

DACx3508 オクタル、10 ビットまたは 8 ビット、SPI インターフェイス、バッファ付き電圧出力 DAC、超小型 3 × 3 WQFN パッケージ

1 特長

- $\pm 1\text{LSB}$ INL および DNL
- 幅広い動作範囲
 - 電源: $1.8\text{V} \sim 5.5\text{V}$
 - 温度範囲: $-40^\circ\text{C} \sim +125^\circ\text{C}$
- 3 線式 SPI インターフェイス
 - $2.7\text{V} \leq V_{\text{DD}} \leq 5.5\text{V}$ の場合、 $V_{\text{IH}} = 2.4\text{V}$
 - $1.8\text{V} \leq V_{\text{DD}} \leq 2.7\text{V}$ の場合、 $V_{\text{IH}} = (V_{\text{DD}} - 0.3\text{V})$
- $\overline{\text{LDAC}}$ ピンによる出力の同時更新
- 超低消費電力: チャンネルあたり 0.1mA (1.8V の場合)
- 低消費電力スタートアップ・モード: 出力は A_{GND} に接続した $10\text{k}\Omega$ でパワーダウンします。
- 超小型パッケージ
 - 16 ピン WQFN ($3\text{mm} \times 3\text{mm}$)

2 アプリケーション

- マルチファンクション・プリンタ (プリンタ複合機)
- TV 向けディスプレイ・パネル
- OLED (有機 EL) TV
- バーチャル・リアリティ・ヘッドセット
- 貨幣計数機
- 現金自動預け払い機 (ATM)

3 概要

10 ビット DAC53508 および 8 ビット DAC43508 (DACx3508) は、低消費電力、8 チャンネル、電圧出力の D/A コンバータ (DAC) です。DACx3508 は $1.8\text{V} \sim 5.5\text{V}$ の広い電源電圧範囲にわたって単調性を維持するように設計されています。DACx3508 は、外部リファレンスを使用して、 $1.8\text{V} \sim 5.5\text{V}$ のフルスケール出力電圧範囲に対応する一方、消費する静止電流はチャンネルあたり 0.1mA です。また、DACx3508 には、チャンネルごとにユーザーがプログラム可能なパワーダウン・レジスタも内蔵しています。これらのレジスタにより、DAC 出力バッファは起動時は $10\text{k}\Omega$ - A_{GND} パワーダウン状態にされ、これらの出力バッファにパワーアップ・コマンドが発行されるまで、この状態を維持します。

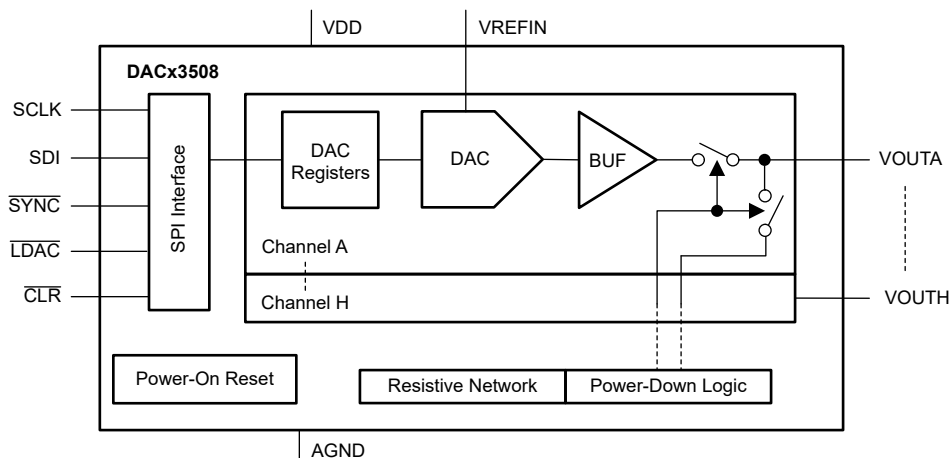
低静止電流、広い電源電圧範囲、8 チャンネル、チャンネルあたりのパワーダウン・オプションから、DACx3508 は高密度、低消費電力のバッテリー駆動システムに最適です。

これらのデバイスは、3 線式 (書き込み専用) SPI インターフェイス経由で通信します。これらのデバイスは、ロード DAC ($\overline{\text{LDAC}}$) とクリア $\overline{\text{CLR}}$ 入力も備えています。

デバイス情報

部品番号	パッケージ (1)	本体サイズ (公称)
DAC53508	WQFN (16)	$3.00\text{mm} \times 3.00\text{mm}$
DAC43508		

(1) 利用可能なパッケージについては、このデータシートの末尾にある注文情報を参照してください。



ブロック図



Table of Contents

1 特長	1	8.3 Feature Description.....	19
2 アプリケーション	1	8.4 Device Functional Modes.....	21
3 概要	1	8.5 Programming.....	21
4 Revision History	2	8.6 Register Map.....	22
5 Device Comparison Table	3	9 Application and Implementation	25
6 Pin Configurations and Functions	3	9.1 Application Information.....	25
7 Specifications	4	9.2 Typical Applications.....	25
7.1 Absolute Maximum Ratings.....	4	10 Power Supply Recommendations	29
7.2 ESD Ratings.....	4	11 Layout	29
7.3 Recommended Operating Conditions.....	4	11.1 Layout Guidelines.....	29
7.4 Thermal Information.....	4	11.2 Layout Example.....	29
7.5 Electrical Characteristics.....	5	12 Device and Documentation Support	30
7.6 Timing Requirements: SPI.....	7	12.1 Documentation Support.....	30
7.7 Timing Requirements: Logic.....	7	12.2 ドキュメントの更新通知を受け取る方法.....	30
7.8 Timing Diagrams.....	7	12.3 サポート・リソース.....	30
7.9 Typical Characteristics: Static Performance.....	8	12.4 Trademarks.....	30
7.10 Typical Characteristics: Dynamic Performance.....	14	12.5 静電気放電に関する注意事項.....	30
7.11 Typical Characteristics: General.....	16	12.6 用語集.....	30
8 Detailed Description	18	13 Mechanical, Packaging, and Orderable Information	30
8.1 Overview.....	18		
8.2 Functional Block Diagram.....	18		

4 Revision History

DATE	REVISION	NOTES
December 2021	*	Initial Release

5 Device Comparison Table

DEVICE	RESOLUTION
DAC53508	10-Bit
DAC43508	8-Bit

6 Pin Configurations and Functions

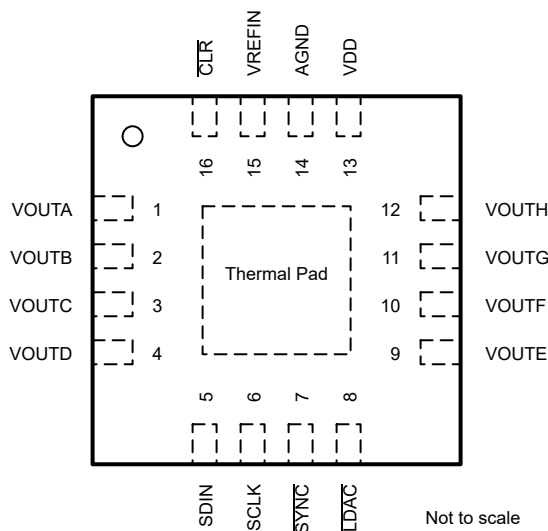


图 6-1. RTE (16-Pin WQFN) Package, Top View

表 6-1. Pin Functions

PIN		TYPE	DESCRIPTION
NO.	NAME		
1	VOUTA	Output	Analog voltage output from DAC channel A.
2	VOUTB	Output	Analog voltage output from DAC channel B.
3	VOUTC	Output	Analog voltage output from DAC channel C.
4	VOUTD	Output	Analog voltage output from DAC channel D.
5	SDIN	Input	SPI data input.
6	SCLK	Input	SPI clock input.
7	SYNC	Input	SPI chip select input (active low).
8	LDAC	Input	Load DAC (active low) input for synchronous output update, simultaneous output update, or both.
9	VOUTE	Output	Analog voltage output from DAC channel E.
10	VOUTF	Output	Analog voltage output from DAC channel F.
11	VOUTG	Output	Analog voltage output from DAC channel G.
12	VOUTH	Output	Analog voltage output from DAC channel H.
13	VDD	Power	Power supply input (1.8 V to 5.5 V).
14	AGND	Ground	Ground reference for all circuitry on the device.
15	VREFIN	Power	External reference input. To use VDD as the reference, connect this pin to VDD.
16	CLR	Input	Asynchronous output clear input (active low).
—	Thermal Pad	Ground	Connect thermal pad to AGND.

7 Specifications

7.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT
V _{DD}	Power-supply voltage to A _{GND}	−0.3	6	V
V _{REFIN}	External reference voltage to A _{GND}	−0.3	V _{DD} + 0.3	V
	Digital input(s) to A _{GND}	−0.3	V _{DD} + 0.3	V
V _{OUT}	Voltage output to A _{GND}	−0.3	V _{DD} + 0.3	V
	Current into any pin	−10	10	mA
T _J	Junction temperature, T _J	−40	150	°C
T _{stg}	Storage temperature, T _{stg}	−65	150	°C

- (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.

