AMC1203 Precision, ±280mV Input, Basic Isolated Delta-Sigma Modulator With 10MHz Internal Clock

1 Features

- Linear input voltage range: ±280mV
- Supply voltage range:
  - High side: 4.5V to 5.5V
  - Low side: 4.5V to 5.5V
- Low DC errors:
  - AMC1203:
    - Offset error: ±1mV (max)
    - Offset drift: ±5µV/°C (max)
    - Gain error: ±2% (max)
    - Gain drift: ±20ppm/°C (max)
  - AMC1203B:
    - Offset error: ±1mV (max)
    - Offset drift: ±5µV/°C (max)
    - Gain error: ±1% (max)
    - Gain drift: ±20ppm/°C (max)
- Transient immunity: 15kV/µs (min)
- Internal 10MHz clock generator
- Safety-related certifications:
  - $3500V_{PEAK}$ basic isolation per DIN EN IEC 60747-17 (VDE 0884-17)
  - $2500V_{RMS}$ isolation for 1 minute per UL1577
- Specified temperature range: –40°C to +105°C

2 Applications

- Industrial motor drives
- Frequency inverters
- Uninterruptible power supplies (UPS)
- Power conversion circuits

3 Description

The AMC1203 is a precision, galvanically isolated, delta-sigma (ΔΣ) modulator. The isolation barrier separates parts of the system that operate on different common-mode voltage levels. The isolation barrier is highly resistant to magnetic interference and is certified to provide basic isolation of up to $3500V_{PEAK}$ according to the DIN EN IEC 60747-17 (VDE 0884-17) and UL1577 standards.

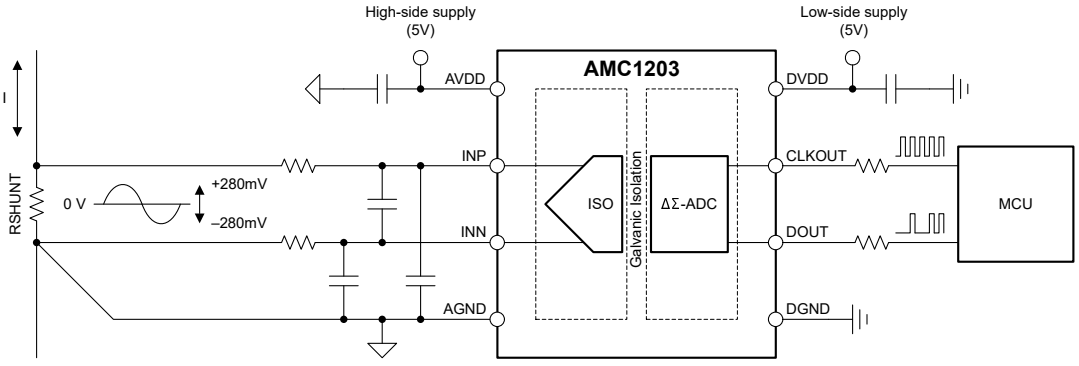
The input of the AMC1203 is optimized for direct connection to shunt resistors or other low-impedance signal sources. The output bitstream of the AMC1203 is synchronized to the internally generated clock. Combined with a digital low-pass filter, such as a $sinc^3$, OSR 256 filter, the device achieves 16 bits of resolution with an 87dB dynamic range and a 39kSPS data rate.

The AMC1203 is offered in a SOP-8 gull-wing package (DUB), a SOP-8 package (PSA), and a SOIC-16 package (DW). The device is characterized over the ambient temperature range of –40°C to +105°C.

Package Information

PART NUMBER	PACKAGE(1)	PACKAGE SIZE(2)
AMC1203	DUB (SOP, 8)	9.5mm × 10.4mm
	PSA (SOP, 8)	5.27mm × 7.9mm
	DW (SOIC, 16)	10.3mm × 10.3mm

(1) For more information, see the *Mechanical, Packaging, and Orderable Information*.
(2) The package size (length x width) is a nominal value and includes pins, where applicable.



Typical Application

An IMPORTANT NOTICE at the end of this data sheet addresses availability, warranty, changes, use in safety-critical applications, intellectual property matters and other important disclaimers. PRODUCTION DATA.

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Device Comparison Table

PARAMETER	AMC1203	AMC1203B
Gain error (INL)	±9LSB (max)	±6LSB (max)
Offset error (E_O)	±2% (max)	±1% (max)
THD	–84.5dB (max)	–88dB (max)
SFDR	86dB (min)	89dB (min)

4 Pin Configuration and Functions

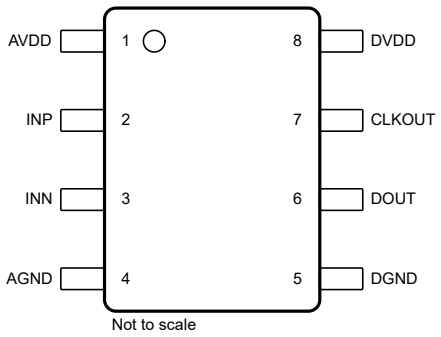


Figure 4-1. DUB Package, 8-Pin SOP Gull-Wing (Top View), and PSA Package, 8-Pin SOP (Top View)

Table 4-1. Pin Functions: SOP

PIN		TYPE	DESCRIPTION
NO.	NAME		
1	AVDD	High-side power	Analog (high-side) power supply(1).
2	INP	Analog input	Noninverting analog input.
3	INN	Analog input	Inverting analog input.
4	AGND	High-side ground	Analog (high-side) ground reference.
5	DGND	Low-side ground	Digital (low-side) ground reference.
6	DOUT	Digital output	Modulator data output.
7	CLKOUT	Digital output	Modulator clock output.
8	DVDD	Low-side power	Digital (low-side) power supply(1).

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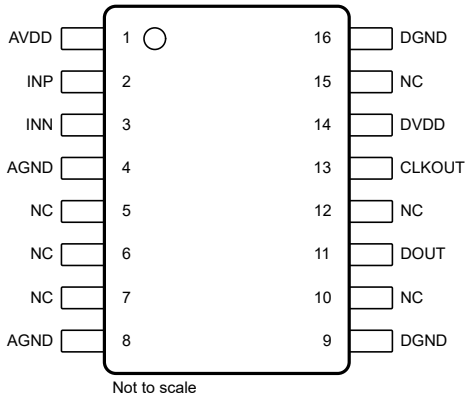


Figure 4-2. DW Package, 16-Pin SOIC (Top View)

Table 4-2. Pin Functions: SOIC

PIN		TYPE	DESCRIPTION
NO.	NAME		
1	AVDD	High-side power	Analog (high-side) power supply(1).
2	INP	Analog input	Noninverting analog input.
3	INN	Analog input	Inverting analog input.
4, 8(2)	AGND	High-side ground	Analog (high-side) ground.
5, 6, 7, 10, 12, 15	NC	N/A	No internal connection. Tie these pins to any potential or leave unconnected.
9, 16(2)	DGND	Low-side ground	Digital (low-side) ground.
11	DOUT	Digital output	Modulator data output.
13	CLKOUT	Digital output	Modulator clock output.
14	DVDD	Low-side power	Digital (low-side) power supply(1).

(1) See the *Power Supply Recommendations* section for power-supply decoupling recommendations.
(2) Both pins are connected internally by a low-impedance path. Only one pin must be tied to the ground plane.

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5 Specifications

5.1 Absolute Maximum Ratings

see(1)

		MIN	MAX	UNIT
Power-supply voltage	AVDD to AGND	–0.3	6	V
	DVDD to DGND	–0.3	6	
Analog input voltage	INP, INN	GND1 – 0.3	VDD1 + 0.3	V
Output voltage	OUTP, OUTN	GND2 – 0.5	VDD2 + 0.5	V
Input current	Continuous, any pin except power-supply pins	–10	10	mA
Temperature	Junction, T_J		150	°C
	Storage, T_{stg}	–65	150	

(1) Operation outside the *Absolute Maximum Ratings* may cause permanent device damage. *Absolute Maximum Ratings* do not imply functional operation of the device at these or any other conditions beyond those listed under *Recommended Operating Conditions*. If used outside the Recommended Operating Conditions but within the Absolute Maximum Ratings, the device may not be fully functional, and this may affect device reliability, functionality, performance, and shorten the device lifetime.

5.2 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 per ANSI/ESDA/JEDEC JS-002(2)	±1000	

(1) JEDEC document JEP155 states that 500V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250V CDM allows safe manufacturing with a standard ESD control process.

5.3 Recommended Operating Conditions

over operating ambient temperature range (unless otherwise noted)

			MIN	NOM	MAX	UNIT
POWER SUPPLY						
AVDD	Hgh-side power supply	AVDD to AGND	4.5	5.0	5.5	V
DVDD	Low-side power supply	DVDD to DGND	4.5	5.0	5.5	V
ANALOG INPUT						
$V_{Clipping}$	Differential input voltage before clipping output	$V_{IN} = V_{INP} – V_{INN}$		±320		mV
V_{FSR}	Specified linear differential input voltage	$V_{IN} = V_{INP} – V_{INN}$	–280		280	mV
V_{CM}	Operating common-mode input voltage	$(V_{INP} + V_{INN}) / 2$ to AGND	0		AVDD	V
$C_{IN, EXT}$	Minimum external capacitance connected to the input	From INP to INN	10			nF
TEMPERATURE RANGE						
T_A	Specified ambient temperature		–40		105	°C

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5.4 Thermal Information

THERMAL METRIC(1)		DUB (SOP)	PSA (SOP)	DW (SOIC)	UNIT
		8 PINS	8 PINS	16 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	78.0	164.0	104.0	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	61.0	32.0	58.0	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	N/A	N/A	N/A	°C/W

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

5.5 Power Ratings

PARAMETER		TEST CONDITIONS	VALUE	UNIT
P_D	Maximum power dissipation (both sides)	AVDD = DVDD = 5.5V	110	mW
P_{D1}	Maximum power dissipation (high-side)	AVDD = 5.5V	44	mW
P_{D2}	Maximum power dissipation (low-side)	DVDD = 5.5V	66	mW

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5.6 Insulation Specifications

over operating ambient temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS	VALUE	UNIT
GENERAL				
CLR	External clearance(1)	Shortest pin-to-pin distance through air (DUB package)	≥ 7	mm
		Shortest pin-to-pin distance through air (PSA package)	≥ 6.3	
		Shortest pin-to-pin distance through air (DW package)	≥ 8	
CPG	External creepage(1)	Shortest pin-to-pin distance across the package surface (DUB)	≥ 7	mm
		Shortest pin-to-pin distance across the package surface (PSA)	≥ 6.3	
		Shortest pin-to-pin distance across the package surface (DW)	≥ 8	
DTI	Distance through insulation	Minimum internal gap (internal clearance) of the insulation	≥ 8	µm
CTI	Comparative tracking index	DIN EN 60112 (VDE 0303-11); IEC 60112	≥ 175	V
	Material group	According to IEC 60664-1	IIIa	
	Overvoltage category per IEC 60664-1	Rated mains voltage ≤ 150V_{RMS}	I-IV	
		Rated mains voltage ≤ 300V_{RMS}	I-III	
DIN EN IEC 60747-17 (VDE 0884-17)(2)				
V_{IORM}	Maximum repetitive peak isolation voltage	At AC voltage	560	V_{PK}
V_{IOWM}	Maximum-rated isolation working voltage	At AC voltage (sine wave)	400	V_{RMS}
		At DC voltage	560	V_{DC}
V_{IOTM}	Maximum transient isolation voltage	$V_{TEST} = V_{IOTM}$, t = 60s (qualification test), $V_{TEST} = 1.2 \times V_{IOTM}$, t = 1s (100% production test)	3500	V_{PK}
V_{IMP}	Maximum impulse voltage(3)	Tested in air, 1.2/50µs waveform per IEC 62368-1	3100	V_{PK}
V_{IOSM}	Maximum surge isolation voltage(4)	Tested in oil (qualification test), 1.2/50-µs waveform per IEC 62368-1	4000	V_{PK}
q_{pd}	Apparent charge(5)	Method a, after input/output safety test subgroups 2 and 3, $V_{pd(ini)} = V_{IOTM}$, t_{ini} = 60s, $V_{pd(m)} = 1.2 \times V_{IORM}$, t_m = 10s	≤ 5	pC
		Method a, after environmental tests subgroup 1, $V_{pd(ini)} = V_{IOTM}$, t_{ini} = 60s, $V_{pd(m)} = 1.3 \times V_{IORM}$, t_m = 10s	≤ 5	
		Method b1, at preconditioning (type test) and routine test, $V_{pd(ini)} = V_{IOTM}$, t_{ini} = 1s, $V_{pd(m)} = 1.5 \times V_{IORM}$, t_m = 1s	≤ 5	
		Method b2, at routine test (100% production)(7), $V_{pd(ini)} = V_{IOTM} = V_{pd(m)}$, $t_{ini} = t_m$ = 1s	≤ 5	
C_{IO}	Barrier capacitance, input to output(6)	V_{IO} = 0.5 V_{PP} at 1MHz	~1.5	pF
R_{IO}	Insulation resistance, input to output(6)	V_{IO} = 500V at T_A = 25°C	> 10^{12}	Ω
		V_{IO} = 500V at 100°C ≤ T_A ≤ 125°C	> 10^{11}	
		V_{IO} = 500V at T_S = 150°C	> 10^9	
	Pollution degree		2	
	Climatic category		40/105/21	
UL1577				
V_{ISO}	Withstand isolation voltage	$V_{TEST} = V_{ISO}$, t = 60s (qualification test), $V_{TEST} = 1.2 \times V_{ISO}$, t = 1s (100% production test)	2500	V_{RMS}

(1) Apply creepage and clearance requirements according to the specific equipment isolation standards of an application. Care must be taken to maintain the creepage and clearance distance of a board design to ensure that the mounting pads of the isolator on the printed circuit board (PCB) do not reduce this distance.
(2) This coupler is suitable for *safe electrical insulation* only within the safety ratings. Compliance with the safety ratings shall be ensured by means of suitable protective circuits.
(3) Testing is carried out in air to determine the surge immunity of the package.
(4) Testing is carried out in oil to determine the intrinsic surge immunity of the isolation barrier.
(5) Apparent charge is electrical discharge caused by a partial discharge (pd).
(6) All pins on each side of the barrier are tied together, creating a two-pin device.

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(7) Either method b1 or b2 is used in production.

5.7 Safety-Related Certifications

VDE	UL
DIN EN IEC 60747-17 (VDE 0884-17), EN IEC 60747-17, DIN EN 61010-1 (VDE 0411-1) Clause : 6.4.3 ; 6.7.1.3 ; 6.7.2.1 ; 6.7.2.2 ; 6.7.3.4.2 ; 6.8.3.1	Recognized under 1577 component recognition and CSA component acceptance NO 5 programs
Basic insulation	Single protection
Certificate number: 40047657	File number: E181974

5.8 Safety Limiting Values

Safety limiting(1) intends to minimize potential damage to the isolation barrier upon failure of input or output circuitry. A failure of the I/O can allow low resistance to ground or the supply and, without current limiting, dissipate sufficient power to over-heat the die and damage the isolation barrier potentially leading to secondary system failures.

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
DUB PACKAGE						
I_S	Safety input, output, or supply current	$R_{\theta JA}$ = 78°C/W, xVDD = 5.5V, T_J = 150°C, T_A = 25°C			291	mA
P_S	Safety input, output, or total power	$R_{\theta JA}$ = 78°C/W, T_J = 150°C, T_A = 25°C			1603	mW
T_S	Maximum safety temperature				150	°C
PSA PACKAGE						
I_S	Safety input, output, or supply current	$R_{\theta JA}$ = 164°C/W, xVDD = 5.5V, T_J = 150°C, T_A = 25°C			139	mA
P_S	Safety input, output, or total power	$R_{\theta JA}$ = 164°C/W, T_J = 150°C, T_A = 25°C			762	mW
T_S	Maximum safety temperature				150	°C
DW PACKAGE						
I_S	Safety input, output, or supply current	$R_{\theta JA}$ = 58°C/W, xVDD = 5.5V, T_J = 150°C, T_A = 25°C			219	mA
P_S	Safety input, output, or total power	$R_{\theta JA}$ = 58°C/W, T_J = 150°C, T_A = 25°C			1202	mW
T_S	Maximum safety temperature				150	°C

(1) The maximum safety temperature, T_S, has the same value as the maximum junction temperature, T_J, specified for the device. The I_S and P_S parameters represent the safety current and safety power, respectively. Do not exceed the maximum limits of I_S and P_S. These limits vary with the ambient temperature, T_A.
The junction-to-air thermal resistance, $R_{\theta JA}$, in the Thermal Information table is that of a device installed on a high-K test board for leaded surface-mount packages. Use these equations to calculate the value for each parameter:
$T_J = T_A + R_{\theta JA} \times P$, where P is the power dissipated in the device.
$T_{J(max)} = T_S = T_A + R_{\theta JA} \times P_S$, where $T_{J(max)}$ is the maximum junction temperature.
$P_S = I_S \times VDD_{max}$, where VDD_{max} is the maximum supply voltage for high-side and low-side.

