INA2128 デュアル、低消費電力計測アンプ

1 特長

- 低いオフセット電圧:50µV (最大値)
- 低いドリフト:0.5µV/℃ (最大値)
- 低い入力バイアス電流:5nA (最大値)
- 入力電圧ノイズ:1kHz で 8nV/√Hz
- 広い帯域幅:GDIFF = 1V/V で 1.3MHz
- 高い CMR:120dB (最小値)
- ±40V までの入力保護
- 広い電源電圧範囲:±2.25V～±18V
- 低い静止電流:700µA (チャネルあたり)
- 温度範囲:-40℃～+85℃
- パッケージ:16 ピン SOIC

2 アプリケーション

- 圧力トランスミッタ
- 温度トランスミッタ
- 重量計
- 心電図 (ECG)
- アナログ入力モジュール
- データ・アクイジション (DAQ)

3 概要

INA2128 は、精度の優れた低消費電力のデュアル汎用計測アンプ (IA) です。本デバイスは、用途が広い 3 オペアンプ設計を採用しており、サイズが小型であるため、広範なアプリケーションに非常に適しています。電流帰還入力回路により、高いゲインでも広い帯域幅が得られます (G = 100 で 200kHz)。単一の外付け抵抗により、1～10,000 の範囲で任意のゲインを設定できます。内部入力保護機能は、損傷なしに ±40V まで耐えられます。

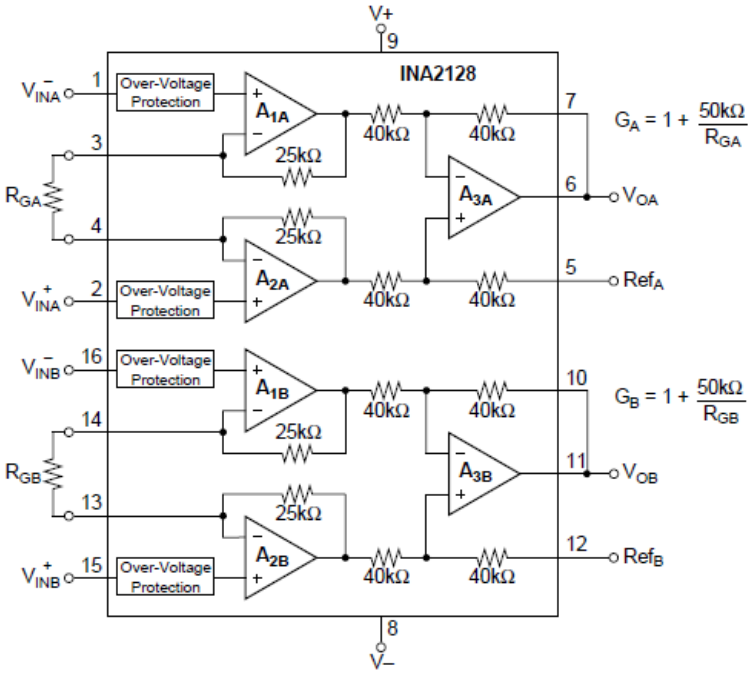
INA2128 はレーザー・トリムにより、非常に低いオフセット電圧 (50µV) とドリフト係数 (0.5µV/℃)、高い同相除去 (G ≥ 100 で 120dB) を実現しています。このデバイスは最低 ±2.25V の電源で動作し、静止電流は IA あたりわずか 700µA であるため、バッテリ駆動の複数チャネル・システムに理想的です。

INA2128 は、SOIC-16 パッケージで供給され、-40℃～+85℃で動作が規定されています。

パッケージ情報

部品番号	パッケージ (1)	パッケージ・サイズ (2)
INA2128	DW (SOIC、16)	10.3mm x 10.3mm

(1) 利用可能なパッケージについては、このデータシートの末尾にある注文情報を参照してください。
(2) パッケージ・サイズ (長さ×幅) は公称値であり、該当する場合はピンも含まれます。



概略回路図

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4 Revision History

資料番号末尾の英字は改訂を表しています。その改訂履歴は英語版に準じています。

Changes from Revision A (April 2007) to Revision B (May 2023)	Page

- ドキュメント全体にわたって表、図、相互参照の採番方法を更新 ... 1
- 「パッケージ情報」表、「ピン構成および機能」セクション、「仕様」セクション、「詳細説明」セクション、「アプリケーションと実装」セクション、「デバイスおよびドキュメントのサポート」セクション、「メカニカル、パッケージ、および注文情報」セクションを追加 ... 1
- 「特長」に入力電圧ノイズ、高帯域幅、および温度範囲の箇条書き項目を追加 ... 1
- 正しいパッケージ名を示すように「特長」の箇条書き項目を変更 ... 1
- 更新されたリンクを示すよう「アプリケーション」の箇条書き項目を変更 ... 1
- 「パッケージ情報」表の列名を本体サイズ (NOM) からパッケージ・サイズに変更し、パッケージ・サイズに関する注を追加 ... 1
- Added single supply specification to *Absolute Maximum Ratings* ... 5
- Added note clarifying output short-circuit to ground in *Absolute Maximum Ratings* refers to short-circuit to VS / 2 ... 5
- Added single supply specification to *Recommended Operating Conditions* ... 5
- Changed input common-mode voltage range specification from V – 2 to (V–) + 2 in *Recommended Operating Conditions* ... 5
- Deleted INA128-HT and INA129-HT operating temperature specifications from *Recommended Operating Conditions* ... 5
- Added specified temperature range to *Recommended Operating Conditions* ... 5
- Added test conditions below *Electrical Characterstics* title ... 6
- Changed test condition for offset voltage drift specification in *Electrical Characteristics* from "TA = TMIN to TMAX" to " TA = –40°C to +85°C" for clarity ... 6
- Changed "±0.5±0/G" to "±0.5±20/G" in MAX column of Offset voltage RTI vs temperature row of *Electrical Characteristics* ... 6
- Changed typical long-term stability specification from ±0.1±3/GµV/mo to ±0.2±3/GµV/mo in *Electrical Characteristics* ... 6
- Deleted typical specification and changed common-mode voltage specification from (V–) + 2 V minimum and (V+) – 2 V maximum across one row in Electrical Characteristics ... 6
- Deleted typical VCM specifications in *Electrical Characteristics* ... 6
- Added test condition of "RS = 0 Ω" to safe input voltage specification in *Electrical Characteristics* for clarity ... 6
- Changed parameter name to Input bias current and added test condition "TA = –40°C to +85°C" to input bias current drift specification in *Electrical Characteristics* for clarity ... 6
- Changed parameter name to Input offset current drift and added test condition "TA = –40°C to +85°C" to input offset current drift specification in *Electrical Characteristics* for clarity ... 6

- Changed maximum gain error specification for INA128PA/UA and INA129PA/UA with G = 1 from ±0.01% to ±0.1% in *Electrical Characteristics* 6
- Changed parameter name to Gain drift and added test condition "TA = –40°C to +85°C" for gain drift in *Electrical Characteristics* for clarity..... 6
- Changed parameter names from "Voltage - Positive" to "Positive output voltage swing" and from "Voltage - Negative" to "Negative output voltage swing" in *Electrical Characteristics* 6
- Deleted typical positive and negative output voltage swing specifications in *Electrical Characteristics* 6
- Added test condition "Continuous to VS / 2" short-circuit current specification in *Electrical Characteristics* for clarity..... 6
- Changed typical bandwidth specification for G = 10 from 700 kHz to 600 kHz in *Electrical Characteristics* 6
- Changed typical slew rate specification from 4 V/µs to 1.2 V/µs in *Electrical Characteristics* 6
- Changed typical settling time specification for G = 1, G = 10, from 7 µs to 9 µs in *Electrical Characteristics* 6
- Deleted parameter "Temperature Range" as made redundant by *"Recommended Operating Conditions"* and *"Absolute Maximum Ratings"* 6
- Changed parameter name to "Total quiescent current" and deleted redundant voltage range, operating temperature range, and specification temperature range specifications from *Electrical Characteristics* 6
- Added test conditions below the *Typical Characteristics* title..... 8
- Changed Figure 6-1, *Gain vs Frequency* 8
- Changed Figure 6-3, *Positive Power Supply Rejection vs Frequency* 8
- Changed Figure 6-4, *Negative Power Supply Rejection vs Frequency* 8
- Changed Figure 6-7, *Crosstalk vs Frequency* 8
- Changed Figure 6-8, *Input-Referred Voltage Noise vs Frequency* 8
- Changed Figure 6-9, *Settling Time vs Gain* 8
- Changed Figure 6-11, *Input Overvoltage V/I Characteristics* 8
- Changed Figure 6-12, *Offset Voltage Warm-Up* 8
- Changed *Output Voltage Swing vs Output Current*, into two separate plots, one for positive (Figure 6-14) and one for negative (Figure 6-15)..... 8
- Changed Figure 6-22 to Figure 6-24, *Large-Signal Step Response* 8

5 Pin Configuration and Functions

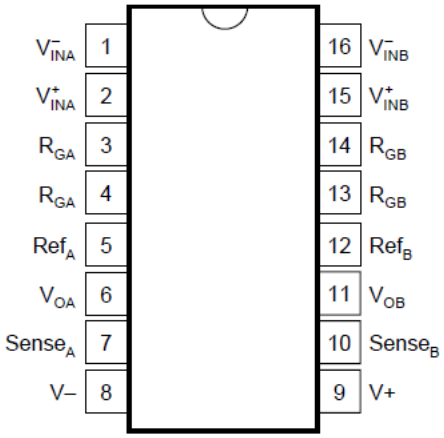


図 5-1. DW Package, 16-Pin SOIC (Top View)

6 Specifications

6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)(1)

			MIN	MAX	UNIT
V_S	Supply voltage	Dual supply, V_S = (V+) – (V–)		±18	V
		Single supply, V_S = (V+) – 0 V		36	
	Analog input voltage			±40	V
	Output short-circuit(2)		Continuous		
T_A	Operating temperature		–40	125	°C
	Junction temperature			150	°C
	Lead temperature (soldering, 10 s)			300	°C
T_{stg}	Storage temperature		–55	125	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) Short-circuit to V_S / 2.

