High Voltage, Precision, Zero-drift, Instrumentation Amplifier

The HT8421 is a low cost, wide supply range instrumentation amplifier that requires only one external resistor to set any gain between 1 and 1,000. The HT8421 is designed to work with a variety of single voltages. A wide input range and rail-to-rail output allow the signal to make full use of the supply rails. Low voltage offset, low offset drift, low gain drift, high gainaccuracy, and high CMRR make this part an excellent choicein applications that demand the best DC performance.The HT8421 operates from single 4V to 36V supply, offers breakthrough performance throughout the −40°C to +125°C temperature range. It features a zero-drift core, which leads to a typical offset drift of 0.2µV/ °C throughout the operating temperature range.

Features

Excellent DC specifications

Small voltage offset: ±50uV (MAX)

Small voltage offset drift: 0.2µV/°C (MAX) Small input bias current: 1.5nA (MAX)

Excellent AC specifications

CMRR: 80dB @ G=1 (MIN)

Small input noise: 15nV/√Hz @ G=10

Input noise (0.1 Hz to 10 Hz): 1 µV p-p

-3dB Bandwidth: 1.6MHz

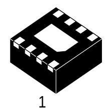
Slew rate: 5V/us

Gain set with 1 external resistor (gain range 1 to 1,000)

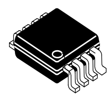
SUPPLY VOLTAGE: ±2V to ±18V

RAIL to RAIL for VOLTAGE OUTPUT

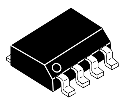
Operating Temperature: –45°C to +125°C



DFN8-3*3 D SUFFIX
HT8421BRDZ



MSOP−8 M SUFFIX
HT8421ARMZ
HT8421BRMZ



SOP8 R SUFFIX
HT8421ARZ
HT8421BRZ

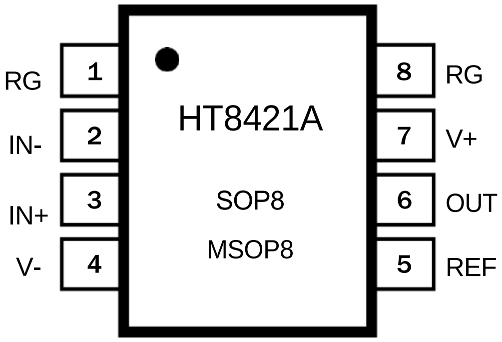
Resin material T_A = -45° to 125°C

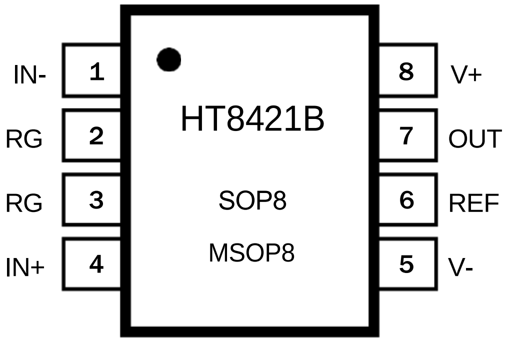
Ceramic materials T_A = -55° to 150°C

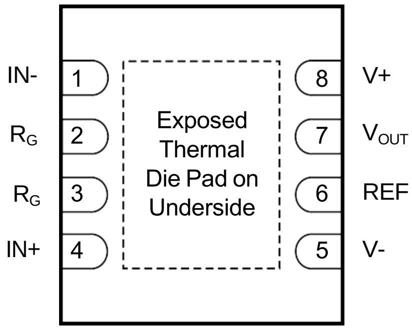
Applications

Weigh scales for bridge amplifiers
Medical and ECG Amplifiers
Industrial Process Control
Precision data acquisition system
Pressure sensors

Pin Configuration







HT8421B

PIN NAME	DESCRIPTION
IN-	Negative Input
IN+	Positive Input.
RG	Gain setting
VREF	Reference Input.
OUT	Output
V+	Positive power supply
V-	Negative power supply
Thermal pad	Exposed thermal die pad is internally connected to –Vs. Connect externally to –Vs or leave floating.

Absolute Maximum Ratings Note 1

Supply Voltage V

Input Voltage .... (V-) – 0.3 to (V+) + 0.3V

Differential Input Voltage.................................. (V+) – (V-)

Input Current: IN+, IN- Note 2...±10mA

Operating Temperature Range .... 40°C to 125°C

Maximum Working Junction Temperature....... 150°C

Storage Temperature Range............... 65°C to 150°C

Lead Temperature (Soldering, 10 sec)............. 260°C

Note 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.

Note 2: The inputs are protected by ESD protection diodes to power supply.

ESD, Electrostatic Discharge Protection

Symbol	Parameter	Condition	Minimum Level	Unit
HBM	Human Body Model ESD	ANSI/ESDA/JEDEC JS-001	3	kV
CDM	Charged Device Model ESD	ANSI/ESDA/JEDEC JS-002	1.5	kV

Thermal Resistance

Package Type	θ_{JA}	θ_{JC}	Unit
8-Pin SOP8	158	43	°C/W
8-Pin MSOP8	210	45	°C/W
DFN3X3-8	51	60	°C/W

Electrical Characteristics

The specifications are at TA = 25°C, V+ = +15V, V- = -15V, REF = 0V, unless otherwise noted