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5.9 Electrical Characteristics

minimum and maximum specifications are at T_A = –40°C to 105°C, AVDD = 4.5 V to 5.5 V, DVDD = 4.5 V to 5.5 V, INP = –280 mV to 280 mV, INN = 0 V, and sinc^3 filter with OSR = 256 (unless otherwise noted); typical specifications are at T_A =25°C, AVDD = 5 V, and DVDD = 5.0 V

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
ANALOG INPUTS						
C_I	Input capacitance to AGND			3		pF
C_{ID}	Differential input capacitance			6		pF
R_{ID}	Differential input resistance			28		kΩ
I_{IL}	Input leakage current	INN = INP = AGND	–5		5	nA
CMTI	Common-mode transient immunity		15			kV/µs
CMRR	Common-mode rejection ratio	INP = INN, DC, $V_{CM\ min} \le V_{IN} \le V_{CM\ max}$		92		dB
		INP = INN, AC up to 10kHz, $V_{CM\ min} \le V_{IN} \le V_{CM\ max}$		105		
DC ACCURACY						
DNL	Differential nonlinearity	Resolution: 16 bits	–0.99		0.99	LSB
INL	Integral nonlinearity(2)	Resolution: 16 bits, AMC1203	–9	±3	9	LSB
		Resolution: 16 bits, AMC1203B	–6	±2	6	
E_O	Offset error(1) (6)	INP = INN = AGND	–1	±0.1	1	mV
TCE_O	Offset error temperature drift(3)		–5		5	µV/°C
E_G	Gain error	T_A = 25°C, AMC1203	–2%	±0.2%	2%	
		T_A = 25°C, AMC1203B	–1%	±0.2%	1%	
TCE_G	Gain error temperature drift(4)			±20		ppm/°C
PSRR	Power-supply rejection ratio	INP = INN = AGND, 4.5V ≤ AVDD ≤ 5.5V, 10kHz, 100mV ripple		80		dB
AC ACCURACY						
SNR	Signal-to-noise ratio	f_{IN} = 1kHz	80.5	85		dB
SINAD	Signal-to-noise + distortion	f_{IN} = 1kHz	80	85		dB
THD	Total harmonic distortion(5)	f_{IN} = 1kHz, AMC1203		–92	–84.5	dB
		f_{IN} = 1kHz, AMC1203B		–95	–88	
SFDR	Spurious-free dynamic range	f_{IN} = 1kHz, AMC1203	86	92		dB
		f_{IN} = 1kHz, AMC1203B	89	95		
CMOS LOGIC WITH SCHMITT-TRIGGER						
V_{OH}	High-level output voltage	I_{OH} = –4mA	DVDD – 0.4			V
		I_{OH} = –8mA	DVDD – 0.8			
V_{OL}	Low-level output voltage	I_{OL} = 4mA			0.4	V
		I_{OL} = 8mA			0.8	

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5.9 Electrical Characteristics (continued)

minimum and maximum specifications are at T_A = –40°C to 105°C, AVDD = 4.5 V to 5.5 V, DVDD = 4.5 V to 5.5 V, INP = –280 mV to 280 mV, INN = 0 V, and sinc^3 filter with OSR = 256 (unless otherwise noted); typical specifications are at T_A =25°C, AVDD = 5 V, and DVDD = 5.0 V

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
POWER SUPPLY						
I_{AVDD}	High-side supply current			6	8	mA
I_{DVDD}	Low-side supply current			10	12	mA

(1) This parameter is input referred.
(2) Integral nonlinearity is defined as the maximum deviation from a straight line passing through the end-points of the ideal ADC transfer function expressed as number of LSBs or as a percent of the specified linear full-scale range FSR.
(3) Offset error temperature drift is calculated using the box method, as described by the following equation: $TCE_O = (E_{O,MAX} – E_{O,MIN}) / TempRange$ where $E_{O,MAX}$ and $E_{O,MIN}$ refer to the maximum and minimum E_O values measured within the temperature range (–40 to 105°C).
(4) Gain error temperature drift is calculated using the box method, as described by the following equation: $TCE_G\ (ppm) = ((E_{G,MAX} - E_{G,MIN}) / TempRange) \times 10^4$ where $E_{G,MAX}$ and $E_{G,MIN}$ refer to the maximum and minimum E_G values (in %) measured within the temperature range (–40 to 105°C).
(5) THD is the ratio of the rms sum of the amplitudes of first five higher harmonics to the amplitude of the fundamental.
(6) Maximum values, including temperature drift, are ensured over the full specified temperature range.

5.10 Switching Characteristics

over operating ambient temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
f_{CLK}	Internal clock frequency		8	10	12	MHz
t_{CLK}	CLKOUT clock period		83.3	100	125	ns
t_{HIGH}	CLKOUT high time		(t_{CLK} / 2) – 8(1)	t_{CLK} / 2	(t_{CLK} / 2) + 8(1)	ns
t_D	DOUT delay time after falling edge of CLKOUT		–2		2	ns
t_S	DOUT setup time prior to rising edge of CLKOUT		31.5			ns
t_H	DOUT hold time after rising edge of CLKOUT		31.5			ns

(1) t_{CLK} refers to the actual clock period of the device

5.11 Timing Diagram

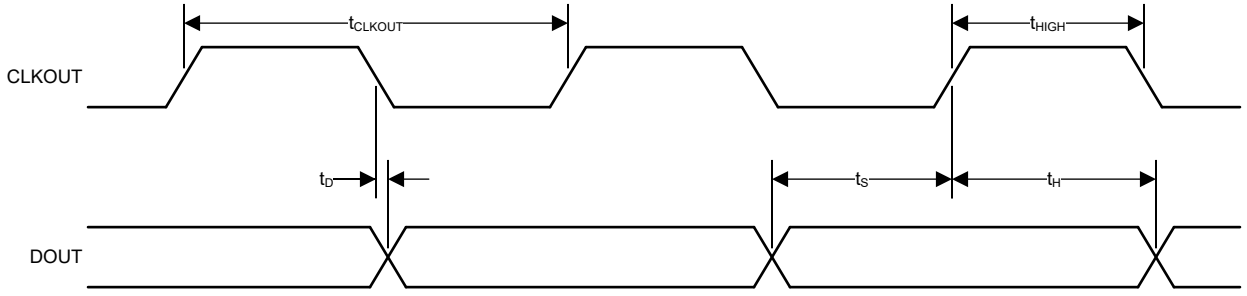


Figure 5-1. Digital Interface Timing

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5.12 Typical Characteristics

at V_{DD1} = V_{DD2} = 5V, V_{IN+} = –280mV to +280mV, $V_{IN–}$ = 0V, and sinc^3 filter with OSR = 256 (unless otherwise noted)

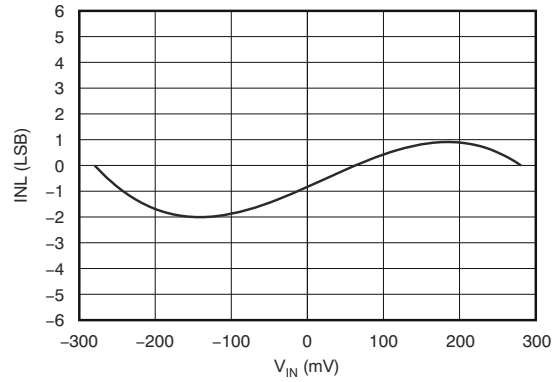


Figure 5-2. Integral Nonlinearity vs Input Signal Amplitude

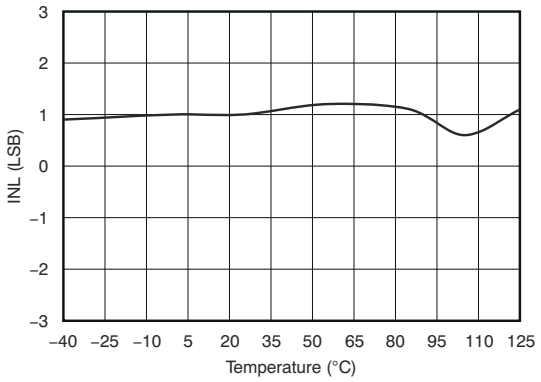


Figure 5-3. Integral Nonlinearity vs Temperature

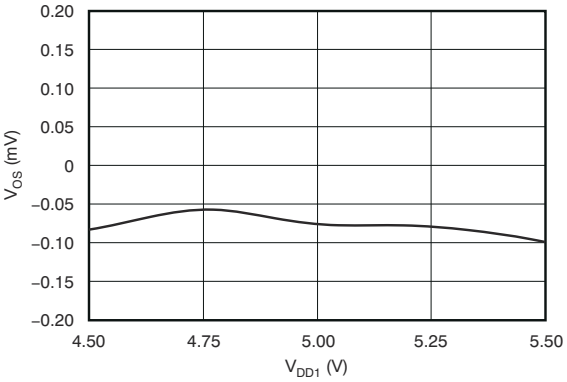


Figure 5-4. Offset Error vs Supply Voltage

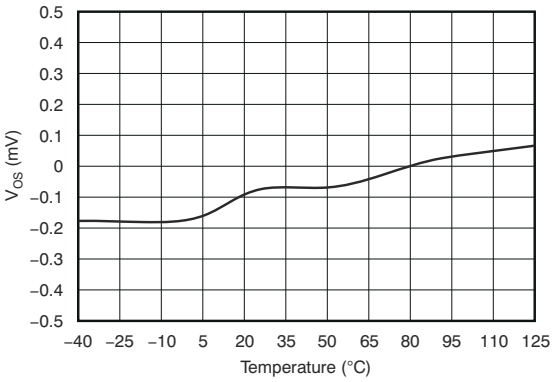


Figure 5-5. Offset Error vs Temperature

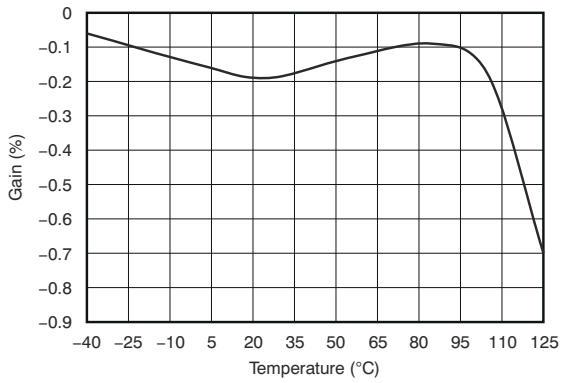


Figure 5-6. Gain Error vs Temperature

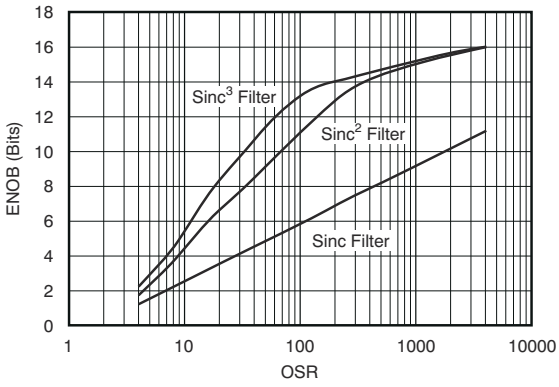


Figure 5-7. Effective Number of Bits vs Oversampling Ratio

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5.12 Typical Characteristics (continued)

at V_{DD1} = V_{DD2} = 5V, V_{IN+} = –280mV to +280mV, $V_{IN–}$ = 0V, and sinc^3 filter with OSR = 256 (unless otherwise noted)

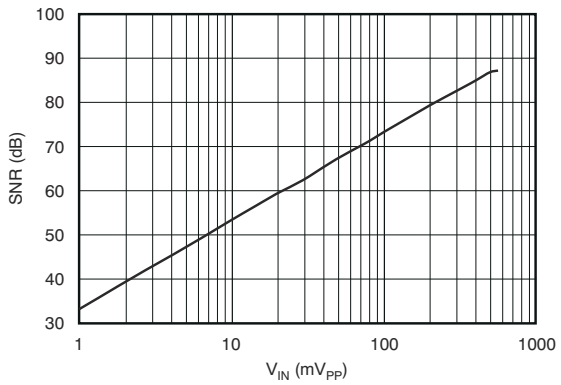


Figure 5-8. Signal-to-Noise Ratio vs Input Signal Amplitude

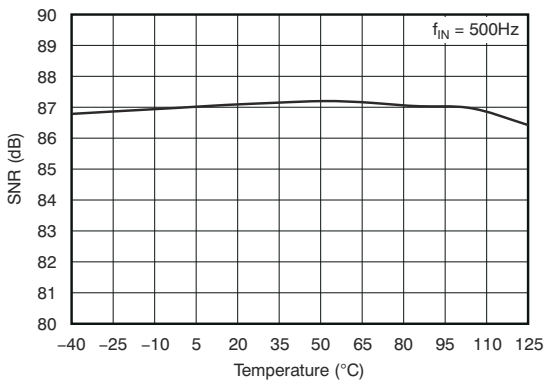


Figure 5-9. Signal-to-Noise Ratio vs Temperature

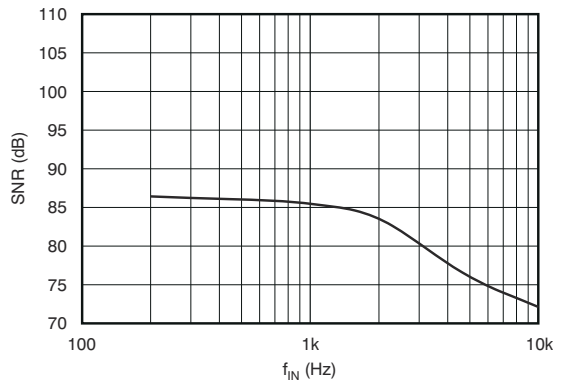


Figure 5-10. Signal-to-Noise Ratio vs Input Signal Frequency

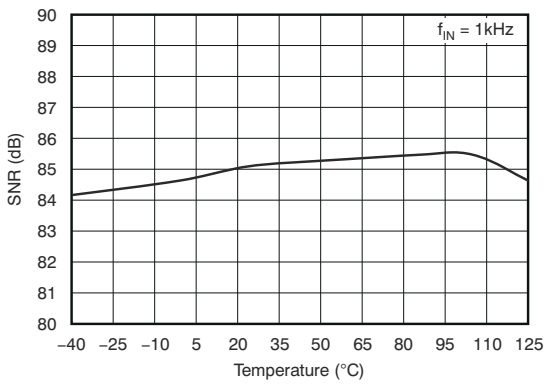


Figure 5-11. Signal-to-Noise Ratio vs Temperature

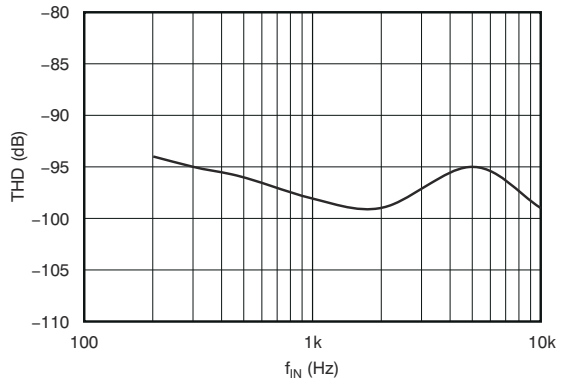


Figure 5-12. Total Harmonic Distortion vs Input Signal Frequency

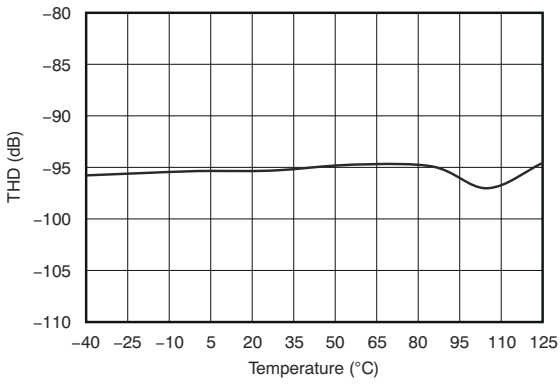


Figure 5-13. Total Harmonic Distortion vs Temperature

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5.12 Typical Characteristics (continued)

at V_{DD1} = V_{DD2} = 5V, V_{IN+} = –280mV to +280mV, $V_{IN–}$ = 0V, and sinc^3 filter with OSR = 256 (unless otherwise noted)

