TEXAS INSTRUMENTS
AMC3306M05-Q1
JAJSS45 – AUGUST 2024

AMC3306M05-Q1 DC/DC コンバータ内蔵、車載用、高精度、±50mV 入力対応、強化絶縁デルタ シグマ変調器

1 特長

- 車載アプリケーション用に AEC-Q100 認定済み:
  - 温度グレード 1:-40℃～+125℃、T_A
- DC/DC コンバータ内蔵の単電源動作 (3.3V または 5V)
- シャント抵抗を使用する電流測定用に最適化された入力電圧範囲 (±50mV)
- 小さい DC 誤差:
  - オフセット誤差:±50µV (最大値)
  - オフセット ドリフト:±0.4µV/°C (最大値)
  - ゲイン誤差:±0.2% (最大値)
  - ゲイン ドリフト:±35ppm/℃ (最大値)
- 「高 CMTI:75kV/µs (最小値)
- システム レベル診断機能
- 低 EMI:CISPR-11 および CISPR-25 規格に準拠
- 安全関連認証:
  - DIN EN IEC 60747-17 (VDE 0884-17) に準拠した強化絶縁耐圧:6000V_{PK}
  - UL 1577 に準拠した絶縁耐圧:4250V_{RMS} (1 分間)

2 アプリケーション

- 次の用途における小型の絶縁型シャント ベース電流センシング
  - HEV/EV のオンボード チャージャ (OBC)
  - HEV/EV の DC/DC コンバータ
  - HEV/EV のトラクション インバータ
  - HEV/EV のバッテリ管理システム (BMS)

3 概要

AMC3306M05-Q1 は、シャントを用いた電流測定に最適化された高精度絶縁型デルタ シグマ (ΔΣ) 変調器です。完全に統合された絶縁型 DC/DC コンバータのおかげで、本デバイスの低電圧側から電力を供給する単一電源動作が可能であるため、スペースに制約があるアプリケーション向けのユニークなソリューションとして活用できます。この容量性強化絶縁バリアは、DIN EN IEC 60747-17 (VDE 0884-17) および UL1577 により認証済みであり、最大 1.2kV_{RMS} の作動電圧に対応しています。

この絶縁バリアは、異なる同相電圧レベルで動作するシステム領域を分離し、危険な電圧と損傷から低電圧側を保護します。

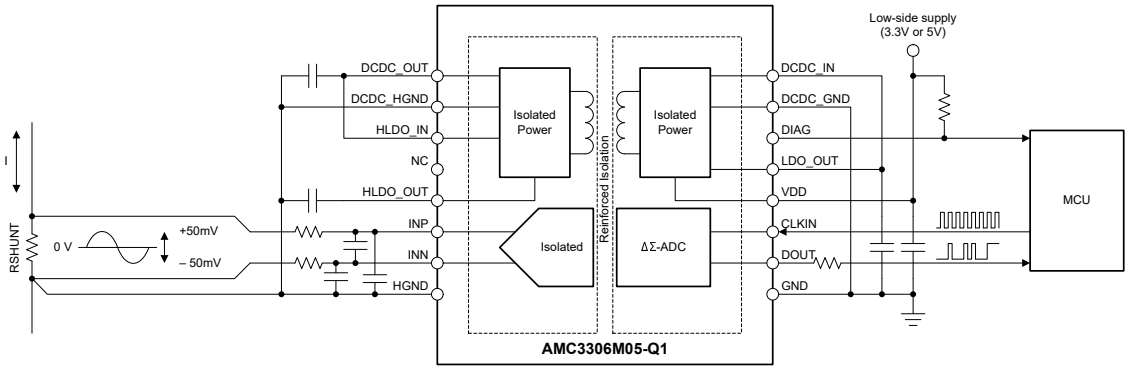
AMC3306M05-Q1 の入力は、低インピーダンスのシャント抵抗またはその他の信号レベルが小さい低インピーダンス電圧源と直接接続できるように最適化されています。優れた DC 精度と小さい温度ドリフトにより、拡張産業用温度範囲 (–40℃～+125℃) にわたる高精度電流測定に対応できます。

デジタル フィルタ (sinc^3 フィルタなど) を使用して 、ビットストリームを間引きます。このデジタル フィルタを使用することで、78kSPS のデータ速度、85dB のダイナミック レンジで 16 ビットの分解能が得られます。

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)
AMC3306M05-Q1	DWE (SOIC、16)	10.3mm × 10.3mm

(1) 詳細については、「メカニカル、パッケージ、および注文情報」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。



代表的なアプリケーション

Table of Contents

4 Pin Configuration and Functions

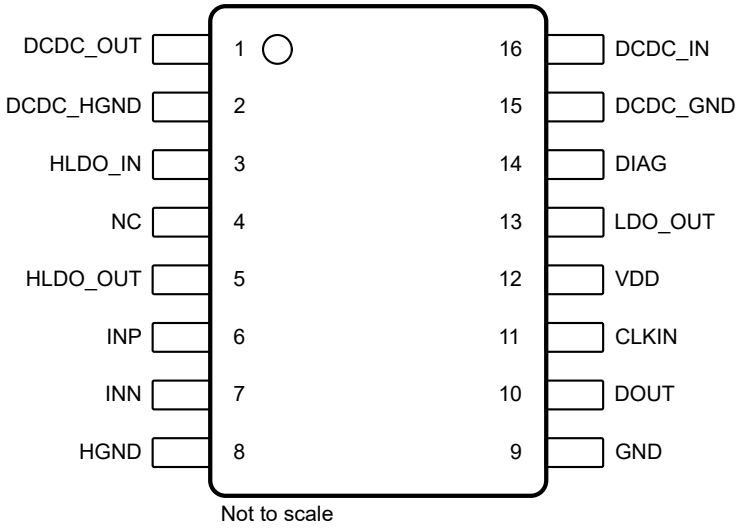


図 4-1. DWE Package, 16-Pin SOIC (Top View)

表 4-1. Pin Functions

PIN		TYPE	DESCRIPTION
NO.	NAME		
1	DCDC_OUT	Power	High-side output of the DC/DC converter; connect this pin to the HLDO_IN pin.(1)
2	DCDC_HGND	High-side power ground	High-side ground reference for the DC/DC converter; connect this pin to the HGND pin.
3	HLDO_IN	Power	Input of the high-side LDO; connect this pin to the DCDC_OUT pin.(1)
4	NC	—	No internal connection. Connect this pin to the high-side ground or leave unconnected (floating).
5	HLDO_OUT	Power	Output of the high-side LDO.(1)
6	INP	Analog input	Noninverting analog input. Make sure INP or INN has a DC current path to HGND to define the common-mode input voltage.(2)
7	INN	Analog input	Inverting analog input. Make sure INP or INN has a DC current path to HGND to define the common-mode input voltage.(2)
8	HGND	High-side signal ground	High-side analog signal ground; connect this pin to the DCDC_HGND pin.
9	GND	Low-side signal ground	Low-side analog signal ground; connect this pin to the DCDC_GND pin.
10	DOUT	Digital output	Modulator data output.
11	CLKIN	Digital input	Modulator clock input with an internal pulldown resistor (typical value: 1.5MΩ).
12	VDD	Low-side power	Low-side power supply.(1)
13	LDO_OUT	Power	Output of the low-side LDO; connect this pin to the DCDC_IN pin. Do not load the output of the LDO with external circuitry.(1)
14	DIAG	Digital output	Active-low, open-drain status indicator output. Connect this pin to the pullup supply (for example, VDD) using a resistor or leave this pin floating if not used.
15	DCDC_GND	Low-side power ground	Low-side ground reference for the DC/DC converter; connect this pin to the GND pin.
16	DCDC_IN	Power	Low-side input of the DC/DC converter; connect this pin to the LDO_OUT pin.(1)

(1) See the *Power Supply Recommendations* section for power-supply decoupling recommendations.
(2) See the *Layout* section for details.

5 Specifications

5.1 Absolute Maximum Ratings

see (1)

		MIN	MAX	UNIT
Power-supply voltage	VDD to GND	–0.3	6.5	V
Analog input voltage	INP, INN	HGND – 6	V_{HLDO_OUT} + 0.5	V
Digital input voltage	CLKIN	GND – 0.5	VDD + 0.5	V
Digital output voltage	DOUT	GND – 0.5	VDD + 0.5	V
	DIAG	GND – 0.5	6.5	
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 AEC Q100-002(1), HBM ESD classification Level 2	±2000	V
		Charged-device model (CDM), per AEC Q100-011, CDM ESD classification Level C6	±1000	

(1) AEC Q100-002 indicates that HBM stressing shall be in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

5.3 Recommended Operating Conditions

over operating ambient temperature range (unless otherwise noted)

			MIN	NOM	MAX	UNIT
POWER SUPPLY						
VDD	Low-side power supply	VDD to GND	3	3.3	5.5	V
ANALOG INPUT						
$V_{Clipping}$	Differential input voltage before clipping output	$V_{IN} = V_{INP} – V_{INN}$		±64		mV
V_{FSR}	Specified linear differential full-scale voltage	$V_{IN} = V_{INP} – V_{INN}$	–50		50	mV
	Absolute common-mode input voltage (1)	$(V_{INP} + V_{INN}) / 2$ to HGND	–2		V_{HLDO_OUT}	V
V_{CM}	Operating common-mode input voltage	$(V_{INP} + V_{INN}) / 2$ to HGND	–0.032		0.9	V
DIGITAL I/O						
V_{IO}	Digital input / output voltage		0		VDD	V
f_{CLKIN}	Input clock frequency		5	20	21	MHz
	Input clock duty cycle	5MHz ≤ f_{CLKIN} ≤ 21MHz	40%	50%	60%	
TEMPERATURE RANGE						
T_A	Specified ambient temperature		–40		125	°C

(1) Steady-state voltage supported by the device in case of a system failure. See specified common-mode input voltage V_{CM} for normal operation. Observe analog input voltage range as specified in the *Absolute Maximum Ratings* table.

5.4 Thermal Information

THERMAL METRIC(1)		DWE (SOIC)	UNIT
		16 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	73.5	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	31	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	44	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	16.7	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	42.8	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	N/A	°C/W

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

5.5 Power Ratings

PARAMETER		TEST CONDITIONS	VALUE	UNIT
P_D	Maximum power dissipation	VDD = 5.5V	231	mW
		VDD = 3.6V	151	

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	≥ 8	mm
CPG	External creepage(1)	Shortest pin-to-pin distance across the package surface	≥ 8	mm
DTI	Distance through insulation	Minimum internal gap (internal clearance - capacitive signal isolation)	≥ 21	µm
DTI	Distance through insulation	Minimum internal gap (internal clearance - transformer power isolation)	≥ 120	µm
CTI	Comparative tracking index	DIN EN 60112 (VDE 0303-11); IEC 60112	≥ 600	V
	Material group	According to IEC 60664-1	I	
	Overvoltage category per IEC 60664-1	Rated mains voltage ≤ 600V_{RMS}	I-III	
		Rated mains voltage ≤ 1000V_{RMS}	I-II	
DIN EN IEC 60747-17 (VDE 0884-17)				
V_{IORM}	Maximum repetitive peak isolation voltage	At AC voltage	1700	V_{PK}
V_{IOWM}	Maximum-rated isolation working voltage	At AC voltage (sine wave)	1200	V_{RMS}
		At DC voltage	1700	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)	6000	V_{PK}
V_{IMP}	Maximum impulse voltage(2)	Tested in air, 1.2/50µs waveform per IEC 62368-1	7700	V_{PK}
V_{IOSM}	Maximum surge isolation voltage(3)	Tested in oil (qualification test), 1.2/50µs waveform per IEC 62368-1	10000	V_{PK}
q_{pd}	Apparent charge(4)	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, $V_{pd(m)} = 1.6 \times V_{IORM}$, t_m = 10 s	≤ 5	
		Method b1, at preconditioning (type test) and routine test, $V_{pd(ini)} = 1.2 \times V_{IOTM}$, t_{ini} = 1s, $V_{pd(m)} = 1.875 \times V_{IORM}$, t_m = 1s	≤ 5	
		Method b2, at routine test (100% production)(6), $V_{pd(ini)} = V_{pd(m)} = 1.2 \times V_{IOTM}$, $t_{ini} = t_m$ = 1s	≤ 5	
C_{IO}	Barrier capacitance, input to output(5)	V_{IO} = 0.5 V_{PP} at 1MHz	~4.5	pF
R_{IO}	Insulation resistance, input to output(5)	V_{IO} = 500 V at T_A = 25°C	> 10^{12}	Ω
		V_{IO} = 500 V at 100°C ≤ T_A ≤ 125°C	> 10^{11}	
		V_{IO} = 500 V at T_S = 150°C	> 10^9	
	Pollution degree		2	
	Climatic category		40/125/21	
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)	4250	V_{RMS}

(1) Apply creepage and clearance requirements according to the specific equipment isolation standards of an application.Maintain the creepage and clearance distance of a board design to make sure that the mounting pads of the isolator on the printed circuit board (PCB) do not reduce this distance. Creepage and clearance on a PCB become equal in certain cases. Techniques such as inserting grooves, ribs, or both on a PCB are used to help increase these specifications.
(2) Testing is carried out in air to determine the surge immunity of the package.
(3) Testing is carried in oil to determine the intrinsic surge immunity of the isolation barrier.
(4) Apparent charge is electrical discharge caused by a partial discharge (pd).
(5) All pins on each side of the barrier are tied together, creating a two-pin device.
(6) 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 IEC 62368-1 (VDE 0868-1), EN IEC 62368-1, IEC 62368-1 Clause : 5.4.3 ; 5.4.4.4 ; 5.4.9	Recognized under 1577 component recognition and CSA component acceptance NO 5 programs
Reinforced insulation	Single protection
Certificate number: 40040142	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 overheat the die and damage the isolation barrier potentially leading to secondary system failures.