6.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)	±2000	V
		Charged-device model (CDM), per JEDEC specification JESD22-C101(2)	±50	

(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.

6.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

			MIN	TYP	MAX	UNIT
V_S	Supply voltage	Single-supply	4.5	30	36	V
		Dual-supply	±2.25	±15	±18	
	Input common-mode voltage range for V_O = 0 V		(V–) + 2		(V+) – 2	V
T_A	Specified temperature		–40		85	°C

6.4 Thermal Information

THERMAL METRIC(1)		INA12x		UNIT
		D (SOIC)	P (PDIP)	
		8 PINS	8 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	110	46.1	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	57	34.1	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	54	23.4	°C/W
ψ_{JT}	Junction-to-top characterization parameter	11	11.3	°C/W
ψ_{JB}	Junction-to-board characterization parameter	53	23.2	°C/W

(1) For more information about traditional and new thermal metrics, see the Semiconductor and IC Package Thermal Metrics application report.

6.5 Electrical Characteristics

at T_A = 25°C, V_S = ±15 V, R_L = 10 kΩ, V_{REF} = 0 V, V_{CM} = V_S / 2, and G = 1 (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
INPUT								
V_{OS}	Offset voltage (RTI)	INA2128U				±10 ±100 / G	±50 ±500 / G	µV
		INA2128UA				±25 ±100 / G	±125 ±1000 / G	
	Offset voltage drift (RTI)	T_A = –40°C to +85°C	INA2128U			±0.2 ±2 / G	±0.5 ±20 / G	µV/°C
			INA2128UA			±0.2 ±5 / G	±1 ±20 / G	
PSRR	Power-supply rejection ratio (RTI)	V_S = ±2.25 V to ±18 V	INA2128U			±0.2 ±20 / G	±1 ±100 / G	µV/V
			INA2128UA			±0.2 ±20 / G	±2 ±200 / G	
	Long-term stability					±0.2 ±3 / G		µV/mo
	Input impedance	Differential				10 || 2		GΩ || pF
		Common-mode				100 || 9		
V_{CM}	Common-mode voltage[1]	V_O = 0 V			(V–) + 2		(V+) – 2	V
	Safe input voltage	R_S = 0 Ω					±40	V
CMRR	Common-mode rejection ratio	ΔR_S = 1 kΩ, V_{CM} = ±13 V	G = 1	INA2128U	80	86		dB
				INA2128UA	73	86		
			G = 10	INA2128U	100	106		
				INA2128UA	93	106		
			G = 100	INA2128U	120	125		
				INA2128UA	110	125		
			G = 1000	INA2128U	120	130		
				INA2128UA	110	130		
INPUT BIAS CURRENT								
I_B	Input bias current	INA2128U				±2	±5	nA
		INA2128UA				±2	±10	
	Input bias current drift	T_A = –40°C to +85°C				±30		pA/°C
I_{OS}	Input offset current	INA2128U				±1	±5	nA
		INA2128UA				±1	±10	
	Input offset current drift	T_A = –40°C to +85°C				±30		pA/°C
NOISE								
e_N	Voltage noise (RTI)	G = 1000, R_S = 0 Ω	f = 10 Hz			10		nV/√Hz
			f = 100 Hz			8		
			f = 1 kHz			8		
			f_B = 0.1 Hz to 10 Hz			0.2		μV_{PP}
	Current noise	f = 10 Hz				0.9		pA/√Hz
		f = 1 kHz				0.3		
		f_B = 0.1 Hz to 10 Hz				30		pA_{PP}

6.5 Electrical Characteristics (continued)

at T_A = 25°C, V_S = ±15 V, R_L = 10 kΩ, V_{REF} = 0 V, V_{CM} = V_S / 2, and G = 1 (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
GAIN							
	Gain equation				1 + (50 kΩ / R_G)		V/V
G	Gain			1		10000	V/V
GE	Gain error	G = 1	INA2128U		±0.01	±0.024	%
			INA2128UA		±0.01	±0.1	
		G = 10	INA2128U		±0.02	±0.4	
			INA2128UA		±0.02	±0.5	
		G = 100	INA2128U		±0.05	±0.5	
			INA2128UA		±0.05	±0.7	
		G = 1000	INA2128U		±0.5	±1	
			INA2128UA		±0.5	±2	
	Gain drift(2)	T_A = –40°C to +85°C			±1	±10	ppm/°C
			50-kΩ or 49.4-kΩ resistance(3)		±25	±100	
	Gain nonlinearity	G = 1, V_O = ±13.6 V	INA2128U		±0.0001	±0.001	% of FSR
			INA2128UA		±0.0001	±0.002	
		G = 10	INA2128U		±0.0003	±0.002	
			INA2128UA		±0.0003	±0.004	
		G = 100	INA2128U		±0.0005	±0.002	
			INA2128UA		±0.0005	±0.004	
		G = 1000(4)			±0.001		
OUTPUT							
	Positive output voltage			(V+) – 1.4			V
	Negative output voltage			(V–) + 1.4			V
C_L	Load capacitance	Stable operation			1000		pF
I_{SC}	Short-circuit current	Continuous to V_S / 2			+6/–15		mA
FREQUENCY RESPONSE							
BW	Bandwidth, –3 dB	G = 1			1.3		MHz
		G = 10			600		kHz
		G = 100			200		
		G = 1000			20		
SR	Slew rate	G = 10, V_O = ±10 V			1.2		V/µs
t_S	Settling time	To 0.01%	G = 1		9		µs
			G = 10		9		
			G = 100		12		
			G = 1000		80		
	Overload recovery	50% input overload			4		µs
POWER SUPPLY							
I_Q	Total quiescent current	V_{IN} = 0 V			±1.4	±1.5	mA

(1) Input common-mode voltage varies with output voltage; see *Typical Characteristics*.
(2) Specified by wafer test.
(3) Temperature coefficient of the 50-kΩ or 49.4-kΩ term in the gain equation.
(4) Nonlinearity measurements in G = 1000 are dominated by noise. Typical nonlinearity is ±0.001%.

6.6 Typical Characteristics

at T_A = +25°C, V_S = ±15 V, V_{REF} = 0 V, G = 1, R_L = 10 kΩ, and V_{CM} = V_S / 2 (unless otherwise noted)