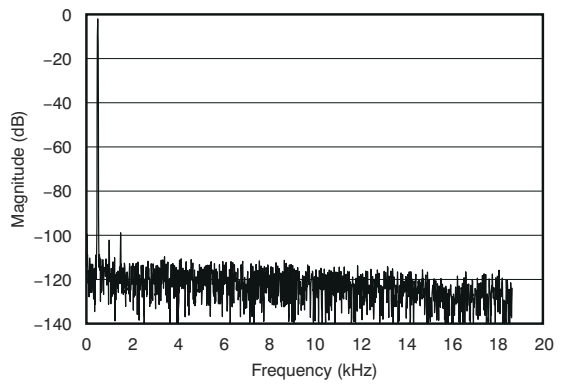


Figure 5-14. Frequency Spectrum (4096-Point FFT, f_{IN} = 500Hz, 0.56V_{PP})

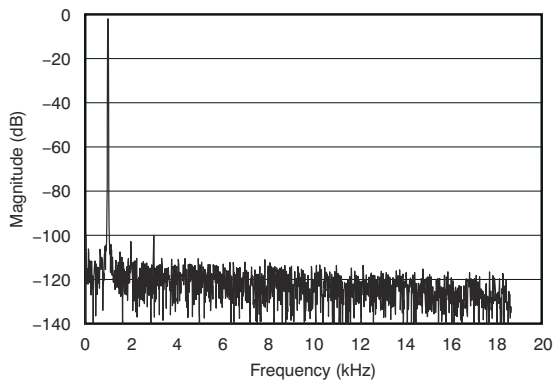


Figure 5-15. Frequency Spectrum (4096-Point FFT, f_{IN} = 1kHz, 0.56V_{PP})

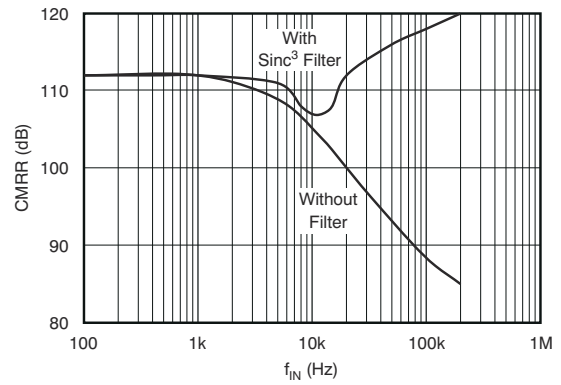


Figure 5-16. Common-Mode Rejection Ratio vs Input Signal Frequency

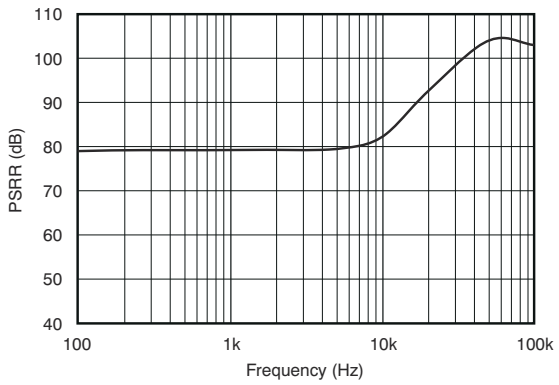


Figure 5-17. Power-Supply Rejection Ratio vs Frequency

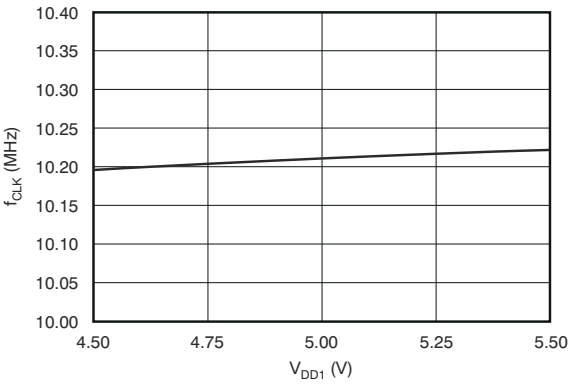


Figure 5-18. Internal Clock Frequency vs Supply Voltage

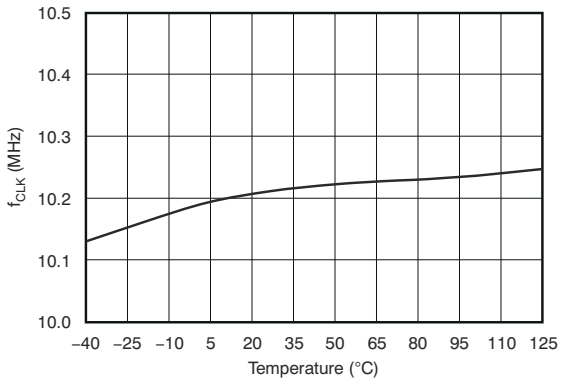


Figure 5-19. Internal Clock Frequency vs Temperature

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5.12 Typical Characteristics (continued)

at V_{DD1} = V_{DD2} = 5V, V_{IN+} = –280mV to +280mV, $V_{IN–}$ = 0V, and sinc^3 filter with OSR = 256 (unless otherwise noted)

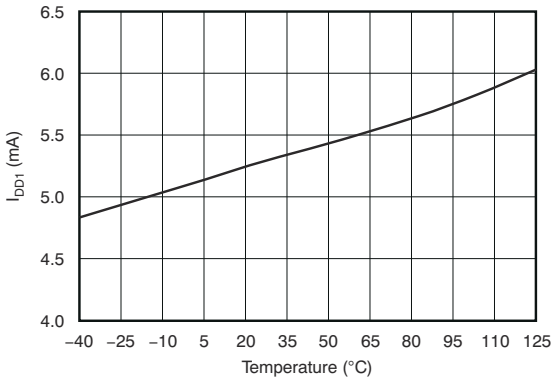


Figure 5-20. Analog Supply Current vs Temperature

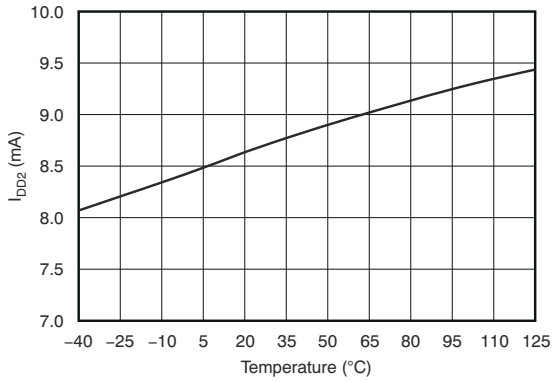


Figure 5-21. Digital Supply Current vs Temperature

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6 Detailed Description

6.1 Overview

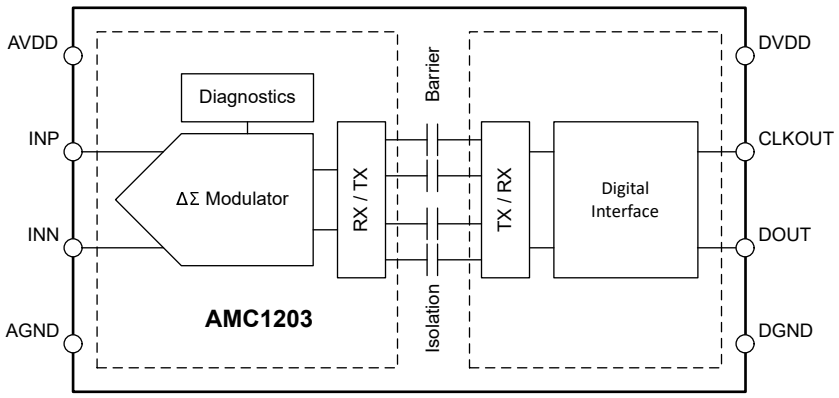
The AMC1203 is a single-channel, second-order, CMOS, delta-sigma (ΔΣ) modulator designed for high resolution shunt-based current sensing. The differential analog input is implemented with a switched-capacitor circuit. The isolated output of the converter (DOUT) provides a stream of digital ones and zeros synchronous to the internally generated clock available at the CLKOUT pin. The time average of this serial output is proportional to the analog input voltage.

The modulator shifts the quantization noise to high frequencies. Therefore, use a low-pass digital filter (such as a Sinc filter) at the device output to increase the signal-to-noise ratio (SNR). The Sinc filter also converts the 1-bit data stream at a high sampling rate into a higher-bit data word at a lower rate (decimation). Use a microcontroller (MCU) with integrated sigma-delta-filter-module (SDFM) or a field-programmable gate array (FPGA) to implement the filter.

The overall performance (speed and resolution) depends on the selection of an appropriate oversampling ratio (OSR) and filter type. A higher OSR results in higher resolution while operating at a lower refresh rate. A lower OSR results in lower resolution, but provides data at a higher refresh rate. This system allows flexibility with the digital filter design and is capable of analog-to-digital conversion results of 256 OSR and exceeding an 84dB dynamic range.

The silicon-dioxide (SiO_2) based capacitive isolation barrier supports a high level of magnetic field immunity; see the *ISO72x Digital Isolator Magnetic-Field Immunity* application note. The AMC1203 uses digital modulation to transmit data across the isolation barrier. This modulation and the isolation barrier characteristics, result in high reliability in noisy environments and high common-mode transient immunity.

6.2 Functional Block Diagram



6.3 Feature Description

6.3.1 Analog Input

As shown in Figure 6-1, the input of the AMC1203 is a fully differential, switched-capacitor circuit with a dynamic input impedance of 28kΩ.

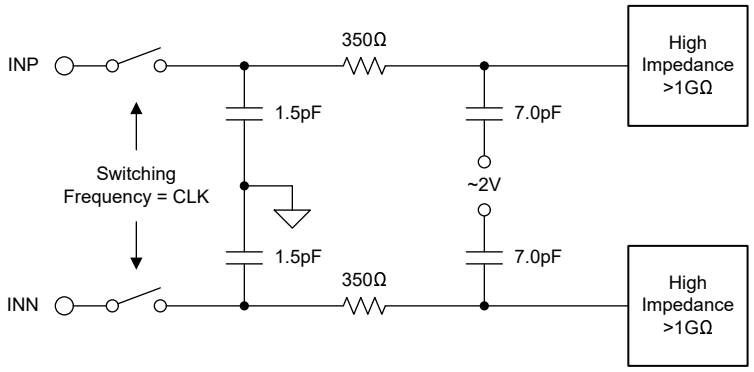


Figure 6-1. Equivalent Input Circuit

The analog input range is tailored to directly accommodate a voltage drop across a shunt resistor used for current sensing. There are two restrictions on the analog input signals (INP and INN). First, if the input voltage exceeds the input range specified in the *Absolute Maximum Ratings* table, the input current must be limited to 10mA. This limitation is caused by the device input electrostatic discharge (ESD) diodes turning on. Second, linearity and noise performance are specified only when the differential input voltage is within the linear full-scale range (V_{FSR}) and the common-mode input voltage range (V_{CM}). V_{FSR} and V_{CM} are specified in the *Recommended Operating Conditions* table.

6.3.2 Modulator

Figure 6-2 conceptualizes the second-order, switched-capacitor, ΔΣ modulator implemented in the AMC1203. The output V_6 of the 1-bit, digital-to-analog converter (DAC) is subtracted from the input voltage V_{IN} = (V_{INN} – V_{INP}). This subtraction provides an analog voltage V_2 at the input of the first integrator stage. V_6 is again subtracted from the output of the first integrator, resulting in a voltage V_3 that feeds the input of the second integrator stage. The output of the second integrator stage, V_4, is compared against an internal reference voltage V_{REF}. Depending on the value of V_4, the output of the comparator potentially changes. In this case, the 1-bit DAC responds on the next clock pulse by changing the associated analog output voltage V_6. This change causes the integrators to progress in the opposite direction and forces the integrator output value to track the average input value.

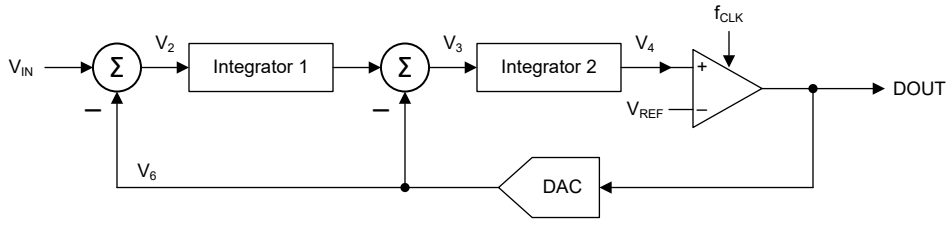


Figure 6-2. Block Diagram of a Second-Order Modulator

The modulator shifts the quantization noise to high frequencies. In a typical application, the sigma-delta output bitstream is filtered by a digital low-pass filter to increase the resolution of the analog-to-digital conversion. This filter also converts the 1-bit data stream at a high sampling rate into a higher-bit data word at a lower rate (decimation). TI's C2000™ and Sitara™ microcontroller families offer a programmable, hardwired filter structure, termed a *sigma-delta filter module* (SDFM), optimized for use with the AMC1203. Alternatively, use a field-programmable gate array (FPGA) or complex programmable logic device (CPLD) to implement the filter.

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6.3.3 Digital Output

A differential input signal of 0V ideally produces a stream of ones and zeros that are high 50% of the time. A differential input of 280mV produces a stream of ones and zeros that are high 93.75% of the time. With 16 bits of resolution, that percentage ideally corresponds to code 62440. A differential input of –280mV produces a stream of ones and zeros that are high 6.25% of the time and ideally results in code 4096. The ±280mV range is the specified linear range of the AMC1203. If the input voltage value exceeds ±280mV, the output of the modulator shows increasingly nonlinear behavior as the quantization noise increases. The modulator output clips with a constant stream of zeros with an input ≤ –320mV or with a constant stream of ones with an input ≥ 320mV. Figure 6-3 shows the input voltage versus the output modulator signal.

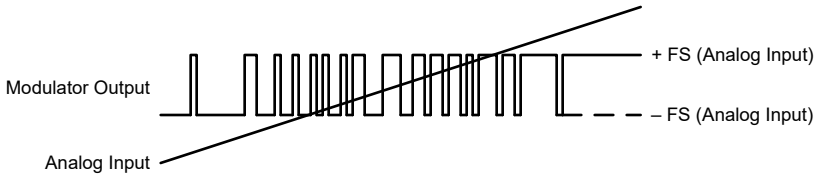


Figure 6-3. Modulator Output vs Analog Input

Calculate the density of ones in the output bitstream with Equation 1 for any input voltage value of V_{IN}, where $V_{IN} = (V_{INP} – V_{INN})$:

$$\rho = \frac{V_{IN} + V_{Clipping}}{2 \times V_{Clipping}} \quad (1)$$

6.4 Device Functional Modes

The AMC1203 operates under one of the following conditions:

- Off state (OFF): The low-side of the device (AVDD) is not supplied. The device is not responsive and CLKOUT and DOUT are both low. Internally, CLKOUT and OUT are clamped to DVDD and DGND by ESD protection diodes.
- Missing high-side supply: DVDD is supplied but AVDD is missing. The device outputs a constant bitstream of logic 1's or logic 0's.
- Normal operation: AVDD and DVDD are within the recommended operating conditions. The device outputs a digital bitstream, as explained in the *Digital Output* section.