7.2 ESD Ratings

			VALUE	UNIT
V _(ESD)	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins ⁽¹⁾	±1000	V
		Charged device model (CDM), per ANSI/ESDA/JEDEC JS-002, all pins ⁽²⁾	±500	

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

7.3 Recommended Operating Conditions

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

		MIN	NOM	MAX	UNIT
V _{DD} to A _{GND}	Positive supply voltage to ground	1.8		5.5	V
V _{REFIN} to A _{GND}	Reference input supply voltage to ground	1.8		V _{DD}	V
V _{IH}	Digital input high voltage, 1.8 V ≤ V _{DD} ≤ 2.7 V	V _{DD} − 0.3			V
	Digital input high voltage, 2.7 V < V _{DD} ≤ 5.5 V	2.4			
V _{IL}	Digital input low voltage			0.5	V
T _A	Ambient temperature	−40		125	°C

7.4 Thermal Information

THERMAL METRIC ⁽¹⁾		DACx3508	UNIT
		RTE (WQFN)	
		16 PIN	
R _{θJA}	Junction-to-ambient thermal resistance	49	°C/W
R _{θJC(top)}	Junction-to-case (top) thermal resistance	50	°C/W
R _{θJB}	Junction-to-board thermal resistance	24.1	°C/W
Ψ _{JT}	Junction-to-top characterization parameter	1.1	°C/W
Y _{JB}	Junction-to-board characterization parameter	24.1	°C/W
R _{θJC(bot)}	Junction-to-case (bottom) thermal resistance	8.7	°C/W

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

7.5 Electrical Characteristics

all minimum/maximum specifications at $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$ and all typical specification at $T_A = 25^\circ\text{C}$, $1.8\text{ V} \leq V_{DD} \leq 5.5\text{ V}$, $V_{REFIN} = 2.5\text{ V}$ for $V_{DD} \geq 2.7\text{ V}$, $V_{REFIN} = 1.8\text{ V}$ for $V_{DD} \leq 2.7\text{ V}$, $R_L = 5\text{ k}\Omega$ to A_{GND} , $C_L = 200\text{ pF}$ to A_{GND} , and digital inputs at V_{DD} or A_{GND} (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
STATIC PERFORMANCE						
	Resolution	DAC53508	10			Bits
		DAC43508	8			
INL	Integral nonlinearity ⁽¹⁾		–1		1	LSB
DNL	Differential nonlinearity ⁽¹⁾		–1		1	LSB
	Zero-code error	Code 0d into DAC		6	12	mV
	Zero-code-error temperature coefficient	Code 0d into DAC		±5		μV/°C
	Offset error ⁽¹⁾		–0.5	0.25	0.5	%FSR
	Offset-error temperature coefficient ⁽¹⁾			±0.0003		%FSR/°C
	Gain error ⁽¹⁾		–0.5	0.25	0.5	%FSR
	Gain-error temperature coefficient ⁽¹⁾			±0.0004		%FSR/°C
	Full-scale error ⁽⁴⁾	$2.7\text{ V} \leq V_{DD} \leq 5.5\text{ V}$	–0.5	0.25	0.5	%FSR
		$1.8\text{ V} \leq V_{DD} \leq 2.7\text{ V}$	–1	0.5	1	
	Full-scale-error temperature coefficient ⁽⁴⁾			±0.0004		%FSR/°C
OUTPUT						
V_{OUTX}	Output voltage		0		5.5	V
C_L	Capacitive load ⁽²⁾	$R_L = \text{Infinite}$			1	nF
					2	
	Load regulation	DAC at midscale, $-10\text{ mA} \leq I_{OUT} \leq +10\text{ mA}$, $V_{DD} = 5.5\text{ V}$		0.1		mV/mA
	Short-circuit current ⁽³⁾	$V_{DD} = 1.8\text{ V}$		10		mA
		$V_{DD} = 2.7\text{ V}$		25		
		$V_{DD} = 5.5\text{ V}$		50		
	Output voltage headroom	To V_{DD} , DAC output unloaded		0.05		V
	Output voltage headroom ⁽²⁾	To V_{DD} , load current = 10 mA at $V_{DD} = 5.5\text{ V}$, load current = 3 mA at $V_{DD} = 2.7\text{ V}$, load current = 1 mA at $V_{DD} = 1.8\text{ V}$, DAC code at full-scale	10			%FSR
Z_O	DC output impedance	DAC at midscale		0.25		Ω
		DAC at code 4d		0.25		
		DAC at code 1016d		0.26		
DC PSRR	Power supply rejection ratio (dc)	DAC at midscale, $V_{DD} = 5\text{ V} \pm 10\%$		0.25		mV/V

7.5 Electrical Characteristics (continued)

all minimum/maximum specifications at $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$ and all typical specification at $T_A = 25^\circ\text{C}$, $1.8\text{ V} \leq V_{DD} \leq 5.5\text{ V}$, $V_{REFIN} = 2.5\text{ V}$ for $V_{DD} \geq 2.7\text{ V}$, $V_{REFIN} = 1.8\text{ V}$ for $V_{DD} \leq 2.7\text{ V}$, $R_L = 5\text{ k}\Omega$ to A_{GND} , $C_L = 200\text{ pF}$ to A_{GND} , and digital inputs at V_{DD} or A_{GND} (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
DYNAMIC PERFORMANCE						
t_{sett}	Output voltage settling time	1/4 to 3/4 scale and 3/4 to 1/4 scale settling to 10%FSR, $V_{DD} = 5.5\text{ V}$		10		μs
SR	Slew rate	$V_{DD} = 5.5\text{ V}$		0.6		$\text{V}/\mu\text{s}$
	Power-on glitch magnitude			110		mV
V_n	Output noise	$f = 0.1\text{ Hz to }10\text{ Hz}$, DAC at midscale, $V_{DD} = 5.5\text{ V}$		40		μV_{pp}
V_n	Output noise	$f = 0.1\text{ Hz to }100\text{ kHz}$, DAC at midscale, $V_{DD} = 5.5\text{ V}$		0.05		mV_{rms}
V_n	Output noise density	$f = 1\text{ kHz}$, DAC at midscale, $V_{DD} = 5.5\text{ V}$		0.2		$\mu\text{V}/\sqrt{\text{Hz}}$
		$f = 10\text{ kHz}$, DAC at midscale, $V_{DD} = 5.5\text{ V}$		0.2		
AC PSRR	Power-supply rejection ratio (ac)	200-mV, 50-Hz or 60-Hz sine wave superimposed on power-supply voltage, DAC at midscale		-71		dB
	Channel-to-channel ac crosstalk	Full-scale swing on adjacent channel		1.5		nV-s
	Channel-to-channel dc crosstalk	Full-scale swing on all channels, measured channel at zero-scale or full-scale		0.05		LSB
	Code change glitch impulse	± 1 -LSB change around midscale (including feedthrough)		10		nV-s
	Code change glitch impulse magnitude	± 1 -LSB change around midscale (including feedthrough)		25		mV
VOLTAGE REFERENCE INPUT						
	Reference input impedance	All channels powered on		12.5		k Ω
	Reference input capacitance			50		pF
DIGITAL INPUTS						
	Digital feedthrough	SCLK = 1 MHz, DAC output static at midscale		20		nV-s
	Pin capacitance	Per pin		10		pF
POWER						
I_{DD}	Current flowing into V_{DD}	Normal mode, all DACs at full-scale, SPI static		3	5	mA
		All DAC channels powered down		50		μA

- (1) End point fit between codes: code 4d to code 1016d for 10 bit, code 1d to code 251d for 8 bit.
- (2) Characterized by design. Not production tested.
- (3) Full-scale output shorted per channel to A_{GND} or zero-scale output shorted to V_{DD} .
- (4) Code 1023d into DAC, no headroom.

7.6 Timing Requirements: SPI

All inputs signals are specified with $t_R = t_F = 1 \text{ V/ns}$ (10% to 90% of V_{DD}) and timed from a voltage level of $V_{DD}/2$, $1.8 \text{ V} \leq V_{DD} \leq 5.5 \text{ V}$ and $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$

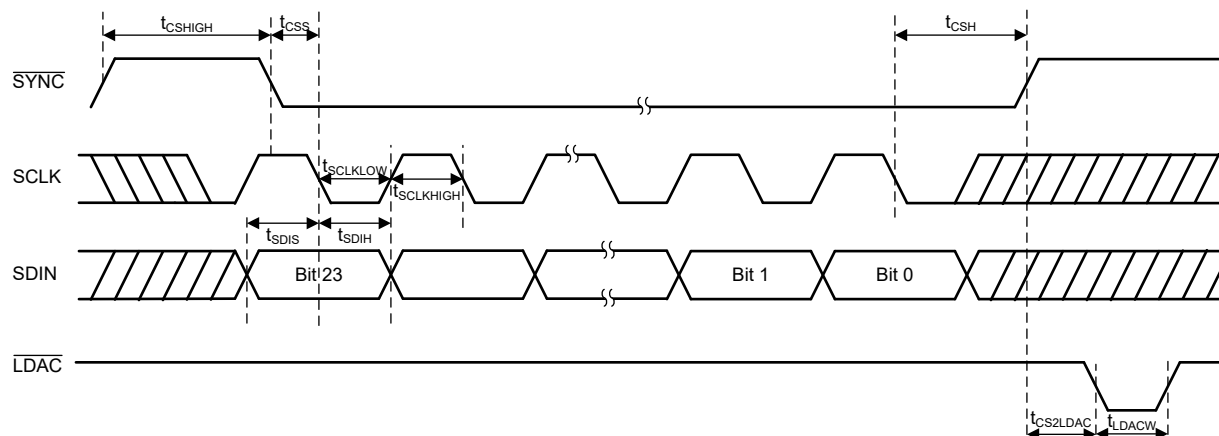
		MIN	NOM	MAX	UNIT
$f_{(\text{SCLK})}$	Serial clock frequency, $1.7 \text{ V} \leq V_{DD} < 2.7 \text{ V}$			25	MHz
	Serial clock frequency, $2.7 \text{ V} \leq V_{DD} \leq 5.5 \text{ V}$			50	
t_{SCLKHIGH}	SCLK high time, $1.7 \text{ V} \leq V_{DD} < 2.7 \text{ V}$	20			ns
	SCLK high time, $2.7 \text{ V} \leq V_{DD} \leq 5.5 \text{ V}$	10			
t_{SCLKLOW}	SCLK low time, $1.7 \text{ V} \leq V_{DD} < 2.7 \text{ V}$	20			ns
	SCLK low time, $2.7 \text{ V} \leq V_{DD} \leq 5.5 \text{ V}$	10			
t_{SDIS}	SDI setup time, $1.7 \text{ V} \leq V_{DD} < 2.7 \text{ V}$	16			ns
	SDI setup time, $2.7 \text{ V} \leq V_{DD} \leq 5.5 \text{ V}$	8			
t_{SDIH}	SDI hold time, $1.7 \text{ V} \leq V_{DD} < 2.7 \text{ V}$	10			ns
	SDI hold time, $2.7 \text{ V} \leq V_{DD} \leq 5.5 \text{ V}$	5			
t_{CSS}	$\overline{\text{SYNC}}$ to SCLK falling edge setup time, $1.7 \text{ V} \leq V_{DD} < 2.7 \text{ V}$	36			ns
	$\overline{\text{SYNC}}$ to SCLK falling edge setup time, $2.7 \text{ V} \leq V_{DD} \leq 5.5 \text{ V}$	18			
t_{CSH}	SCLK falling edge to $\overline{\text{SYNC}}$ rising edge, $1.7 \text{ V} \leq V_{DD} < 2.7 \text{ V}$	10			ns
	SCLK falling edge to $\overline{\text{SYNC}}$ rising edge, $2.7 \text{ V} \leq V_{DD} \leq 5.5 \text{ V}$	5			
t_{CSHIGH}	$\overline{\text{SYNC}}$ high time, $1.7 \text{ V} \leq V_{DD} < 2.7 \text{ V}$	50			ns
	$\overline{\text{SYNC}}$ high time, $2.7 \text{ V} \leq V_{DD} \leq 5.5 \text{ V}$	25			