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
INPUT						
V_{OSI}	Input Stage Offset Voltage	At RTI		±10	±50	μV
		At RTI, -40°C to 125°C		±0.1	±0.2	μV/°C
V_{OSO}	Output Stage Offset Voltage	At RTI		±100	±300	μV
		At RTI, -40°C to 125°C		±0.2	±0.3	μV/°C
V_{OS}	Offset Voltage	At RTI		±10 ±100/G	±50 ±300/G	μV
V_{OS} TC	Input Offset Voltage Drift	-40°C to 125°C			±0.2 ±0.3/G	μV/°C
V_{CM}	Common-mode Input Range	-40°C to 125°C	(V-) +0.1		(V+) - 1.5	V
CMRR	Common Mode Rejection Ratio	CMRR at DC, G=1	80	100		dB
		CMRR at DC, G=10	100	120		dB
		CMRR at DC, G=100	110	130		
		CMRR at DC, G=1000	120	140		
I_B	Input Bias Current			0.3	1.5	nA
		-40°C to 125°C		10		pA/°C
I_{OS}	Input Offset Current			0.3	1.5	nA
		-40°C to 125°C		10		pA/°C
Input impedance	Input impedance	Differential		57||6		GΩ||pF
		Common mode		44||14		GΩ||pF
PSRR	Power Supply Rejection Ratio	G=1	100	120		dB
		G=10	110	130		dB
		G=100	120	138		dB
		G=1000	130	140		dB
RIN	Reference input			20		kΩ
NOISE RTI						
e_n	Input Voltage Noise Density	f = 1kHz，G=10		15		nV/√Hz
		f = 0.1Hz to 10Hz, G=1		1		μV p-p
OUTPUT						
G	G = 1 + (49.4 kΩ/RG)		1		1000	V/V
GE	Gain Error	G=1		±0.01%	±0.05%	
		G=10		±0.1%	±0.15%	
		G=100		±0.1%	±0.2%	
		G=1000		±0.3%	±0.6%	
G TC	Gain Vs Temperature	-40°C to 125°C, G=1		1	5	ppm/°C

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
I_{SC}	Short circuit current	-40°C to 125°C		±70		mA
V_{OH}	Output Swing from Supply Rail	-40°C to 125°C, R_L = 10 kΩ		0.12	0.2	V
V_{OL}	Output Swing from Supply Rail	-40°C to 125°C, R_L = 10 kΩ		0.05	0.1	V
FREQUENCY RESPONSE						
BW	-3dB Bandwidth	G=1		1600		kHz
		G=10		400		kHz
		G=100		100		kHz
		G=1000		11		kHz
ST	Setting time to 0.01%	G=1		2.1		μs
SR	Slew Rate	G=1		5		V/μs
		G=100		2.5		V/μs
POWER SUPPLY						
V+	Supply Voltage		±2		±18	V
I_Q	Quiescent Current			3.8	4.5	mA
TEMPERATURE RANGE						
Specified range			-40		125	°C

Typical Performance Characteristics

The HT8421 is used for characteristics at TA = 25°C, Vs = ±15V, RL = 10 kΩ, unless otherwise noted.