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7 Application and Implementation

Note

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

The AMC1203 features low analog input voltage range, high accuracy, and low temperature drift. These features make the AMC1203 a high-performance solution for shunt-based current sensing in the presence of high common-mode voltage levels.

7.2 Typical Application

Figure 7-1 shows the AMC1203 in a typical motor drive application. The load current flowing through an external shunt resistor RSHUNT produces a voltage drop sensed by the AMC1203. The AMC1203 digitizes the analog input signal on the high side. The device then transfers the data across the isolation barrier to the low side, and outputs the digital bitstream on the DOUT pin. The 5V high-side power supply (AVDD) is generated from the floating gate driver supply using a resistor (R4) and a Zener diode (D1). Use the 49.9Ω resistors on the CLKOUT and DOUT pins for line termination to improve signal integrity on the receiving end.

The differential input, digital output, and high common-mode transient immunity (CMTI) of the AMC1203 provide reliable and accurate operation even in high-noise environments.

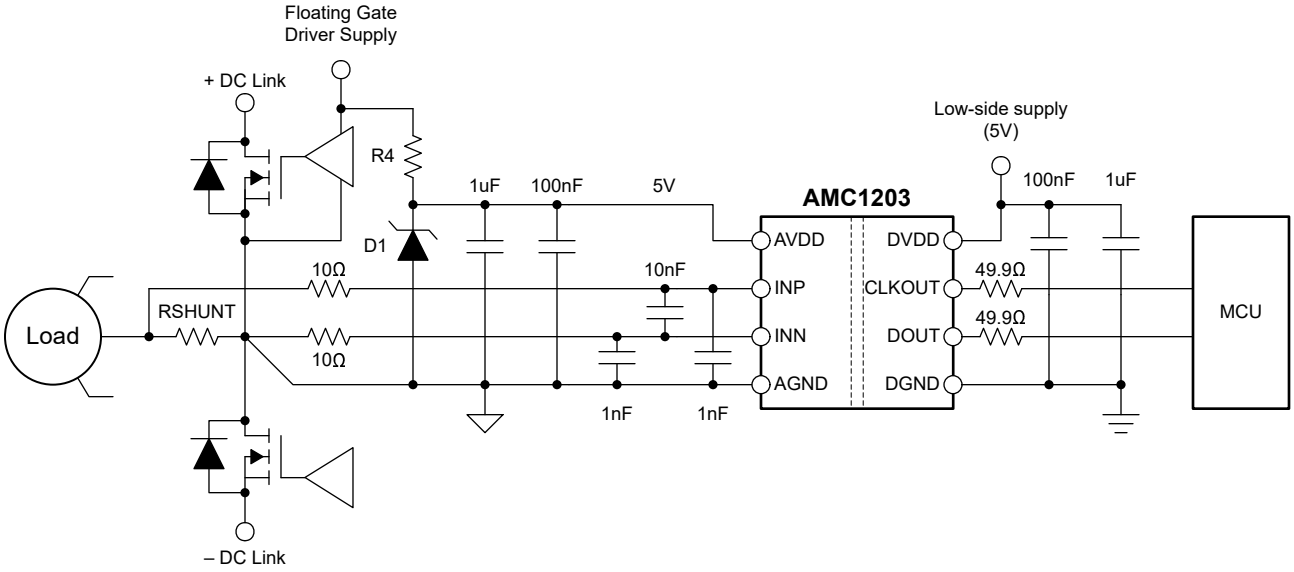


Figure 7-1. Using the AMC1203 for Current Sensing in a Typical Application

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7.2.1 Design Requirements

Table 7-1 lists the parameters for this typical application.

Table 7-1. Design Requirements

PARAMETER	VALUE
High-side supply voltage	5V
Low-side supply voltage	5V
Linear current sensing range	±5.6A (maximum)
Voltage drop across RSHUNT for a linear response	±280mV (maximum)

7.2.2 Detailed Design Procedure

The high-side power supply (AVDD) for the AMC1203 is derived from the floating power supply of the upper gate driver. Figure 7-1 provides an example using a resistor (R4) and a Zener diode (D1).

The floating ground reference (AGND) is derived from the end of the shunt resistor connected to the negative input of the AMC1203 (INN). If using a four-pin shunt, connect the inputs of the AMC1203 to the sense terminals of the shunt. Route the ground connection as a separate trace to the shunt to minimize offset and improve accuracy. See the *Layout* section for more details.

7.2.2.1 Shunt Resistor Sizing

The shunt resistor (RSHUNT) value is determined by the device linear input voltage range (±280mV) and the desired ±5.6A linear current sensing range. RSHUNT is calculated as 280mV / 5.6A = 50mΩ. The peak power dissipated in the shunt resistor is RSHUNT × I_{PEAK}^{2} = 50mΩ × $(5.6A)^2$ = 1.57W. For a linear response, operate the shunt resistor at no more than 2/3 of the rated power. Therefore, select a shunt resistor with a nominal power rating of approximately 2W.

Select a lower shunt resistor value if overcurrent transients are expected in the system that exceed the linear input voltage range of the AMC1203. Alternatively, the voltage drop across the shunt is allowed to exceed the linear input voltage range of the AMC1203. Outside the linear range, however, the output accuracy and noise performance degrades. Regardless, make sure the maximum overcurrent does not cause a voltage drop across the shunt that exceeds the clipping voltage of the AMC1203. That is, make sure $|V_{SHUNT}| \leq |V_{Clipping}|$.

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7.2.2.2 Input Filter Design

Place a differential RC filter (R1, R2, C5) in front of the isolated modulator to improve signal-to-noise performance of the signal path. Design the input filter such that:

- The filter capacitance (C5) is a minimum of 10nF
- The filter cutoff frequency is at least one order of magnitude lower than the sampling frequency (10MHz) of the ΔΣ modulator
- The input bias current does not generate significant voltage drop across the DC impedances (R1, R2) of the input filter
- The impedances measured from the analog inputs are equal (R1 equals R2)

Capacitors C6 and C7 are optional and improve common-mode rejection at high frequencies (>1MHz). For best performance, make sure C6 matches the value of C7 and both capacitors are 10 to 20 times lower in value than C5. For most applications, the structure shown in Figure 7-2 achieves excellent performance.

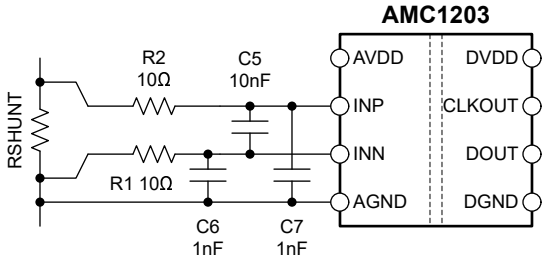


Figure 7-2. Differential Input Filter

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7.2.2.3 Bitstream Filtering

The modulator generates a bitstream that is processed by a digital filter. This process obtains a digital word similar to a conversion result of a conventional analog-to-digital converter (ADC). As described by Equation 2, a very simple filter built with minimal effort and hardware, is a sinc^3-type filter:

$$H(z) = \left(\frac{1 - z^{-OSR}}{1 - z^{-1}}\right)^3 \quad (2)$$

This filter provides the best output performance at the lowest hardware size (count of digital gates) for a second-order modulator. All characterization in this document is done with a sinc^3 filter with a 256 oversampling ratio (OSR) and a 16-bit output word width, unless specified otherwise. The measured effective number of bits (ENOB) as a function of the OSR is illustrated in Figure 7-3 of the *Typical Application* section.

A *delta sigma modulator filter calculator* is available for download at www.ti.com. This calculator aids in filter design and selecting the right OSR and filter order to achieve the desired output resolution and filter response time.

The *Combining the ADS1202 with an FPGA Digital Filter for Current Measurement in Motor Control Applications* application note includes example code for implementing a sinc^3 filter in an FPGA. This application note is available for download at www.ti.com.

For modulator output bitstream filtering, use a device from TI's C2000™ or Sitara™ microcontroller families. These families support up to eight channels of dedicated hardwired filter structures that significantly simplify system level design by offering two filtering paths per channel. One path provides high-accuracy results for the control loop and the other a fast-response path for overcurrent detection.

7.2.3 Application Curve

The effective number of bits (ENOB) is often used to compare the performance of ADCs and ΔΣ modulators. Figure 7-3 shows the ENOB of the AMC1203 with different oversampling ratios.

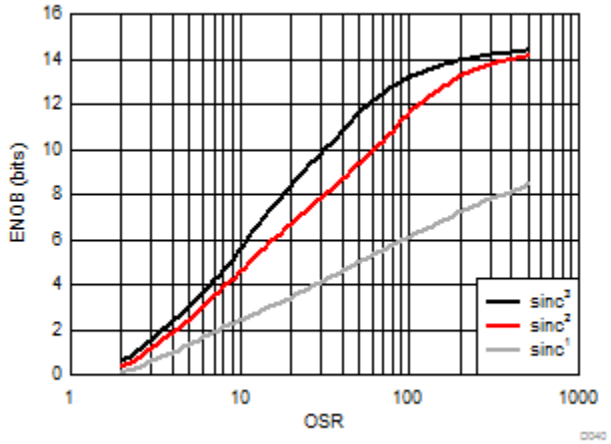


Figure 7-3. Measured Effective Number of Bits vs Oversampling Ratio

7.3 Best Design Practices

Place a minimum 10nF capacitor at the input of the device (from INP to INN). This capacitor helps avoid voltage droop at the input during the sampling period of the switched-capacitor input stage.

Do not leave the inputs of the AMC1203 unconnected (floating) when the device is powered up. If the device inputs are left floating, the input bias current potentially drives the inputs to a positive value exceeding the operating common-mode input voltage. As a result, DOUT is permanently high.

Connect the high-side ground (AGND) to INN, either by a hard short (at the shunt, not at the device pins) or through a resistive path. A DC current path between INN and AGND is required to define the input common-mode voltage. Take care not to exceed the input common-mode range as specified in the *Recommended Operating Conditions* table. For best accuracy, route the ground connection as a separate trace to the shunt. See the *Layout* section for more details.

7.4 Power Supply Recommendations

Typically, as shown in Figure 7-4, the device high-side power supply (AVDD) is generated from a floating gate driver supply or an isolated DC/DC converter. A low-cost solution is based on the push-pull driver SN6501 and a transformer that supports the desired isolation voltage ratings.

The AMC1203 does not require any specific power-up sequencing. The high-side power supply (AVDD) is decoupled with a low-ESR, 100nF capacitor (C1) parallel to a low-ESR, 1µF capacitor (C2). The low-side power supply (DVDD) is equally decoupled with a low-ESR, 100nF capacitor (C3) parallel to a low-ESR, 1µF capacitor (C4). Place all four capacitors (C1, C2, C3, and C4) as close to the device as possible. Figure 7-4 shows a decoupling diagram for the AMC1203.

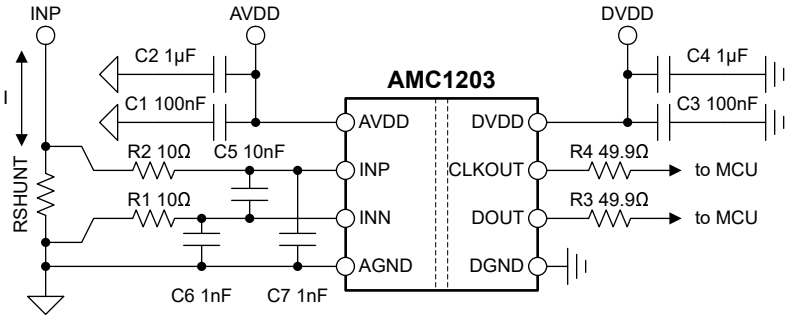


Figure 7-4. Decoupling of the AMC1203

Make sure capacitors provide adequate *effective* capacitance under the applicable DC bias conditions experienced in the application. Multilayer ceramic capacitors (MLCC) typically exhibit only a fraction of the nominal capacitance under real-world conditions. Consider this factor when selecting these capacitors. This issue is especially acute in low-profile capacitors, where the dielectric field strength is higher than in taller components. Reputable capacitor manufacturers provide capacitance versus DC bias curves that greatly simplify component selection.

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7.5 Layout

7.5.1 Layout Guidelines

Figure 7-5 shows a layout recommendation with the critical placement of the decoupling capacitors (as close as possible to the AMC1203 supply pins). This figure also shows the placement of the other components required by the device. For best performance, place the shunt resistor close to the device input pins (INN and INP).

7.5.2 Layout Example

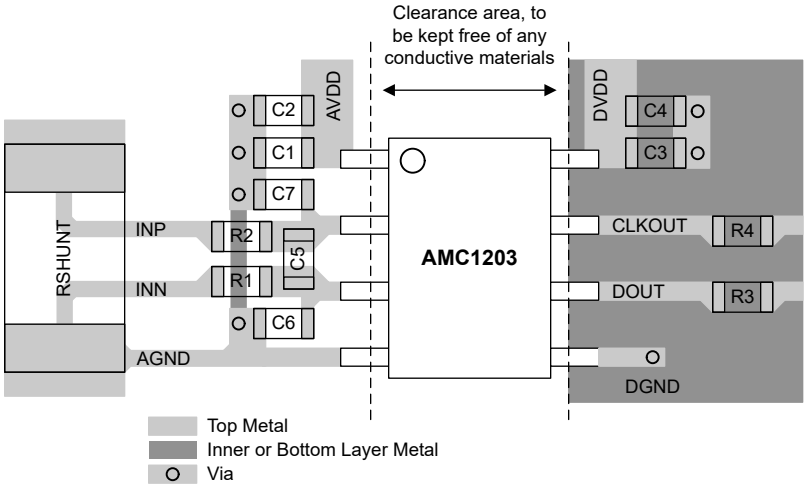


Figure 7-5. Recommended Layout of the AMC1203

8 Device and Documentation Support

8.1 Documentation Support

8.1.1 Related Documentation

For related documentation see the following:

- Texas Instruments, *Isolation Glossary* application note
- Texas Instruments, *Semiconductor and IC Package Thermal Metrics* application note
- Texas Instruments, *ISO72x Digital Isolator Magnetic-Field Immunity* application note
- Texas Instruments, *ISO72x Digital Isolator Magnetic-Field Immunity* application note
- Texas Instruments, *Combining the ADS1202 with an FPGA Digital Filter for Current Measurement in Motor Control Applications* application note
- Texas Instruments, *Delta Sigma Modulator Filter Calculator* design tool

8.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. Click on *Notifications* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

8.3 Support Resources

TI E2E™ support forums are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

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8.5 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

8.6 Glossary

TI Glossary	This glossary lists and explains terms, acronyms, and definitions.

9 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision D (June 2024) to Revision E (June 2025)	Page
• Changed isolation specifications in *Features*: Changed DIN EN IEC value from $4000V_{PEAK}$ to $3500V_{PEAK}$ and UL1577 value from $2800V_{RMS}$ to $2500V_{RMS}$	1
• Changed VDE 0884-17 isolation specification from $3800V_{PEAK}$ to $3500V_{PEAK}$ in *Description*	1
• Changed V_{IOTM} from $3800V_{PK}$ to $3500V_{PK}$ and V_{ISO} from $2700V_{RMS}$ to $2500V_{RMS}$	7

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Changes from Revision C (June 2011) to Revision D (June 2024)	Page

- Updated the numbering format for tables, figures, and cross-references throughout the document..... 1
- Added *Package Information* table, *Device Comparison Table*, *ESD Ratings*, *Power Ratings*, *Insulation Specifications*, *Power Ratings*, *Insulation Specifications*, *Safety-Related Certifications*, *Safety Limiting Values*, *Switching Characteristics*, *Overview*, *Functional Block Diagram*, *Feature Description*, *Device Functional Modes*, *Application and Implementation*, *Typical Application*, *Best Design Practices*, *Power Supply Recommendations*, *Layout*, *Device and Documentation Support*, and *Mechanical, Packaging, and Orderable Information* sections.....1
- Deleted *Package/Ordering Information*, *Dissipation Ratings*, *Regulatory Information*, *IEC 60747-5-2 Isolation Characteristics*, *Package Characteristics*, *IEC Safety Limiting Values*, *IEC 61000-4-5 Ratings*, and *IEC 60664-1 Ratings* tables.....1
- Changed entire document to align with current family format..... 1
- Added PSA and DW package options to document.....1
- Changed V_{IOTM} from $4000V_{PK}$ to $3800V_{PK}$ and V_{ISO} from $2800V_{RMS}$ to $2700V_{RMS}$ 7
- Changed V_{IOSM} from $6000V_{PK}$ to $4000V_{PK}$ 7

10 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.

