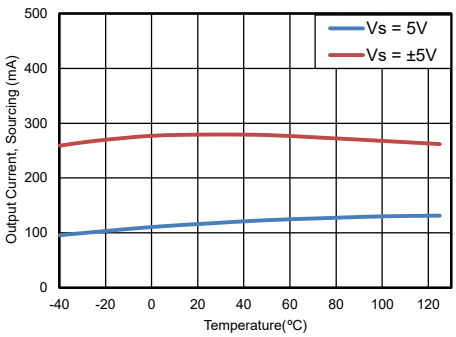


Figure 8. Source Current vs. Temperature

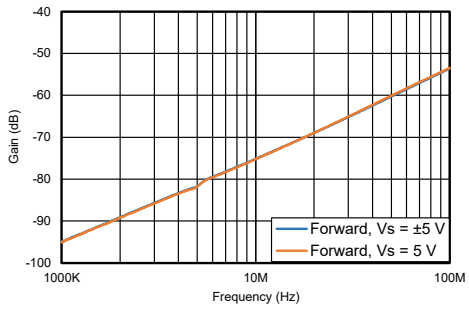


Figure 9. Disabled Feedthrough vs Frequency

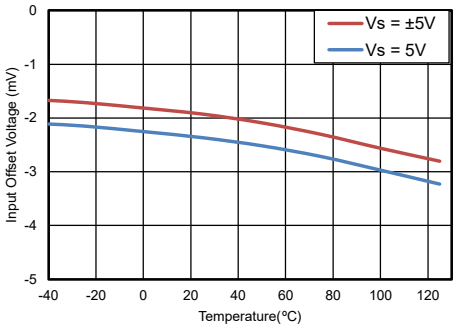


Figure 10. Input Offset Voltage vs. Temperature

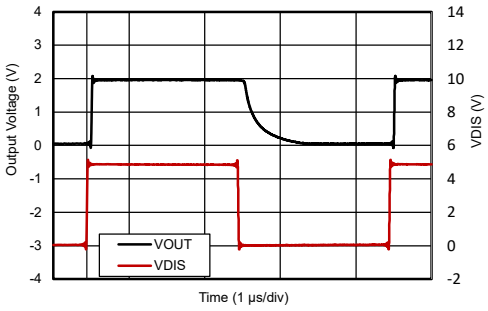


Figure 11. Large-Signal Disable and Enable Response (V_S = ±5 V)

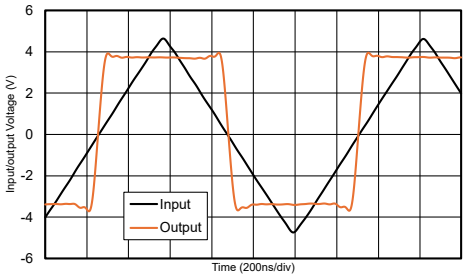


Figure 12. Noninverting Overdrive Recovery (V_S = ±5 V)

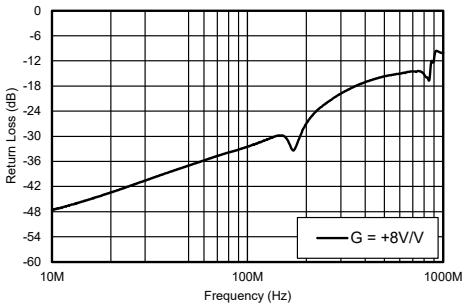


Figure 13. Input Return Loss vs Frequency (S11) (V_S = ±5 V)

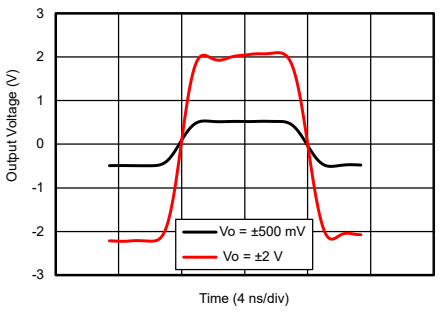


Figure 14. Noninverting Large- and Small-Signal Frequency Response (V_S = ±5 V)