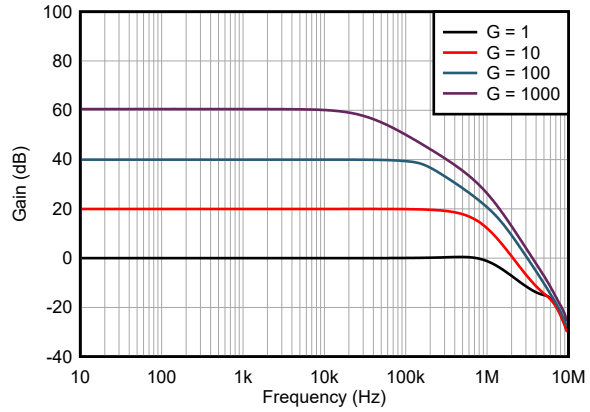


図 6-1. Gain vs Frequency

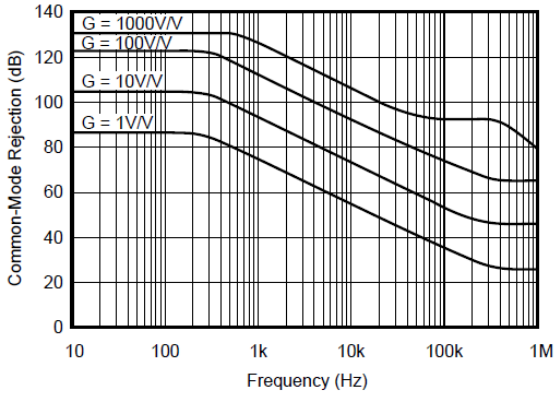


図 6-2. Common-Mode Rejection vs Frequency

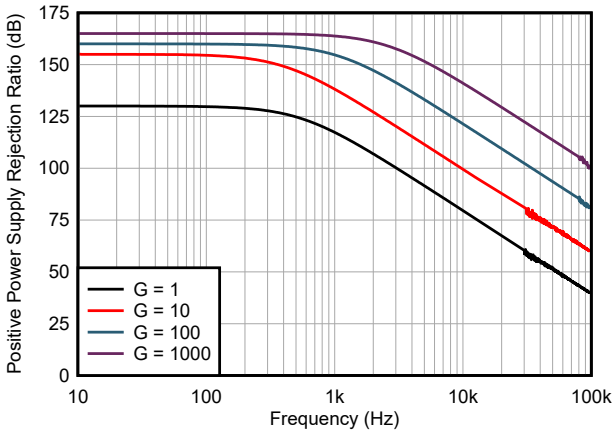


図 6-3. Positive Power Supply Rejection vs Frequency

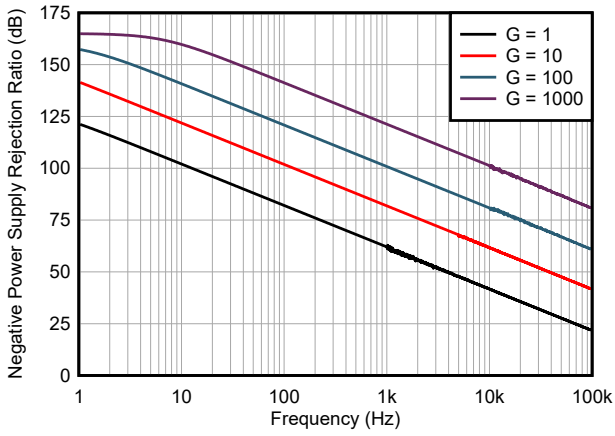
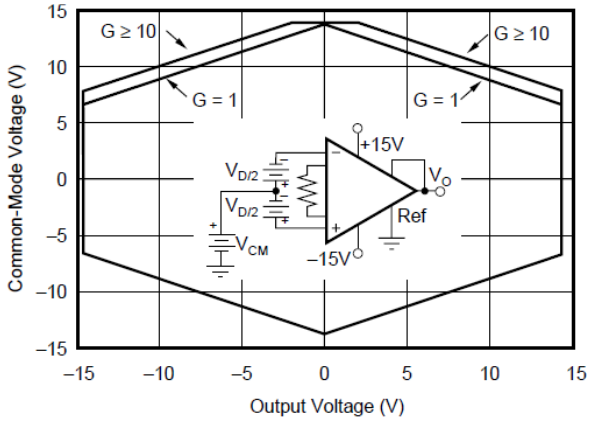
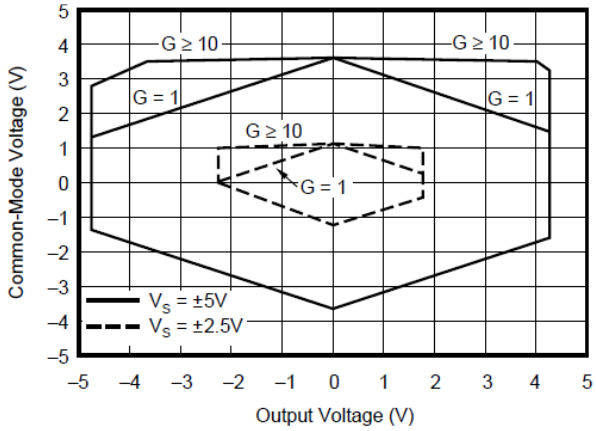


図 6-4. Negative Power Supply Rejection vs Frequency



V_S = ±15 V

図 6-5. Input Common-Mode Range vs Output Voltage



V_S = ±5, ±2.5 V

図 6-6. Input Common-Mode Range vs Output Voltage

6.6 Typical Characteristics (continued)

at T_A = +25°C, V_S = ±15 V, V_{REF} = 0 V, G = 1, R_L = 10 kΩ, and V_{CM} = V_S / 2 (unless otherwise noted)

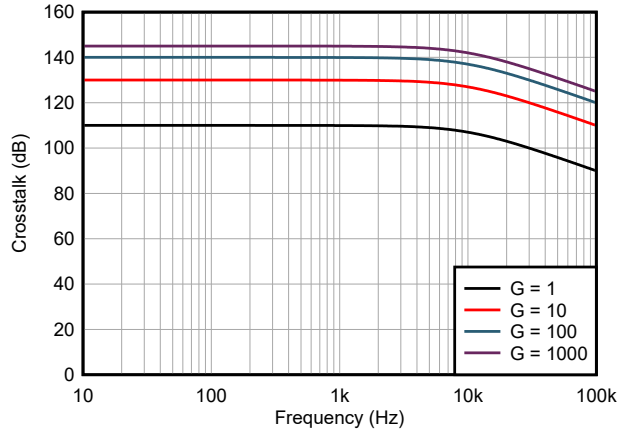


図 6-7. Crosstalk vs Frequency

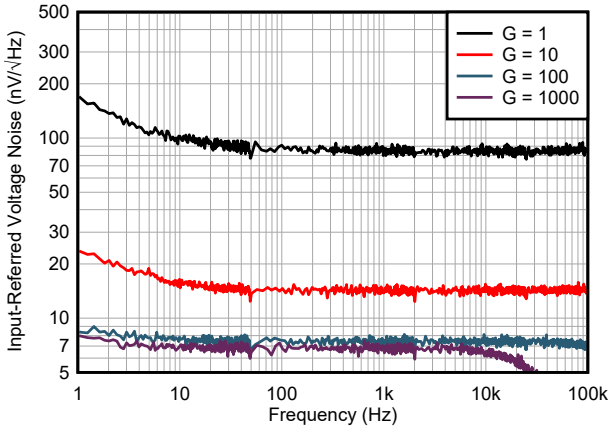


図 6-8. Input-Referred Voltage Noise vs Frequency

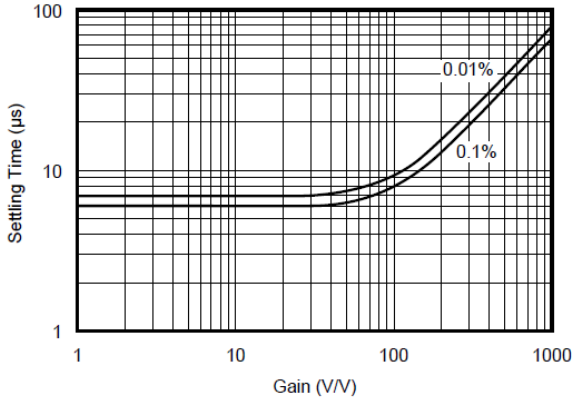


図 6-9. Settling Time vs Gain

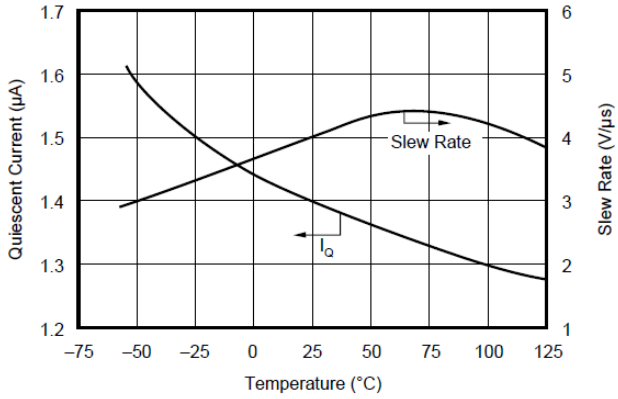


図 6-10. Quiescent Current and Slew Rate vs Temperature

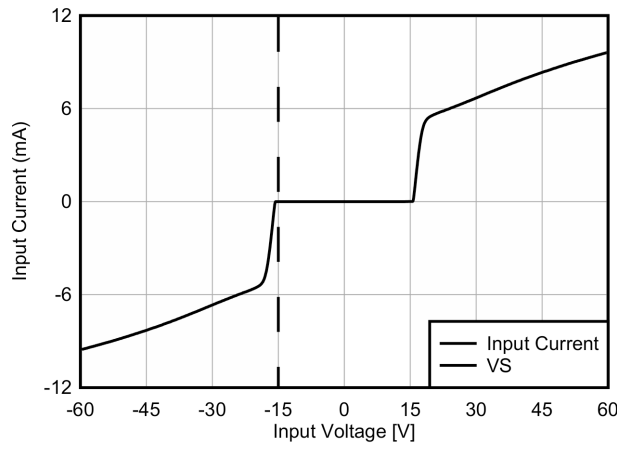


図 6-11. Input Overvoltage V/I Characteristics

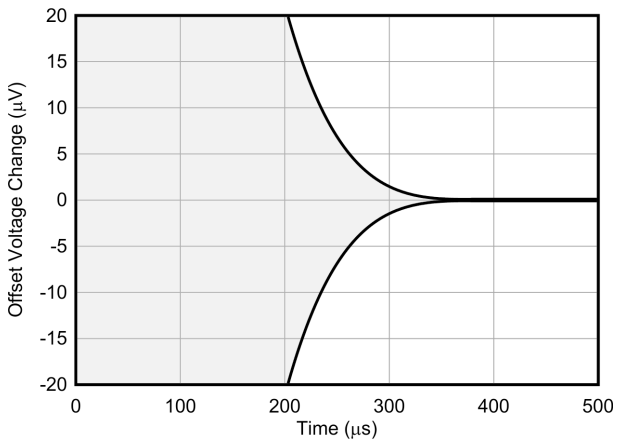


図 6-12. Offset Voltage Warm-Up

6.6 Typical Characteristics (continued)

at T_A = +25°C, V_S = ±15 V, V_{REF} = 0 V, G = 1, R_L = 10 kΩ, and V_{CM} = V_S / 2 (unless otherwise noted)