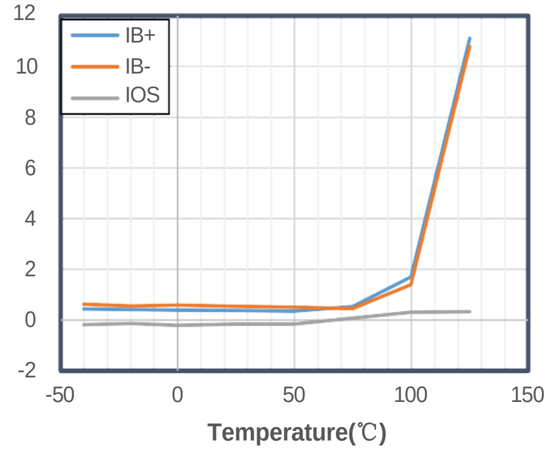


Figure 1 IB Vs. Temperature

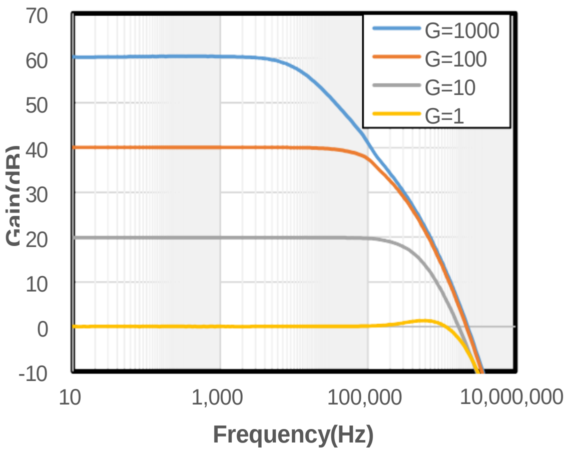


Figure 2 Gain Vs. Frequency

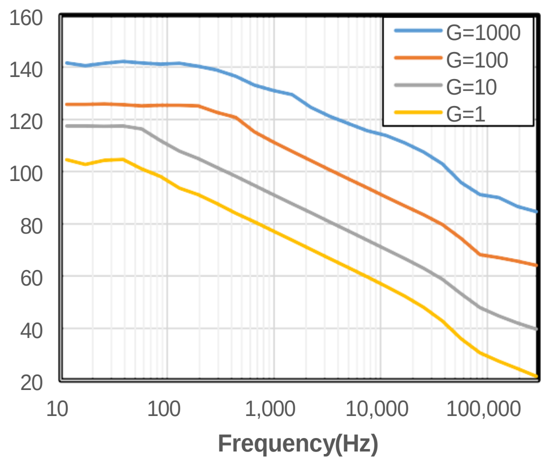


Figure 3 Positive PSRR Vs. Frequency

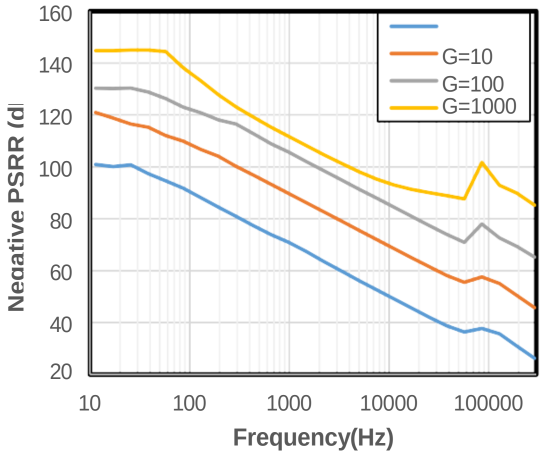


Figure 4 Negative PSRR Vs. Frequency

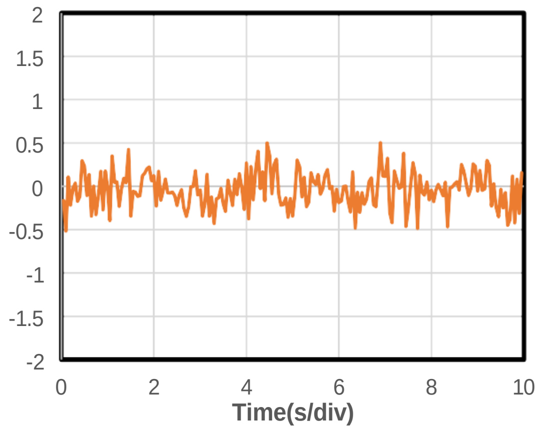


Figure 5 0.1Hz to 10Hz RTI Noise

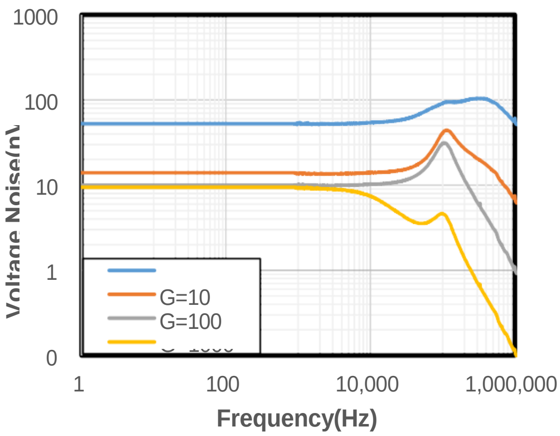


Figure 6 Noise Density Vs Frequency

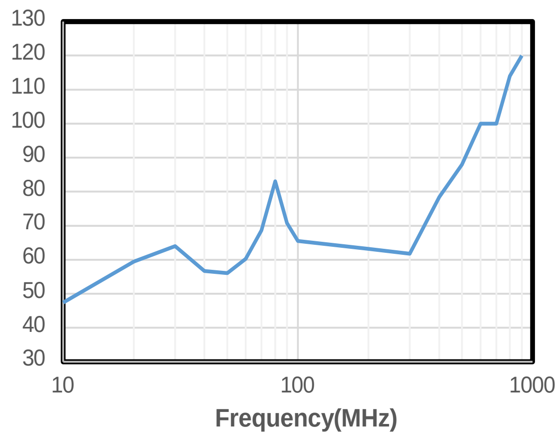


Figure 7 EMIRR

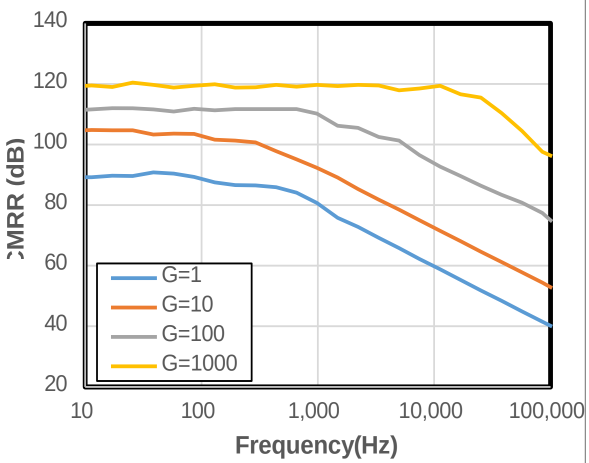


Figure 8 CMRR Vs. Frequency

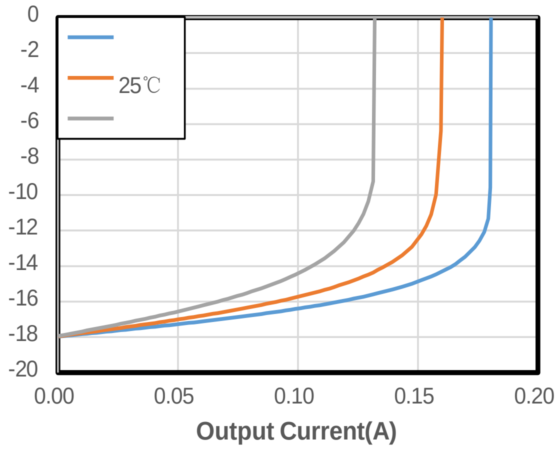


Figure 9 Negative Output Voltage Swing
Vs. Output Voltage

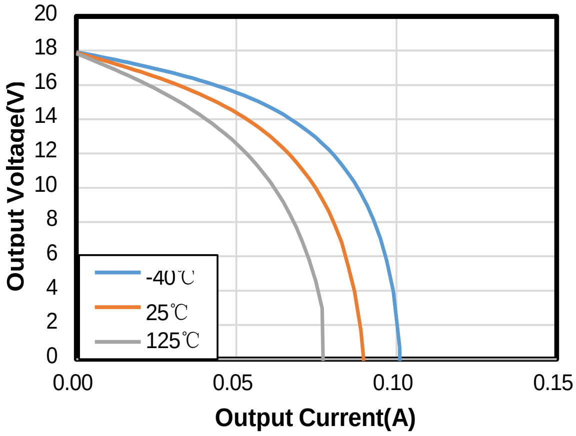


Figure 10 Positive Output Voltage Swing
Vs. Output Voltage

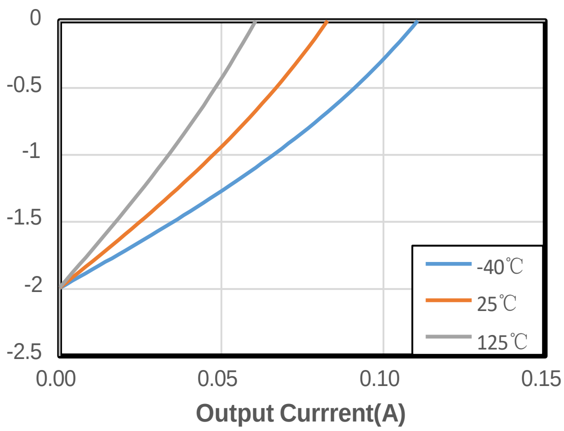


Figure 11 Negative Output Voltage Swing
Vs. Output Voltage

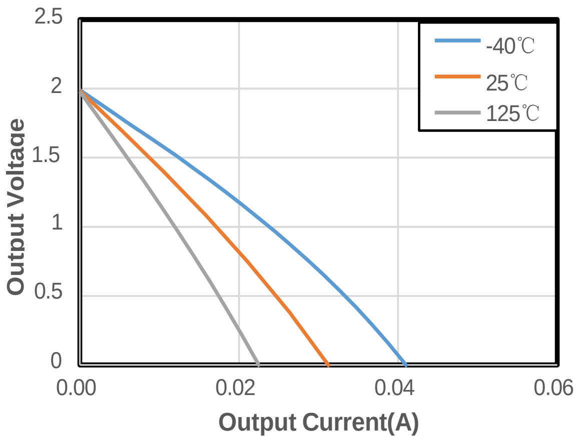


Figure 12 Positive Output Voltage Swing
Vs. Output Voltage