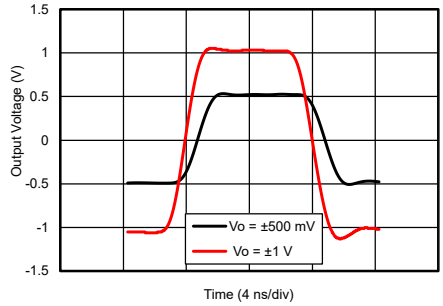


Figure 15. Noninverting Large- and Small-Signal Frequency Response (V_S = 5 V)

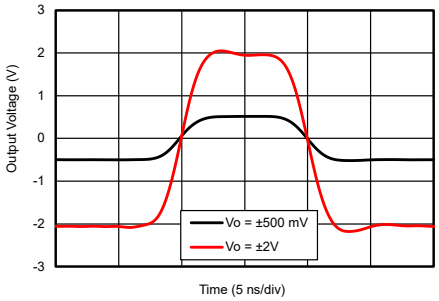


Figure 16. Inverting Large- and Small-Signal Frequency Response (V_S = ±5 V)

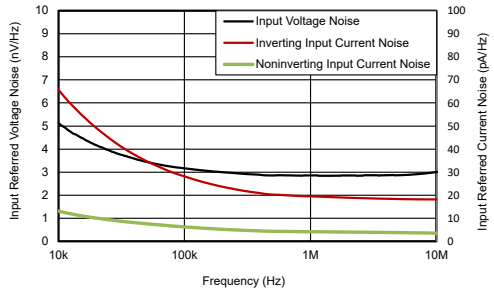


Figure 17. Input Voltage and Current Noise Density

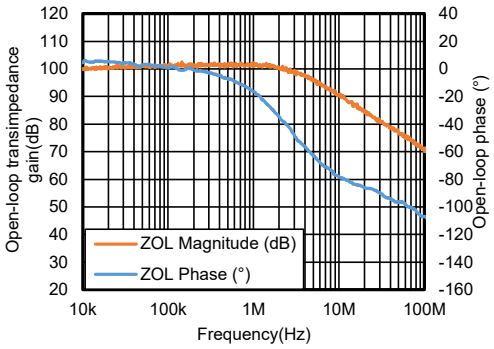


Figure 18. Open-Loop Transimpedance Gain and Phase

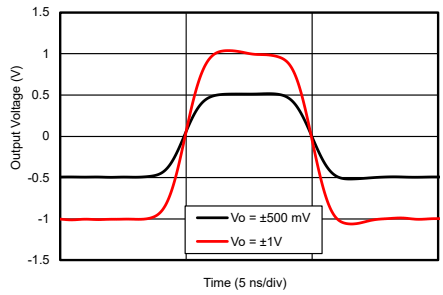


Figure 19. Inverting Large and Small-Signal Frequency Response (V_S = 5 V)

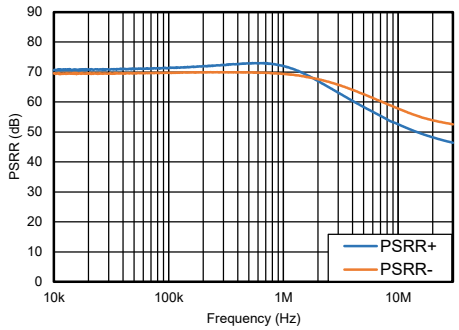


Figure 20. PSRR vs Frequency

Detailed Description

Overview

The TPH1021 is a high-speed current-feedback amplifier (CFA) designed to operate over a wide supply range of ±2.5 V (5 V) to ±6 V (12 V) for applications requiring low distortion along with wide bandwidth and high slew rate. Common applications for current-feedback operational amplifiers include gain blocks in high-speed data-acquisition systems, coaxial cable drivers, analog-to-digital converter (ADC) drivers, and digital-to-analog converter (DAC) drivers. The TPH1021 features a power-down pin that puts the amplifier in low-power standby mode and lowers the quiescent current from 16 mA to 120 µA.