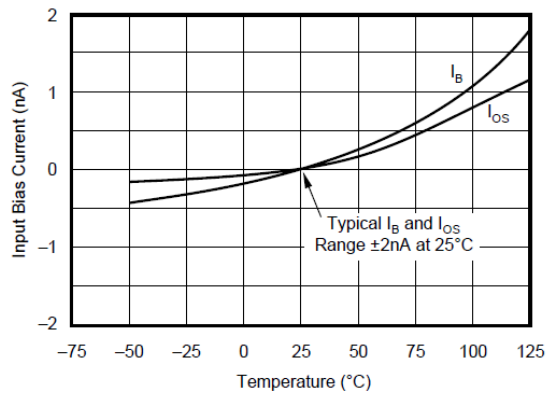


図 6-13. Input Bias Current vs Temperature

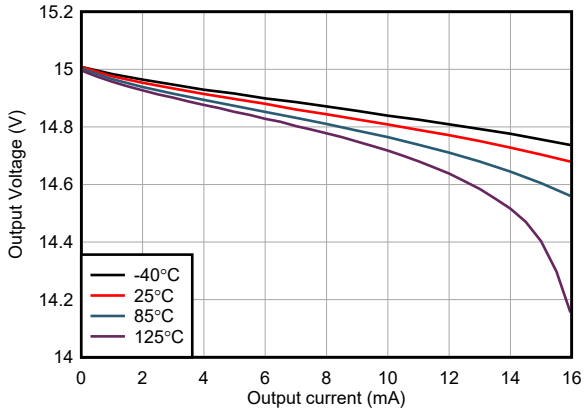


図 6-14. Positive Output Voltage Swing vs Output Current

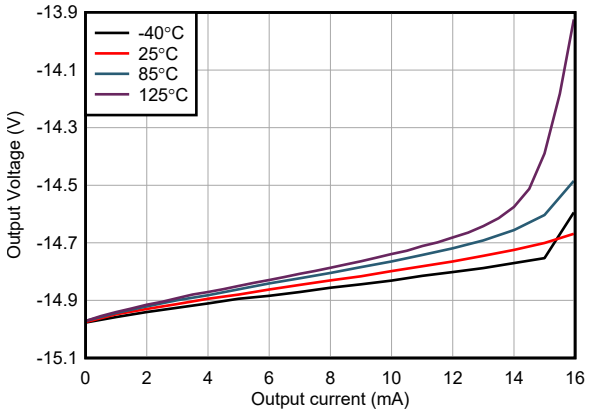


図 6-15. Negative Output Voltage Swing vs Output Current

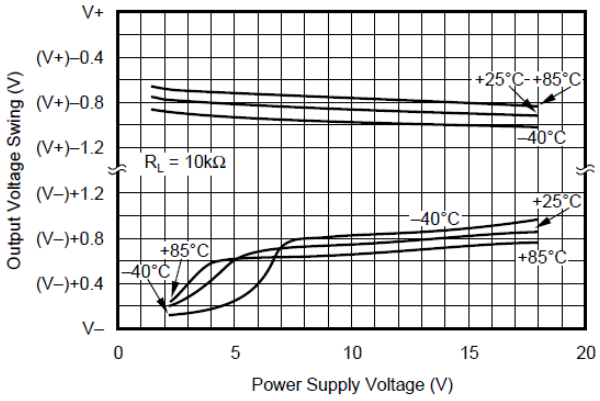


図 6-16. Output Voltage Swing vs Power Supply Voltage

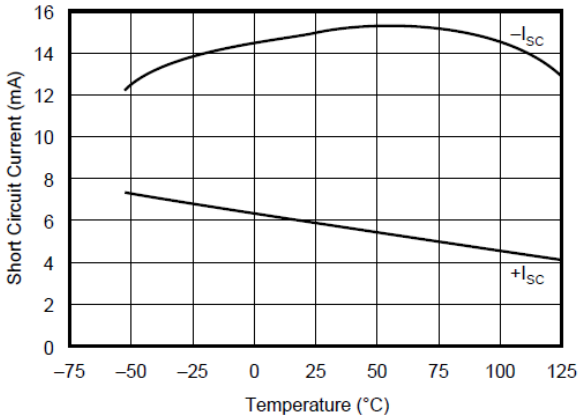


図 6-17. Short-Circuit Output Current vs Temperature

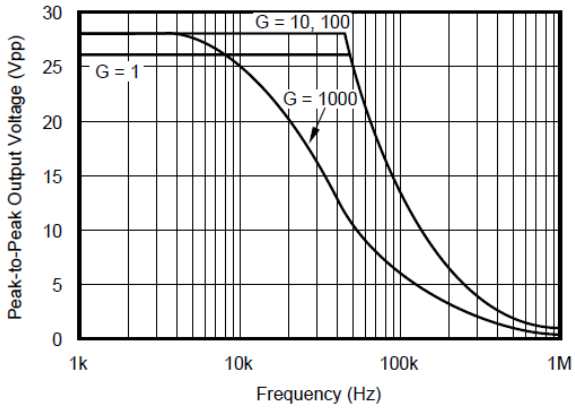


図 6-18. Maximum Output Voltage vs Frequency

6.6 Typical Characteristics (continued)

at T_A = +25°C, V_S = ±15 V, V_{REF} = 0 V, G = 1, R_L = 10 kΩ, and V_{CM} = V_S / 2 (unless otherwise noted)

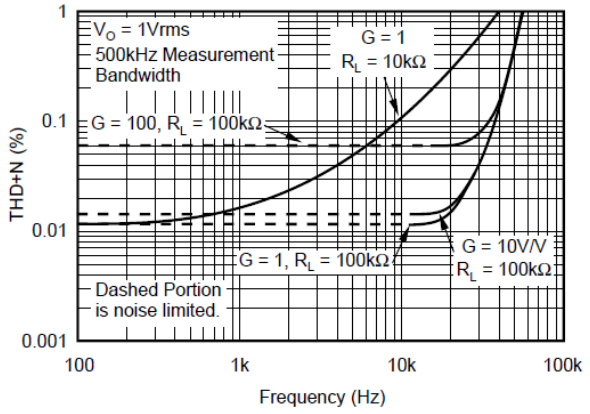
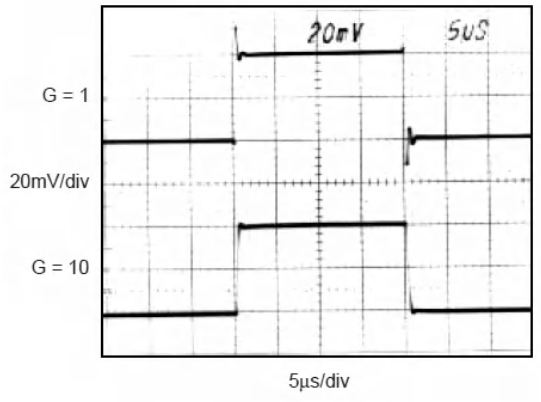
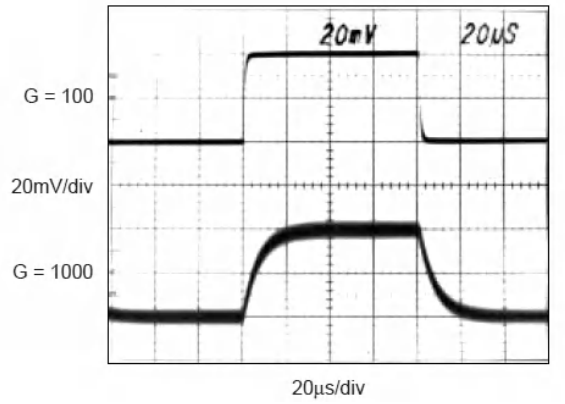