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_S	Safety input, output, or supply current	$R_{\theta JA}$ = 73.5°C/W, VDD = 5.5V, T_J = 150°C, T_A = 25°C			309	mA
		$R_{\theta JA}$ = 73.5°C/W, VDD = 3.6V, T_J = 150°C, T_A = 25°C			472	
P_S	Safety input, output, or total power	$R_{\theta JA}$ = 73.5°C/W, T_J = 150°C, T_A = 25°C			1700	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 low-side voltage.

5.9 Electrical Characteristics

all minimum and maximum specifications are at T_A = –40°C to +125°C, VDD = 3.0V to 5.5V, INP = –50mV to +50mV, INN = 0V, and sinc^3 filter with OSR = 256 (unless otherwise noted); typical values are at T_A = 25°C, CLKIN = 20MHz, VDD = 3.3V

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
ANALOG INPUT						
R_{IN}	Single-ended input resistance	INN = HGND		4.75		kΩ
R_{IND}	Differential input resistance			4.9		kΩ
I_{IB}	Input bias current	INP = INN = HGND; $I_{IB} = (I_{IBP} + I_{IBN}) / 2$	–48	–36	–28	µA
I_{IO}	Input offset current(1)	$I_{IO} = I_{IBP} – I_{IBN}$; INP = INN = HGND		±10		nA
C_{IN}	Single-ended input capacitance	INN = HGND, f_{IN} = 310kHz		4		pF
C_{IND}	Differential input capacitance	f_{IN} = 310kHz		2		pF
ACCURACY						
E_O	Offset error(1)	INN = INP = HGND, T_A = 25°C	–50	±10	50	µV
TCE_O	Offset error thermal drift(4)	INN = INP = HGND	–0.4		0.4	µV/°C
E_G	Gain error	T_A = 25°C	–0.2%	±0.005%	0.2%	
TCE_G	Gain error drift(5)		–35		35	ppm/°C
DNL	Differential nonlinearity	Resolution: 16 bits	–0.99		0.99	LSB
INL	Integral nonlinearity	Resolution: 16 bits	–4	±1	4	LSB
SNR	Signal-to-noise ratio	f_{IN} = 1kHz	77	81		dB
SINAD	Signal-to-noise + distortion	f_{IN} = 1kHz	77	81		dB
THD	Total harmonic distortion(3)	5MHz ≤ f_{CLKIN} ≤ 21MHz, f_{IN} = 1kHz		–93	–86	dB
SFDR	Spurious-free dynamic range	f_{IN} = 1kHz	87	94		dB
CMRR	Common-mode rejection ratio	f_{IN} = 0Hz, $V_{CM\ min} ≤ V_{IN} ≤ V_{CM\ max}$		–100		dB
		f_{IN} = 10kHz, $V_{CM\ min} ≤ V_{IN} ≤ V_{CM\ max}$, $V_{INP} = V_{INN}$ = 100mV_{PP}		–100		
PSRR	Power-supply rejection ratio	VDD from 3.0V to 5.5V, at DC		–120		dB
		INP = INN = HGND, VDD from 3.0V to 5.5V, 10kHz, 100mV ripple		–120		
DIGITAL I/O						
I_{IN}	Input leakage current	GND ≤ V_{IN} ≤ VDD	0		7	µA
C_{IN}	Input capacitance			4		pF
V_{IH}	High-level input voltage		0.7 × VDD		VDD + 0.3	V
V_{IL}	Low-level input voltage		–0.3		0.3 × VDD	V
C_{LOAD}	Output load capacitance			15	30	pF
V_{OH}	High-level output voltage	I_{OH} = –20µA	VDD – 0.1			V
		I_{OH} = –4mA	VDD – 0.4			
V_{OL}	Low-level output voltage	I_{OL} = 20µA			0.1	V
		I_{OL} = 4mA			0.4	
CMTI	Common-mode transient immunity		75	135		kV/µs

5.9 Electrical Characteristics (続き)

all minimum and maximum specifications are at T_A = –40°C to +125°C, VDD = 3.0V to 5.5V, INP = –50mV to +50mV, INN = 0V, and sinc^3 filter with OSR = 256 (unless otherwise noted); typical values are at T_A = 25°C, CLKIN = 20MHz, VDD = 3.3V

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
POWER SUPPLY						
IDD	Low-side supply current	No external load on HLDO		26	40	mA
		1mA external load on HLDO		28	42	
V_{DCDC_OUT}	DC/DC output voltage	DCDC_OUT to HGND	3.1	3.5	4.65	V
V_{DCDCUV}	DC/DC output undervoltage detection threshold voltage	V_{DCDC_OUT} falling	2.1	2.25		V
V_{HLDO_OUT}	High-side LDO output voltage	HLDO_OUT to HGND, up to 1mA external load(2)	3	3.2	3.4	V
V_{HLDOUV}	High-side LDO output undervoltage detection threshold voltage	V_{HLDO_OUT} falling	2.4	2.6		V
I_H	High-side supply current for auxiliary circuitry	Load connected from HLDO_OUT to HGND; non-switching; -40°C ≤ T_A ≤ 85°C(2)			1	mA
t_{START}	Device startup time	VDD step to 3.0V to bitstream valid		0.9	1.4	ms

(1) The typical value includes one sigma statistical variation at nominal operating conditions.
(2) High-side LDO supports external loads only up to T_A = 85°C. See the *Isolated DC/DC Converter* section for more details.
(3) THD is the ratio of the rms sum of the amplitues of first five higher harmonics to the amplitude of the fundamental.
(4) 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 125°C).
(5) 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 125°C).

5.10 Switching Characteristics

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_H	DOUT hold time after rising edge of CLKIN	C_{LOAD} = 15pF	3.5			ns
t_D	Rising edge of CLKIN to DOUT valid delay	C_{LOAD} = 15pF; CLKIN 50% to DOUT 10% / 90%			15	ns
t_r	DOUT rise time	10% to 90%, 3.0V ≤ VDD ≤ 3.6V, C_{LOAD} = 15pF		2.5	6	ns
		10% to 90%, 4.5V ≤ VDD ≤ 5.5V, C_{LOAD} = 15pF		3.2	6	
t_f	DOUT fall time	10% to 90%, 3.0V ≤ VDD ≤ 3.6V, C_{LOAD} = 15pF		2.2	6	ns
		10% to 90%, 4.5V ≤ VDD ≤ 5.5V,C_{LOAD} = 15pF		2.9	6	

5.11 Timing Diagrams

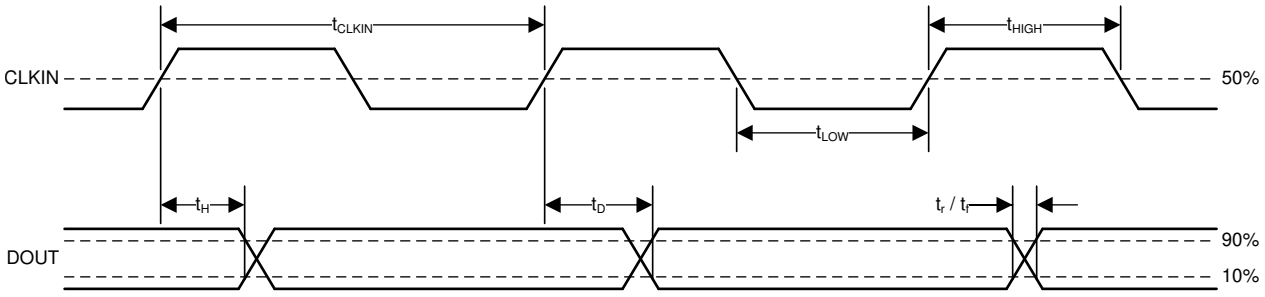


図 5-1. Digital Interface Timing

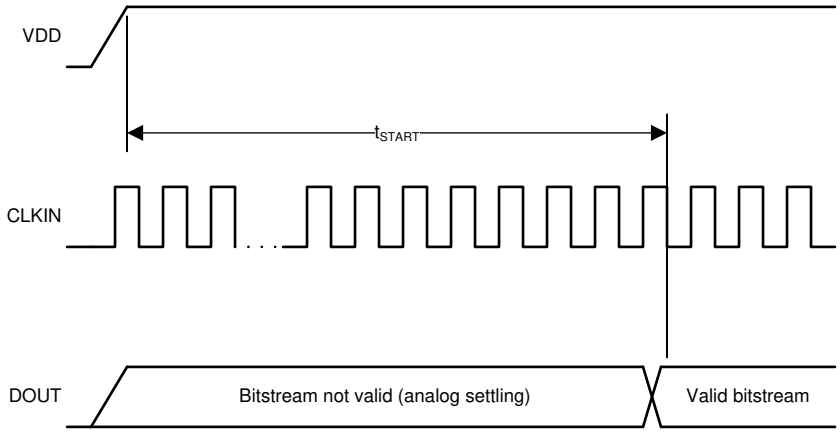


図 5-2. Device Start-Up Timing

5.12 Insulation Characteristics Curves

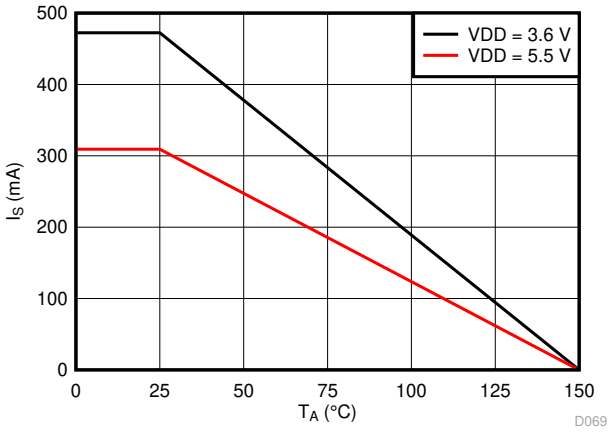


図 5-3. Thermal Derating Curve for Safety-Limiting Current Per VDE

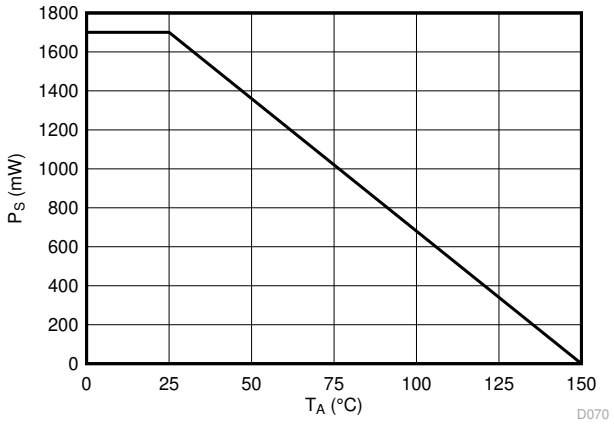
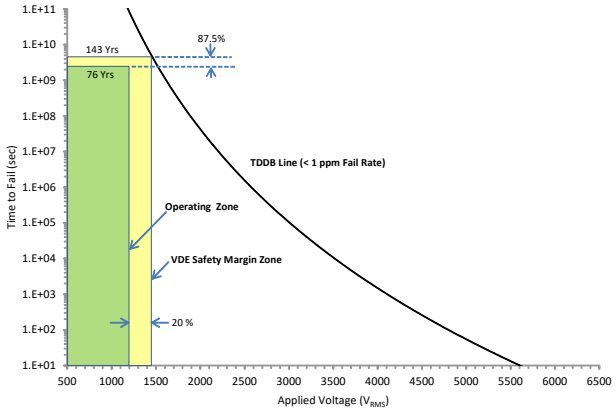


図 5-4. Thermal Derating Curve for Safety-Limiting Power Per VDE



T_A up to 150°C, stress-voltage frequency = 60Hz, isolation working voltage = 1200V_{RMS}, operating lifetime = 76 years