Functional Block Diagram

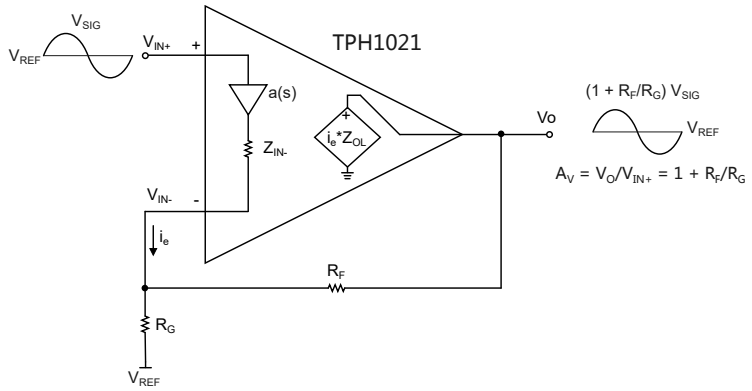


Figure 21. Functional Block Diagram

Feature Description

Device Functional Modes

The TPH1021 has two functional modes: enabled and disabled. The disable control pin ($\overline{DIS}$) is typically left open or applied a logic 1 (> 3.5 V) for normal amplifier operation and will draw a supply current of 16 mA typically. Assert the disable control pin low (< 1.7 V) to shut off the TPH1021. In this mode, the amplifier is fully disabled and draws a current of only 120 µA.

Wideband Current-Feedback Operation

The primary advantage of a current-feedback op amp over a voltage-feedback op amp is that AC performance (bandwidth and distortion) is relatively independent of signal gain. The nearly constant AC performance over a wide gain range, along with a 4700-V/µs slew rate and ultra-low distortion makes the TPH1021 an excellent choice for high-speed data acquisition gain stages. Single +5-V supply operation is also supported with similar bandwidths but reduced output power capability. Figure 22 shows the DC-coupled, gain of +8 V/V, dual-power supply circuit used as the basis of the ±5-V specifications and typical characteristic curves. The total effective load is 100 Ω || 458 Ω = 82 Ω. Figure 23 shows the DC-coupled, gain of –8 V/V, dual-power supply circuit used as the basis of the inverting typical characteristic curves. In this case, the gain resistor (R_G) becomes part of the input resistance for the source, so the input resistance is 54.9 Ω || 562 Ω = 50 Ω.