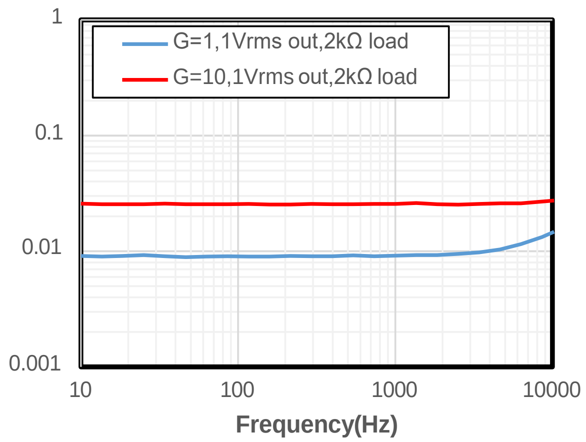


Figure 13 THD + N Vs. Frequency

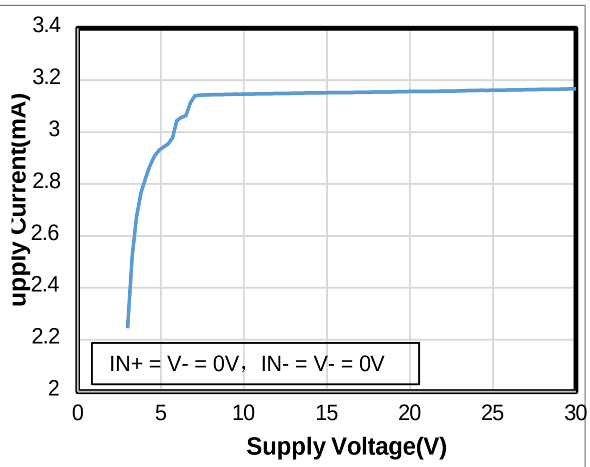


Figure 14 Supply Current Vs. Voltage

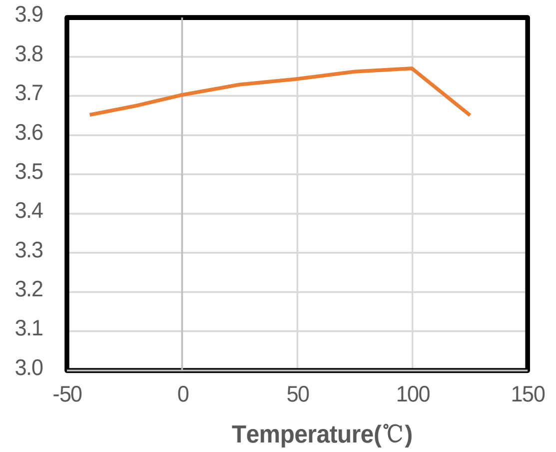


Figure15 Supply Current Vs. Temp

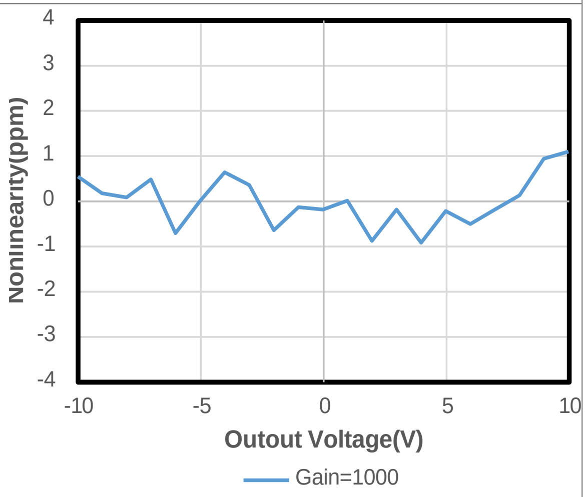


Figure 16 Gain Nonlineraity

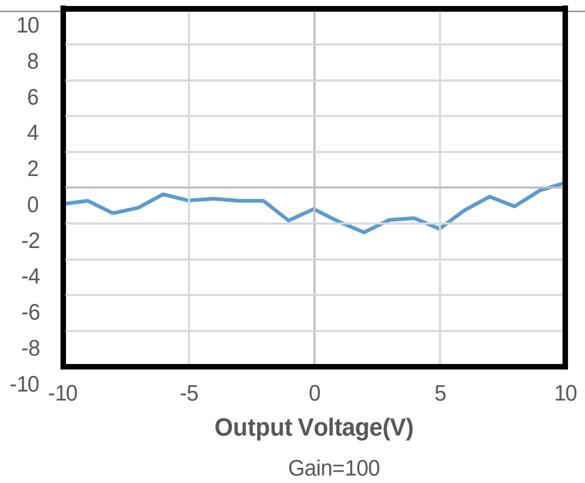


Figure 17 Gain Nonlinearity

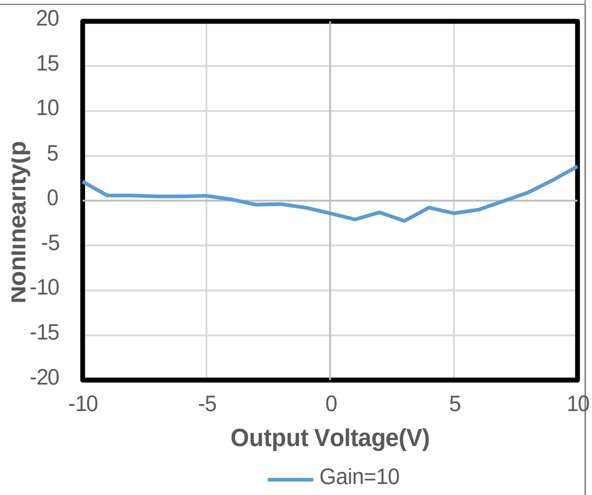


Figure 18 Gain Nonlinearity

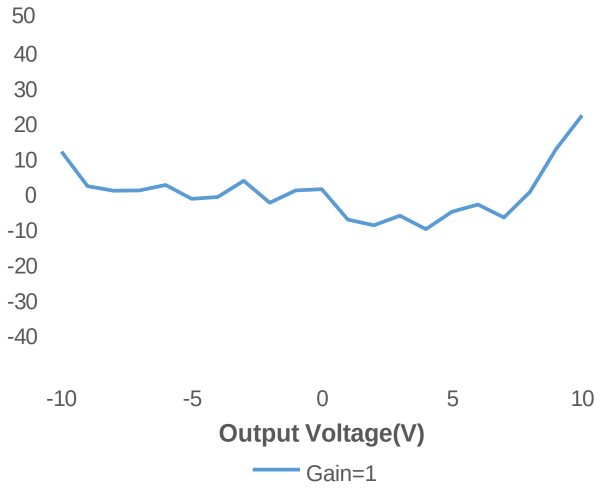


Figure 19 Gain Nonlinearity

Voltage: 2V/div for Output, Time: 10us/div G=1, VREF = GND; VIN=10VPP, Load R=10K

Figure 20 Slew Rate

Voltage: 5V/div for Output, Time: 2us/div G=10, VREF = GND; VIN=10VPP, Load R=10K C=100pF

Figure 21 Positive Overload Recovery

Voltage: 5V/div for Output, Time: 2us/div G=10, VREF = GND; VIN=10VPP, Load R=10K C=100pF

Figure 22 Negative Overload Recovery

Voltage: 2V/div for Output, Time: 10us/div G=1, VREF = GND; VIN=10VPP, Load R=10K C=100pF