7.7 Timing Requirements: Logic

all input signals are timed from VIL to 70% of V_{DD} , $1.8 \text{ V} \leq V_{DD} \leq 5.5 \text{ V}$, $1.8 \text{ V} \leq V_{\text{REFIN}} \leq V_{DD}$, $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$, $V_{\text{pullup}} = V_{DD}$ for $1.8 \text{ V} \leq V_{DD} \leq 2.7 \text{ V}$, $V_{\text{pullup}} = 2.7 \text{ V}$ or V_{DD} for $2.7 \text{ V} \leq V_{DD} \leq 5.5 \text{ V}$

		MIN	NOM	MAX	UNIT
t_{CS2LDAC}	$\overline{\text{SYNC}}$ rise edge to $\overline{\text{LDAC}}$ fall edge, $1.7 \text{ V} \leq V_{DD} < 2.7 \text{ V}$	100			ns
	$\overline{\text{SYNC}}$ rise edge to $\overline{\text{LDAC}}$ fall edge, $2.7 \text{ V} \leq V_{DD} \leq 5.5 \text{ V}$	50			
t_{LDACW}	$\overline{\text{LDAC}}$ low time, $1.7 \text{ V} \leq V_{DD} < 2.7 \text{ V}$	60			ns
	$\overline{\text{LDAC}}$ low time, $2.7 \text{ V} \leq V_{DD} \leq 5.5 \text{ V}$	30			
$t_{\text{CLR W}}$	$\overline{\text{CLR}}$ low time, $1.7 \text{ V} \leq V_{DD} < 2.7 \text{ V}$	60			ns
	$\overline{\text{CLR}}$ low time, $2.7 \text{ V} \leq V_{DD} \leq 5.5 \text{ V}$	30			

7.8 Timing Diagrams



7-1. Serial Interface Timing Diagram

7.9 Typical Characteristics: Static Performance

at $T_A = 25^\circ\text{C}$, reference = 1.8 V, and DAC outputs unloaded (unless otherwise noted)

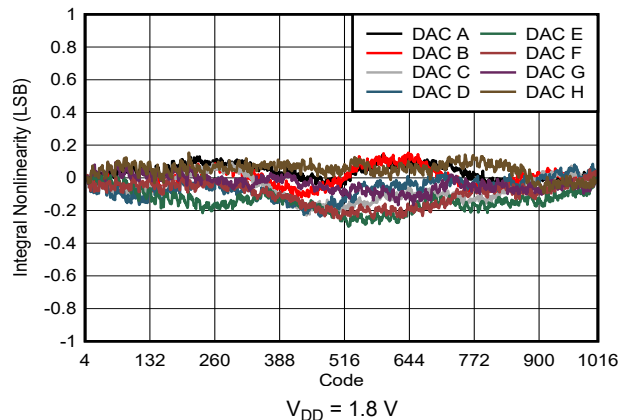


Figure 7-2. Integral Nonlinearity vs Digital Input Code

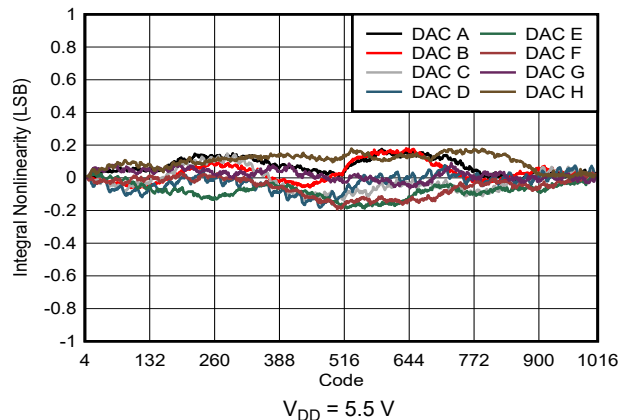


Figure 7-3. Integral Nonlinearity vs Digital Input Code

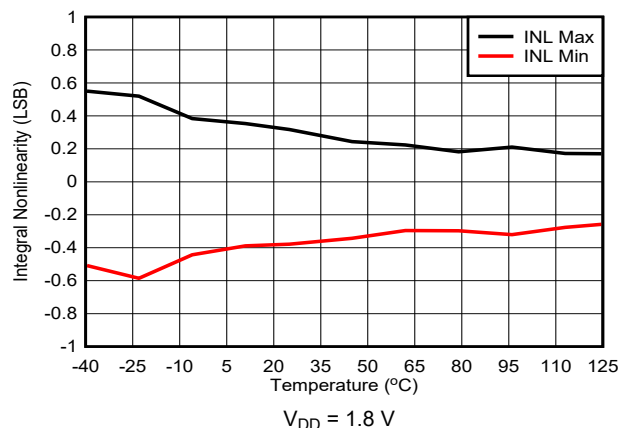


Figure 7-4. Integral Nonlinearity vs Temperature

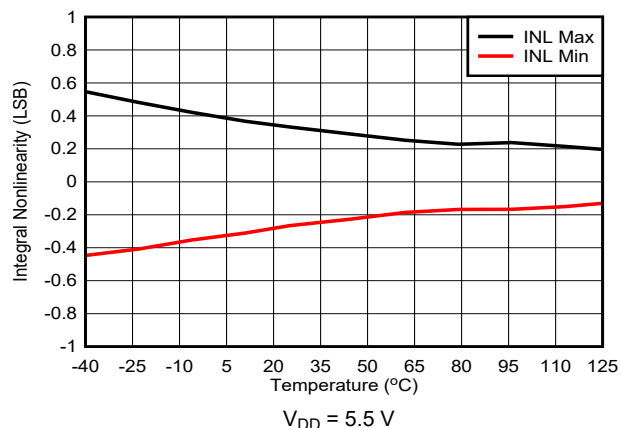


Figure 7-5. Integral Nonlinearity vs Temperature

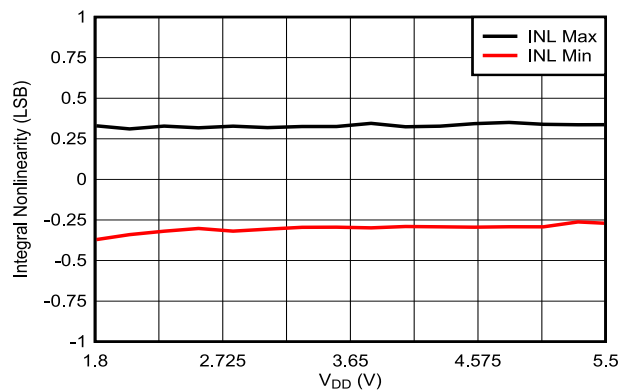


Figure 7-6. Integral Nonlinearity vs Supply Voltage

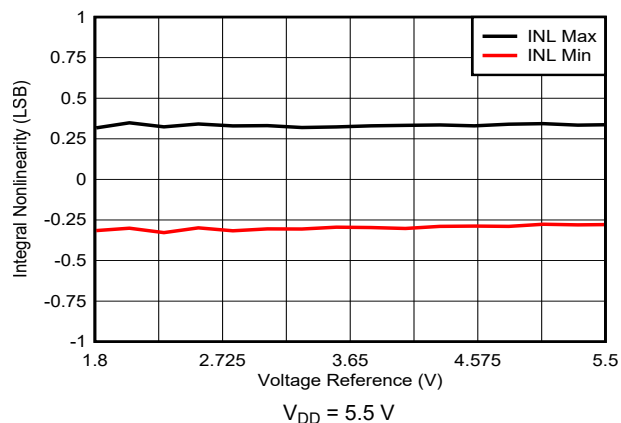
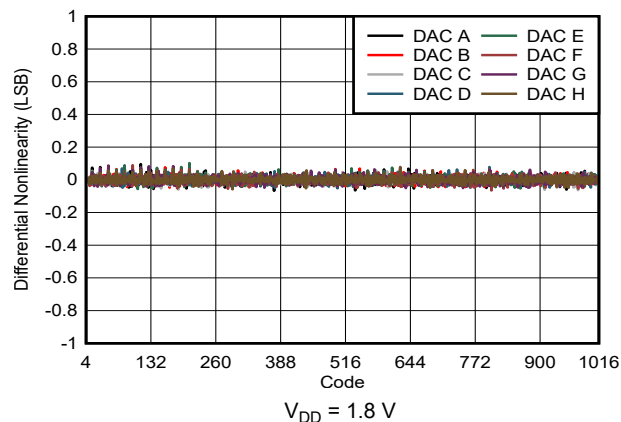


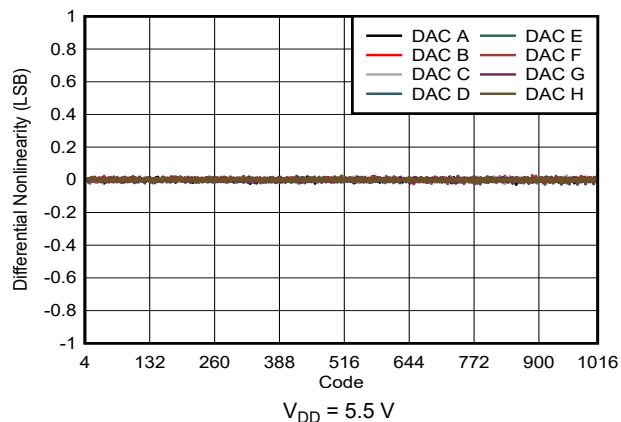
Figure 7-7. Integral Nonlinearity vs Voltage Reference

7.9 Typical Characteristics: Static Performance (continued)

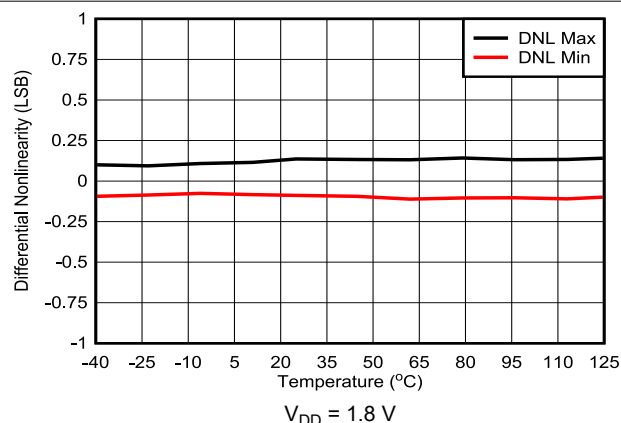
at $T_A = 25^\circ\text{C}$, reference = 1.8 V, and DAC outputs unloaded (unless otherwise noted)