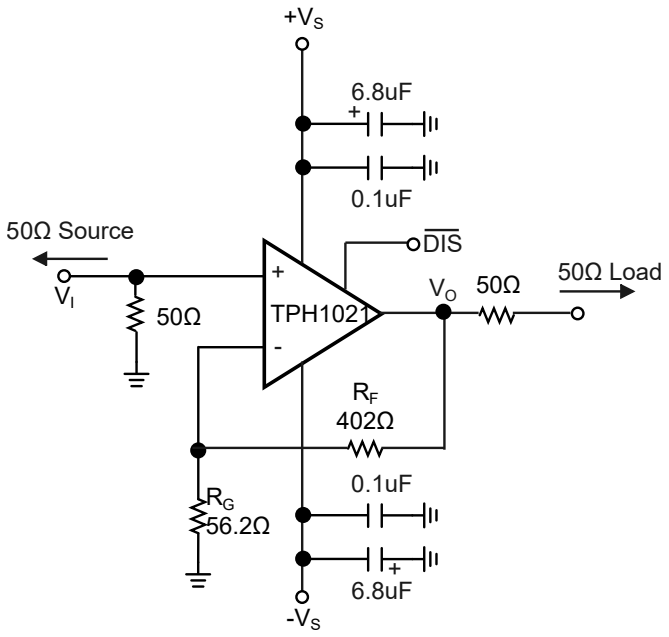


Figure 22. DC-Coupled, G = +8 V/V, Bipolar Supply Specifications

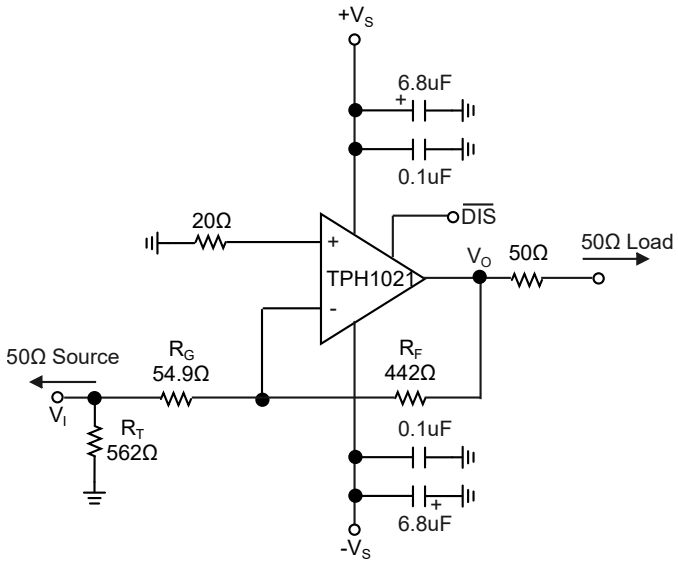


Figure 23. DC-Coupled, G = −8 V/V, Bipolar Supply Specifications

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

Recommended Feedback and Gain Resistor Values

A current-feedback op amp such as the TPH1021 can hold an almost constant bandwidth over signal gain settings with the proper adjustment of the external resistor values, which are shown in the Typical Performance Characteristics. The small-signal bandwidth decreases only slightly with increasing gain. These characteristic curves also show that the feedback resistor is changed for each gain setting. The absolute values of R_F on the inverting side of the circuit for a current-feedback op-amp can be treated as a frequency response compensation element, whereas the ratios of R_F and R_G set the signal gain. Table 2 shows the recommended resistors for an optimized frequency response.

Table 2. Recommended Resistor Values for an Optimized Frequency Response

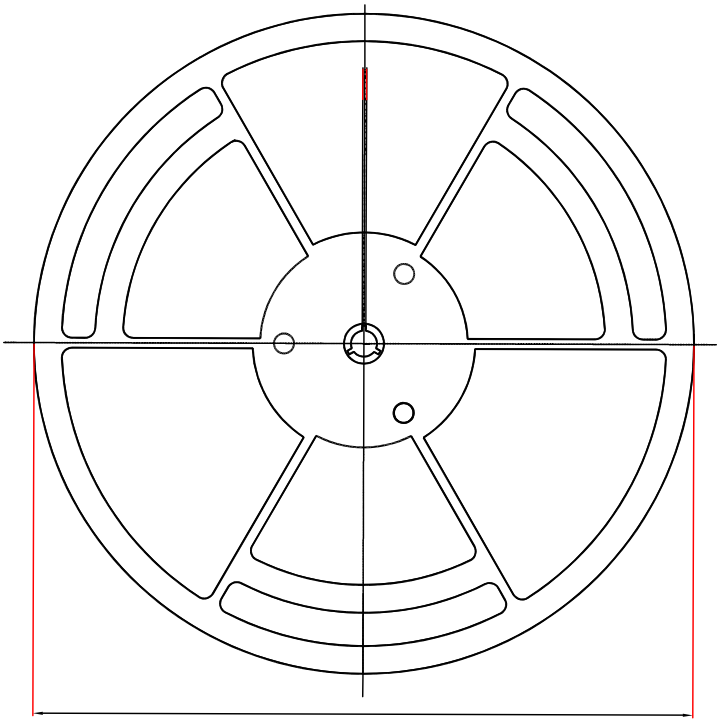
GAIN	R_F for V_S = ±5 V	R_F for V_S = 5 V
1	523	523
2	511	511
8	402	402
16	249	249