Figure 23 Large-Signal Pulse Response

Voltage: 2V/div for Output, Time: 20us/div G=10, VREF = GND; VIN=1VPP, Load R=10K C=100pF

Figure 24 Large-Signal Pulse Response

Voltage: 2V/div for Output, Time: 20us/div G=100, VREF = GND; VIN=0.1VPP, Load R=10K C=100pF

Figure 25 Large-Signal Pulse Response

Voltage: 2V/div for Output, Time: 50us/div G=1000, VREF = GND; VIN=10mVPP, Load R=10K C=100pF

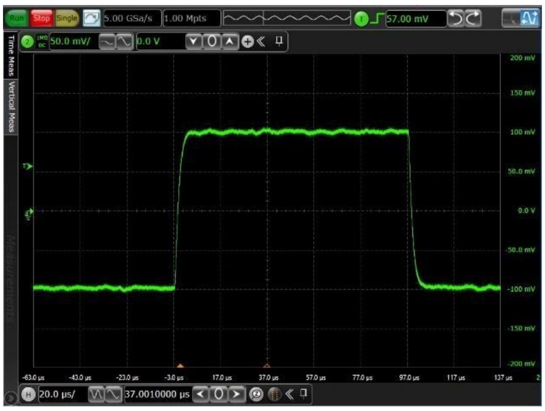
Figure 26 Large-Signal Pulse Response

Voltage: 25mV/div for Output, Time: 10us/div G=1, VREF = GND; VIN=100mVPP, Load R=10K C=100pF

Figure 27 Small-Signal Pulse Response

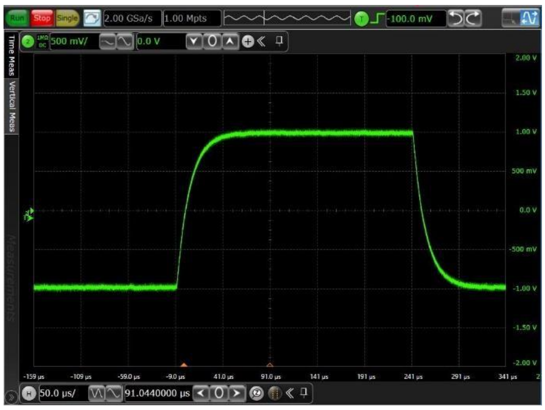
Voltage: 20mV/div for Output, Time: 20us/div G=10, VREF = GND; VIN=10mVPP, Load R=10K C=100pF

Figure 28 Small-Signal Pulse Response



Voltage: 50mV/div for Output, Time: 20us/div G=100, VREF = GND; VIN=2mVPP, Load R=10K C=100pF

Figure 29 Small-Signal Pulse Response



Voltage: 500mV/div for Output, Time: 50us/div G=10, VREF = GND; VIN=2mVPP, Load R=10K C=100pF