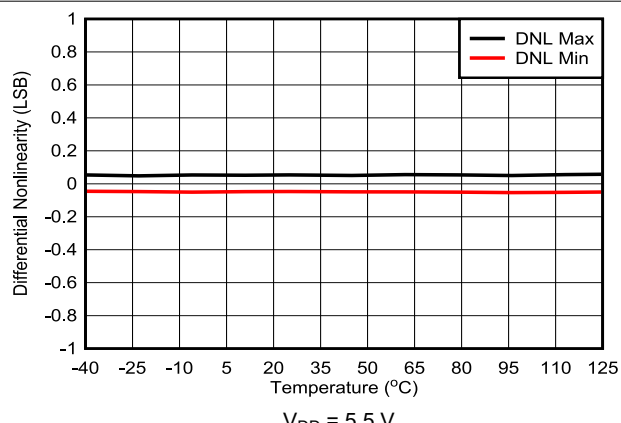
7-8. Differential Nonlinearity vs Digital Input Code



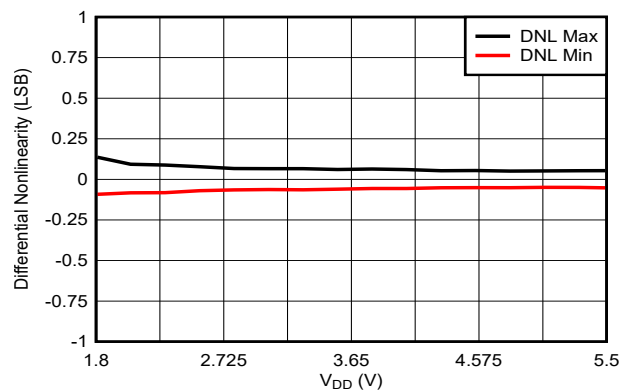
7-9. Differential Nonlinearity vs Digital Input Code



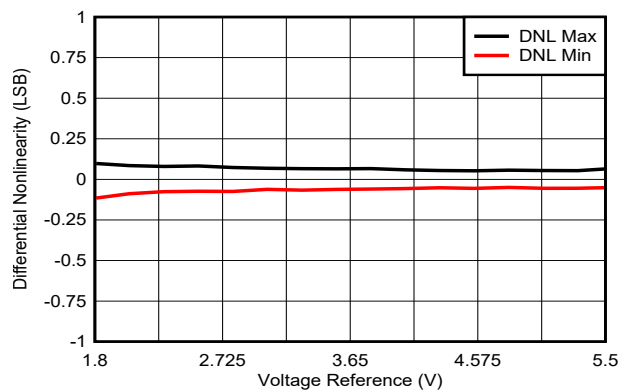
7-10. Differential Nonlinearity vs Temperature



7-11. Differential Nonlinearity vs Temperature



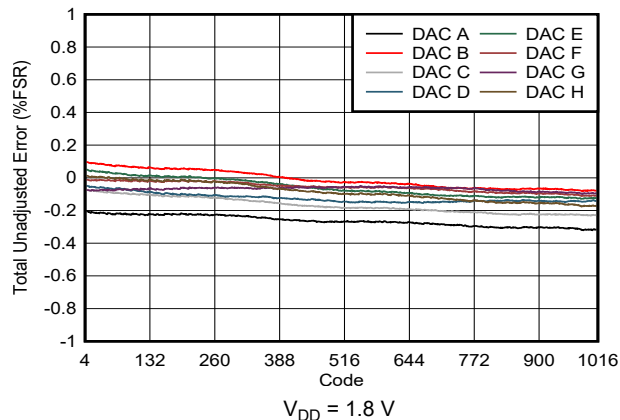
7-12. Differential Nonlinearity vs Supply Voltage



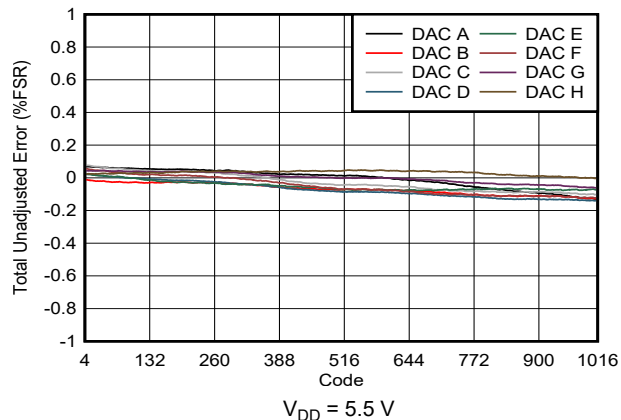
7-13. Differential Nonlinearity vs Voltage Reference

7.9 Typical Characteristics: Static Performance (continued)

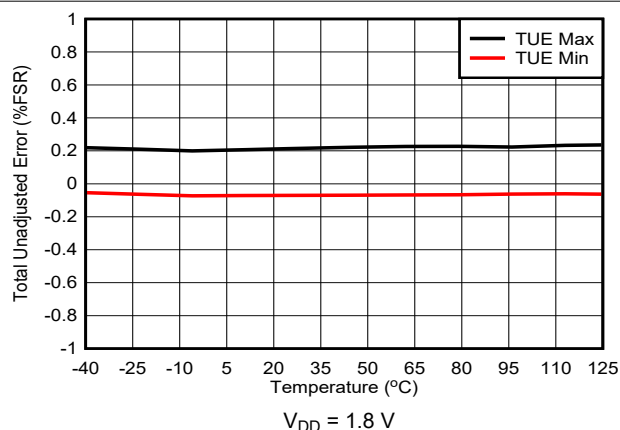
at $T_A = 25^\circ\text{C}$, reference = 1.8 V, and DAC outputs unloaded (unless otherwise noted)



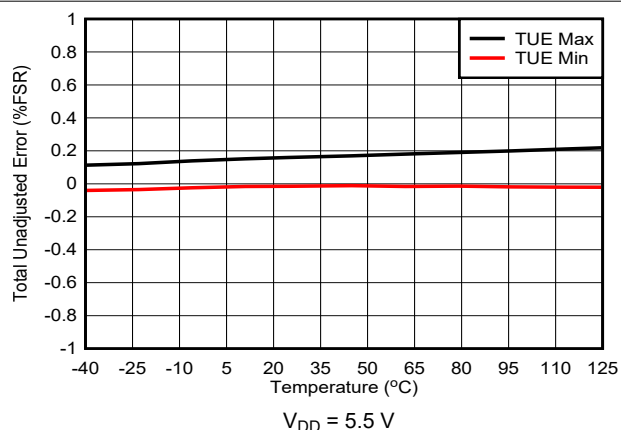
7-14. Total Unadjusted Error vs Digital Input Code



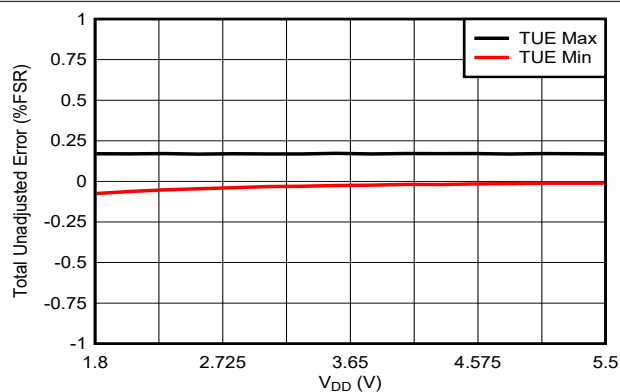
7-15. Total Unadjusted Error vs Digital Input Code



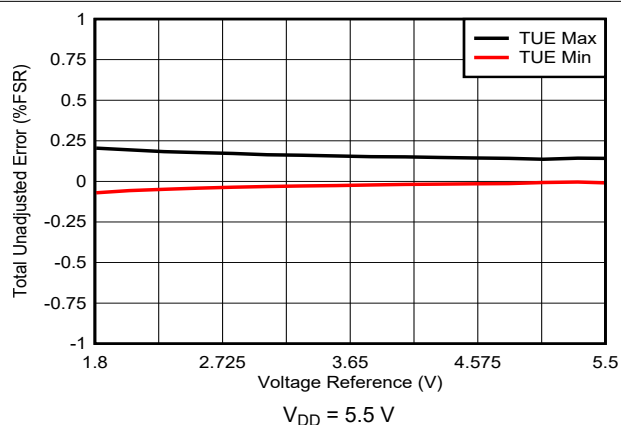
7-16. Total Unadjusted Error vs Temperature



7-17. Total Unadjusted Error vs Temperature



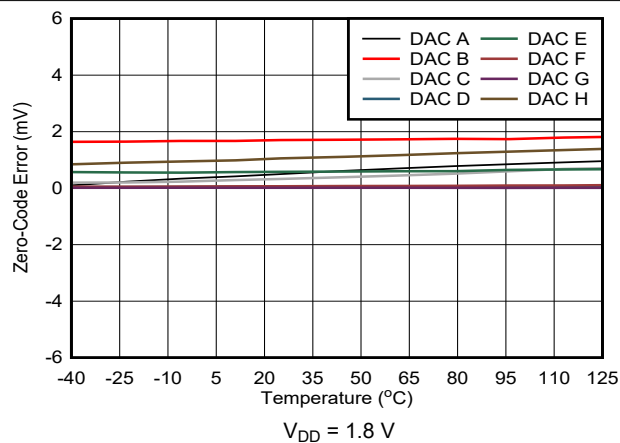
7-18. Total Unadjusted Error vs Supply Voltage



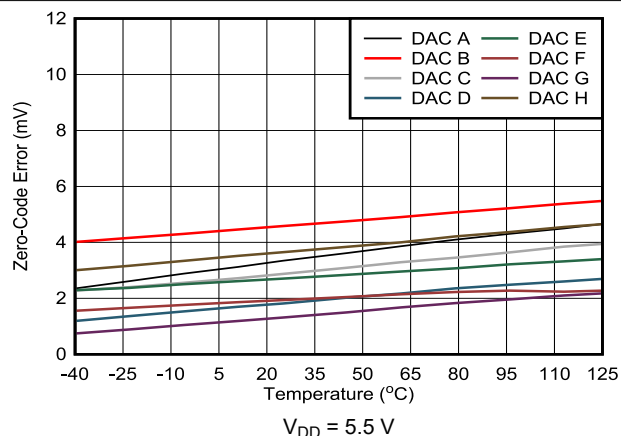
7-19. Total Unadjusted Error vs Voltage Reference