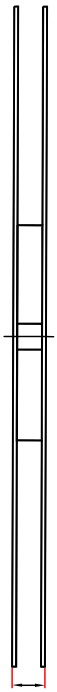
Layout

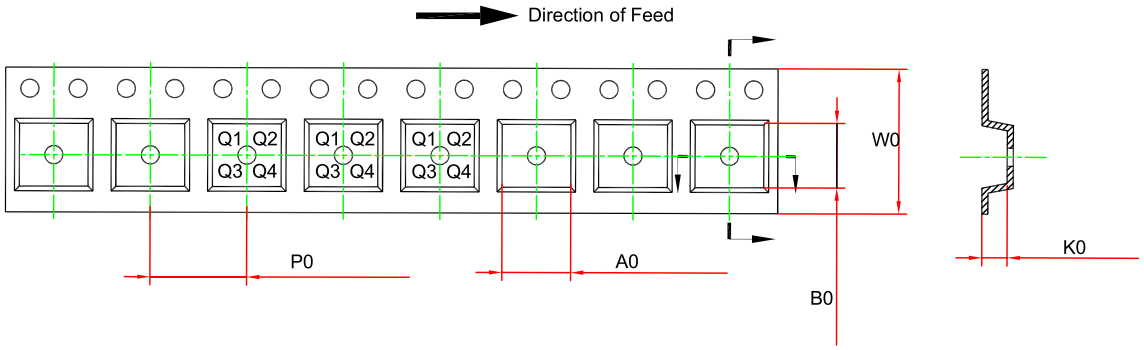
Layout Guideline

- Place 0.1-μF bypass capacitors as close as possible to the power supply pins to reduce coupling errors from the noise or high-impedance power supplies, and additional 1-μF to 10-μF capacitors can be used for better filtering.
- Minimize parasitic capacitance to any AC ground for all of the signal I/O pins.
- Careful selection and placement of external components, such as low-reactance resistors or surface-mount resistors will preserve the high-frequency performance of the TPH1021. Keep the leads and PCB trace length as short as possible, position the feedback and series output resistor as close as possible to the output pin, and reduce the parasitic capacitance of the output pin and inverting input pin.
- Connections to other wideband devices on the board can be made with short, direct traces or through onboard transmission lines.

Tape and Reel Information







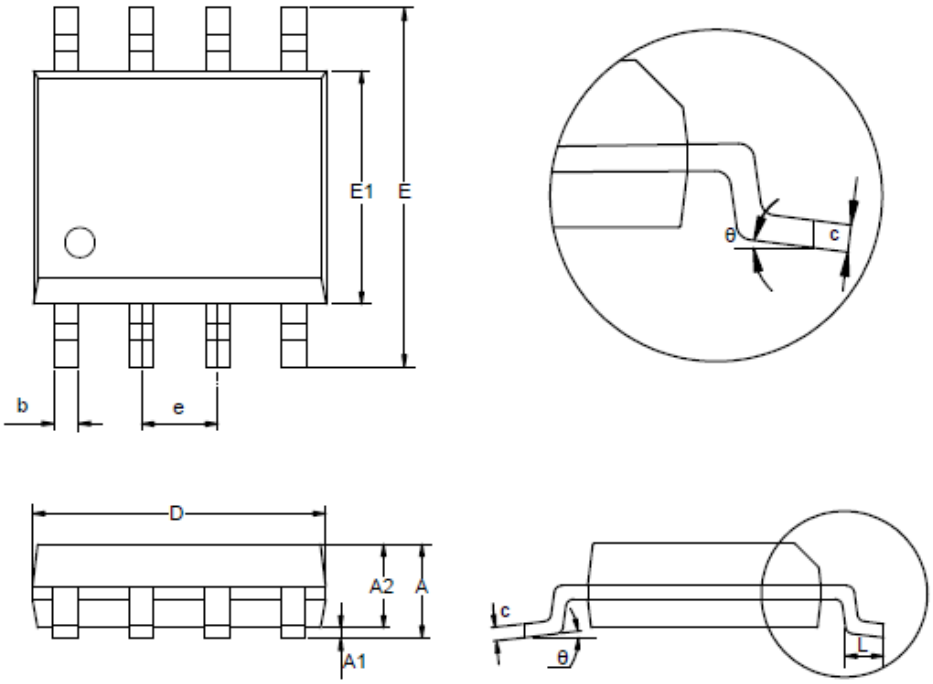
Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm) (1)	B0 (mm) (1)	K0 (mm) (1)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPH1021N-SO1R	SOP-8-A	330	17.6	6.5	5.4	2	8	12	Q1

(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	0.100	0.250	0.004	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
TPH1021N-SO1R	−40 to 125°C	SOP8	1021N	MSL1	Tape and Reel,4000	Green

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

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