Figure 30 Small-Signal Pulse Response

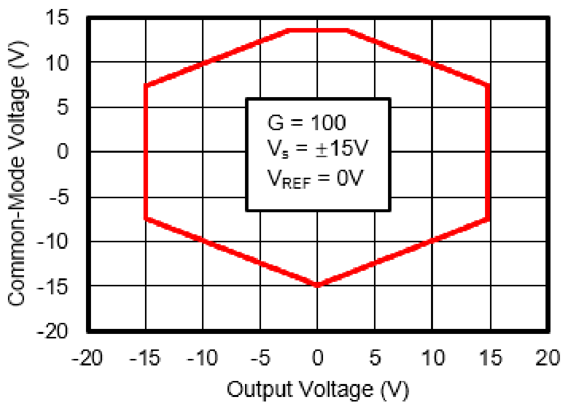


Figure 31 Input Common-Mode Range vs. Output Voltage

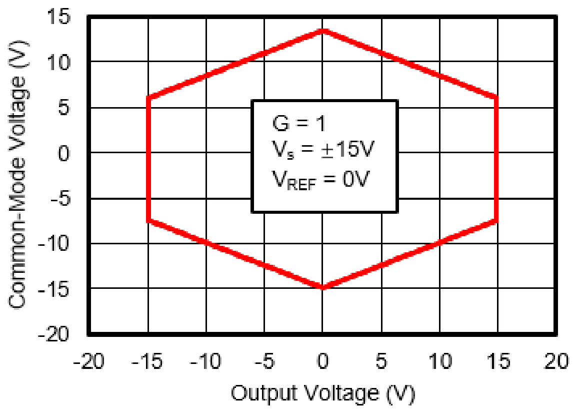


Figure 32 Input Common-Mode Range vs. Output Voltage

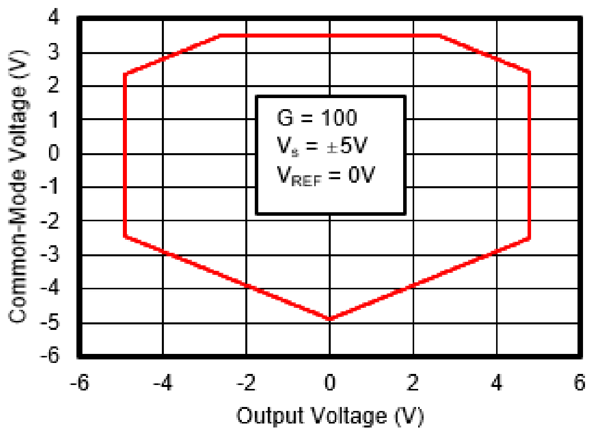


Figure 33 Input Common-Mode Range vs. Output Voltage

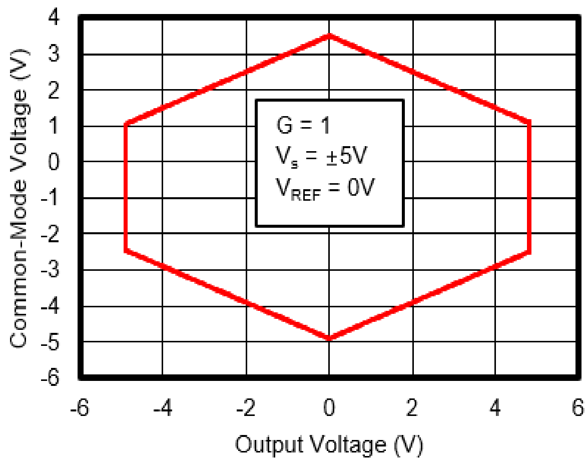


Figure 34 Input Common-Mode Range vs. Output Voltage

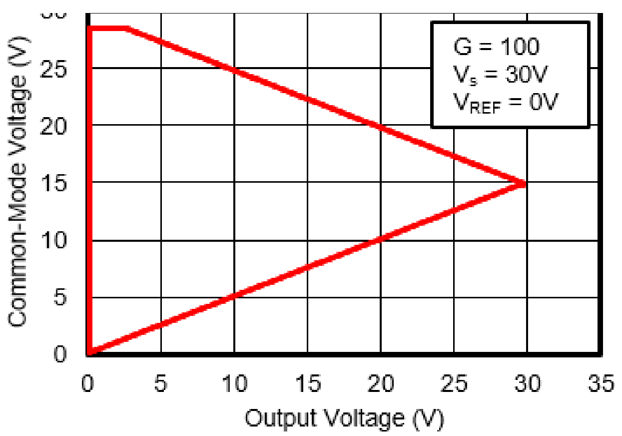


Figure 35 Input Common-Mode Range vs. Output Voltage

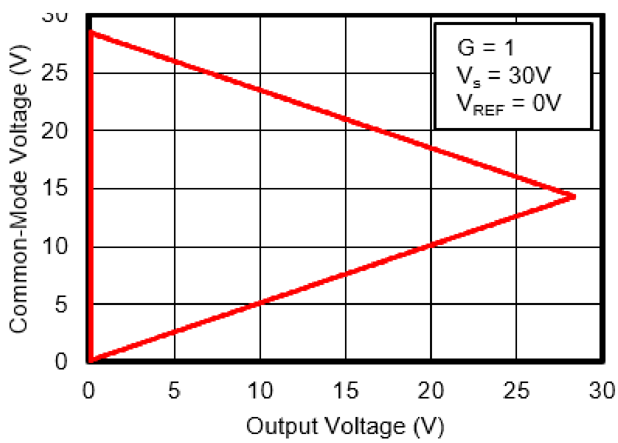


Figure 36 Input Common-Mode Range vs. Output Voltage

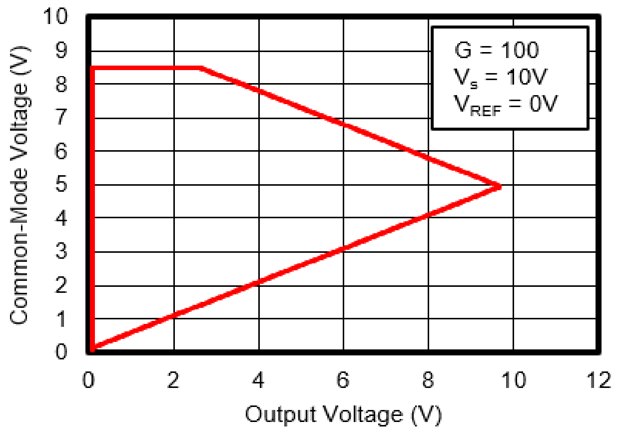


Figure 37 Input Common-Mode Range vs. Output

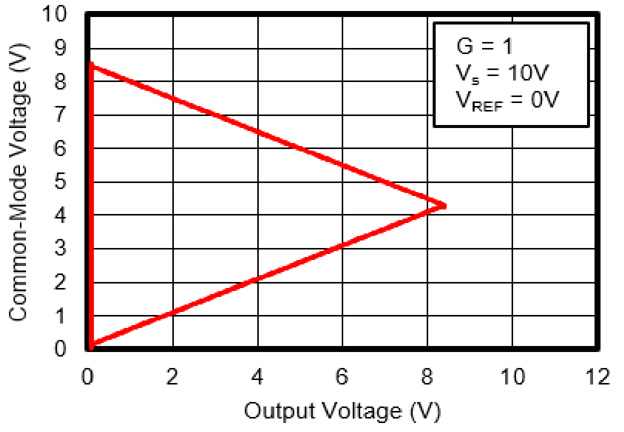


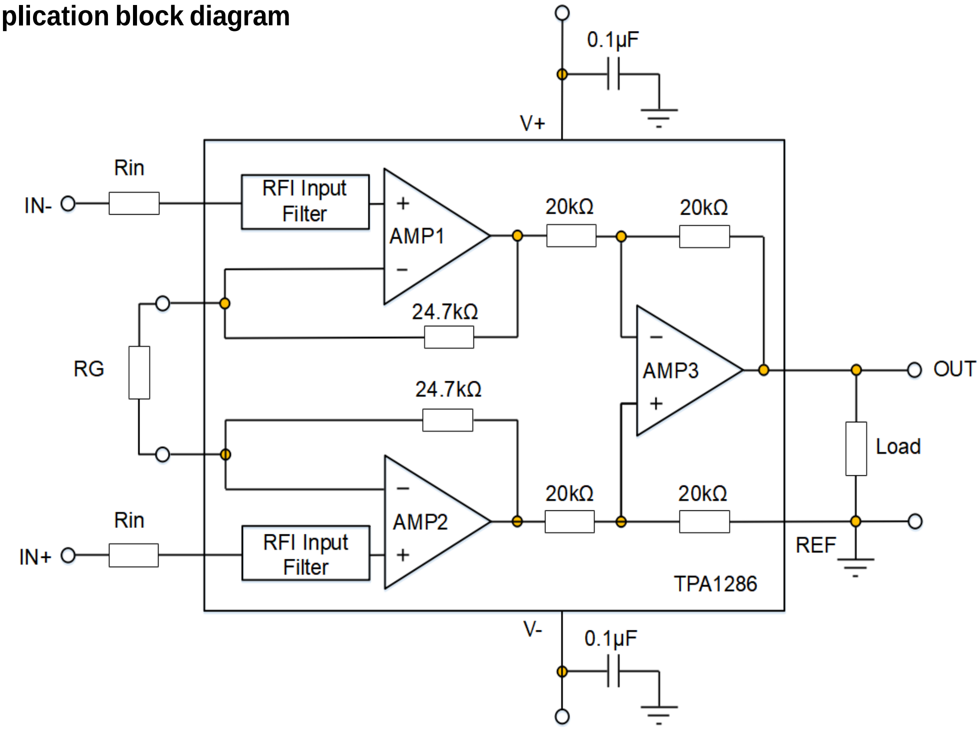
Figure 38 Input Common-Mode Range vs. Output

The HT8421 is a monolithic instrumentation amplifier (INA) based on the high voltage, precision zero-drift OPA core, and classic 3-op amp topology. The HT8421 also integrates precision resistors to ensure excellent common mode rejection and low gain error. The combination of the zero-drift amplifier core and the precision resistors allows this device to achieve outstanding dc precision and makes the HT8421 ideal for many high-voltage industrial applications.

A unique pinout of the HT8421B enable to meet a good CMRR specification. The balanced pinout reduces the parasitic that had adversely affected CMRR performance. In addition, this pinout simplifies board layout because associated traces are grouped together. For example, the gain setting resistor pins are adjacent to the inputs, and the reference pin is next to the output.