図 5-5. Reinforced Isolation Capacitor Lifetime Projection

5.13 Typical Characteristics

at VDD = 3.3V, INP = –50mV to +50mV, INN = HGND, f_{CLKIN} = 20MHz, and $sinc^3$ filter with OSR = 256, and 16-bit resolution (unless otherwise noted)

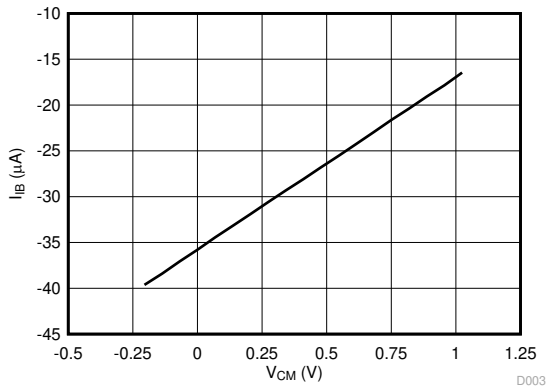


図 5-6. Input Bias Current vs Common-Mode Input Voltage

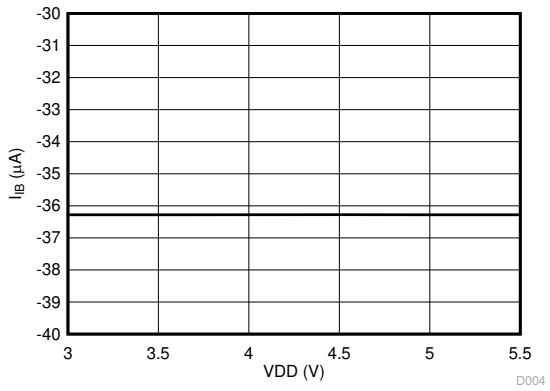


図 5-7. Input Bias Current vs Supply Voltage

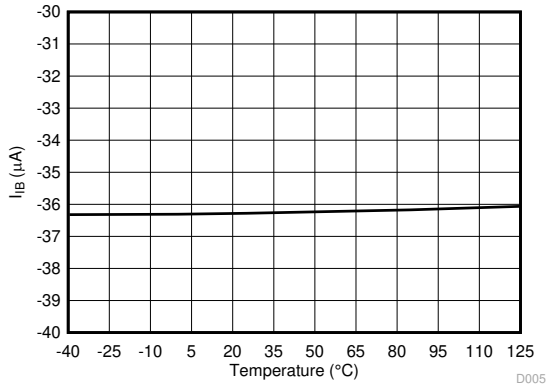


図 5-8. Input Bias Current vs Temperature

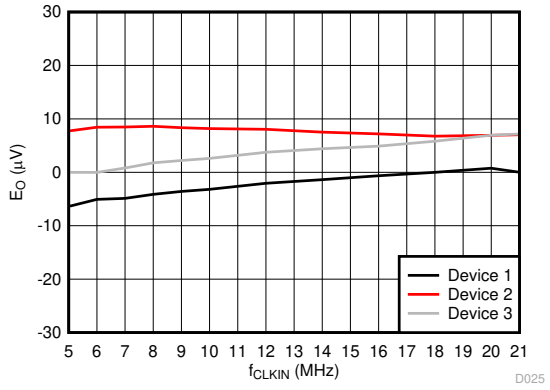


図 5-9. Offset Error vs Input Clock Frequency

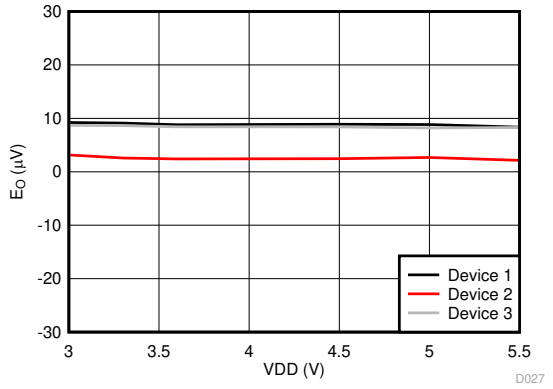


図 5-10. Offset Error vs Supply Voltage

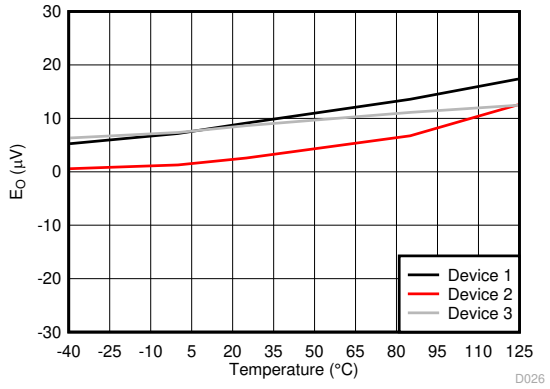


図 5-11. Offset Error vs Temperature

5.13 Typical Characteristics (continued)

at VDD = 3.3V, INP = –50mV to +50mV, INN = HGND, f_{CLKIN} = 20MHz, and $sinc^3$ filter with OSR = 256, and 16-bit resolution (unless otherwise noted)

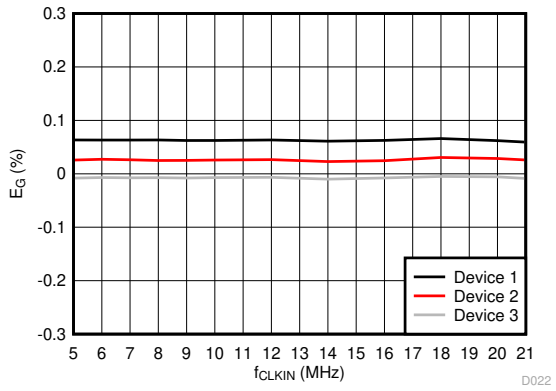


図 5-12. Gain Error vs Input Clock Frequency

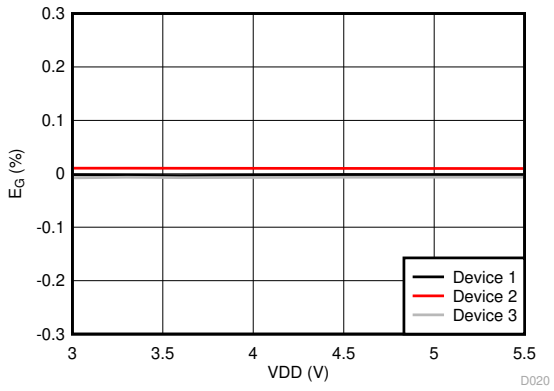


図 5-13. Gain Error vs Supply Voltage

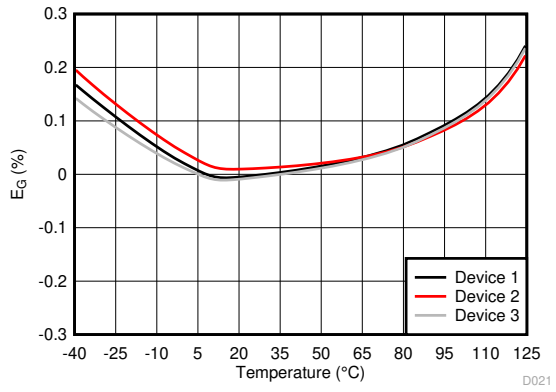


図 5-14. Gain Error vs Temperature

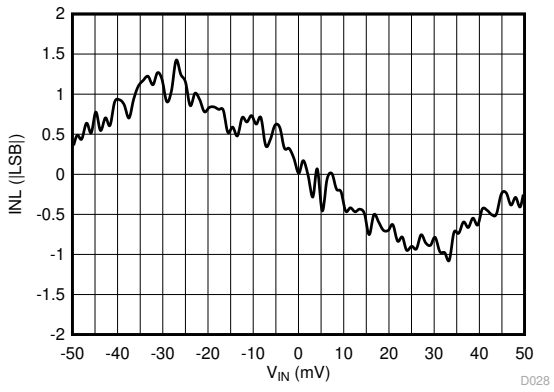


図 5-15. Integral Nonlinearity vs Input Voltage

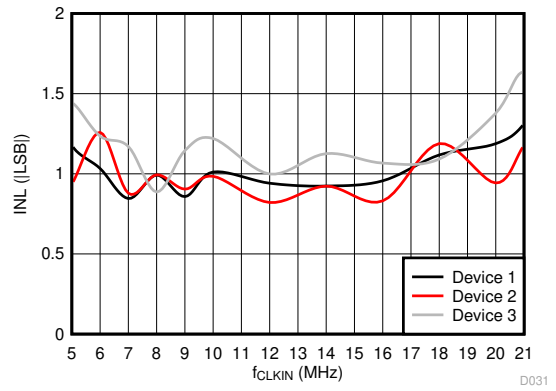


図 5-16. Integral Nonlinearity vs Input Clock Frequency

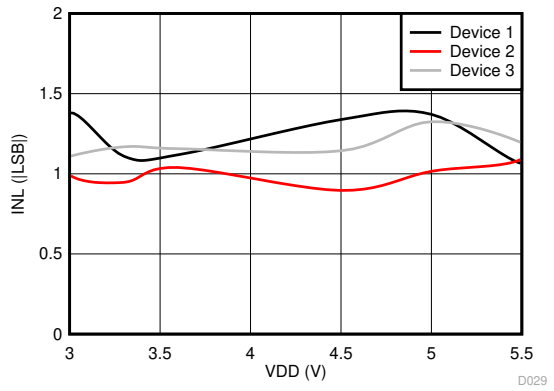


図 5-17. Integral Nonlinearity vs Supply Voltage

5.13 Typical Characteristics (continued)

at VDD = 3.3V, INP = –50mV to +50mV, INN = HGND, f_{CLKIN} = 20MHz, and $sinc^3$ filter with OSR = 256, and 16-bit resolution (unless otherwise noted)

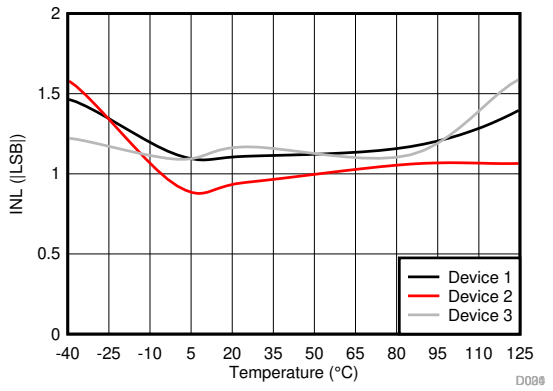


図 5-18. Integral Nonlinearity vs Temperature

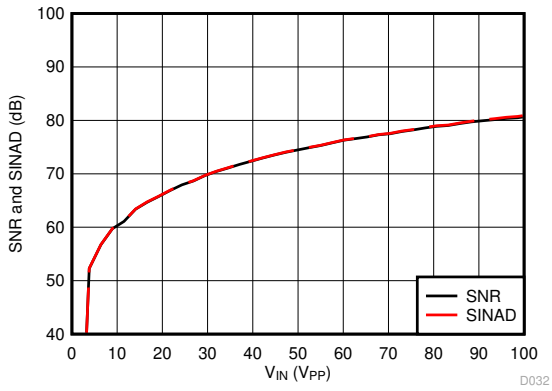


図 5-19. Signal-to-Noise Ratio and Signal-to-Noise + Distortion vs Input Signal Amplitude

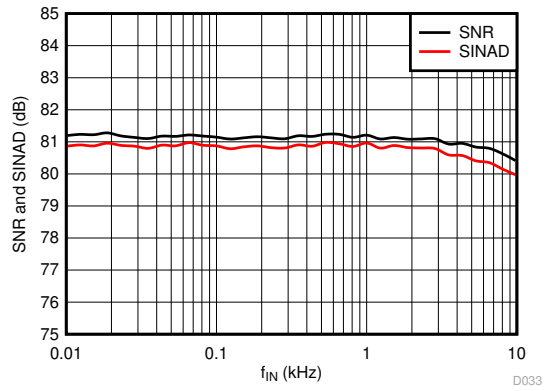


図 5-20. Signal-to-Noise Ratio and Signal-to-Noise + Distortion vs Input Signal Frequency

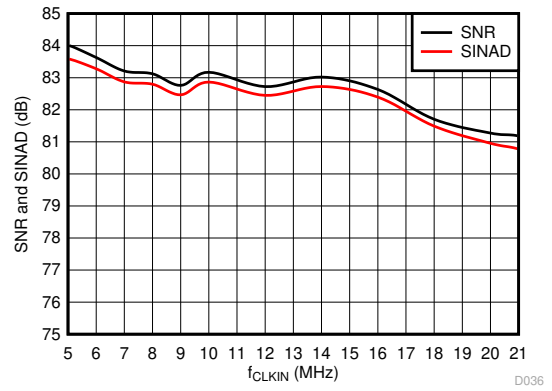


図 5-21. Signal-to-Noise Ratio and Signal-to-Noise + Distortion vs Input Clock Frequency