図 6-19. Total Harmonic Distortion + Noise vs Frequency



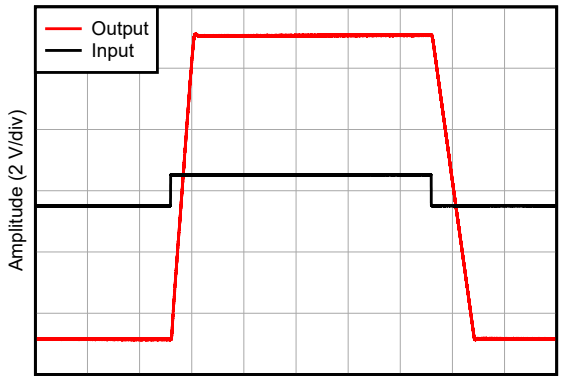
G = 1, 10

図 6-20. Small-Signal Step Response



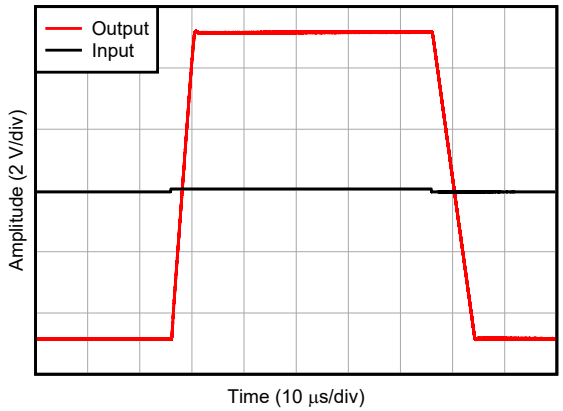
G = 100, 1000

図 6-21. Small-Signal Step Response



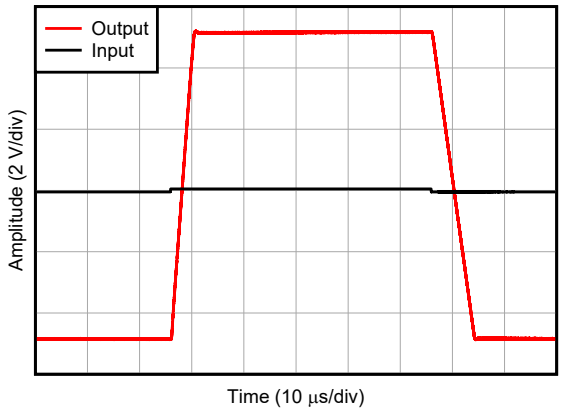
G = 1, 10

図 6-22. Large-Signal Step Response



G = 100

図 6-23. Large-Signal Step Response

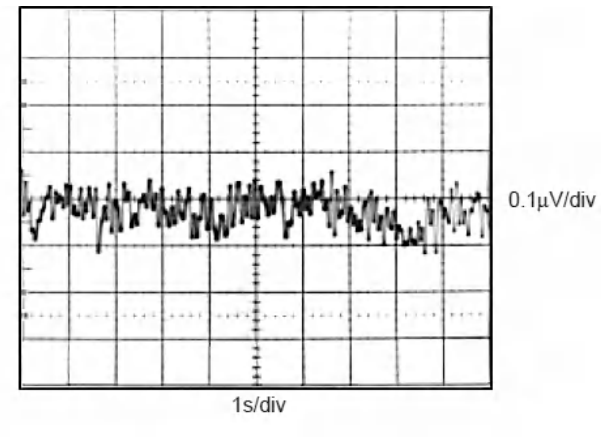


G = 1000

図 6-24. Large-Signal Step Response

6.6 Typical Characteristics (continued)

at T_A = +25°C, V_S = ±15 V, V_{REF} = 0 V, G = 1, R_L = 10 kΩ, and V_{CM} = V_S / 2 (unless otherwise noted)



G ≥ 100

図 6-25. Voltage Noise 0.1 Hz to 10 Hz Input-Referred

7 Application and Implementation

注

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes, as well as validating and testing their design implementation to confirm system functionality.

7.1 Application Information

図 7-1 shows the basic connections required for operation of the INA2128. Applications with noisy or high impedance power supplies may require decoupling capacitors close to the device pins as shown.

The output is referred to the output reference (Ref) terminals (Ref_A and Ref_B) which are normally grounded. These must be low-impedance connections to assure good common-mode rejection. A resistance of 8 Ω in series with a Ref pin will cause a typical device to degrade to approximately 80 dB CMR (G = 1).

The INA2128 has separate output sense feedback connections, $Sense_A$ and Sense $_B$. These must be connected to their respective output terminals for proper operation. The output sense connection can be used to sense the output voltage directly at the load for best accuracy.

7.2 Typical Application

DESIRED GAIN	R_G (Ω)	NEAREST 1% R_G (Ω)
1	NC	NC
2	50.00k	49.9k
5	12.50k	12.4k
10	5.556k	5.62k
20	2.632k	2.61k
50	1.02k	1.02k
100	505.1	511
200	251.3	249
500	100.2	100
1000	50.05	49.9
2000	25.01	24.9
5000	10.00	10
10000	5.001	4.99

NC: No Connection.

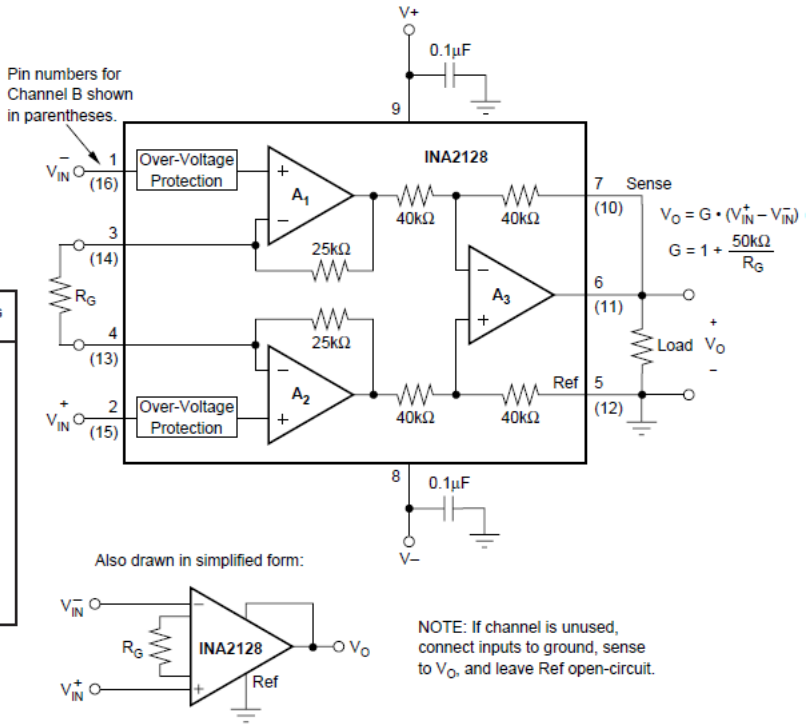


図 7-1. Basic Connections

7.2.1 Setting The Gain

Gain of the INA2128 is set by connecting a single external resistor, RG, connected as shown:

$$G = 1 + \frac{50\text{k}\Omega}{R_G} \quad (1)$$

Commonly-used gains and resistor values are shown in 図 7-1.

The 50 kΩ term in 式 1 comes from the sum of the two internal feedback resistors, A_1 and A_2. These on-chip metal film resistors are laser-trimmed to accurate absolute values. The accuracy and temperature coefficient of these resistors are included in the gain accuracy and drift specifications of the INA2128.

The stability and temperature drift of the external gain setting resistor, RG, also affects gain. RG's contribution to gain accuracy and drift can be directly inferred from the gain equation (1). Low resistor values required for high gain can make wiring resistance important. Sockets add to the wiring resistance which will contribute additional gain error in gains of approximately 100 or greater.

7.2.2 Dynamic Performance

The typical performance curve 図 6-1 shows that despite its low quiescent current, the INA2128 achieves wide bandwidth, even at high gain. This is due to its current feedback topology. Settling time also remains excellent at high gain—see 図 6-9.

7.2.3 Noise Performance

The INA2128 provides very low noise in most applications. Low frequency noise is approximately 0.2 μV_{pp} measured from 0.1 Hz to 10 Hz (G ≥ 100). This provides dramatically improved noise when compared to state-of-the-art chopper-stabilized amplifiers.

7.2.4 Offset Trimming

The INA2128 is laser-trimmed for low offset voltage and offset voltage drift. Most applications require no external offset adjustment. 図 7-2 shows an optional circuit for trimming the output offset voltage. The voltage applied to Ref terminal is summed with the output. The op amp buffer provides low impedance at the Ref terminal to preserve good common-mode rejection.

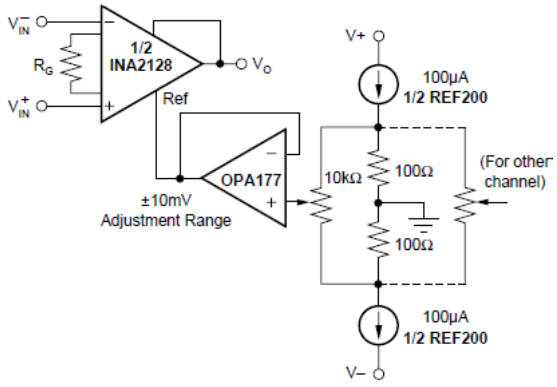


図 7-2. Optional Trimming of Output Offset Voltage

7.2.5 Input Bias Current Return Path

The input impedance of the INA2128 is extremely high—approximately 10^{10} Ω. However, a path must be provided for the input bias current of both inputs. This input bias current is approximately ±2 nA. High input impedance means that this input bias current changes very little with varying input voltage.