Applications Information

HT8421 Application block diagram



Selecting GAIN Resistor

The gain of the HT8421 is set by a single external resistor, RG, connected between RG pins. The value of RG is selected according to below Equation. HT8421 can be set as G = 1 when no gain resistor is used. Gain accuracy is determined by the accuracy of RG. The stability and temperature drift of the external gain setting resistor, RG, also affects gain. The contribution of RG to gain accuracy and drift can be determined from below equation.

$$G = 1 + \frac{49.4\text{k}}{\text{RG}}$$

As shown in above Figure, the reference pin, REF, is connected with a 20 kΩ resistor. The output of the instrumentation amplifier is referenced to the voltage on the REF pin; this is useful when the output signal needs to be offset to a precise mid-supply level. For example, a voltage source can be tied to the REF pin to level-shift the output so that the HT8421 can interface with an ADC. For best performance, source impedance to the REF pin should be kept as low as possible, because parasitic resistance can adversely affect CMRR and gain accuracy. PCB Layout should be very careful to tie REF to the appropriate local cleaning ground.

Power Supply Recommendation

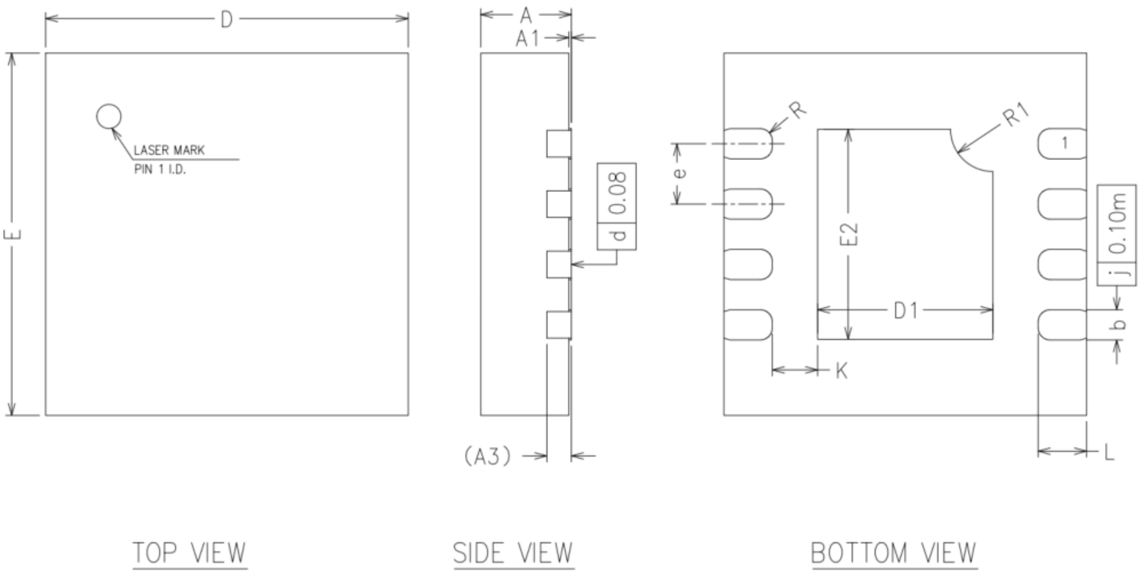
A stable and cleaning dc voltage should be used to be as power supply of the instrumentation amplifier, which noise on the supply pins can affect performance. Bypass capacitors should be used to decouple the amplifier. A 0.1 μF capacitor should be placed close to each supply pin.