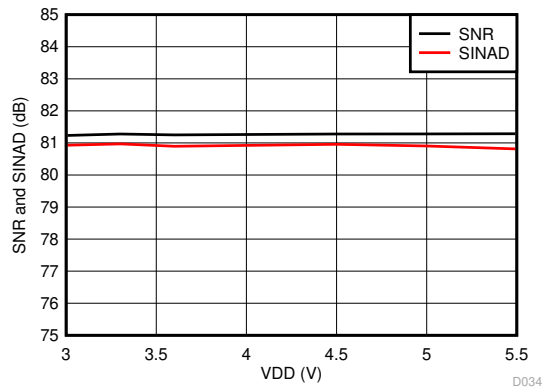


図 5-22. Signal-to-Noise Ratio and Signal-to-Noise + Distortion vs Supply Voltage

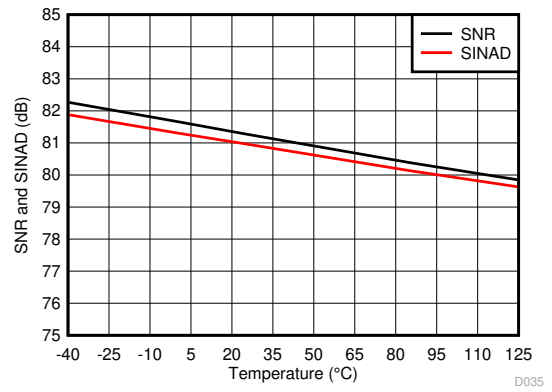


図 5-23. Signal-to-Noise Ratio and Signal-to-Noise + Distortion vs Temperature

5.13 Typical Characteristics (continued)

at VDD = 3.3V, INP = –50mV to +50mV, INN = HGND, f_{CLKIN} = 20MHz, and $sinc^3$ filter with OSR = 256, and 16-bit resolution (unless otherwise noted)

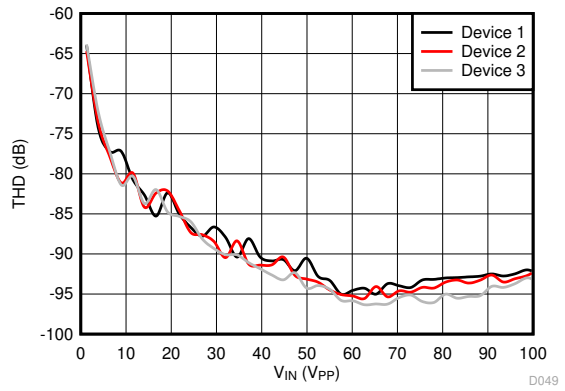


図 5-24. Total Harmonic Distortion vs Input Signal Amplitude

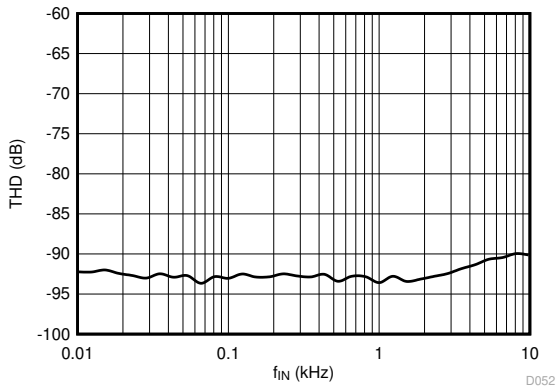


図 5-25. Total Harmonic Distortion vs Input Signal Frequency

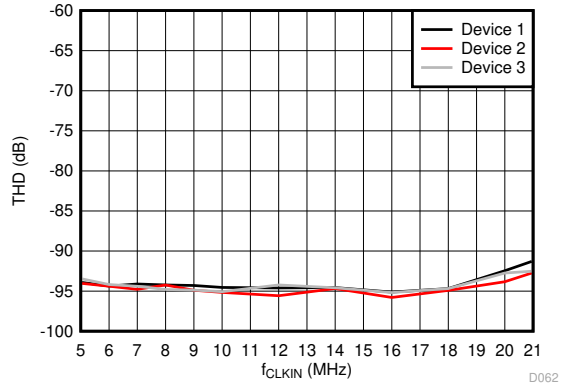


図 5-26. Total Harmonic Distortion vs Input Clock Frequency

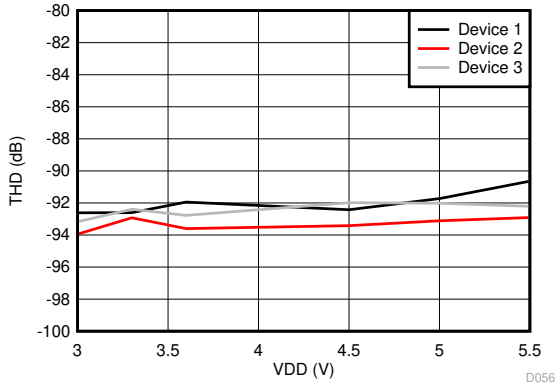


図 5-27. Total Harmonic Distortion vs Supply Voltage

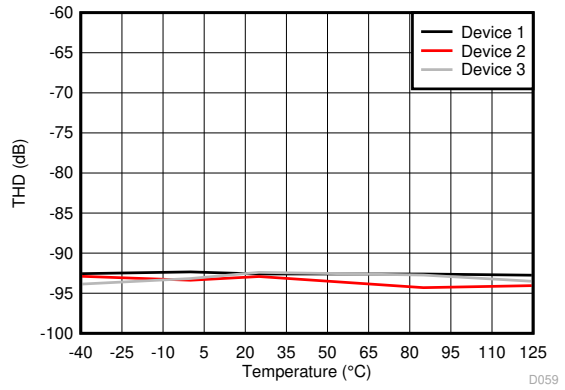


図 5-28. Total Harmonic Distortion vs Temperature

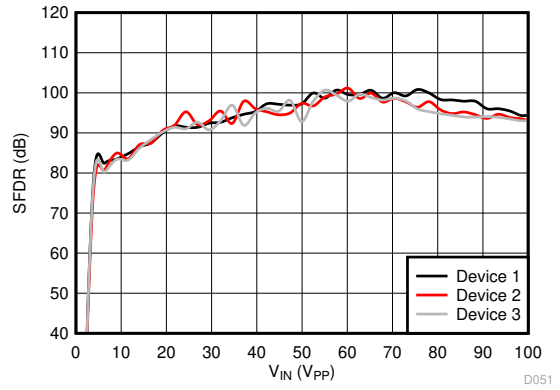


図 5-29. Spurious-Free Dynamic Range vs Input Signal Amplitude

5.13 Typical Characteristics (continued)

at VDD = 3.3V, INP = –50mV to +50mV, INN = HGND, f_{CLKIN} = 20MHz, and $sinc^3$ filter with OSR = 256, and 16-bit resolution (unless otherwise noted)

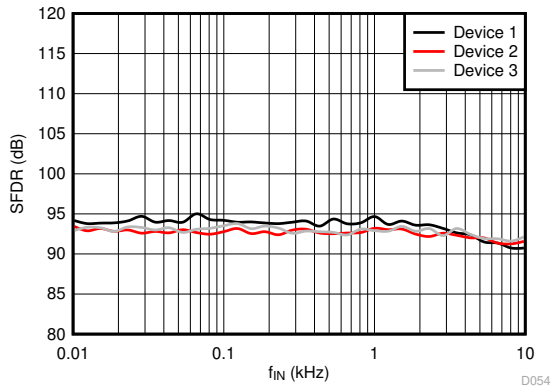


図 5-30. Spurious-Free Dynamic Range vs Input Signal Frequency

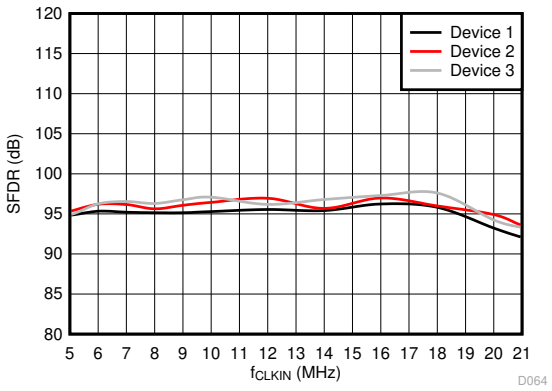


図 5-31. Spurious-Free Dynamic Range vs Input Clock Frequency

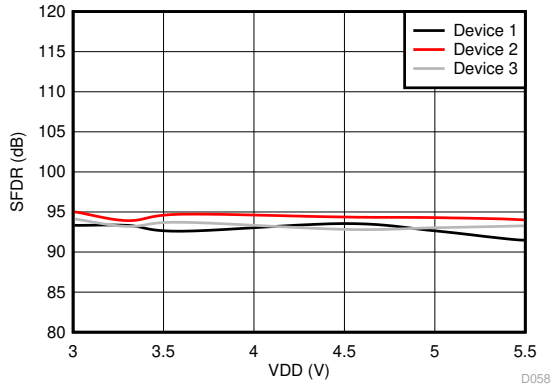


図 5-32. Spurious-Free Dynamic Range vs Supply Voltage

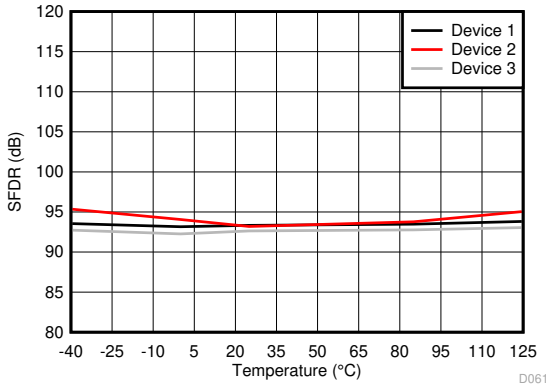


図 5-33. Spurious-Free Dynamic Range vs Temperature

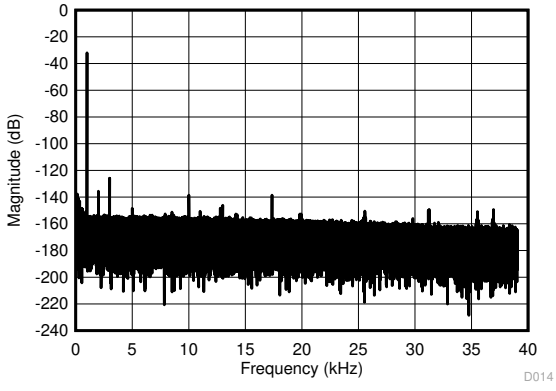


図 5-34. Output Frequency Spectrum With a 1kHz Input Signal

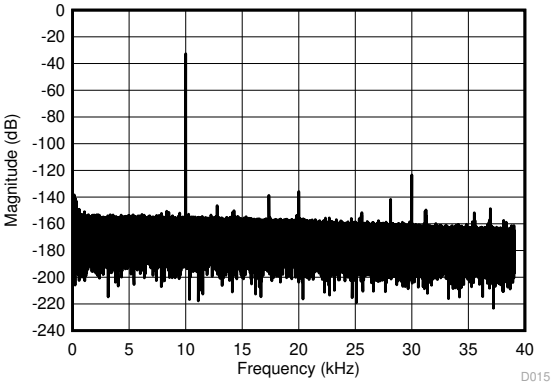


図 5-35. Output Frequency Spectrum With a 10kHz Input Signal

5.13 Typical Characteristics (continued)

at VDD = 3.3V, INP = –50mV to +50mV, INN = HGND, f_{CLKIN} = 20MHz, and $sinc^3$ filter with OSR = 256, and 16-bit resolution (unless otherwise noted)