Input circuitry must provide a path for this input bias current for proper operation. 図 7-3 shows various provisions for an input bias current path. Without a bias current path, the inputs float to a potential that exceeds the common-mode range of the INA2128 and the input amplifiers saturate.

If the differential source resistance is low, the bias current return path can be connected to one input (see the thermocouple example in 図 7-3). With higher source impedance, using two equal resistors provides a balanced input with possible advantages of lower input offset voltage due to bias current and better high-frequency common-mode rejection.

7.2.6 Input Common-Mode Range

The linear input voltage range of the input circuitry of the INA2128 is from approximately 1.4 V less than the positive supply voltage to 1.7 V greater than the negative supply. As a differential input voltage causes the output voltage increase, the linear input range is limited by the output voltage swing of amplifiers A_1 and A_2. Therefore, the linear common-mode input range is related to the output voltage of the complete amplifier. This behavior also depends on supply voltage—see performance curves 図 6-6 and 図 6-5.

Input-overload can produce an output voltage that appears normal. For example, if an input overload condition drives both input amplifiers to the positive output swing limit, the difference voltage measured by the output amplifier is near zero. The output of the INA2128 is near 0 V even though both inputs are overloaded.

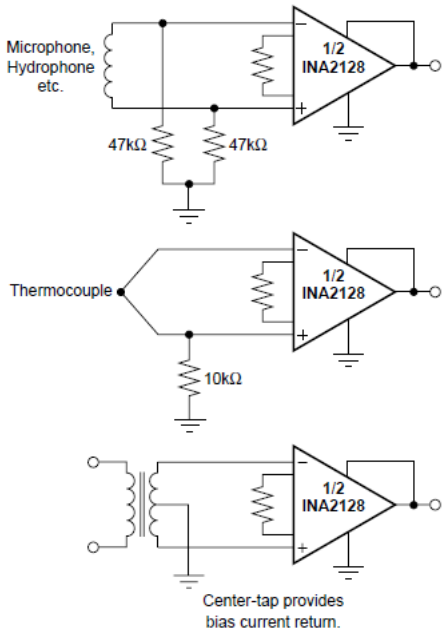


図 7-3. Providing an Input Common-Mode Current Path

7.2.7 Low-Voltage Operation

The INA2128 can be operated on power supplies as low as ±2.25 V. Performance remains excellent with power supplies ranging from ±2.25 V to ±18 V. Most parameters vary only slightly throughout this supply voltage range—see セクション 6.6. Operation at very low supply voltage requires careful attention to make sure that the input voltages remain within the linear range. Voltage swing requirements of internal nodes limit the input common-mode range with low power-supply voltage. Typical performance curves, 図 6-5 and 図 6-6, show the range of linear operation for ±15-V, ±5-V, and ±2.5-V supplies.

7.2.8 Input Protection

The inputs of the INA2128 are individually protected for voltages up to ±40 V. For example, a condition of –40 V on one input and +40 V on the other input will not cause damage. Internal circuitry on each input provides low series impedance under normal signal conditions. To provide equivalent protection, series input resistors would contribute excessive noise. If the input is overloaded, the protection circuitry limits the input current to a safe value of approximately 1.5 mA to 5 mA. The typical performance curve “Input Bias Current vs Common-Mode Input Voltage” shows this input current limit behavior. The inputs are protected even if the power supplies are disconnected or turned off.

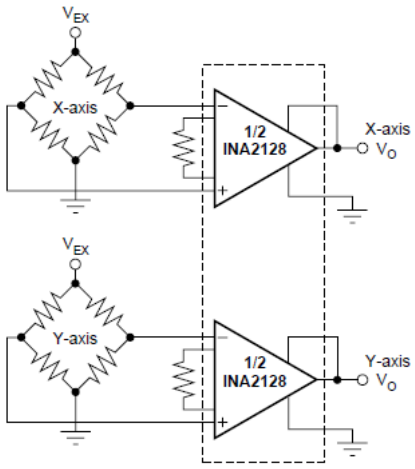


図 7-4. Two-Axis Bridge Amplifier

7.2.9 Channel Crosstalk

The two channels of the INA2128 are completely independent, including all bias circuitry. At dc and low frequency, there is virtually no signal coupling between channels. Crosstalk increases with frequency and depends on circuit gain, source impedance, and signal characteristics.

As source impedance increases, careful circuit layout helps achieve lowest channel crosstalk. Most crossstalk is produced by capacitive coupling of signals from one channel to the input section of the other channel. To minimize coupling, separate the input traces as far as practical from any signals associated with the opposite channel. A grounded guard trace surrounding the inputs helps reduce stray coupling between channels. Run the differential inputs of each channel parallel to each other or directly adjacent on top and bottom side of a circuit board. Stray coupling then tends to produce a common-mode signal which is rejected by the IA input.

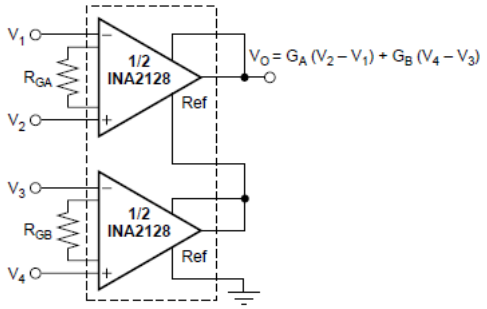


図 7-5. Sum of Differences Amplifier

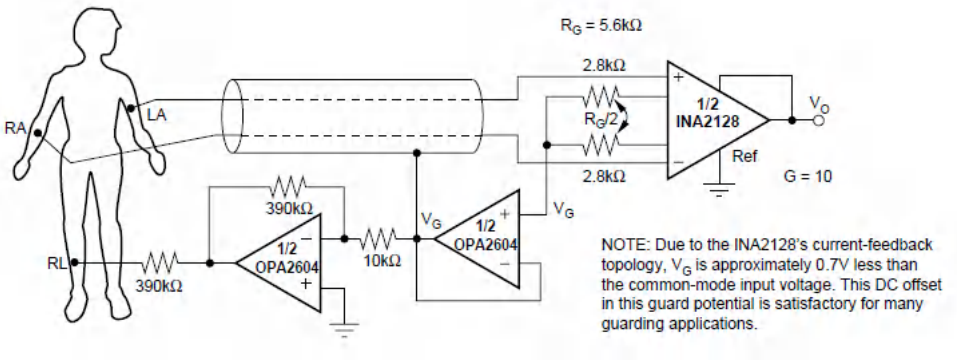


図 7-6. ECG Amplifier With Right-Leg Drive

8 Device and Documentation Support

TI offers an extensive line of development tools. Tools and software to evaluate the performance of the device, generate code, and develop solutions are listed below.

8.1 ドキュメントの更新通知を受け取る方法

ドキュメントの更新についての通知を受け取るには、ti.com のデバイス製品フォルダを開いてください。「更新の通知を受け取る」をクリックして登録すると、変更されたすべての製品情報に関するダイジェストを毎週受け取れます。変更の詳細については、修正されたドキュメントに含まれている改訂履歴をご覧ください。

8.2 サポート・リソース

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8.3 Trademarks

TI E2E™ is a trademark of Texas Instruments.
すべての商標は、それぞれの所有者に帰属します。

8.4 静電気放電に関する注意事項

この IC は、ESD によって破損する可能性があります。テキサス・インスツルメンツは、IC を取り扱う際には常に適切な注意を払うことを推奨します。正しい取り扱いおよび設置手順に従わない場合、デバイスを破損するおそれがあります。

ESD による破損は、わずかな性能低下からデバイスの完全な故障まで多岐にわたります。精密な IC の場合、パラメータがわずかに変化するだけで公表されている仕様から外れる可能性があるため、破損が発生しやすくなっています。

8.5 用語集

テキサス・インスツルメンツ用語集　　この用語集には、用語や略語の一覧および定義が記載されています。

9 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
INA2128U	Active	Production	SOIC (DW) | 16	40 | TUBE	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	INA2128U
INA2128U.B	Active	Production	SOIC (DW) | 16	40 | TUBE	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	INA2128U
INA2128U/1K	Active	Production	SOIC (DW) | 16	1000 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-	INA2128U
INA2128U/1K.B	Active	Production	SOIC (DW) | 16	1000 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	INA2128U
INA2128U1G4	Active	Production	SOIC (DW) | 16	40 | TUBE	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	INA2128U
INA2128U1G4.B	Active	Production	SOIC (DW) | 16	40 | TUBE	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	INA2128U
INA2128UA	Active	Production	SOIC (DW) | 16	40 | TUBE	Yes	NIPDAU	Level-2-260C-1 YEAR	-	(INA2128U, INA2128 UA) A
INA2128UA.B	Active	Production	SOIC (DW) | 16	40 | TUBE	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	(INA2128U, INA2128 UA) A
INA2128UA/1K	Active	Production	SOIC (DW) | 16	1000 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-	(INA2128U, INA2128 UA) A
INA2128UA/1K.B	Active	Production	SOIC (DW) | 16	1000 | LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	(INA2128U, INA2128 UA) A
INA2128UAG4	Active	Production	SOIC (DW) | 16	40 | TUBE	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	INA2128UA
INA2128UAG4.B	Active	Production	SOIC (DW) | 16	40 | TUBE	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	INA2128UA