7.9 Typical Characteristics: Static Performance (continued)

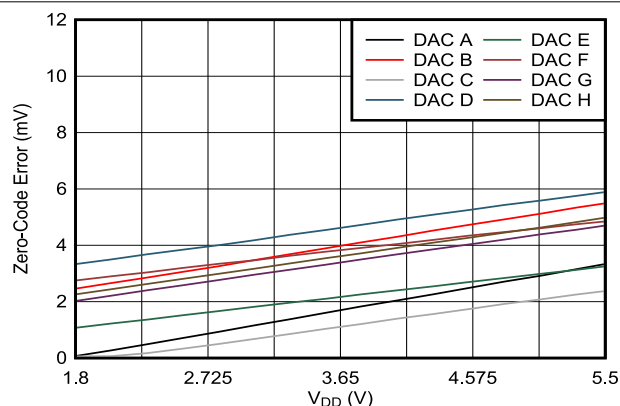
at $T_A = 25^\circ\text{C}$, reference = 1.8 V, and DAC outputs unloaded (unless otherwise noted)



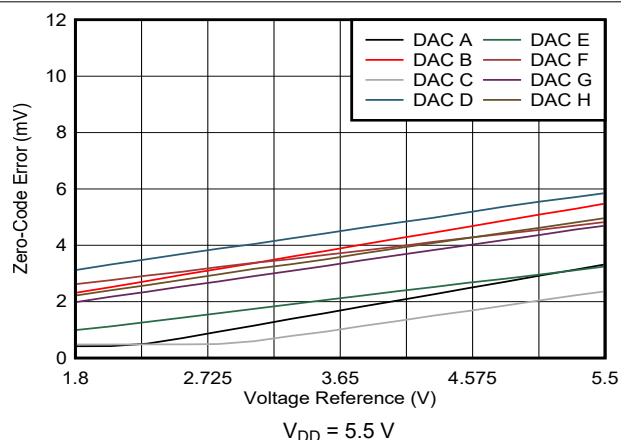
7-20. Zero-Code Error vs Temperature



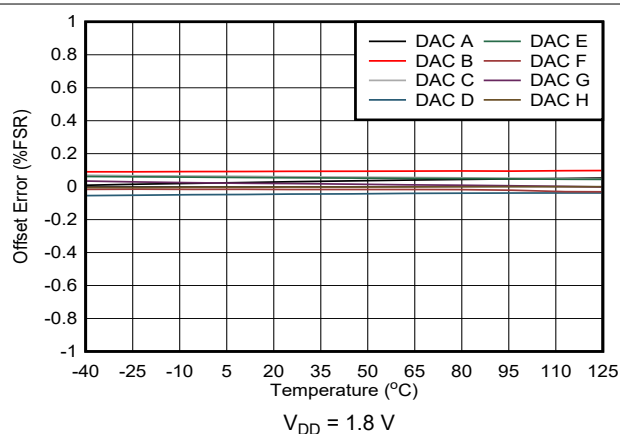
7-21. Zero-Code Error vs Temperature



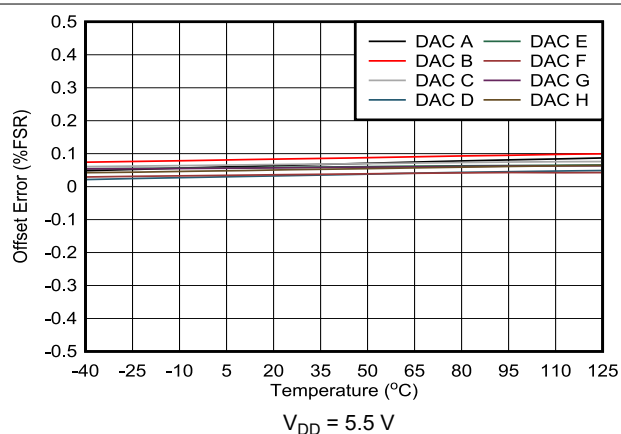
7-22. Zero-Code Error vs Supply Voltage



7-23. Zero-Code Error vs Voltage Reference



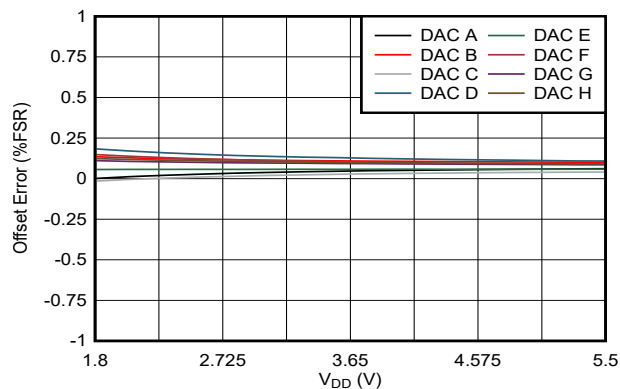
7-24. Offset Error vs Temperature



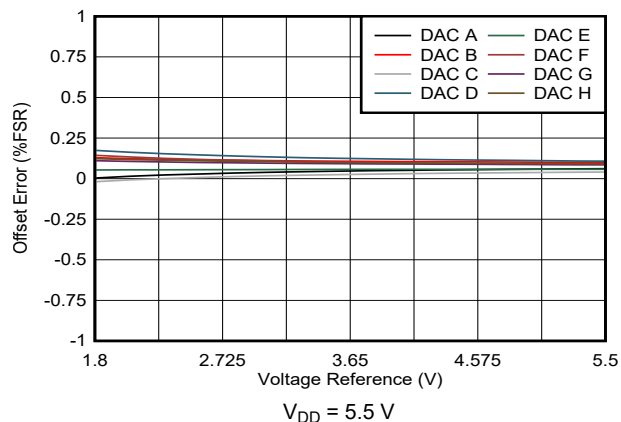
7-25. Offset Error vs Temperature

7.9 Typical Characteristics: Static Performance (continued)

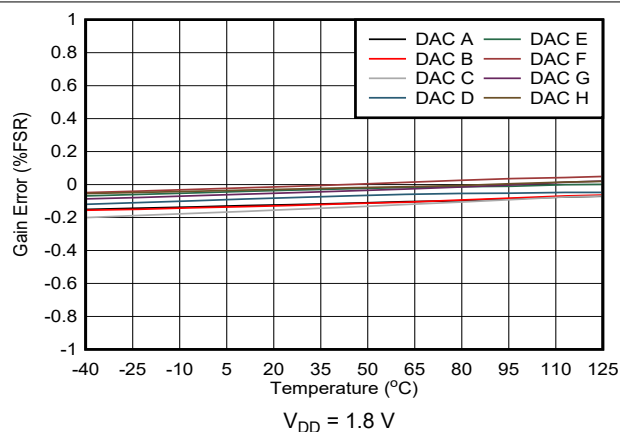
at $T_A = 25^\circ\text{C}$, reference = 1.8 V, and DAC outputs unloaded (unless otherwise noted)



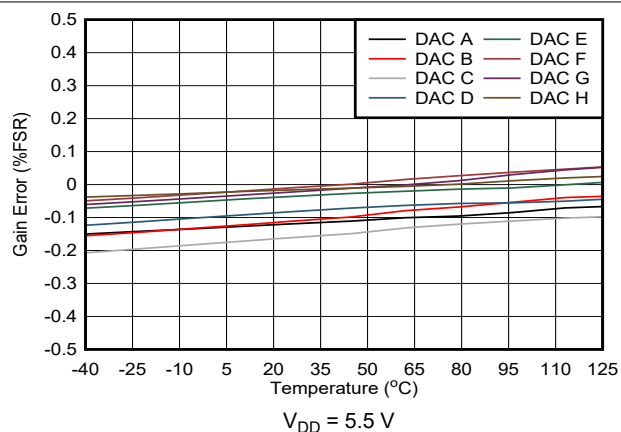
7-26. Offset Error vs Supply Voltage



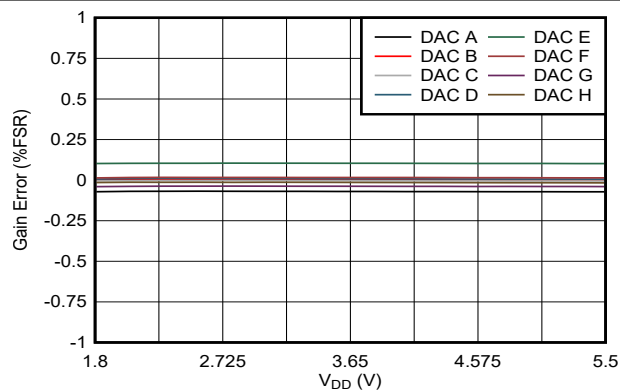
7-27. Offset Error vs Voltage Reference



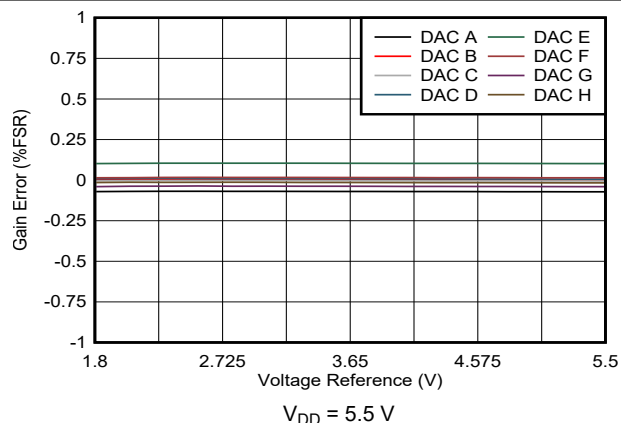
7-28. Gain Error vs Temperature



7-29. Gain Error vs Temperature



7-30. Gain Error vs Supply Voltage



7-31. Gain Error vs Voltage Reference

7.9 Typical Characteristics: Static Performance (continued)

at $T_A = 25^\circ\text{C}$, reference = 1.8 V, and DAC outputs unloaded (unless otherwise noted)