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10.1 Mechanical Data

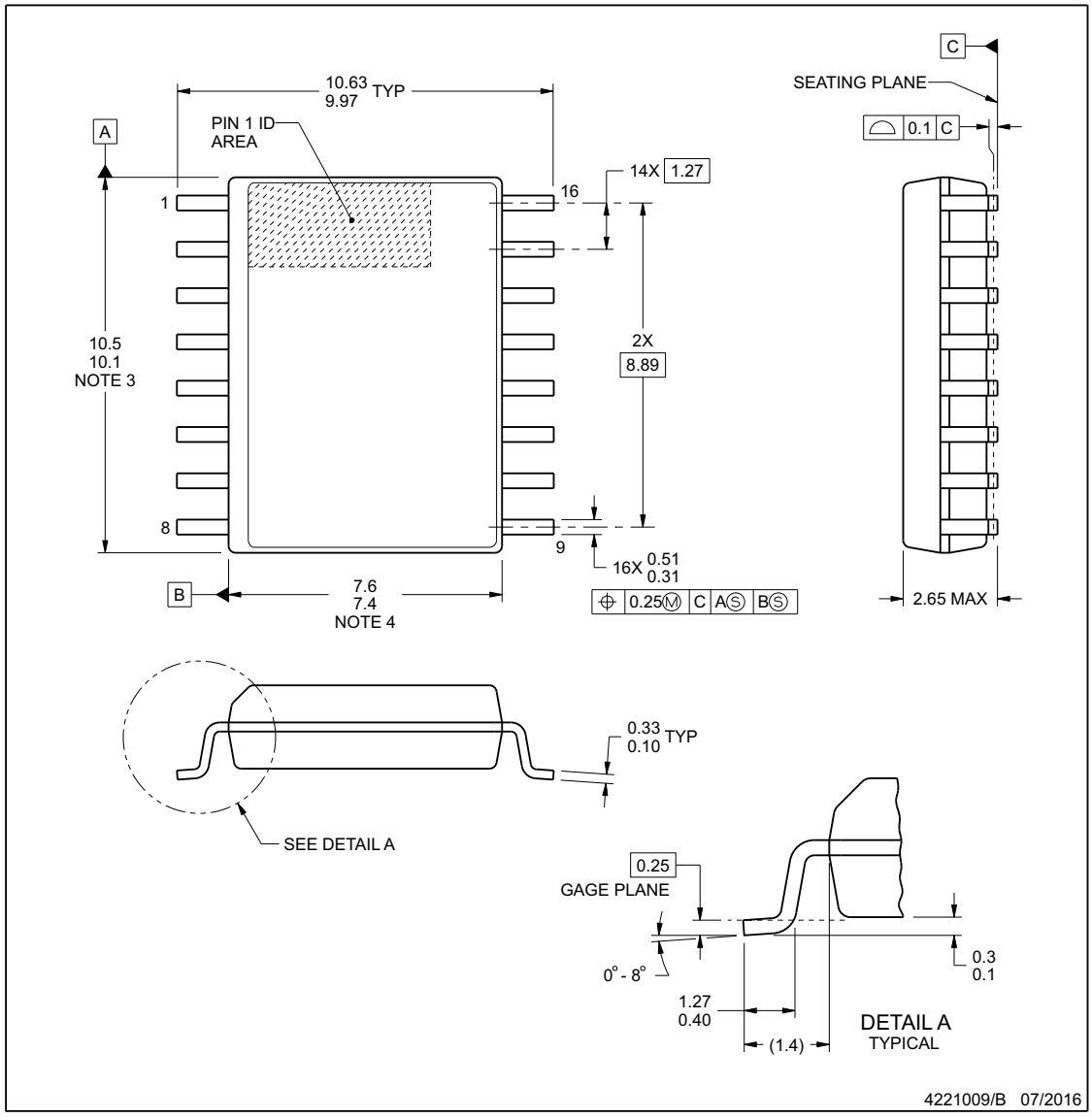


PACKAGE OUTLINE

DW0016B

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.

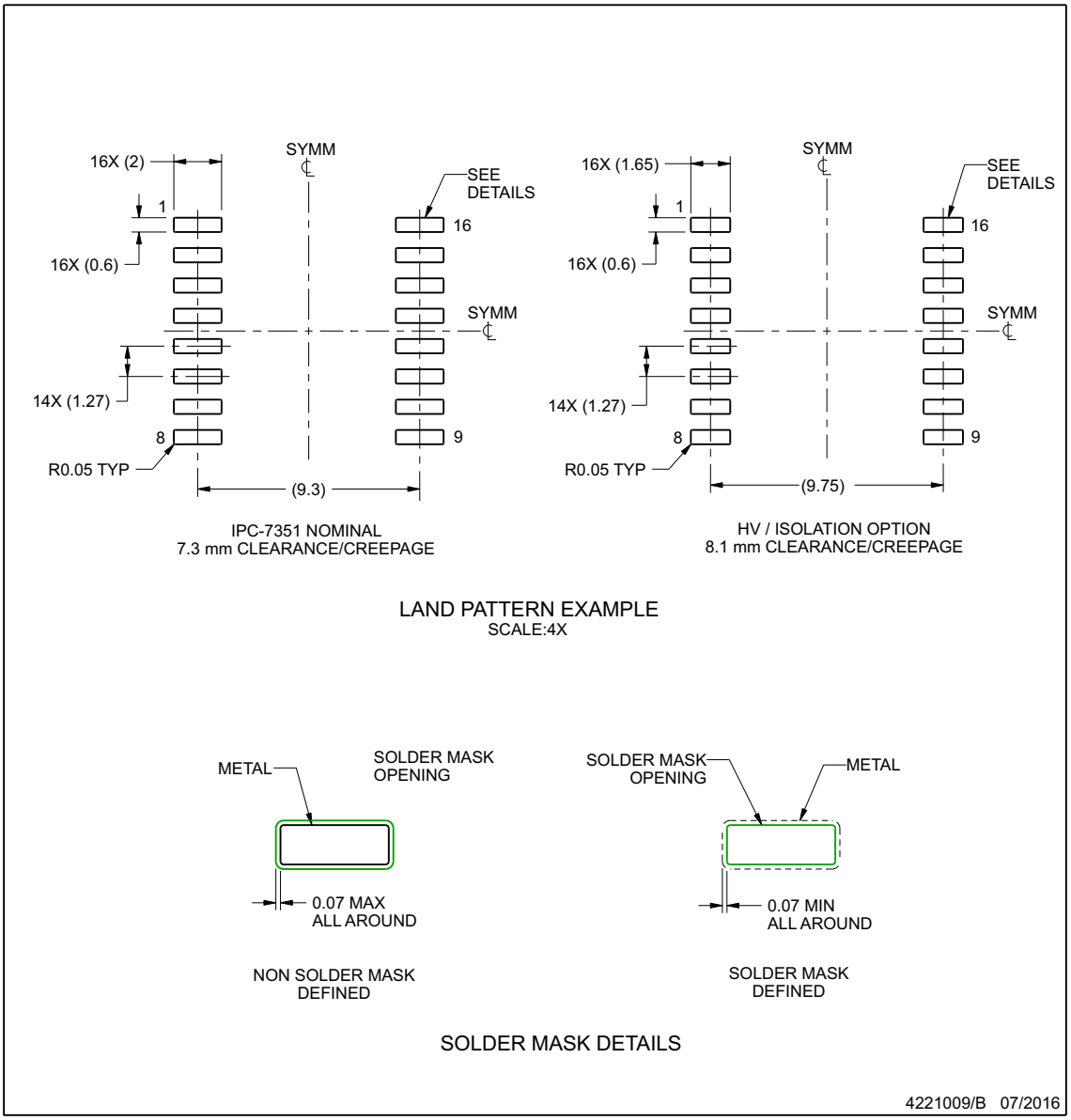
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EXAMPLE BOARD LAYOUT

DW0016B

SOIC - 2.65 mm max height

SOIC



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.

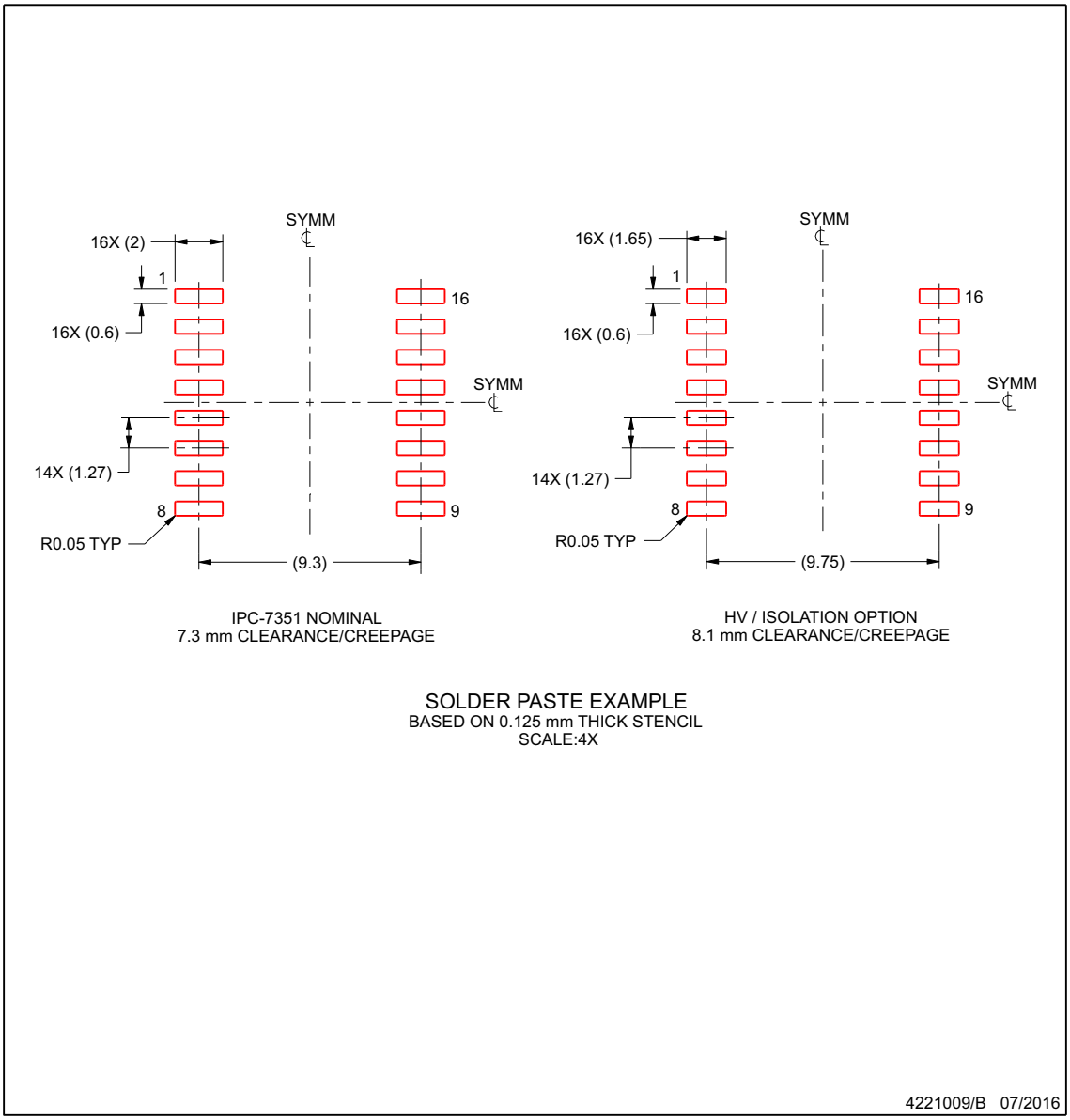
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EXAMPLE STENCIL DESIGN

DW0016B

SOIC - 2.65 mm max height

SOIC



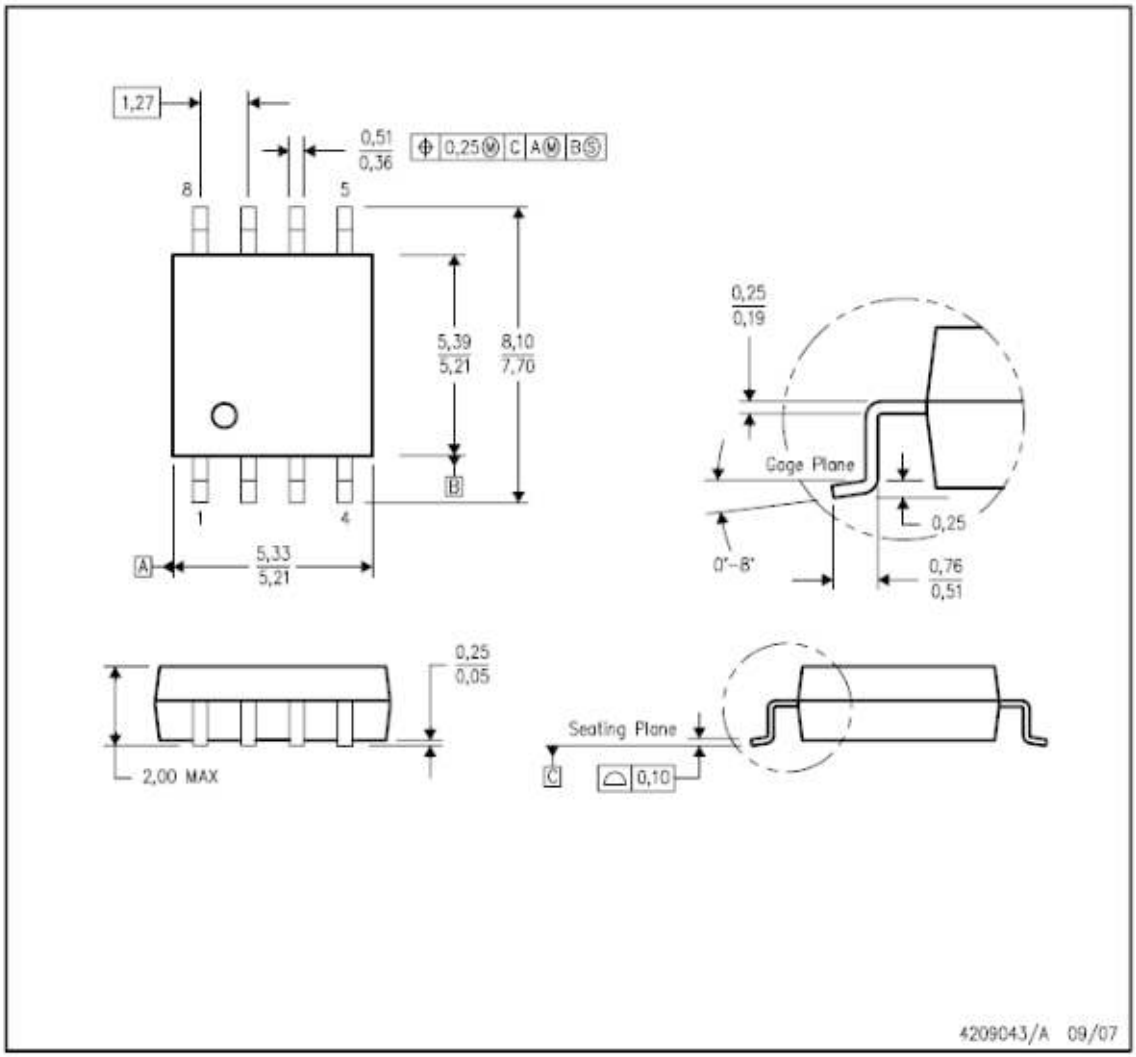
NOTES: (continued)