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

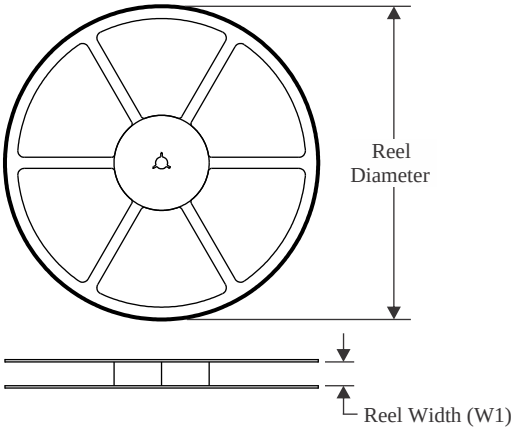
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

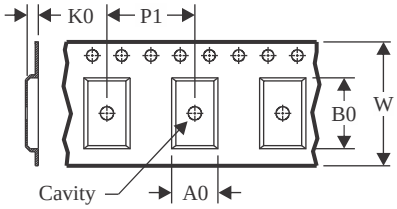
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

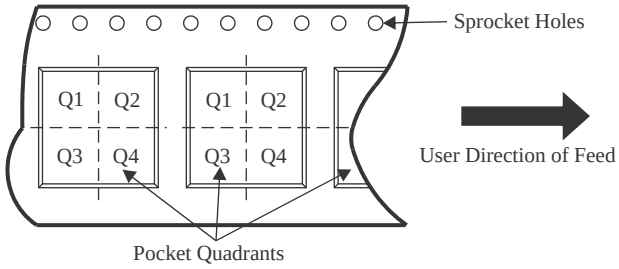


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

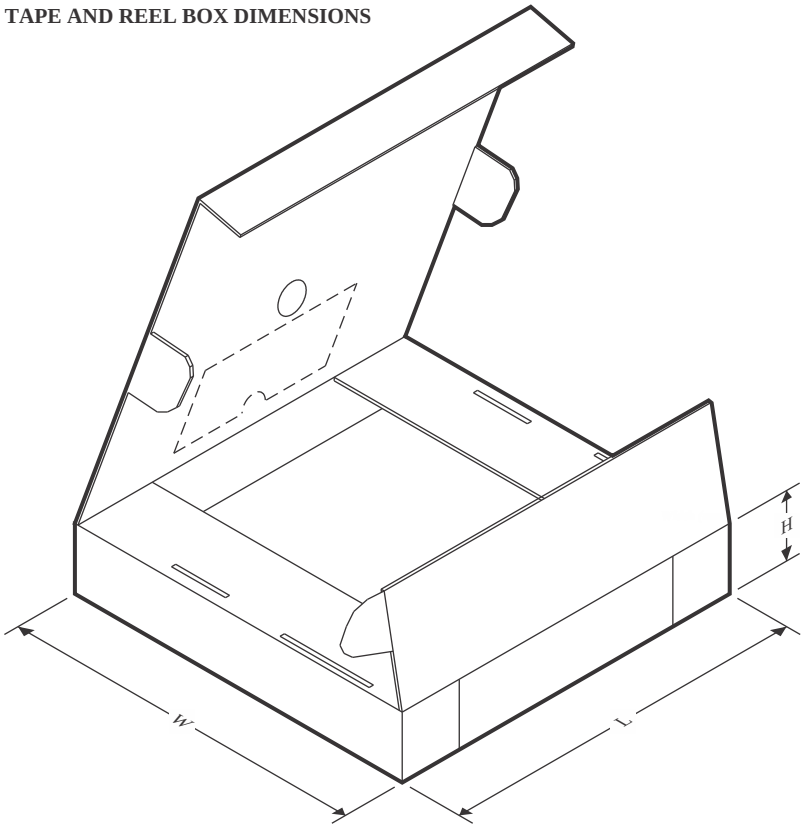
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
INA2128U/1K	SOIC	DW	16	1000	330.0	16.4	10.75	10.7	2.7	12.0	16.0	Q1
INA2128UA/1K	SOIC	DW	16	1000	330.0	16.4	10.75	10.7	2.7	12.0	16.0	Q1

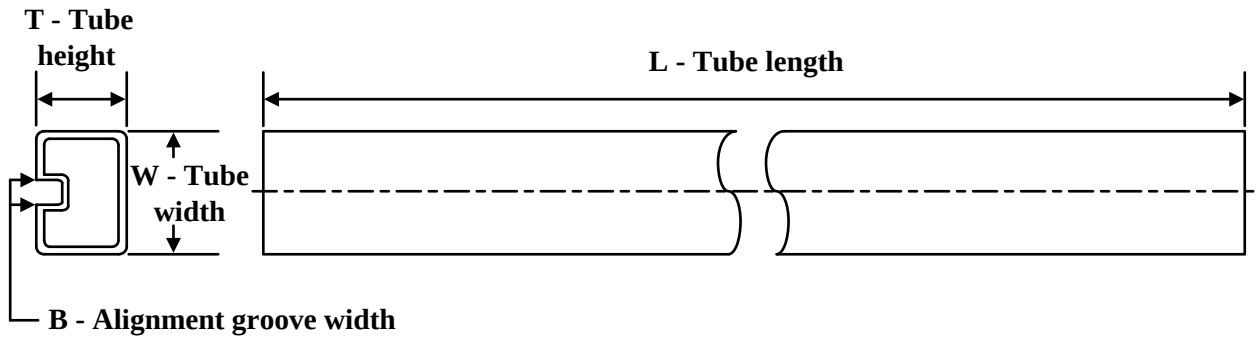
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
INA2128U/1K	SOIC	DW	16	1000	350.0	350.0	43.0
INA2128UA/1K	SOIC	DW	16	1000	350.0	350.0	43.0

TUBE



*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
INA2128U	DW	SOIC	16	40	506.98	12.7	4826	6.6
INA2128U.B	DW	SOIC	16	40	506.98	12.7	4826	6.6
INA2128U1G4	DW	SOIC	16	40	506.98	12.7	4826	6.6
INA2128U1G4.B	DW	SOIC	16	40	506.98	12.7	4826	6.6
INA2128UA	DW	SOIC	16	40	506.98	12.7	4826	6.6
INA2128UA.B	DW	SOIC	16	40	506.98	12.7	4826	6.6
INA2128UAG4	DW	SOIC	16	40	506.98	12.7	4826	6.6
INA2128UAG4.B	DW	SOIC	16	40	506.98	12.7	4826	6.6

GENERIC PACKAGE VIEW

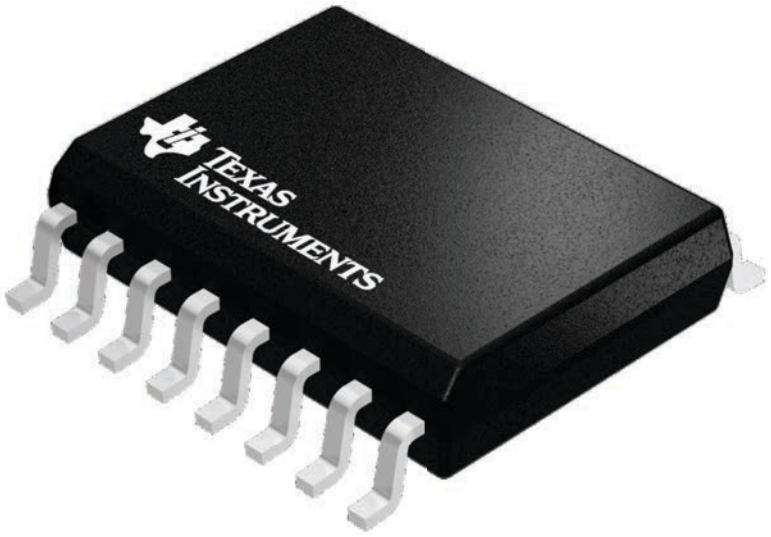
DW 16

SOIC - 2.65 mm max height

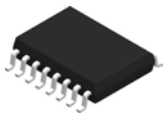
7.5 x 10.3, 1.27 mm pitch

SMALL OUTLINE INTEGRATED CIRCUIT

This image is a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.