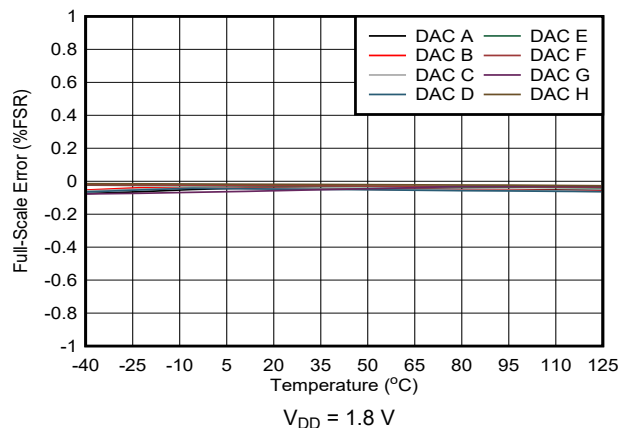


Figure 7-32. Full-Scale Error vs Temperature

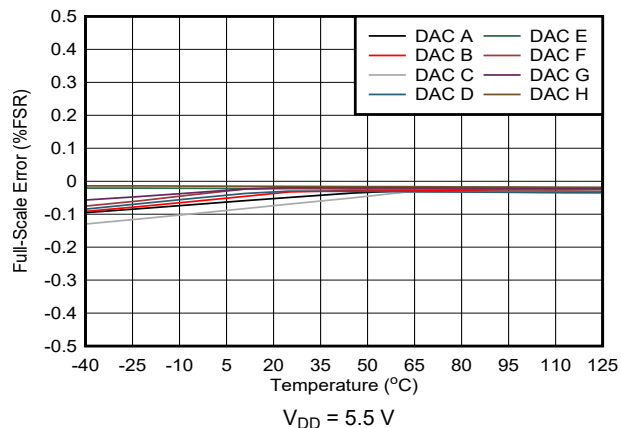


Figure 7-33. Full-Scale Error vs Temperature

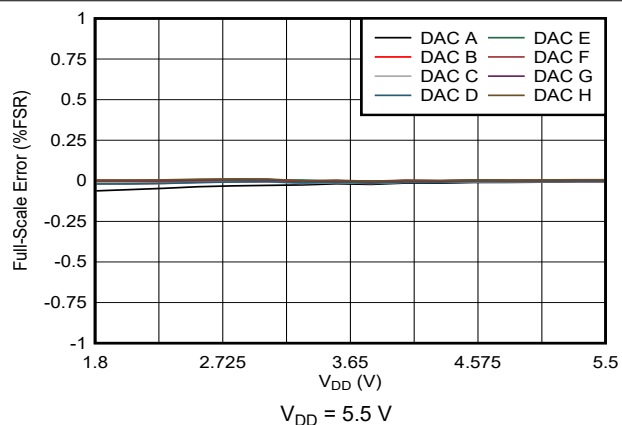


Figure 7-34. Full-Scale Error vs Supply Voltage

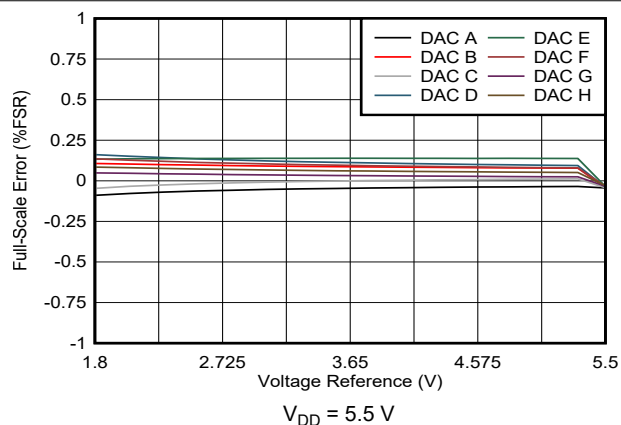
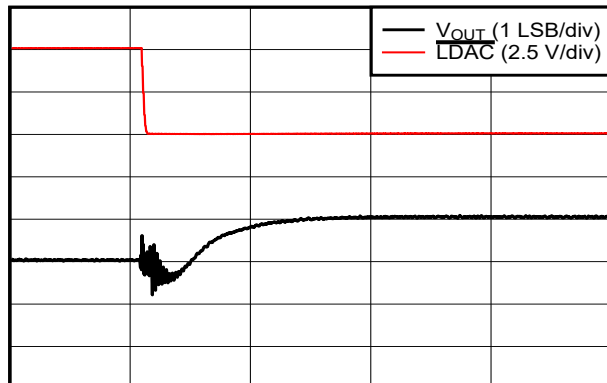


Figure 7-35. Full-Scale Error vs Voltage Reference

7.10 Typical Characteristics: Dynamic Performance

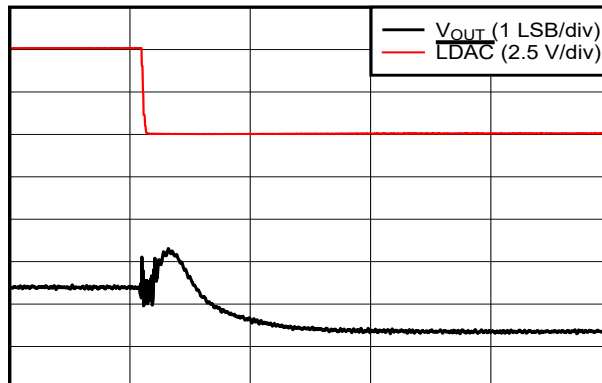
at $T_A = 25^\circ\text{C}$, $V_{DD} = 5.5\text{ V}$, reference = 5.5 V, and DAC outputs unloaded (unless otherwise noted)



Time (1 $\mu\text{s}/\text{div}$)

DAC code transition from midscale – 1 to midscale,
output load: 5 k Ω || 200 pF

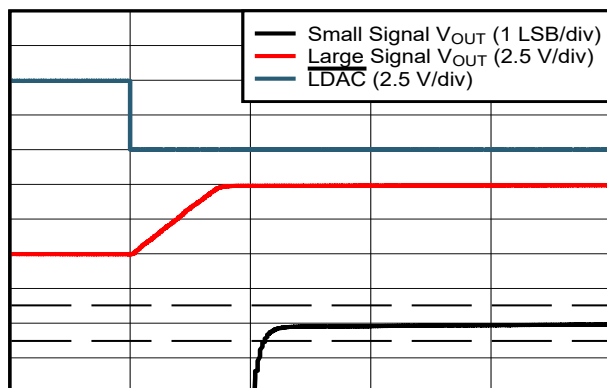
7-36. Glitch Impulse, Rising Edge, 1-LSB Step



Time (1 $\mu\text{s}/\text{div}$)

DAC code transition from midscale to midscale – 1 LSB,
output load: 5 k Ω || 200 pF

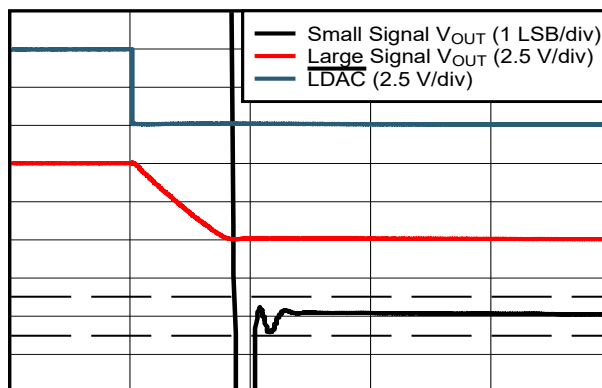
7-37. Glitch Impulse, Falling Edge, 1 LSB Step



Time (5 $\mu\text{s}/\text{div}$)

DAC code transition from 102d to 922d, typical
channel shown, output load: 5 k Ω || 200 pF

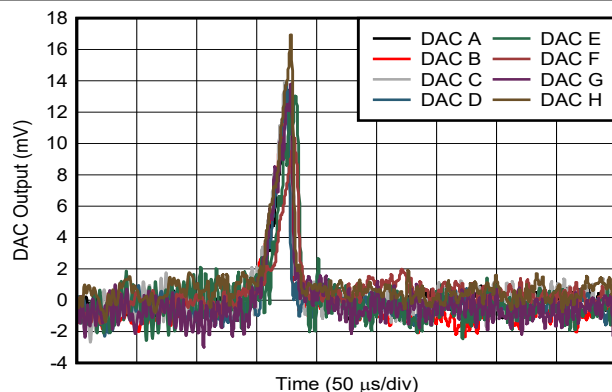
7-38. Full-Scale Settling Time, Rising Edge



Time (5 $\mu\text{s}/\text{div}$)

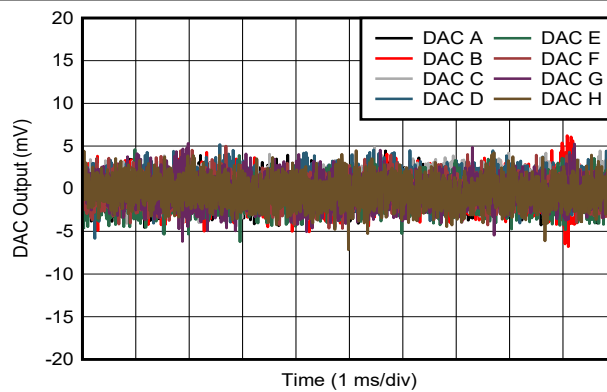
DAC code transition from 922d to 102d, typical
channel shown, output load: 5 k Ω || 200 pF

7-39. Full-Scale Settling Time, Falling Edge



Output load: 5 k Ω || 200 pF

7-40. Power-on Glitch

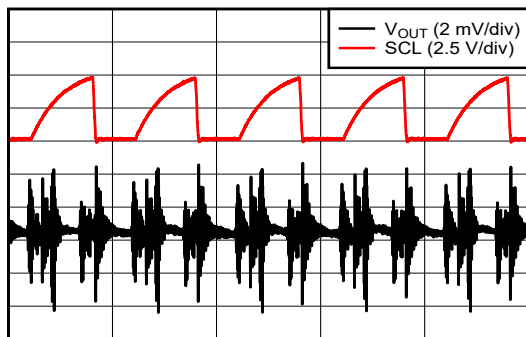


Output load: 5 k Ω || 200 pF

7-41. Power-off Glitch

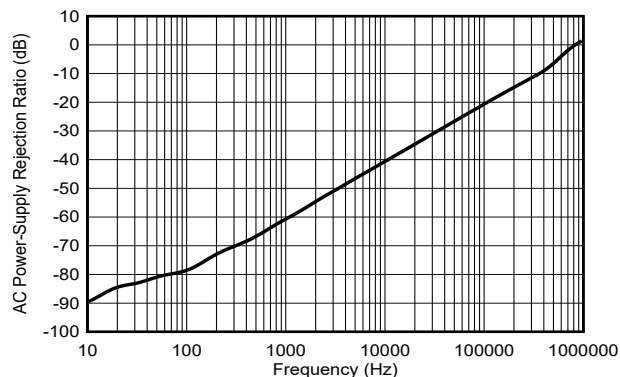
7.10 Typical Characteristics: Dynamic Performance (continued)

at $T_A = 25^\circ\text{C}$, $V_{DD} = 5.5\text{ V}$, reference = 5.5 V, and DAC outputs unloaded (unless otherwise noted)