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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MECHANICAL DATA

PSA (R–PDSO–G8) PLASTIC SMALL–OUTLINE PACKAGE



NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

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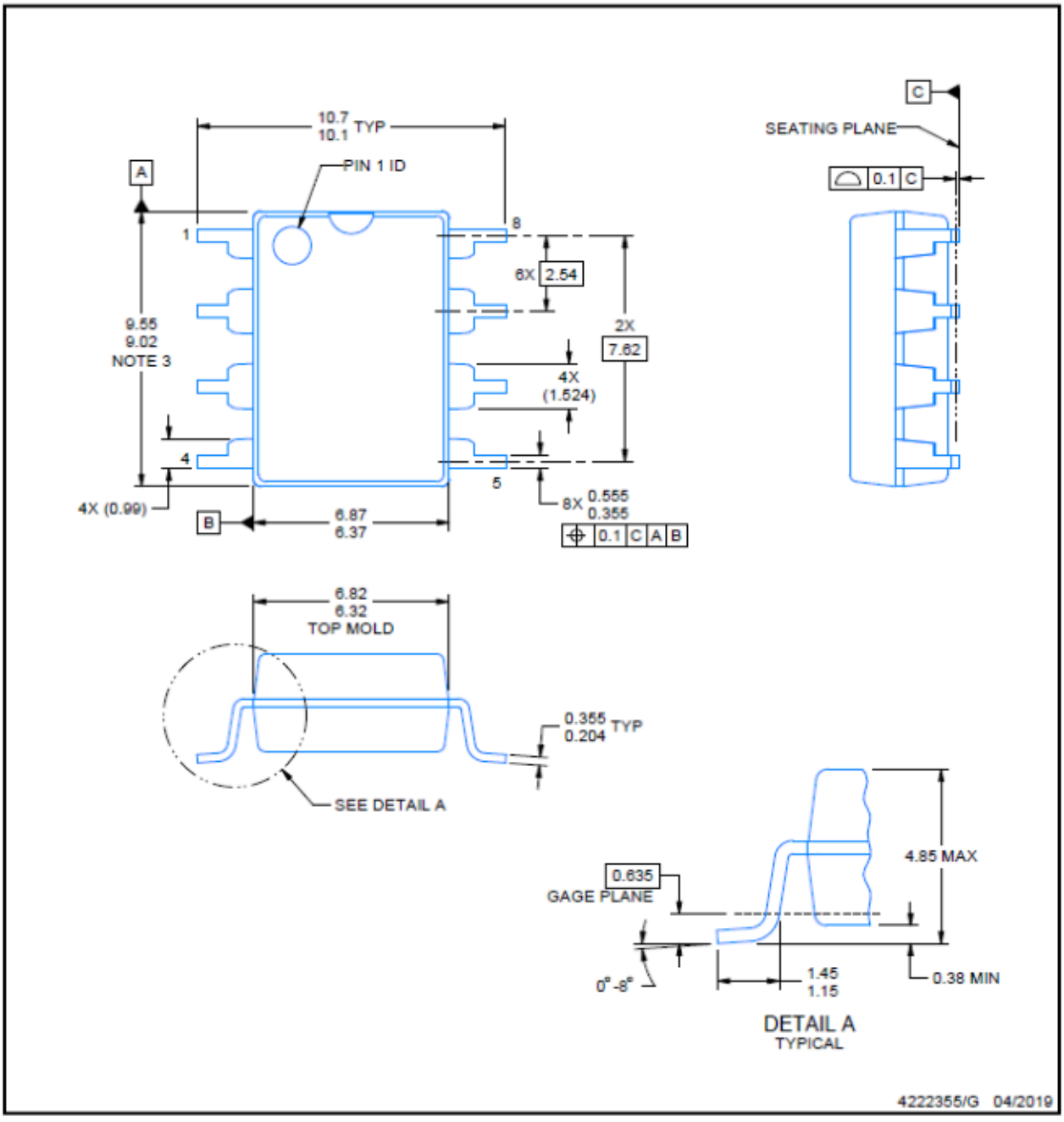
PACKAGE OUTLINE

DUB0008A



SOP - 4.85 mm max height

SMALL OUTLINE PACKAGE



NOTES:

1. All linear dimensions are in millimeters. Any 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 0.254 mm per side.

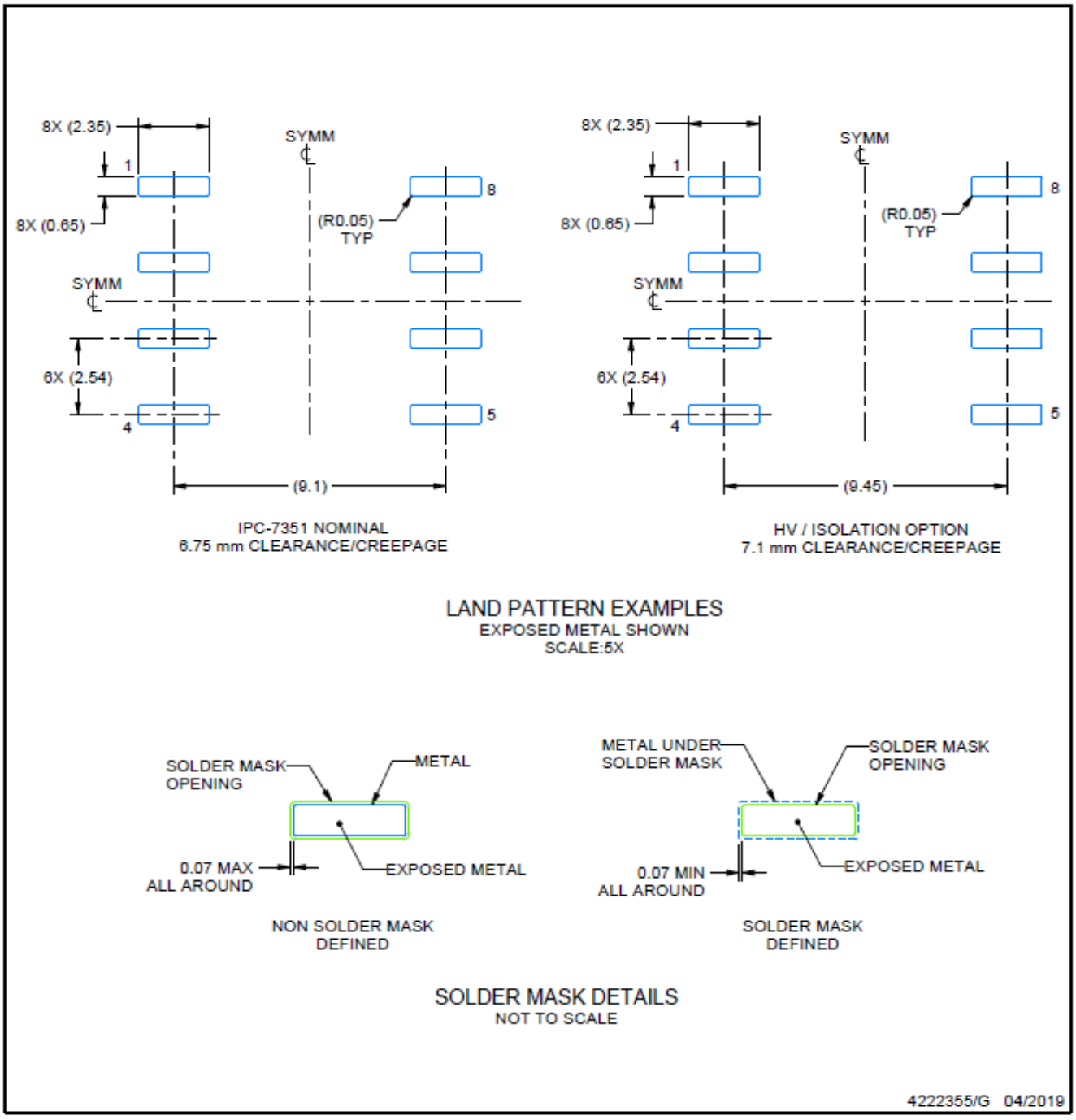
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EXAMPLE BOARD LAYOUT

DUB0008A

SOP - 4.85 mm max height

SMALL OUTLINE PACKAGE



NOTES: (continued)

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

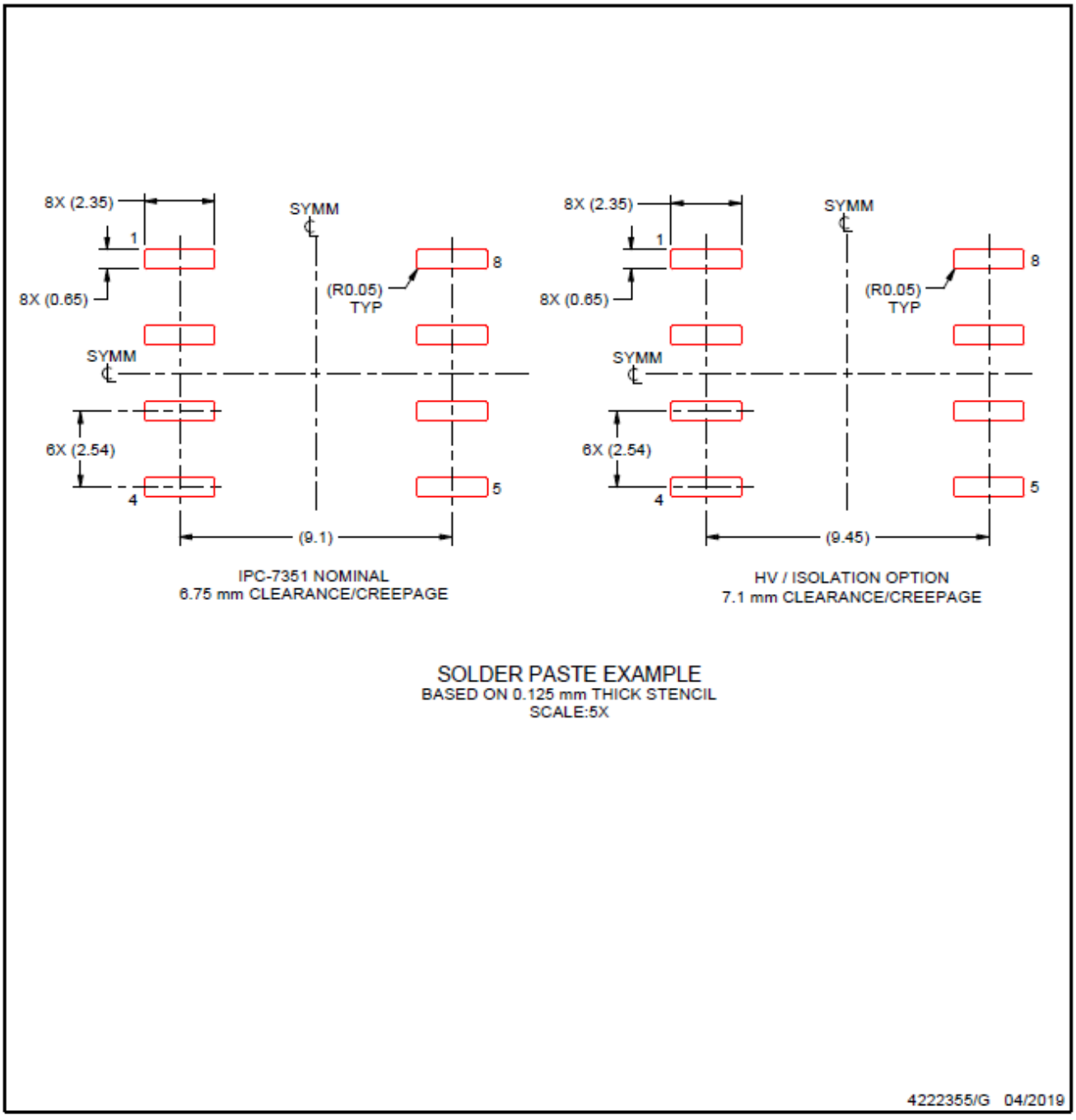
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EXAMPLE STENCIL DESIGN

DUB0008A

SOP - 4.85 mm max height

SMALL OUTLINE PACKAGE



NOTES: (continued)

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

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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)
AMC1203BDUB	Active	Production	SOP (DUB) | 8	50 | TUBE	Yes	Call TI	Level-3-260C-168 HR	-40 to 105	AMC1203 B
AMC1203BDUB.A	Active	Production	SOP (DUB) | 8	50 | TUBE	Yes	Call TI	Level-3-260C-168 HR	-40 to 105	AMC1203 B
AMC1203BDUBR	Active	Production	SOP (DUB) | 8	350 | LARGE T&R	Yes	Call TI	Level-3-260C-168 HR	-40 to 105	AMC1203 B
AMC1203BDUBR.A	Active	Production	SOP (DUB) | 8	350 | LARGE T&R	Yes	Call TI	Level-3-260C-168 HR	-40 to 105	AMC1203 B
AMC1203BDW	Active	Production	SOIC (DW) | 16	40 | TUBE	Yes	Call TI	Level-3-260C-168 HR	-40 to 105	AMC1203 B
AMC1203BDW.A	Active	Production	SOIC (DW) | 16	40 | TUBE	Yes	Call TI	Level-3-260C-168 HR	-40 to 105	AMC1203 B
AMC1203BDWR	Active	Production	SOIC (DW) | 16	2000 | LARGE T&R	Yes	Call TI	Level-3-260C-168 HR	-40 to 105	AMC1203 B
AMC1203BDWR.A	Active	Production	SOIC (DW) | 16	2000 | LARGE T&R	Yes	Call TI	Level-3-260C-168 HR	-40 to 105	AMC1203 B
AMC1203BPSA	Active	Production	SOP (PSA) | 8	95 | TUBE	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 105	1203 B
AMC1203BPSA.A	Active	Production	SOP (PSA) | 8	95 | TUBE	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 105	1203 B
AMC1203BPSAR	Active	Production	SOP (PSA) | 8	2000 | LARGE T&R	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 105	1203 B
AMC1203BPSAR.A	Active	Production	SOP (PSA) | 8	2000 | LARGE T&R	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 105	1203 B
AMC1203DUB	Active	Production	SOP (DUB) | 8	50 | TUBE	Yes	Call TI	Level-3-260C-168 HR	-40 to 105	AMC1203
AMC1203DUB.A	Active	Production	SOP (DUB) | 8	50 | TUBE	Yes	Call TI	Level-3-260C-168 HR	-40 to 105	AMC1203
AMC1203DUBR	Active	Production	SOP (DUB) | 8	350 | LARGE T&R	Yes	Call TI	Level-3-260C-168 HR	-40 to 105	AMC1203
AMC1203DUBR.A	Active	Production	SOP (DUB) | 8	350 | LARGE T&R	Yes	Call TI	Level-3-260C-168 HR	-40 to 105	AMC1203
AMC1203DW	Active	Production	SOIC (DW) | 16	40 | TUBE	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 105	AMC1203
AMC1203DW.A	Active	Production	SOIC (DW) | 16	40 | TUBE	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 105	AMC1203
AMC1203DWR	Active	Production	SOIC (DW) | 16	2000 | LARGE T&R	Yes	Call TI	Level-3-260C-168 HR	-40 to 105	AMC1203
AMC1203DWR.A	Active	Production	SOIC (DW) | 16	2000 | LARGE T&R	Yes	Call TI	Level-3-260C-168 HR	-40 to 105	AMC1203

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)
AMC1203PSA	Active	Production	SOP (PSA) | 8	95 | TUBE	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 105	1203
AMC1203PSA.A	Active	Production	SOP (PSA) | 8	95 | TUBE	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 105	1203
AMC1203PSAR	Active	Production	SOP (PSA) | 8	2000 | LARGE T&R	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 105	1203
AMC1203PSAR.A	Active	Production	SOP (PSA) | 8	2000 | LARGE T&R	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 105	1203

(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.