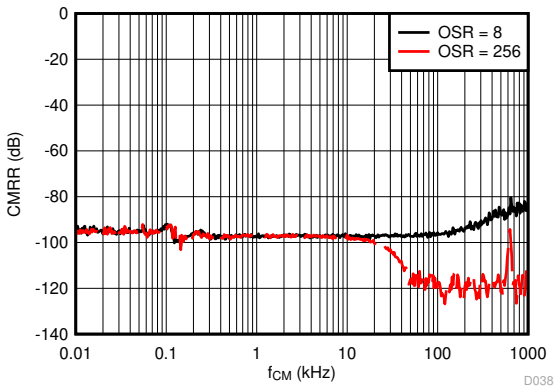


図 5-36. Common-Mode Rejection Ratio vs Input Signal Frequency

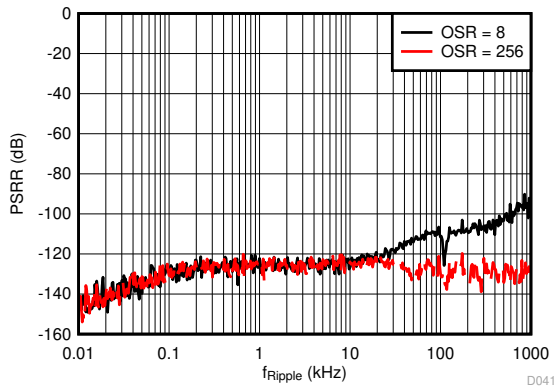


図 5-37. Power-Supply Rejection Ratio vs Ripple Frequency

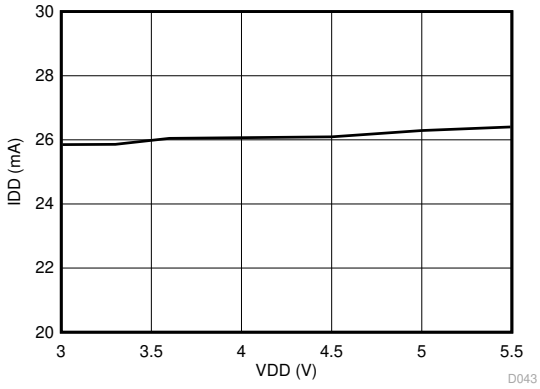


図 5-38. Supply Current vs Supply Voltage

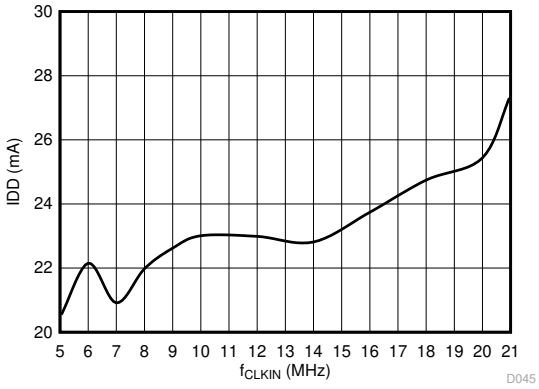


図 5-39. Supply Current vs Input Clock Frequency

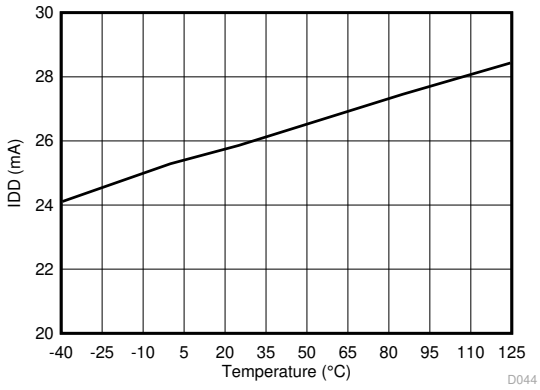


図 5-40. Supply Current vs Temperature

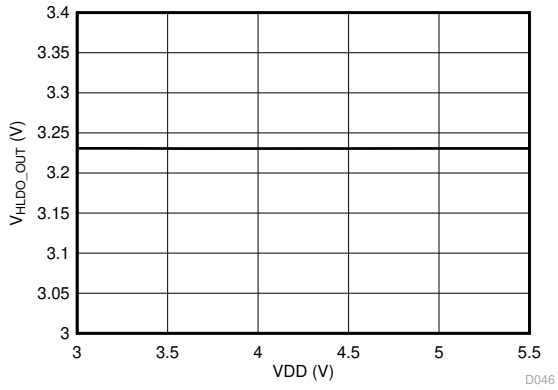


図 5-41. High-Side LDO Output Voltage vs Supply Voltage

5.13 Typical Characteristics (continued)

at VDD = 3.3V, INP = –50mV to +50mV, INN = HGND, f_{CLKIN} = 20MHz, and $sinc^3$ filter with OSR = 256, and 16-bit resolution (unless otherwise noted)

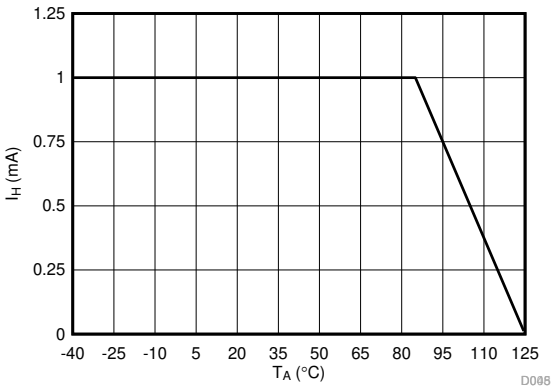


図 5-42. I_H Derating vs Ambient Temperature

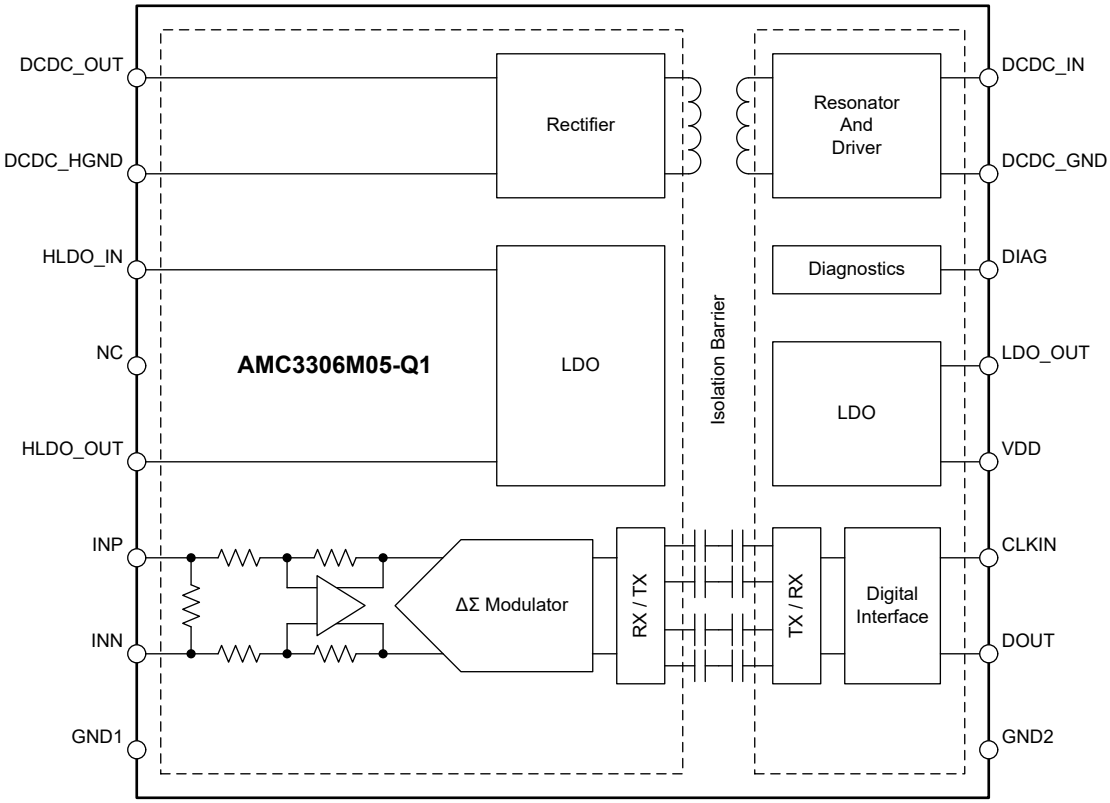
6 Detailed Description

6.1 Overview

The AMC3306M05-Q1 is a fully differential, precision, isolated modulator with an integrated DC/DC converter. The converter supplies the high side of the device from a single 3.3V or 5V voltage supply on the low side. The analog input pins INP and INN are connected to a fully differential amplifier that feeds the switched-capacitor input of a second-order, delta-sigma (ΔΣ) modulator. The modulator converts the analog input signal into a digital bitstream that is transferred across the isolation barrier. The isolated data output DOUT of the converter provides a stream of digital ones and zeros. This data stream is synchronous to the externally provided clock source at the CLKIN pin. The time average of this serial bitstream output is proportional to the analog input voltage. The external clock input simplifies the synchronization of multiple current-sensing channels on the system level.

The signal path is isolated by a double capacitive silicon dioxide (SiO_2) insulation barrier. Power isolation, however, uses an on-chip transformer separated by a thin-film polymer as the insulating material.

6.2 Functional Block Diagram

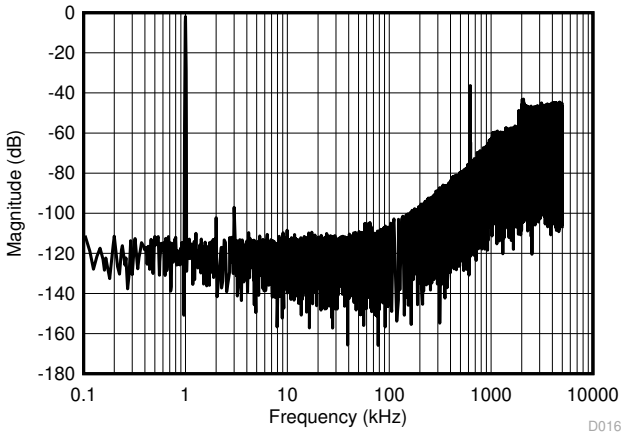


6.3 Feature Description

6.3.1 Analog Input

The differential amplifier input stage of the AMC3306M05-Q1 feeds a second-order, switched-capacitor, feed-forward ΔΣ modulator. The gain of the differential amplifier is set by internal precision resistors with a differential input impedance of R_{IND}. The modulator converts the analog input signal into a bitstream that is transferred across the isolation barrier. See the *Isolation Channel Signal Transmission* section.

For reduced offset and offset drift, the differential amplifier is chopper-stabilized with the switching frequency set at f_{CLKIN} / 32. As shown in 図 6-1, the switching frequency generates a spur at 625kHz.



sinc^3 filter, OSR = 2, f_{CLKIN} = 20MHz, f_{IN} = 1kHz

図 6-1. Quantization Noise Shaping

There are two restrictions on the analog input signals INP and INN. First, if the input voltages V_{INP} or V_{INN} exceed the range specified in the *Absolute Maximum Ratings* table, limit the input currents to the absolute maximum value. Otherwise, the electrostatic discharge (ESD) protection turns on. In addition, the device linearity and parametric performance are specified only when the analog input voltage remains within the V_{FSR} and V_{CM} ranges. The *Recommended Operating Conditions* table describes the linear full-scale range (V_{FSR}) and the common-mode input voltage range (V_{CM}).

6.3.2 Modulator

図 6-2 conceptualizes the second-order, switched-capacitor, feed-forward ΔΣ modulator implemented in the AMC3306M05-Q1. The output V_5 of the 1-bit, digital-to-analog converter (DAC) is subtracted from the input voltage $V_{IN} = (V_{INN} – V_{INP})$ and results in a voltage V_1. V_1 feeds the input of the first integrator stage. The output of the first integrator feeds the input of the second integrator stage, resulting in an output voltage V_3. V_3 is summed with the input signal V_{IN} and the output of the first integrator V_2. Depending on the polarity of the resulting voltage V_4, the output of the comparator is changed. In this case, the 1-bit DAC responds on the next clock pulse by changing the associated analog output voltage V_5. This change causes the integrators to progress in the opposite direction and forces the value of the integrator output to track the average input value.

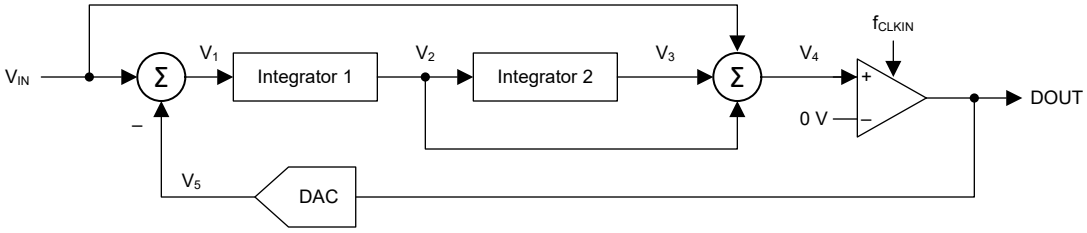


図 6-2. Block Diagram of a Second-Order Modulator

The modulator shifts the quantization noise to high frequencies, as illustrated in 図 6-1. Therefore, use a low-pass digital filter, such as a SINC filter, at the output of the device to increase signal to noise ratio. 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 suitable programmable, hardwired filter structure termed a *sigma-delta filter module* (SDFM) optimized for usage with the AMC3306M05-Q1. Alternatively, use a field-programmable gate array (FPGA) or complex programmable logic device (CPLD) to implement the filter.