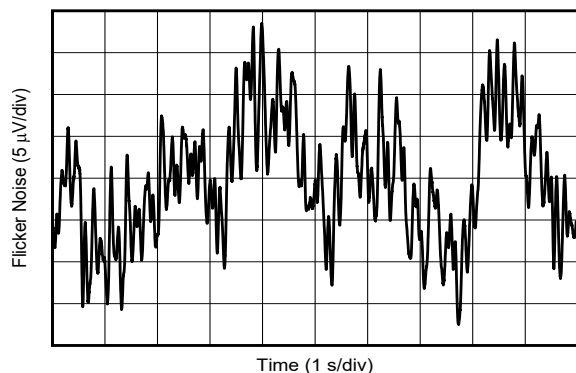
DAC at midscale, reference tied to V_{DD} ,
output load: 5 k Ω || 200 pF, SCLK = 1 MHz

7-42. Clock Feedthrough



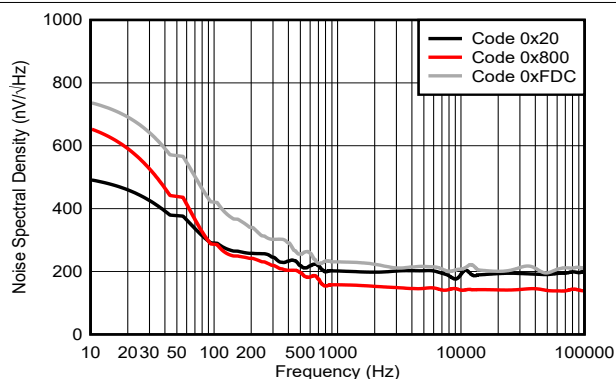
DAC at full-scale, output load: 5 k Ω || 200 pF,
 $V_{DD} = 5.25\text{ V} + 0.2\text{ V}_{PP}$, $V_{REFIN} = 4.5\text{ V}$

7-43. AC Power-Supply Rejection Ratio vs Frequency



DAC at midscale, $f = 0.1\text{ Hz}$ to 10 Hz

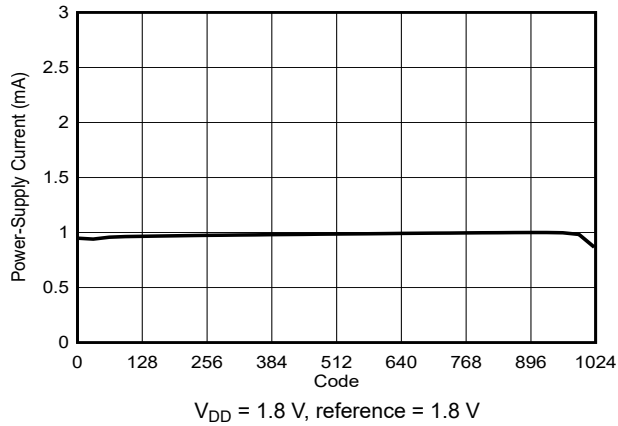
7-44. Flicker Noise



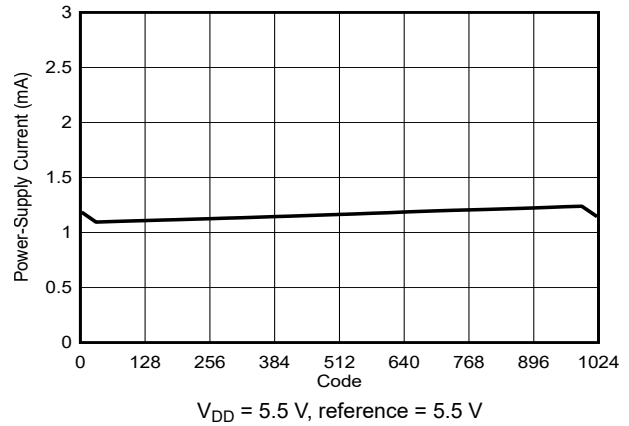
7-45. Noise Spectral Density

7.11 Typical Characteristics: General

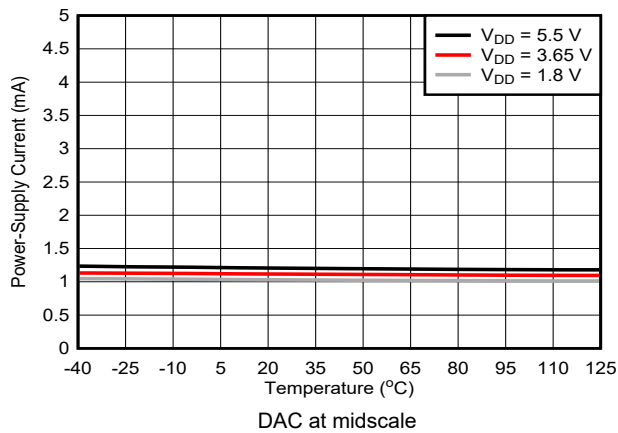
at $T_A = 25^\circ\text{C}$, and DAC outputs unloaded (unless otherwise noted)



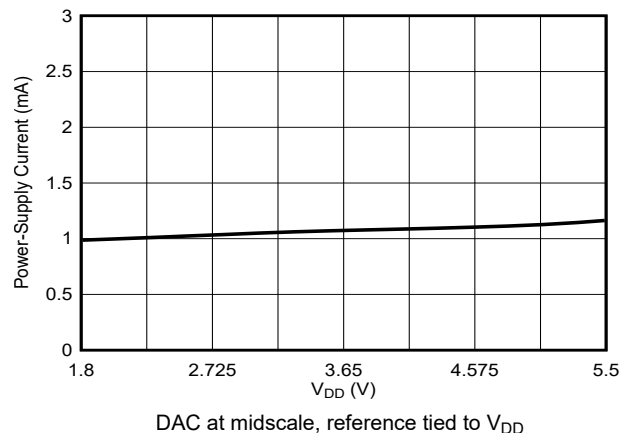
7-46. Power-Supply Current vs Digital Input Code



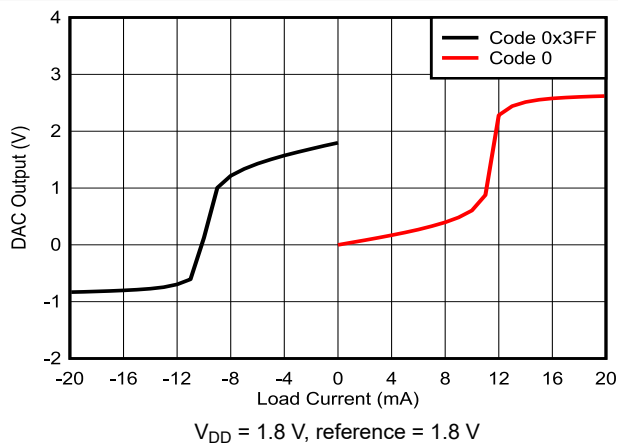
7-47. Power-Supply Current vs Digital Input Code



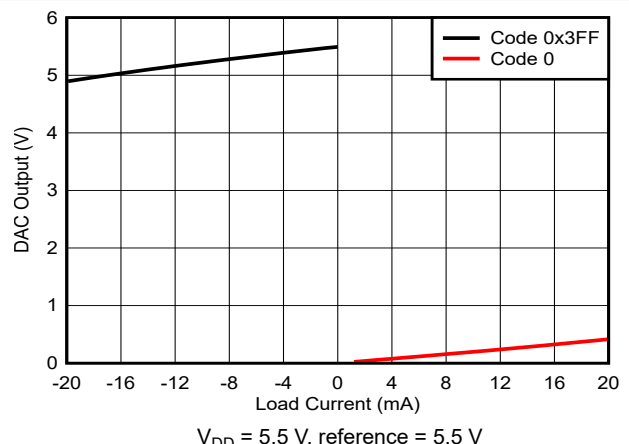
7-48. Power-Supply Current vs Temperature



7-49. Power-Supply Current vs Supply Voltage



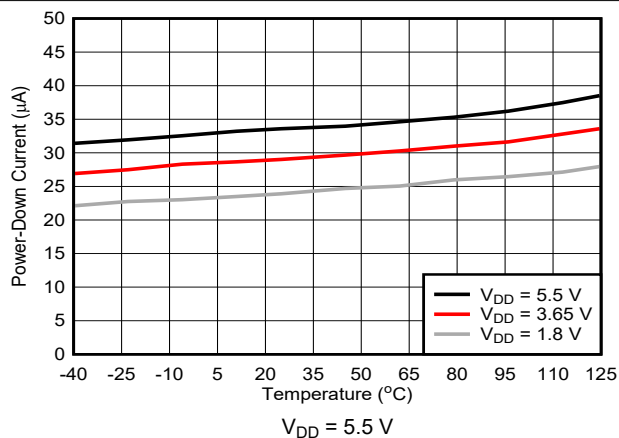
7-50. Output Source and Sink Capability



7-51. Output Source and Sink Capability

7.11 Typical Characteristics: General (continued)

at $T_A = 25^\circ\text{C}$, and DAC outputs unloaded (unless otherwise noted)



7-52. Power-Down Current vs Temperature

8 Detailed Description

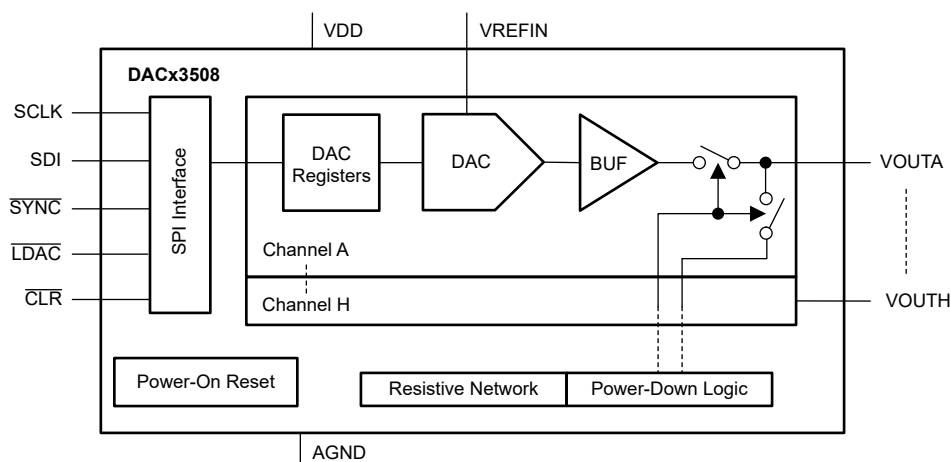
8.1 Overview

The 10-bit DAC53508 and 8-bit DAC43508 (DACx3508) are a pin-compatible family of eight-channel, buffered voltage-output digital-to-analog converters (DACs). With an external reference ranging from 1.8 V to 5.5 V, a full-scale output voltage of 1.8 V to 5.5 V is achievable. These devices are specified monotonic across the power-supply range.