Proper Board Layout

To maximizes system performance, careful board layout is needed. Traces from the gain setting resistor to the RG pins should be kept as short as possible to minimize parasitic inductance. To ensure the most accurate output, the trace from the REF pin should either be connected to the local ground of the HT8421, or connected to a voltage that is referenced to the local ground of the HT8421

Package Dimensions

Package: DFN8-3*3

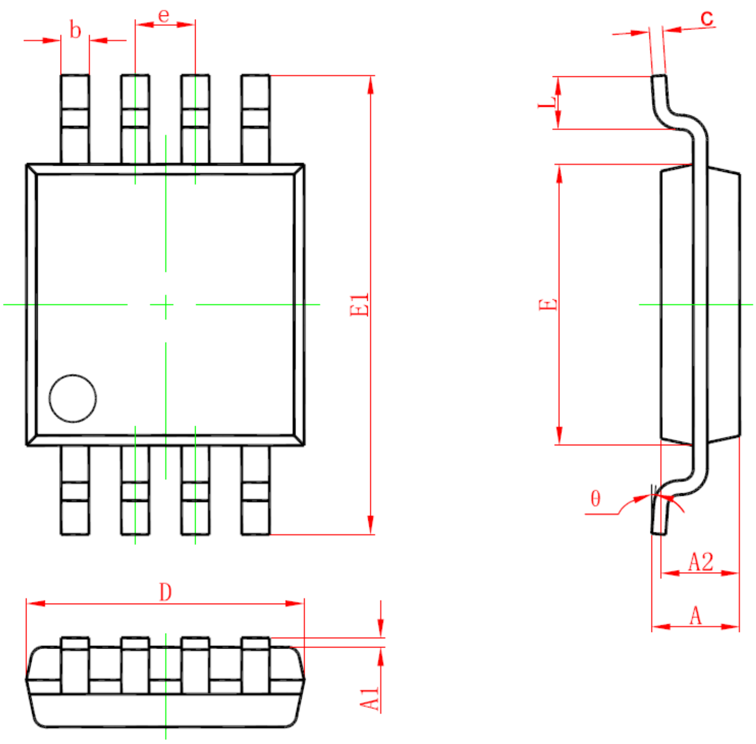


(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	0.00	0.02	0.05
A3	0.203REF		
b	0.20	0.25	0.30
D	2.90	3.00	3.10
E	2.90	3.00	3.10
D2	1.35	1.45	1.55
E2	1.64	1.74	1.84
e	0.40	0.50	0.60
K	0.275	0.375	0.475
L	0.30	0.40	0.50
R	0.10REF		
R1	0.35REF		

Package Dimensions

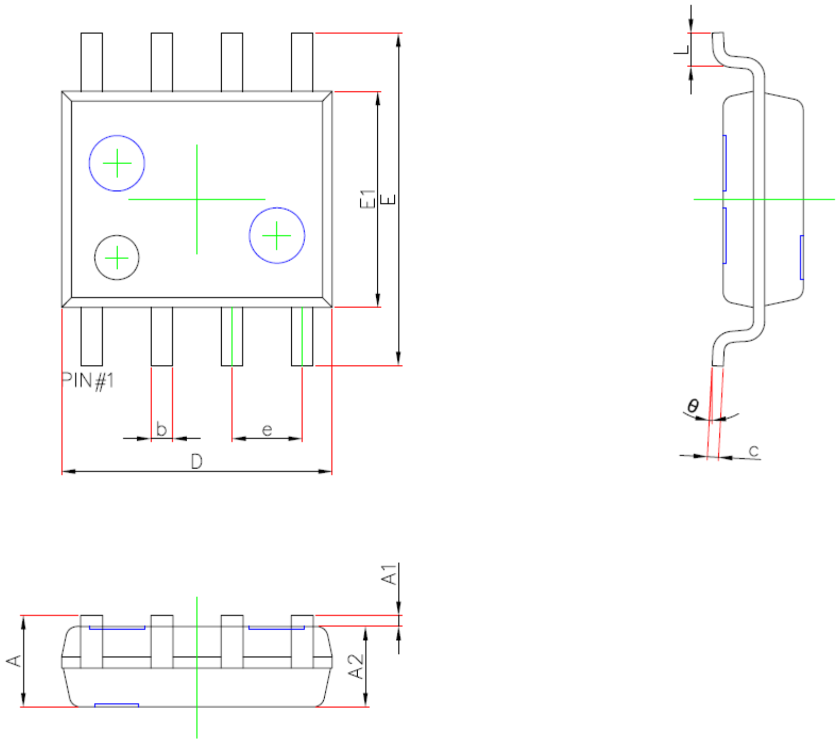
Package: MSOP-8



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0. 820	1. 100	0. 032	0. 043
A1	0. 020	0. 150	0. 001	0. 006
A2	0. 750	0. 950	0. 030	0. 037
b	0. 250	0. 380	0. 010	0. 015
c	0. 090	0. 230	0. 004	0. 009
D	2. 900	3. 100	0. 114	0. 122
e	0.650(BSC)		0.026(BSC)	
E	2. 900	3. 100	0. 114	0. 122
E1	4. 750	5. 050	0. 187	0. 199
L	0. 400	0. 800	0. 016	0. 031
θ	0°	6°	0°	6°

Package Dimensions

Package: SOP8



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	1.350	1.550	0.053	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	0.800	0.016	0.031
θ	0°	8°	0°	8°