6.3.3 Isolation Channel Signal Transmission

The AMC3306M05-Q1 uses an on-off keying (OOK) modulation scheme, as shown in 図 6-3, to transmit the modulator output bitstream across the SiO_2-based isolation barrier. The transmit driver (TX) shown in the *Functional Block Diagram* transmits an internally generated, high-frequency carrier across the isolation barrier to represent a digital *one*. However, TX does not send a signal to represent a digital *zero*. The nominal frequency of the carrier used inside the AMC3306M05-Q1 is 480MHz.

The receiver (RX) on the other side of the isolation barrier recovers and demodulates the signal and produces the output. The AMC3306M05-Q1 transmission channel is optimized to achieve the highest level of common-mode transient immunity (CMTI). This channel is also optimized to achieve the lowest level of radiated emissions caused by the high-frequency carrier and RX/TX buffer switching.

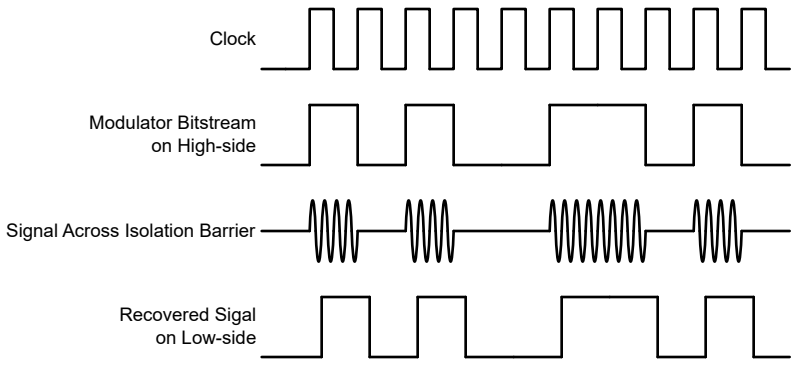


図 6-3. OOK-Based Modulation Scheme

6.3.4 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 50mV produces a stream of ones and zeros that are high 89.06% of the time. With 16 bits of resolution, that percentage corresponds to code 58368. A differential input of –50mV produces a stream of ones and zeros that are high 10.94% of the time and results in code 7168. These input voltages are also the specified linear range of the AMC3306M05-Q1. If the input voltage value exceeds this range, the output of the modulator shows nonlinear behavior as the quantization noise increases. The modulator output clips with constant stream of zeros with an input ≤ –64mV . In this case, the AMC3306M05-Q1 generates a single 1 every 128 clock cycles to indicate proper device function. The modulator output clips with constant stream of ones with an input ≥ 64mV. In this case, the AMC3306M05-Q1 generates a single 0 every 128 clock cycles to indicate proper device function. See the *Output Behavior in Case of a Full-Scale Input* section for more details. 図 6-4 shows the input voltage versus the output modulator signal.

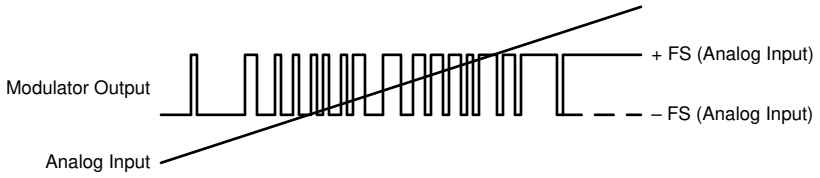


図 6-4. AMC3306M05-Q1 Modulator Output vs Analog Input

Calculate the density of ones in the output bitstream with 式 1 for any input voltage value except a full-scale input signal. See the *Output Behavior in Case of a Full-Scale Input* section.

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

6.3.4.1 Output Behavior in Case of a Full-Scale Input

The device generates a single one or zero every 128 bits at DOUT if an input signal is applied that exceeds the clipping voltage. This voltage is defined as ($|V_{IN}| \geq V_{Clipping}$). 図 6-5 shows the full-scale output timing, which is dependent on the actual polarity of the signal being sensed. In this way, differentiating between a missing high-side supply and a full-scale input signal is possible on the system level.

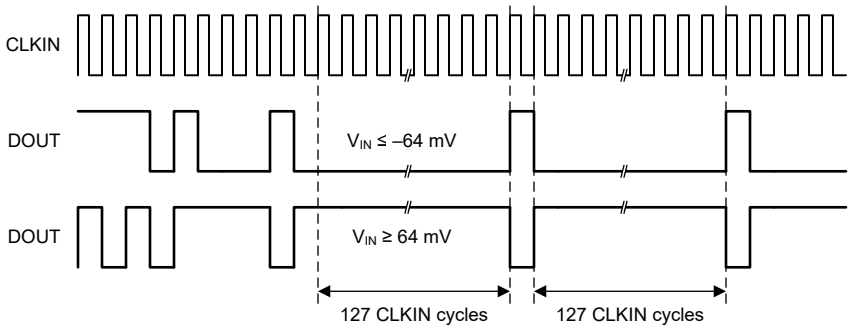


図 6-5. Full-Scale Output of the AMC3306M05-Q1

6.3.4.2 Output Behavior in Case of a High-Side Supply Failure

The device output DOUT is a constant bitstream of logic 0's whenever the integrated DC/DC converter output voltage is below the undervoltage detection threshold. See the *Diagnostic Output* section for more information.

6.3.5 Isolated DC/DC Converter

The AMC3306M05-Q1 offers a fully integrated, isolated DC/DC converter with the following components(see the *Functional Block Diagram* section):

- Low-dropout regulator (LDO) on the low side to stabilize the supply voltage VDD that drives the low side of the converter. This circuit does not output a constant voltage and is not intended for driving any external load.
- Low-side full-bridge inverter and drivers.
- Laminate-based, air-core transformer for high immunity to magnetic fields.
- High-side full-bridge rectifier.
- High-side LDO to stabilize the output voltage of the DC/DC converter for high analog performance of the signal path. The high-side LDO outputs a constant voltage and optionally provides a limited amount of current to power external circuitry.

The DC/DC converter uses a spread-spectrum clock generation technique to reduce the spectral density of the electromagnetic radiation. The resonator frequency is synchronized to the ΔΣ modulator operation to minimize interference with data transmission and support high analog performance of the device.

The architecture of the DC/DC converter is optimized to drive the high-side circuitry of the AMC3306M05-Q1. The DC/DC converter sources up to I_H of additional DC current to power an optional active filter, preamplifier, or isolated comparator (such as the AMC23C12-Q1). As shown in 図 6-6, I_H is specified up to an ambient temperature of 85°C and derates linearly at higher temperatures.

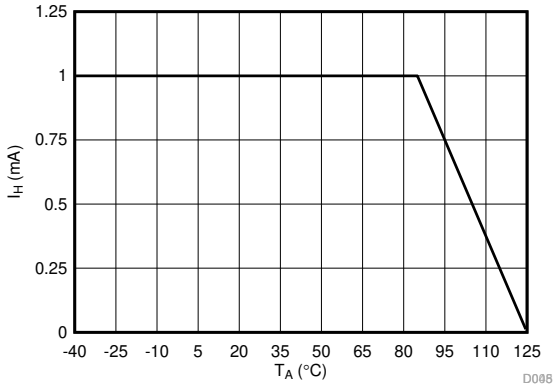


図 6-6. Derating of I_H at Ambient Temperatures >85°C

6.3.6 Diagnostic Output

As shown in 図 6-7, monitor the open-drain DIAG pin to confirm the device is operational and the output data are valid. During power-up, the DIAG pin is actively held low until the high-side supply is in regulation and the modulator starts outputting data. The DIAG pin is actively pulled low if:

- The low side does not receive data from the high side (for example, because of a loss of power on the high side). The modulator outputs a constant bitstream of logic 0's in this case, that is, the DOUT pin is permanently low.
- The high-side DC/DC output voltage (DCDC_OUT) or the high-side LDO output voltage (HLDO_OUT) drop below the respective undervoltage detection thresholds (brown-out). In this case, the low-side still receives data from the high-side but the data is potentially invalid. However, the modulator outputs a constant bitstream of logic 0's in this case, meaning that the DOUT pin is permanently low.

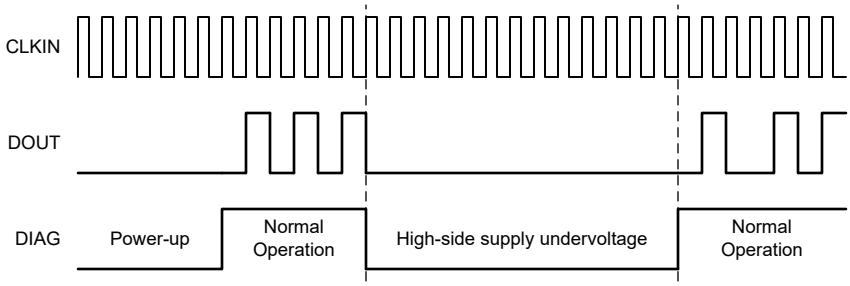


図 6-7. DIAG and Output Under Different Operating Conditions

6.4 Device Functional Modes

The AMC3306M05-Q1 is operational when VDD is applied, as specified in the *Recommended Operating Conditions* table.

7 Application and Implementation

注

以下のアプリケーション情報は、TI の製品仕様に含まれるものではなく、TI ではその正確性または完全性を保証いたしません。個々の目的に対する製品の適合性については、お客様の責任で判断していただくことになります。お客様は自身の設計実装を検証しテストすることで、システムの機能を確認する必要があります。

7.1 Application Information

The AMC3306M05-Q1 is a high-performance solution for shunt-based current sensing in the presence of high common-mode voltage levels.

7.1.1 Digital Filter Usage

The modulator generates a bitstream that is required to be processed by a digital filter. This process obtains a digital word similar to a conversion result of a conventional analog-to-digital converter (ADC). A very simple filter, as shown in 式 2, 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 256 OSR $sinc^3$ filter and a 16-bit output word width, unless otherwise noted. The measured effective number of bits (ENOB) as a function of the OSR is illustrated in 図 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 the filter design and correct OSR and filter-order selection 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, available at www.ti.com, discusses an example code. This example code implements a $sinc^3$ filter in an FPGA.

7.2 Typical Application

7.2.1 Onboard Charger (OBC) Application

The AMC3306M05-Q1 is designed for shunt-based, current-sensing applications where accurate current monitoring is required in the presence of high common-mode voltages. The AMC3306M05-Q1 integrates an isolated power supply for the high-voltage side. This feature makes the device particularly easy to use in applications without a high-side supply readily available

図 7-1 shows a simplified schematic using the AMC3306M05-Q1 to measure the output current of a PFC stage of an onboard charger (OBC). At this location in the system, there is no supply readily available for powering the high side of the isolated amplifier. The integrated isolated power supply solves this problem and, with the bipolar input voltage range, makes the AMC3306M05-Q1 an easy-to-use solution for bidirectional current sensing. In this example, the AC line voltage is sensed by the AMC3336-Q1 on the grid side. On this side, there is no suitable supply available for powering the high side of the isolated amplifier. The integrated power supply, high input impedance, and bipolar input voltage range of the AMC3336-Q1 makes the device a compact solution for AC voltage-sensing applications.