4224780/A

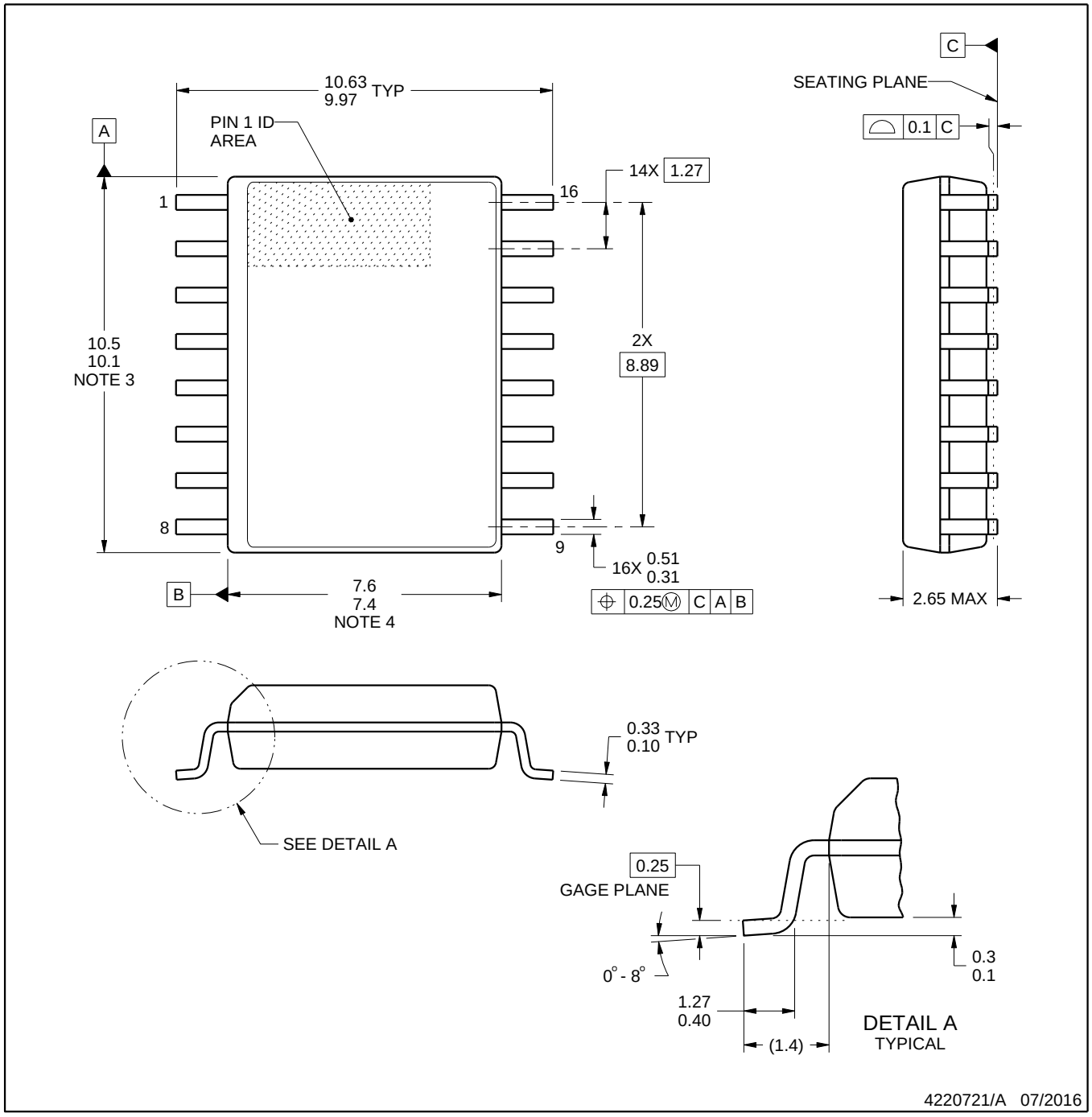


PACKAGE OUTLINE

DW0016A

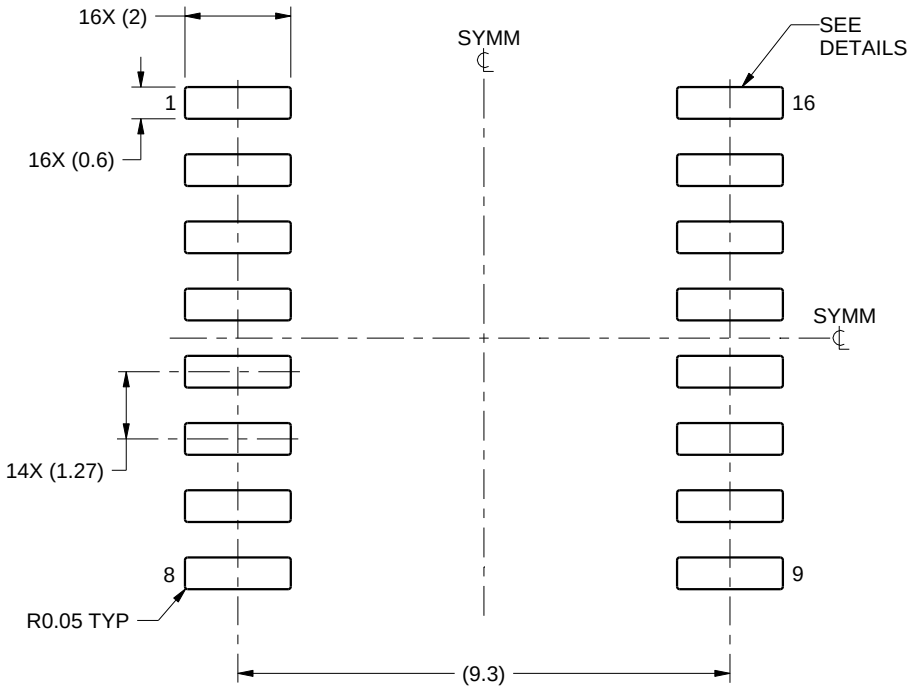
SOIC - 2.65 mm max height

SOIC

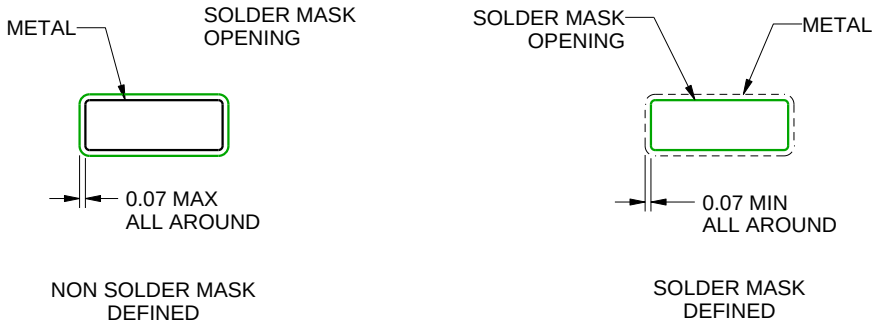


NOTES:

1. All linear dimensions are in millimeters. Dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm, per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm, per side.
5. Reference JEDEC registration MS-013.



LAND PATTERN EXAMPLE
SCALE:7X



SOLDER MASK DETAILS

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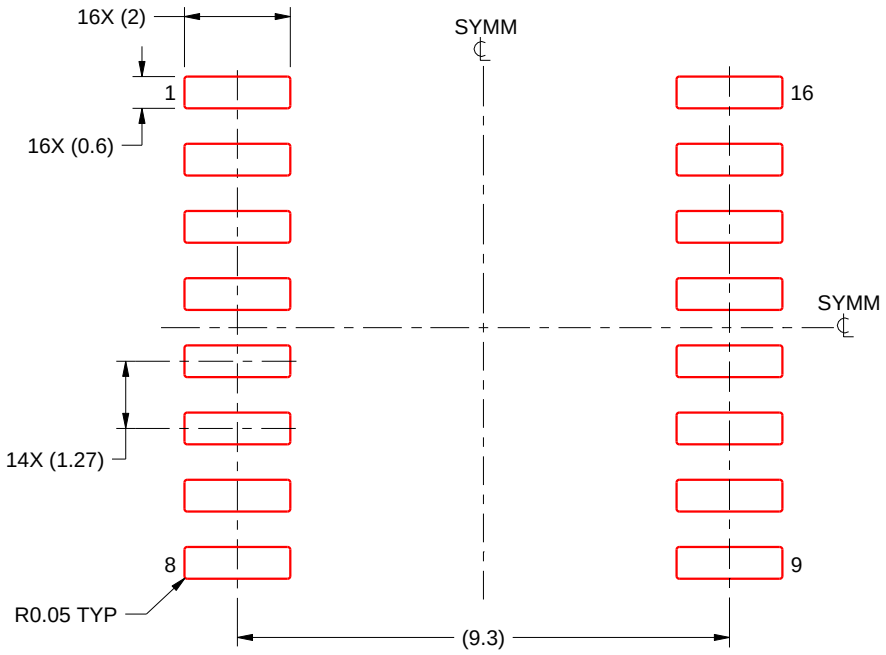
NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:7X

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NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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