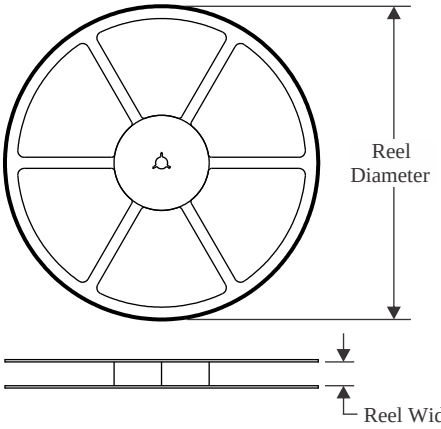
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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.

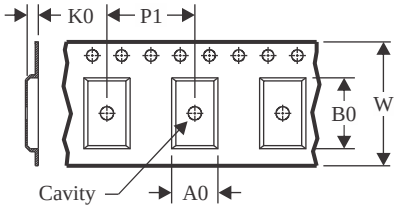
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

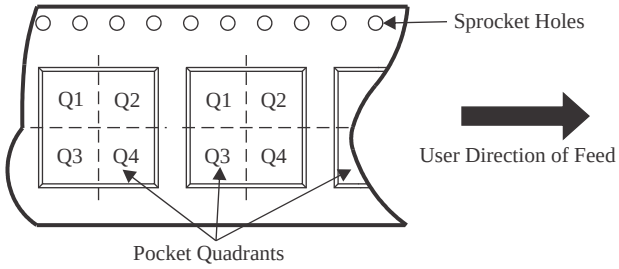


TAPE DIMENSIONS



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

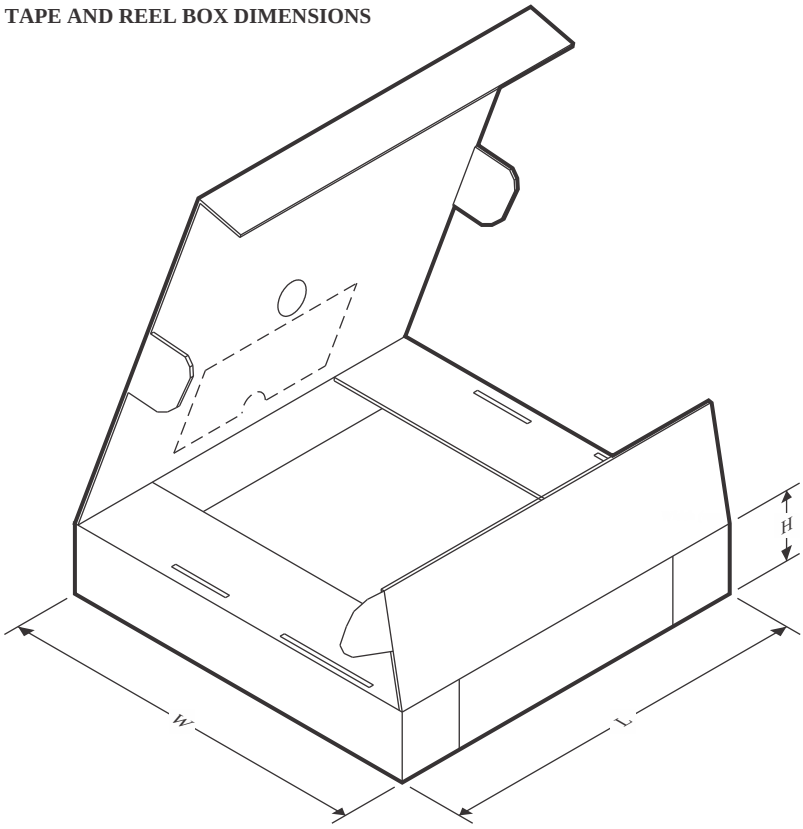
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
AMC1203BDUBR	SOP	DUB	8	350	330.0	24.4	10.9	10.01	5.85	16.0	24.0	Q1
AMC1203BDWR	SOIC	DW	16	2000	330.0	16.4	10.75	10.7	2.7	12.0	16.0	Q1
AMC1203BPSAR	SOP	PSA	8	2000	330.0	16.4	8.3	5.7	2.3	12.0	16.0	Q1
AMC1203DUBR	SOP	DUB	8	350	330.0	24.4	10.9	10.01	5.85	16.0	24.0	Q1
AMC1203DWR	SOIC	DW	16	2000	330.0	16.4	10.75	10.7	2.7	12.0	16.0	Q1
AMC1203PSAR	SOP	PSA	8	2000	330.0	16.4	8.3	5.7	2.3	12.0	16.0	Q1

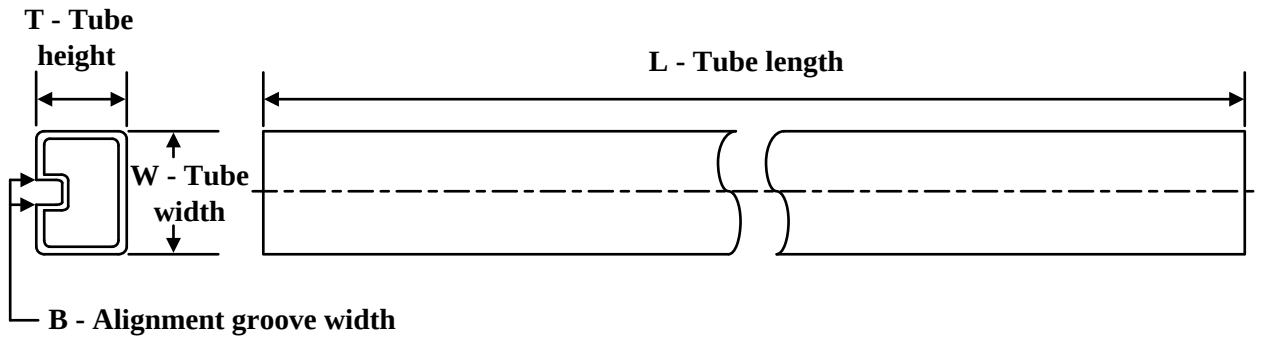
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
AMC1203BDUBR	SOP	DUB	8	350	358.0	335.0	35.0
AMC1203BDWR	SOIC	DW	16	2000	350.0	350.0	43.0
AMC1203BPSAR	SOP	PSA	8	2000	406.0	348.0	63.0
AMC1203DUBR	SOP	DUB	8	350	346.0	346.0	41.0
AMC1203DWR	SOIC	DW	16	2000	350.0	350.0	43.0
AMC1203PSAR	SOP	PSA	8	2000	406.0	348.0	63.0

TUBE



*All dimensions are nominal

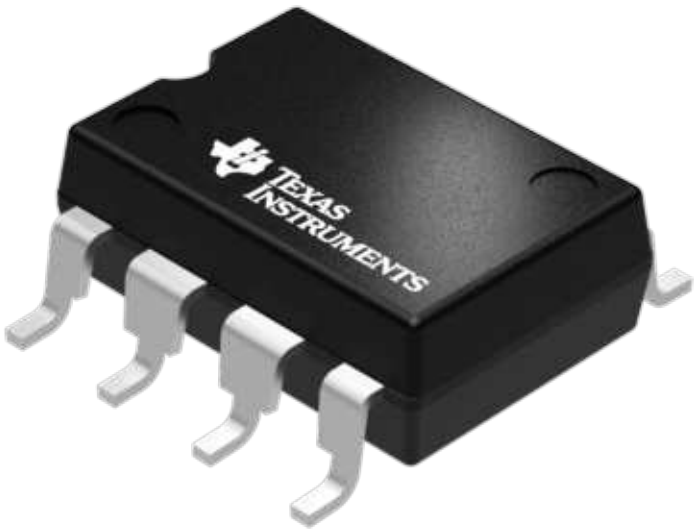
Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
AMC1203BDUB	DUB	SOP	8	50	532.13	13.51	7.36	6.91
AMC1203BDUB.A	DUB	SOP	8	50	532.13	13.51	7.36	6.91
AMC1203BDW	DW	SOIC	16	40	506.98	12.7	4826	6.6
AMC1203BDW.A	DW	SOIC	16	40	506.98	12.7	4826	6.6
AMC1203BPSA	PSA	SOP	8	95	530	10.5	4200	5.7
AMC1203BPSA.A	PSA	SOP	8	95	530	10.5	4200	5.7
AMC1203DUB	DUB	SOP	8	50	532.13	13.51	7.36	6.91
AMC1203DUB.A	DUB	SOP	8	50	532.13	13.51	7.36	6.91
AMC1203DW	DW	SOIC	16	40	506.98	12.7	4826	6.6
AMC1203DW.A	DW	SOIC	16	40	506.98	12.7	4826	6.6
AMC1203PSA	PSA	SOP	8	95	530	10.5	4200	5.7
AMC1203PSA.A	PSA	SOP	8	95	530	10.5	4200	5.7

GENERIC PACKAGE VIEW

DUB 8

SOP - 4.85 mm max height

SMALL OUTLINE PACKAGE



Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

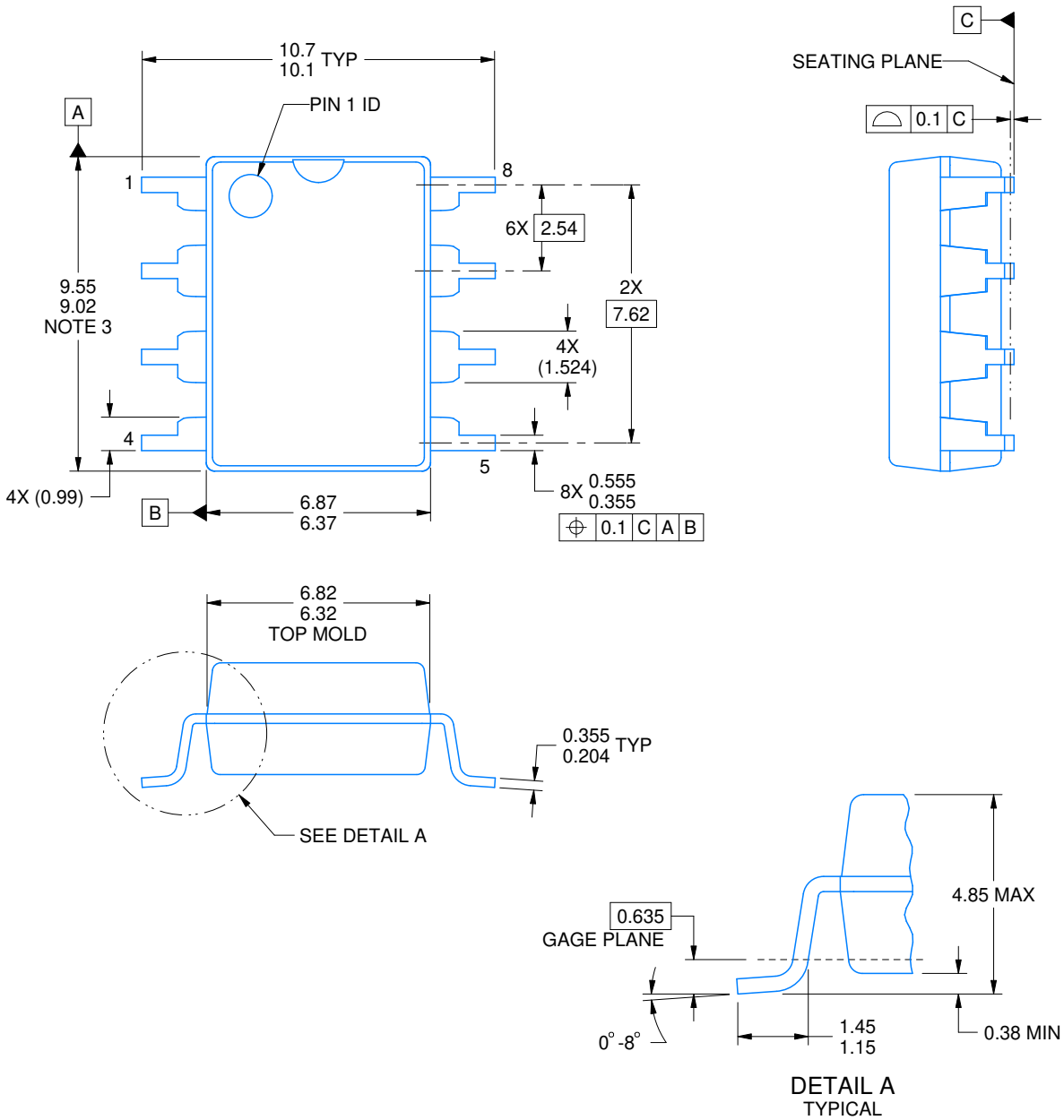
4207614/E

PACKAGE OUTLINE

DUB0008A

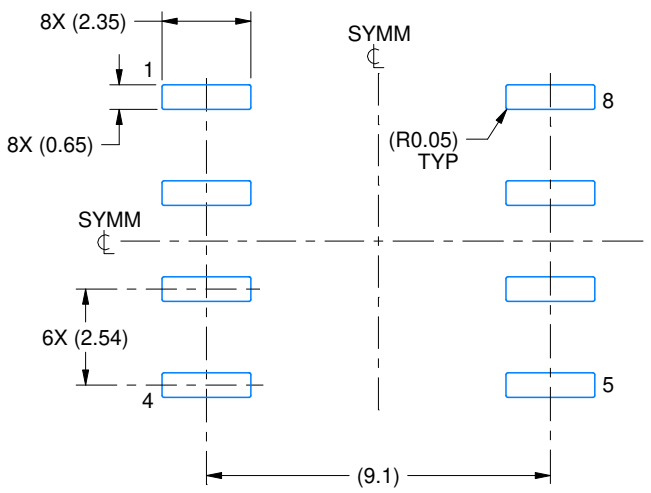
SOP - 4.85 mm max height

SMALL OUTLINE PACKAGE

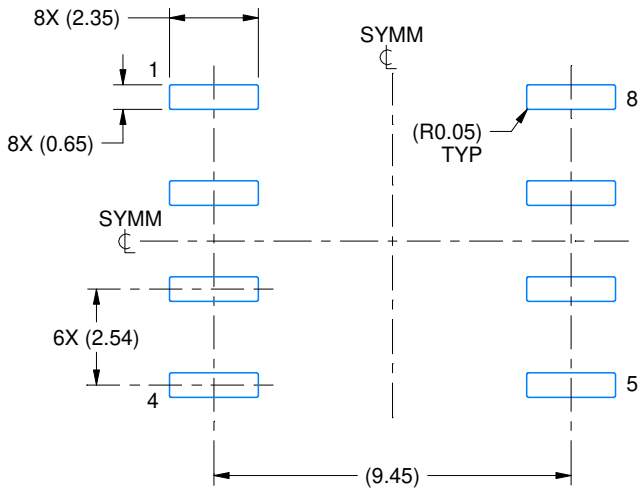


NOTES:

1. All linear dimensions are in millimeters. Any 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 0.254 mm per side.