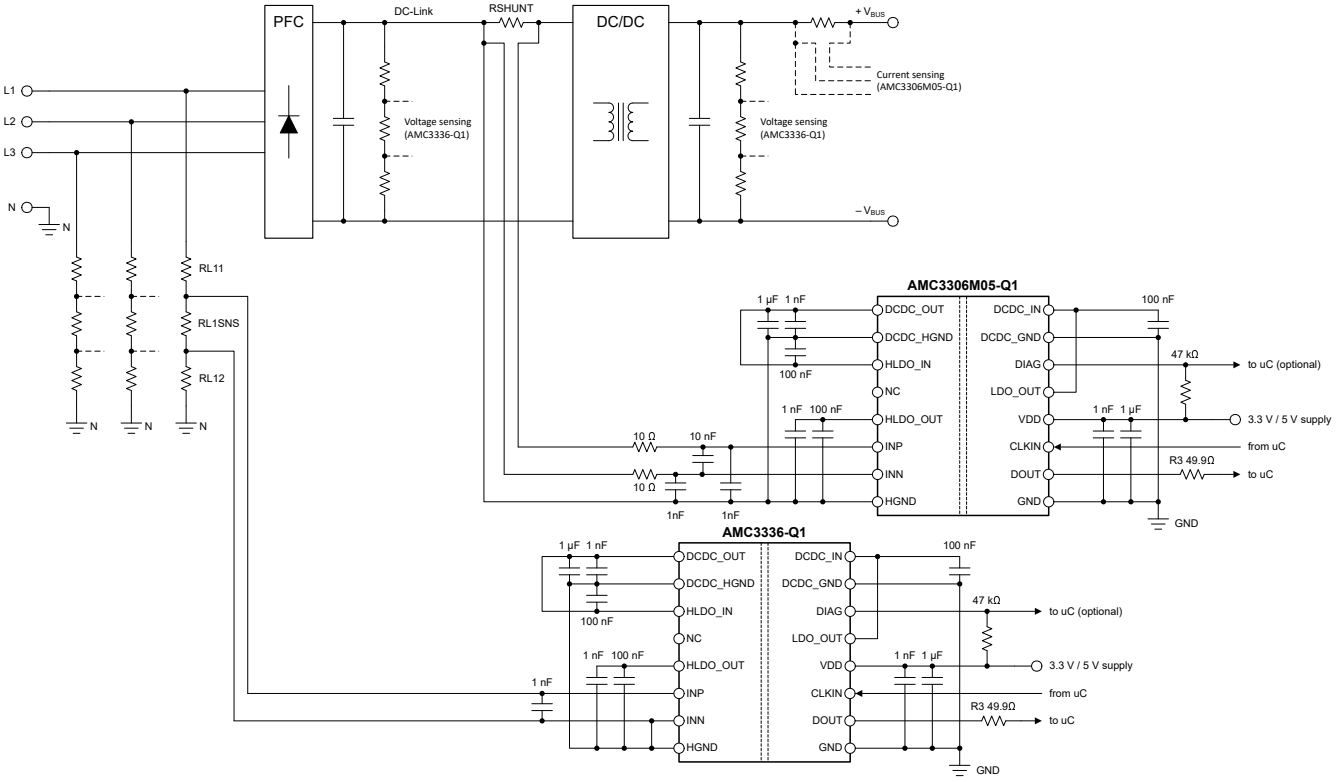


図 7-1. The AMC3306M05-Q1 in an OBC Application

7.2.1.1 Design Requirements

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

表 7-1. Design Requirements

PARAMETER	VALUE
Low-side supply voltage	3.3V or 5V
Voltage drop across RSHUNT for a linear response	±50mV (maximum)

7.2.1.2 Detailed Design Procedure

The AMC3306M05-Q1 requires a single 3.3V or 5V supply on the low side. The high-side supply is internally generated by an integrated DC/DC converter as explained in the *Isolated DC/DC Converter* section.

The ground reference (HGND) is derived from the terminal of the shunt resistor connected to the negative input (INN) of the AMC3306M05-Q1. If using a four-pin shunt, connect the inputs of the AMC3306M05-Q1 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.

7.2.1.2.1 Shunt Resistor Sizing

Use Ohm's Law to calculate the voltage drop across the shunt resistor (V_{SHUNT}) for the desired measured current: V_{SHUNT} = I × RSHUNT.

Consider the following two restrictions to choose the proper value of the shunt resistor, R_{SHUNT}:

- Make sure the voltage drop caused by the nominal current range does not exceed the recommended differential input voltage range for a linear response. In other words, $|V_{SHUNT}| \leq V_{FSR}$.
- Make sure the voltage drop caused by the maximum allowed overcurrent does not exceed the input voltage that causes a clipping output. That is, $|V_{SHUNT}| \leq |V_{Clipping}|$.

7.2.1.2.2 Input Filter Design

Place an RC filter in front of a ΔΣ modulator to improve signal-to-noise performance of the signal path. Design the input filter such that:

- The cutoff frequency of the filter is at least one order of magnitude lower than the sampling frequency of the ΔΣ modulator (f_{CLKIN})
- The input bias current does not generate significant voltage drop across the DC impedance of the input filter
- The impedances measured from the analog inputs are equal (R1 equals R2)

Capacitors C11 and C12 are optional and improve common-mode rejection at high frequencies (>1MHz). For best performance, make sure C11 matches the value of C12 and that both capacitors are 10 to 20 times lower in value than C10. For most applications, the structure shown in 図 7-2 achieves excellent performance.

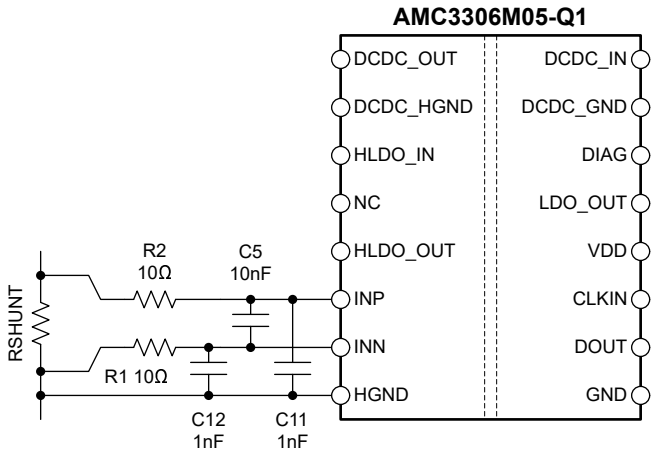


図 7-2. Differential Input Filter

7.2.1.2.3 Bitstream Filtering

For modulator output bitstream filtering, select 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 is a fast-response path for overcurrent detection.

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.

7.2.1.3 Application Curve

The effective number of bits (ENOB) is often used to compare the performance of ADCs and ΔΣ modulators. 図 7-3 shows the ENOB of the AMC3306M05-Q1 with different oversampling ratios. By using 式 3, this number is also calculated from the SINAD:

$$SINAD = 1.76dB + 6.02dB \times ENOB \quad (3)$$

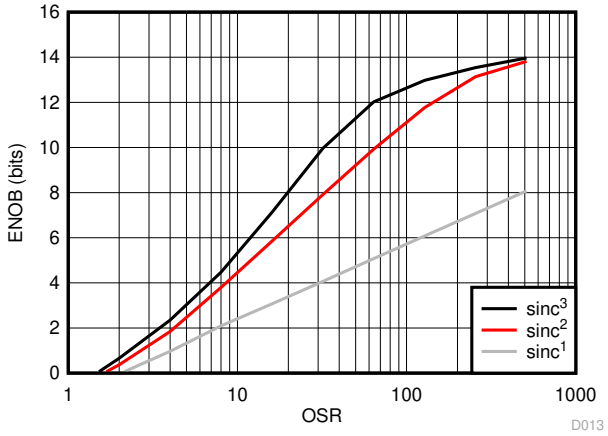


図 7-3. Measured Effective Number of Bits vs Oversampling Ratio

7.2.2 Best Design Practices

Do not leave the inputs of the AMC3306M05-Q1 unconnected (floating) when the device is powered up. If left floating, the input bias currents potentially drive the inputs to a positive value that exceeds the operating common-mode input voltage. As a result, the output of the device is undetermined.

Connect the negative input (INN) to the high-side ground (HGND), either by a hard short or through a resistive path. A DC current path between INN and HGND 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. Connect this trace directly to the shunt resistor rather than shorting AGND to INN directly at the input to the device. See the *Layout* section for more details.

The high-side LDO is capable of sourcing a limited amount of current (I_H) to power external circuitry. Do not to overload the high-side LDO and be aware of derating I_H at high temperatures, as explained in the *Isolated DC/DC Converter* section.

The low-side LDO does not output a constant voltage and is not intended for powering any external circuitry. Do not connect any external load to the LDO_OUT pin.

7.3 Power Supply Recommendations

The AMC3306M05-Q1 is powered from the low-side power supply (VDD) with a nominal value of 3.3V or 5V. Place a low-ESR, 1nF decoupling capacitor (C8 in 図 7-4) as close as possible to the VDD pin. Follow the 1nF capacitor with a 1µF capacitor (C9) to filter this power-supply path.

Decouple the low side of the DC/DC converter with a low-ESR, 100nF capacitor (C4) positioned close to the device between the DCDC_IN and DCDC_GND pins. Use a 1µF capacitor (C2) to decouple the high side. Additionally, place a low-ESR, 1nF capacitor (C3) as close as possible to the device and connect this capacitor to the DCDC_OUT and DCDC_HGND pins.

For the high-side LDO, use low-ESR, 1nF capacitors (C6), placed as close as possible to the AMC3306M05-Q1, followed by a 100nF decoupling capacitor (C5).

The ground reference for the high side (HGND) is derived from the terminal of the shunt resistor connected to the device negative input (INN). For best DC accuracy, use a separate trace to make this connection instead of shorting HGND to INN directly at the device input. The high-side DC/DC ground terminal (DCDC_HGND) is shorted to HGND directly at the device pins.

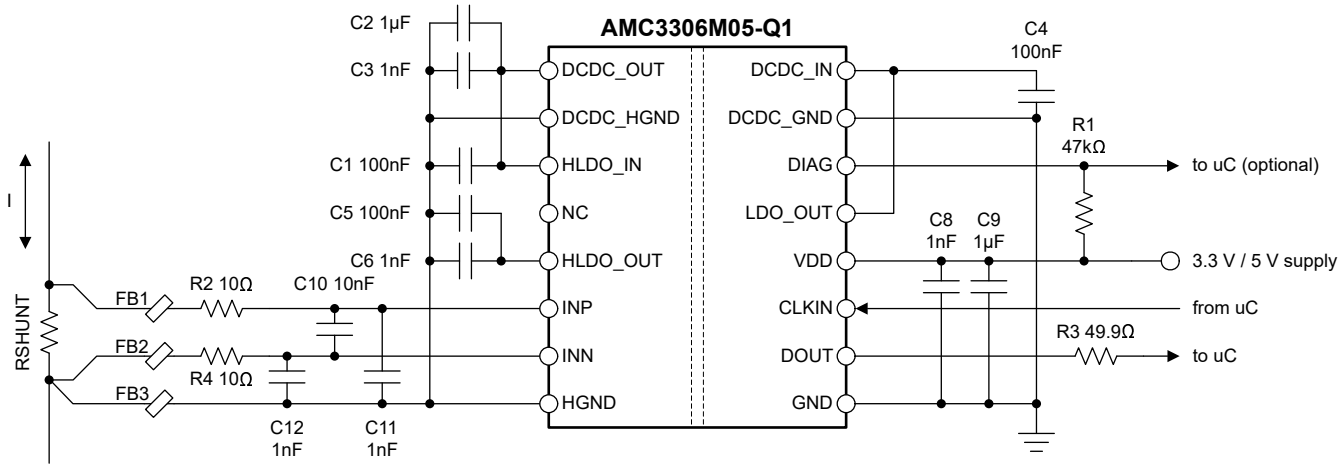


図 7-4. Decoupling the AMC3306M05-Q1

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

The *Best Practices to Attenuate AMC3301 Family Radiated Emissions EMI* application note is available for download at www.ti.com.

表 7-2 lists recommended components for use with the AMC3306M05-Q1. This list is not exhaustive. Other components potentially exist that are equally capable (or better), however these listed components have been validated during the development of the AMC3306M05-Q1.

表 7-2. Recommended External Components

DESCRIPTION		PART NUMBER	MANUFACTURER	SIZE (EIA, L × W)
VDD				
C8	1nF ± 10%, X7R, 50V	12065C102KAT2A(1)	AVX	1206, 3.2mm × 1.6mm
		C0603C102K5RACTU	Kemet	0603, 1.6mm × 0.8mm
C9	1µF ± 10%, X7R, 25V	12063C105KAT2A(1)	AVX	1206, 3.2mm × 1.6mm
		CGA3E1X7R1E105K080AC	TDK	0603, 1.6mm × 0.8mm
DC/DC CONVERTER				
C4	100nF ± 10%, X7R, 50V	C0603C104K5RACAUTO	Kemet	0603, 1.6mm × 0.8mm
C3	1nF ± 10%, X7R, 50V	C0603C102K5RACTU	Kemet	0603, 1.6mm × 0.8mm
C2	1µF ± 10%, X7R, 25V	CGA3E1X7R1E105K080AC	TDK	0603, 1.6mm × 0.8mm
HLDO				
C1	100nF ± 10%, X7R, 50V	C0603C104K5RACAUTO	Kemet	0603, 1.6mm × 0.8mm
C5	100nF ± 5%, NP0, 50V	C3216NP01H104J160AA(1)	TDK	1206, 3.2mm × 1.6mm
	100nF ± 10%, X7R, 50V	C0603C104K5RACAUTO	Kemet	0603, 1.6mm × 0.8mm
C6	1nF ± 10%, X7R, 50V	12065C102KAT2A(1)	AVX	1206, 3.2mm × 1.6mm
		C0603C102K5RACTU	Kemet	0603, 1.6mm × 0.8mm
FERRITE BEADS				
FB1,FB2, FB3	Ferrite bead(2)	74269244182	Wurth Elektronik	0402, 1.0mm × 0.5mm
		BLM15HD182SH1	Murata	0402, 1.0mm × 0.5mm
		BKH1005LM182-T	Taiyo Yuden	0402, 1.0mm × 0.5mm

(1) Component used for parametric validation.
(2) No ferrite beads used for parametric validation.