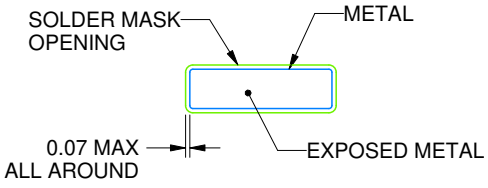


IPC-7351 NOMINAL
6.75 mm CLEARANCE/CREEPAGE

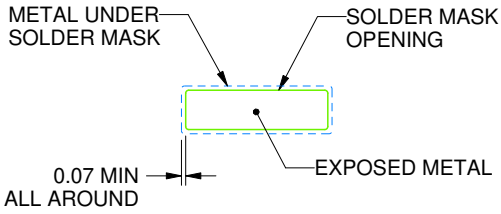


HV / ISOLATION OPTION
7.1 mm CLEARANCE/CREEPAGE

LAND PATTERN EXAMPLES
EXPOSED METAL SHOWN
SCALE:5X



NON SOLDER MASK
DEFINED



SOLDER MASK
DEFINED

SOLDER MASK DETAILS
NOT TO SCALE

4222355/G 04/2019

NOTES: (continued)

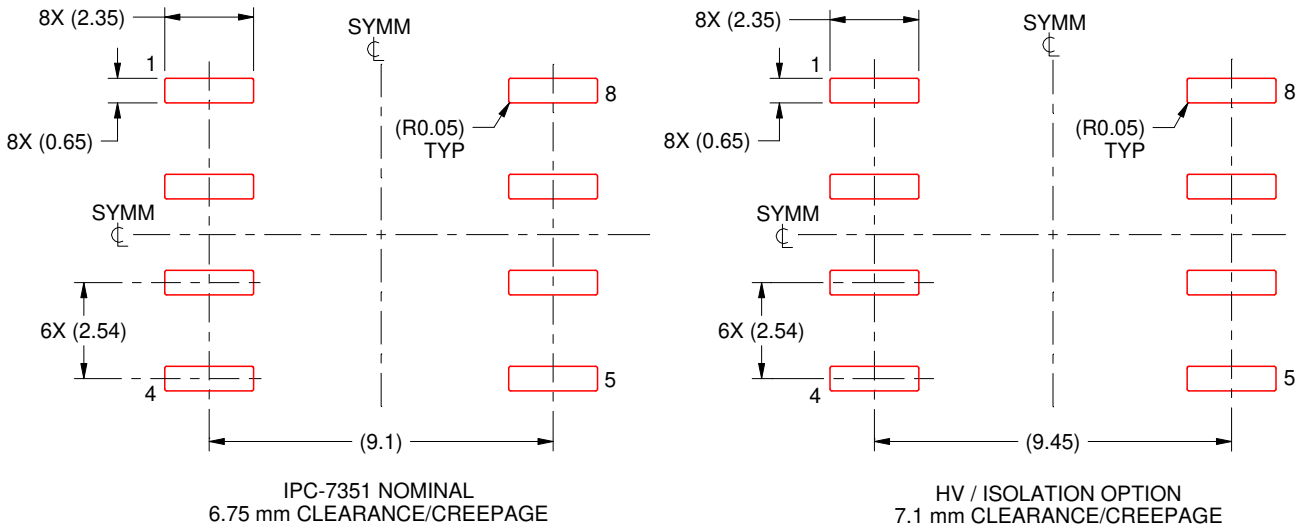
4. Publication IPC-7351 may have alternate designs.
5. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DUB0008A

SOP - 4.85 mm max height

SMALL OUTLINE PACKAGE



IPC-7351 NOMINAL
6.75 mm CLEARANCE/CREEPAGE

HV / ISOLATION OPTION
7.1 mm CLEARANCE/CREEPAGE

SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:5X

4222355/G 04/2019

NOTES: (continued)

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

GENERIC PACKAGE VIEW

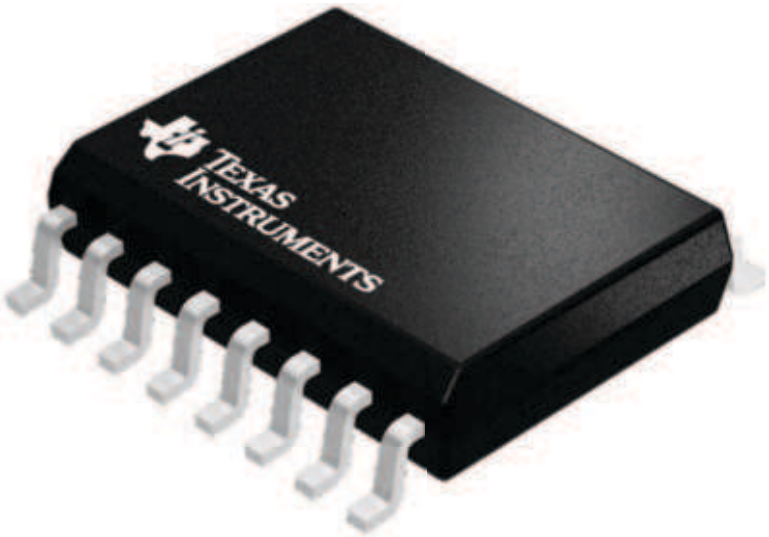
DW 16

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

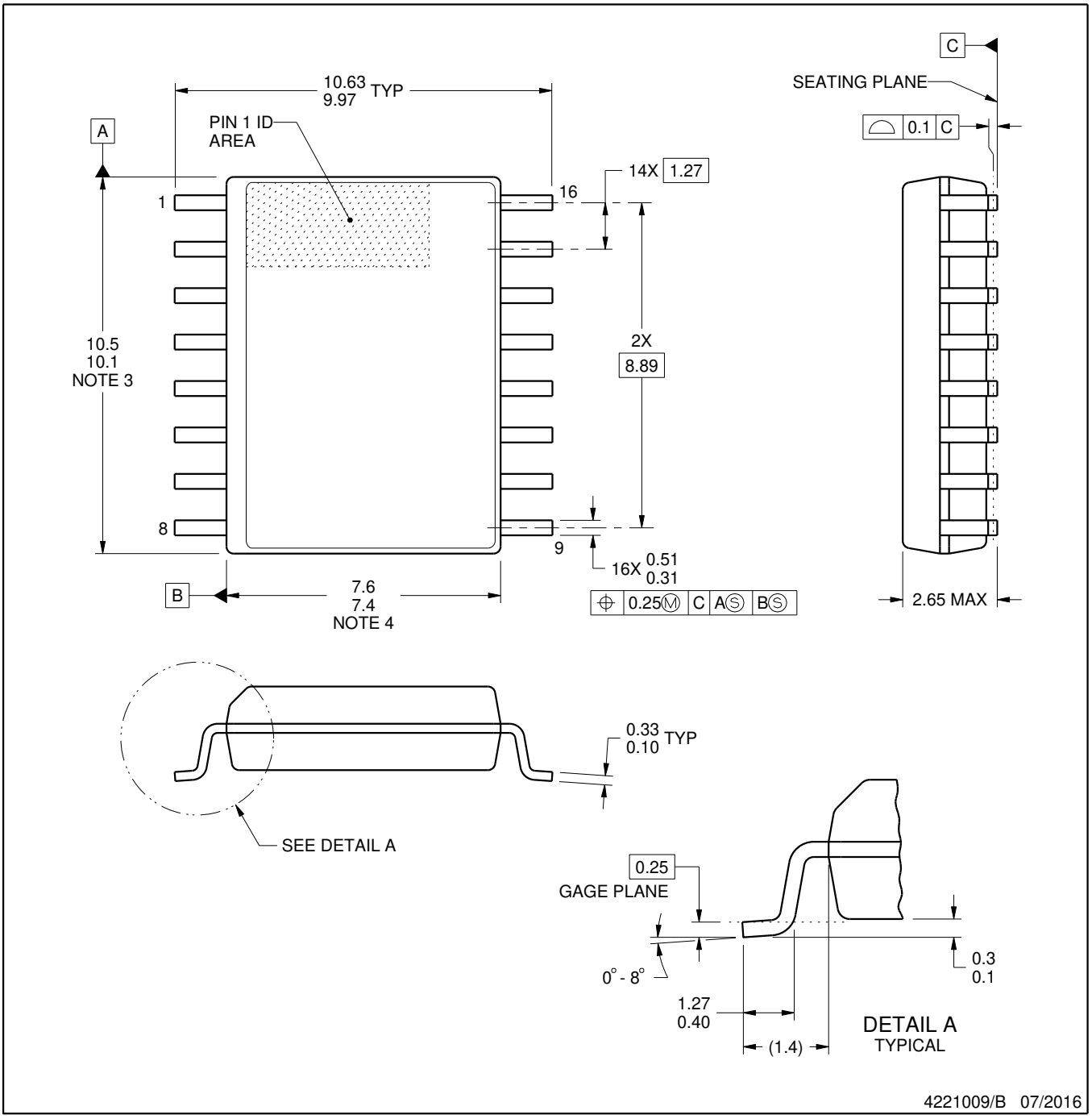


PACKAGE OUTLINE

DW0016B

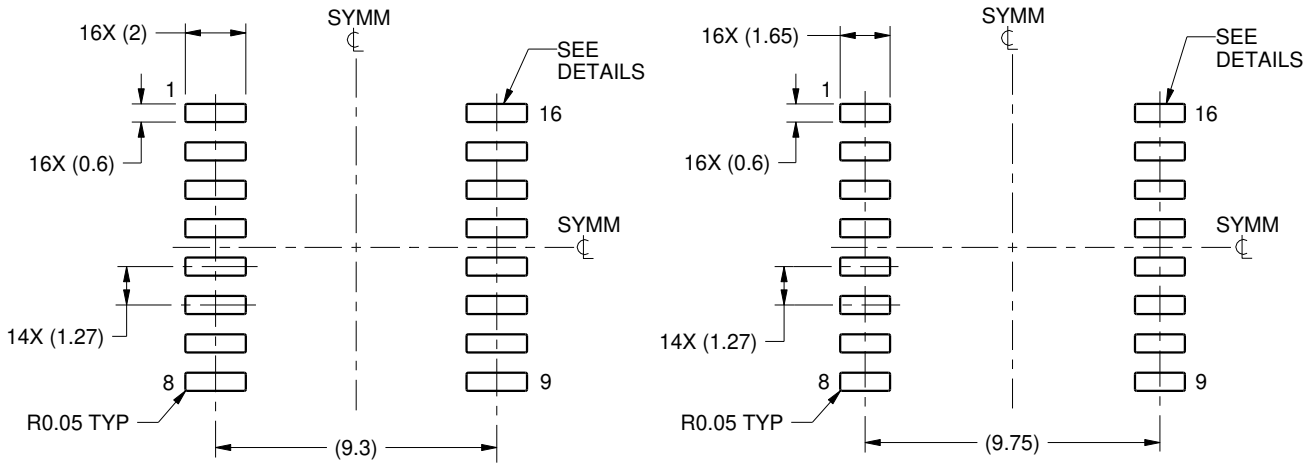
SOIC - 2.65 mm max height

SOIC

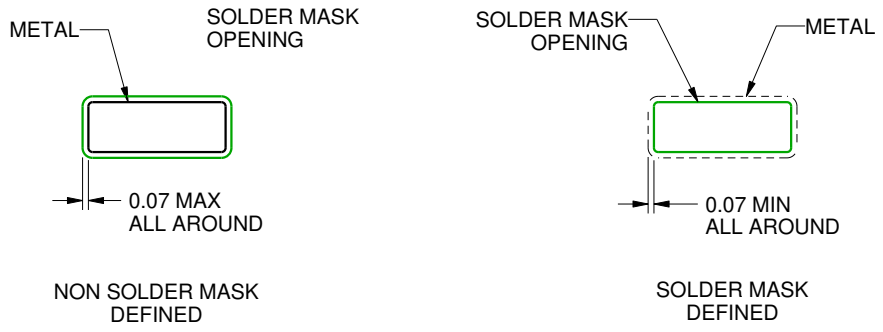


NOTES:

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:4X



SOLDER MASK DETAILS

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NOTES: (continued)

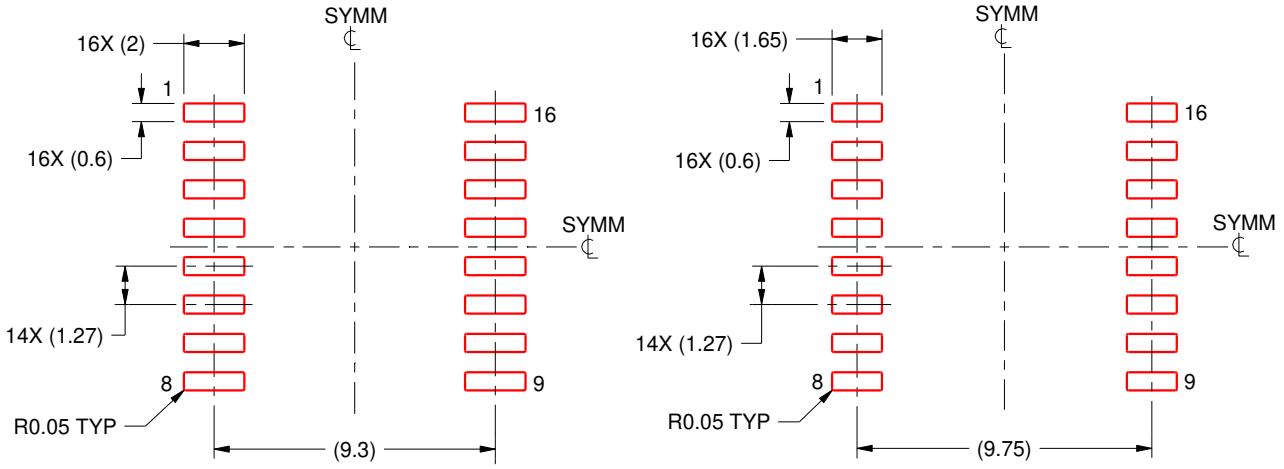
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DW0016B

SOIC - 2.65 mm max height

SOIC



IPC-7351 NOMINAL
7.3 mm CLEARANCE/CREEPAGE

HV / ISOLATION OPTION
8.1 mm CLEARANCE/CREEPAGE

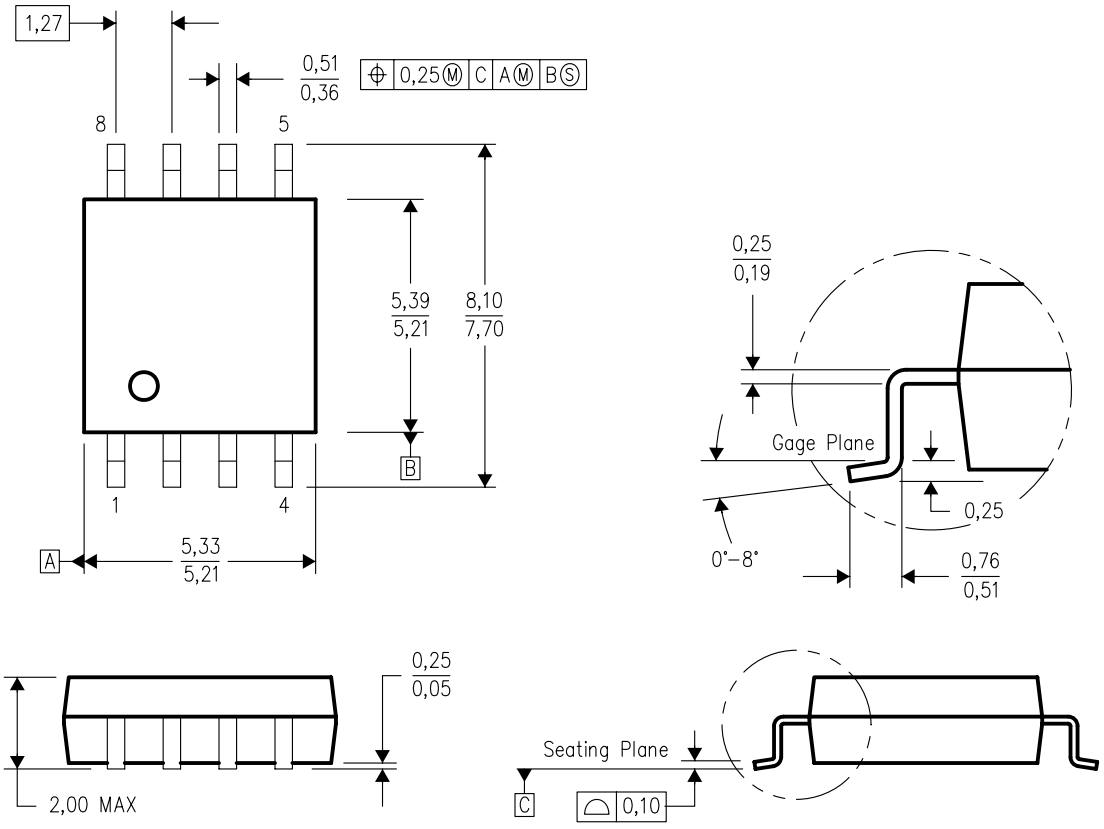
SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:4X

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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.

PSA (R–PDSO–G8) PLASTIC SMALL–OUTLINE PACKAGE



4209043/A 09/07

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

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