7.4 Layout

7.4.1 Layout Guidelines

図 7-5 shows a layout recommendation with the critical placement of the decoupling capacitors and all other components required by the device. Make sure to place the decoupling capacitors as close as possible to the AMC3306M05-Q1 supply pins. For best performance, place the shunt resistor close to the INP and INN inputs of the AMC3306M05-Q1 and keep the layout of both connections symmetrical.

This layout is used on the AMC3306M05-Q1 EVM and supports CISPR-11 compliant electromagnetic radiation levels.

7.4.2 Layout Example

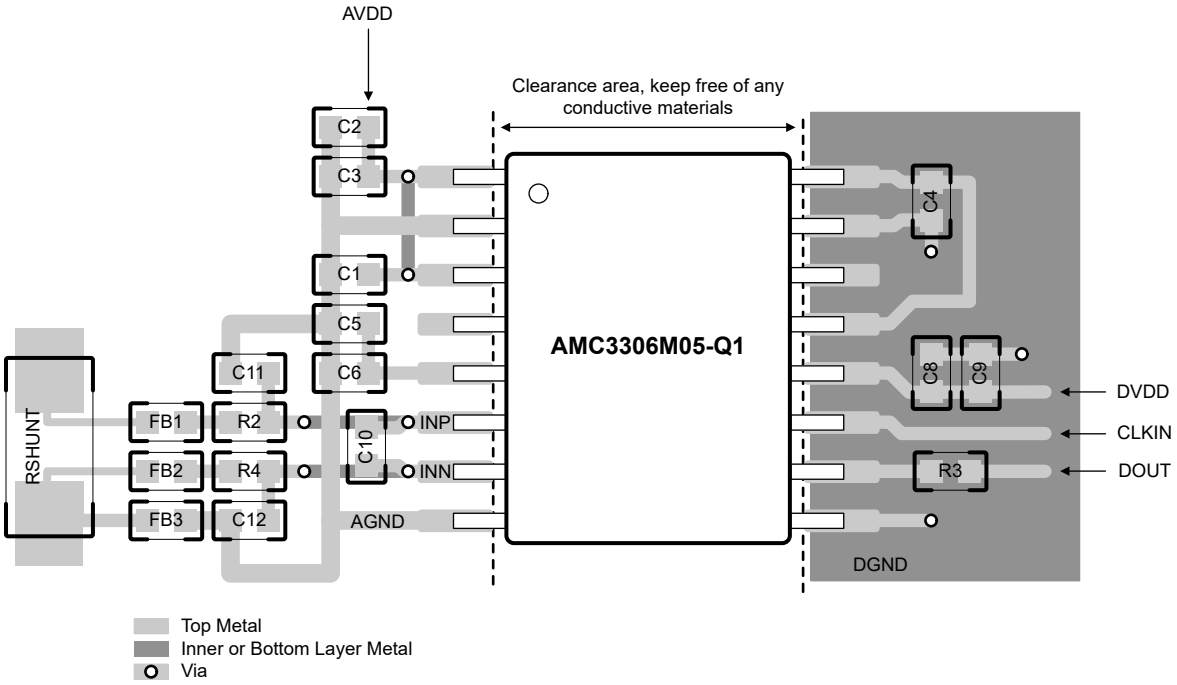


図 7-5. Recommended Layout of the AMC3306M05-Q1

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, *Delta Sigma Modulator Filter Calculator* design tool

8.2 ドキュメントの更新通知を受け取る方法

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8.6 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 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。

DATE	REVISION	NOTES
August 2024	*	Initial Release

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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PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
AMC3306M05QDWERQ1	ACTIVE	SOIC	DWE	16	2000	RoHS & Green	NIPDAU	Level-3-260C-168 HR	-40 to 125	MC3306M05Q	Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

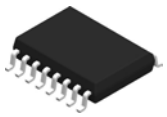
(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

OTHER QUALIFIED VERSIONS OF AMC3306M05-Q1 :

- Catalog : AMC3306M05

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

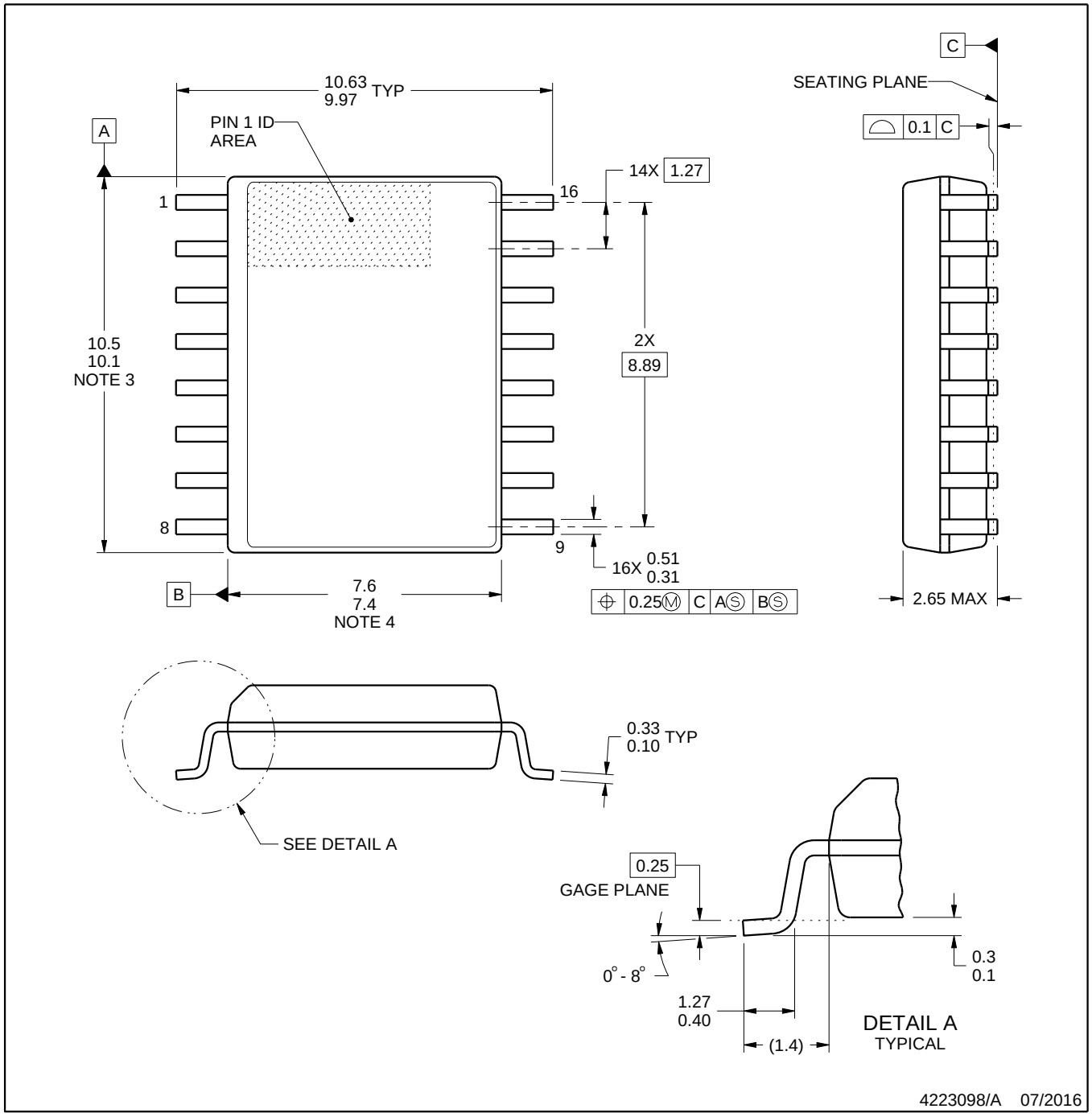


PACKAGE OUTLINE

DWE0016A

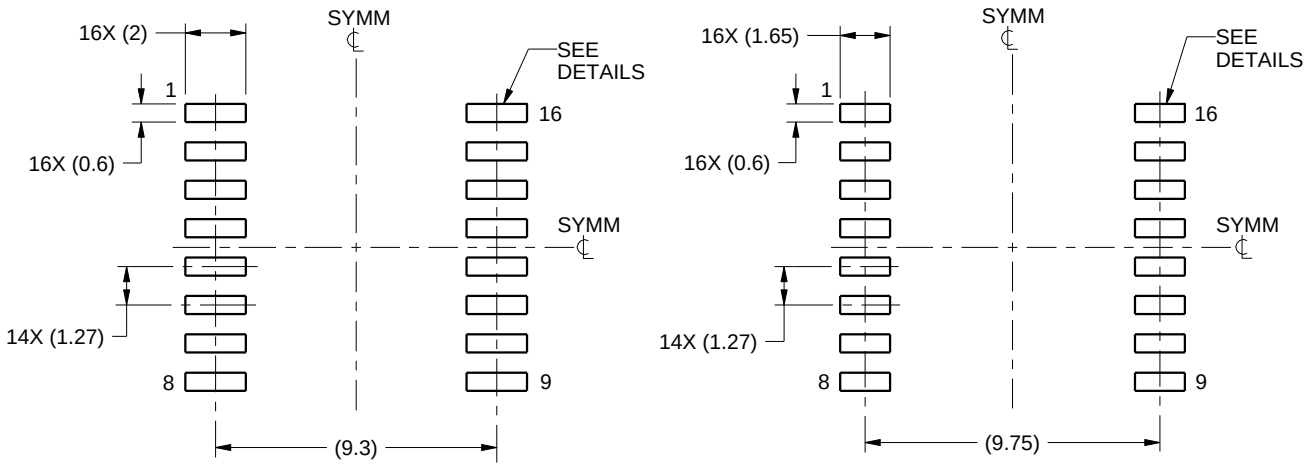
SOIC - 2.65 mm max height

SOIC



NOTES:

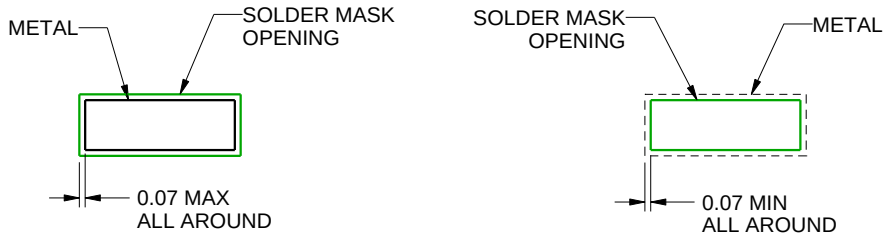
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 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.



IPC-7351 NOMINAL
7.3 mm CLEARANCE/CREEPAGE

HV / ISOLATION OPTION
8.1 mm CLEARANCE/CREEPAGE

LAND PATTERN EXAMPLE
SCALE:4X



NON SOLDER MASK DEFINED

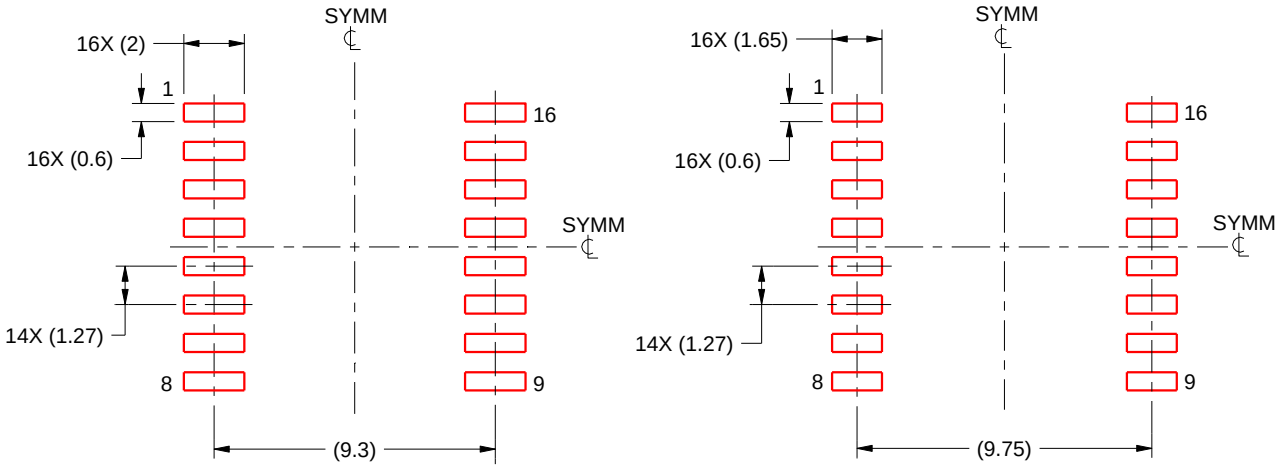
SOLDER MASK DEFINED

SOLDER MASK DETAILS

4223098/A 07/2016

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.



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

4223098/A 07/2016

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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