Communication to the devices is established through a three-wire SPI-compatible interface. These devices do not support readback operation. These devices include a load DAC ($\overline{\text{LDAC}}$) pin for simultaneous DAC updates and a clear ($\overline{\text{CLR}}$) pin for setting the outputs to zero scale.

The DACx3508 devices are characterized for operation over the temperature range of -40°C to $+125^{\circ}\text{C}$ and are available in tiny QFN packages.

8.2 Functional Block Diagram



8.3 Feature Description

8.3.1 Digital-to-Analog Converter (DAC) Architecture

Each output channel in the DACx3508 family of devices consists of string architecture with an output buffer amplifier. Figure 8-1 shows a block diagram of the DAC architecture.

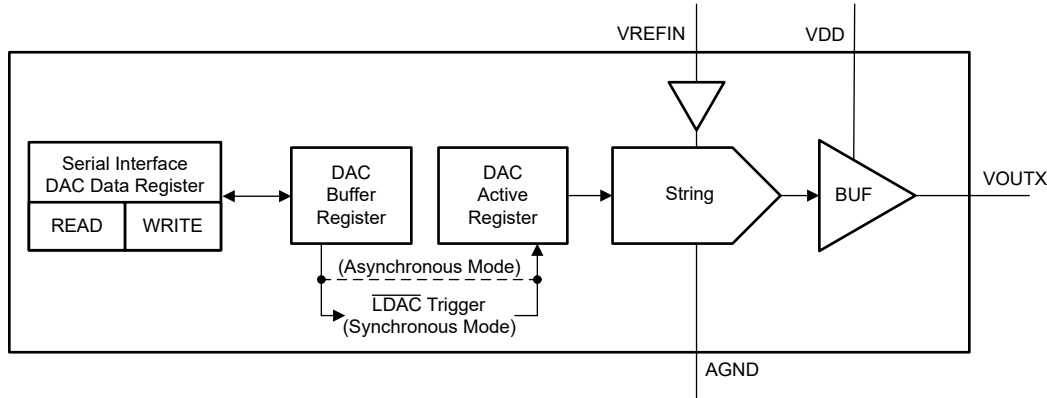


Figure 8-1. DACx3508 DAC Architecture

8.3.1.1 DAC Transfer Function

The device writes the input data to the individual DAC Data registers in straight binary format. After a power-on or a reset event, the device sets all DAC registers to zero-code. Figure 1 shows DAC transfer function.

$$V_{OUTX} = \frac{DACn_DATA}{2^N} \times V_{REFIN} \quad (1)$$

where:

- N = resolution in bits: 10 (DAC53508) or 8 (DAC43508)
- DACn_DATA is the decimal equivalent of the binary code that is loaded to the DAC register
- DACn_DATA ranges from 0 to $2^N - 1$
- V_{REFIN} is the DAC reference voltage

8.3.1.2 DAC Register Update and $\overline{LDAC}$ Functionality

The device stores the data written to the DAC Data registers in the DAC buffer registers. Transfer of data from the DAC buffer registers to the DAC active registers can be set to happen immediately (asynchronous mode) or initiated by an $\overline{LDAC}$ trigger (synchronous mode). After the DAC active registers are updated, the DAC outputs change to the new values.

The update mode for each DAC channel is determined by the status of $\overline{LDAC}$ pin.

In asynchronous mode ($\overline{LDAC}$ = low before the DAC write command), a write to the DAC data register results in an immediate update of the DAC active register and DAC output at the end of SPI frame.

In synchronous mode ($\overline{LDAC}$ = high before the DAC write command), writing to the DAC data register does not automatically update the DAC output. Instead, the update occurs only after $\overline{LDAC}$ is pulled low. The synchronous update mode enables simultaneous update of all DAC outputs.

8.3.1.3 $\overline{CLR}$ Functionality

The $\overline{CLR}$ pin is an asynchronous input pin to the DAC. When this pin is pulled low, the DAC buffers and the DAC active registers are set to zero code.

8.3.1.4 Output Amplifier

The output buffer amplifier generates rail-to-rail voltages on the output, giving a maximum output range of 0 V to V_{DD} . 式 1 shows that the full-scale output range of the DAC output is determined by the voltage on the VREFIN pin

8.3.2 Reference

The DACx3508 require an external reference to operate. However, the reference pin, VREFIN, and the supply pin, V_{DD} , can be tied together. The reference input pin voltage ranges from 1.8 V to V_{DD} . The typical input impedance of this pin when all the channels are powered on is 12.5 k Ω .

8.3.3 Power-On Reset (POR)

The DACx3508 family of devices includes a power-on reset (POR) function that controls the output voltage at power up. After the V_{DD} supply has been established, a POR event is issued. The POR causes all registers to initialize to default values, and communication with the device is valid only after a 5-ms delay, when V_{DD} reaches DAC operating range. The default value for the DAC data registers is zero-code. The DAC output remains at the power-up voltage until a valid command is written to a channel.

When the device powers up, a POR circuit sets the device to the default mode. The POR circuit requires specific V_{DD} levels, as indicated in 図 8-2, to make sure that the internal capacitors discharge and reset the device on power up. To make sure that a POR occurs, V_{DD} must be less than 0.7 V for at least 1 ms. When V_{DD} drops to less than 1.7 V but remains greater than 0.7 V (shown as the undefined region), the device may or may not reset under all specified temperature and power-supply conditions. In this case, initiate a POR. When V_{DD} remains greater than 1.7 V, a POR does not occur.

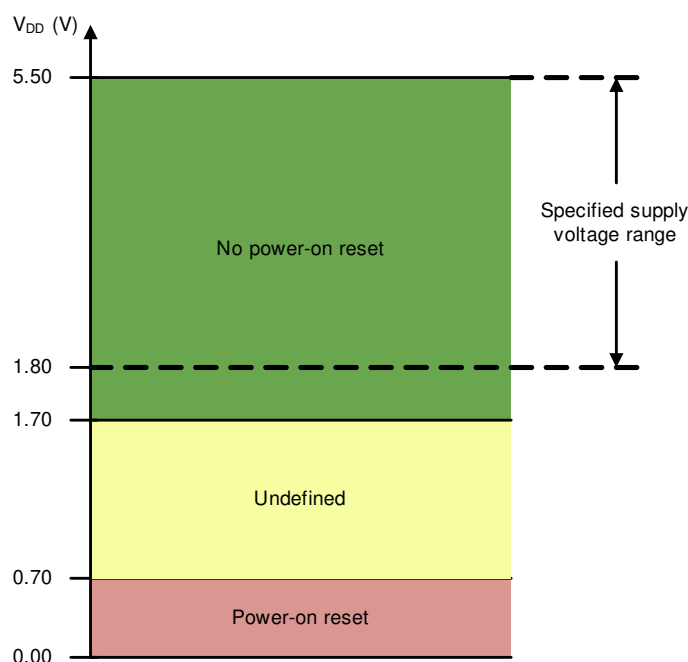


図 8-2. Threshold Levels for V_{DD} POR Circuit

8.3.4 Software Reset

A device software reset event is initiated by writing the reserved code 0x1010 to the SW_RST bit in the STATUS_TRIGGER register.

8.4 Device Functional Modes

The DACx3508 has two modes of operation: normal and power-down.

8.4.1 Power-Down Mode

The DACx3508 DAC output amplifiers can be independently or globally powered down (10 kΩ to A_{GND}) through the DEVICE_CONFIG register. In this state, the device consumes 50 μA (V_{DD} = 1.8 V). At power-up, all output channels buffer amplifiers start in power down (10 kΩ-AGND) mode until a power up command is issued by writing 0 to the per-channel power-down register bits.

8.5 Programming

8.5.1 Serial Peripheral Interface (SPI)

The DACx3508 supports a three-wire SPI interface with write-only functionality. An SPI write cycle for DACx3508 is initiated by asserting the $\overline{\text{SYNC}}$ pin low. The serial clock, SCLK, can be a continuous or gated clock. SDI data are clocked on SCLK falling edges. The SPI frame for DACx3508 is 24 bits long; therefore, the $\overline{\text{SYNC}}$ pin must stay low for at least 24 SCLK falling edges. The write cycle ends when the $\overline{\text{SYNC}}$ pin is deasserted high. If the write cycle contains less than the minimum clock edges, the communication is ignored. If the write cycle contains more than the minimum clock edges, only the first 24 bits are used by the device.

表 8-1 describes the format for the 24-bit SPI write access cycle. The first byte input to SDI is the instruction cycle. The instruction cycle identifies the request as the 8-bit address to be written. The last 16 bits in the cycle form the data cycle.

表 8-1. SPI Write Access Cycle

BIT	FIELD	DESCRIPTION
23-16	A[7:0]	Register address: specifies the register to be accessed during the write operation.
15-0	DI[15:0]	Data cycle bits: The data cycle bits are the values written to the register with address A[7:0].

8.6 Register Map

表 8-2. Register Map

REGISTER NAME	COMMAND BITS	DATA BITS													
		MSDB					LSDB								
	B23-B16	B15-B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	
DEVICE_CONFIG (セクション 8.6.1)	01h	X	RESERVED			PDN-AII	PDNH	PDNG	PDNF	PDNE	PDND	PDNC	PDNB	PDNA	
STATUS_TRIGGER (セクション 8.6.2)	02h	X	X								SW_RST				
BRDCAST (セクション 8.6.3)	03h	X	BRDCAST_DATA[9:0] / BRDCAST_DATA[7:0]										X		
DACA_DATA (セクション 8.6.4)	08h	X	DACA_DATA[9:0] / DACA_DATA[7:0]										X		
DACB_DATA (セクション 8.6.4)	09h	X	DACB_DATA[9:0] / DACB_DATA[7:0]										X		
DACC_DATA (セクション 8.6.4)	0Ah	X	DACC_DATA[9:0] / DACC_DATA[7:0]										X		
DACD_DATA (セクション 8.6.4)	0Bh	X	DACD_DATA[9:0] / DACD_DATA[7:0]										X		
DACE_DATA (セクション 8.6.4)	0Ch	X	DACE_DATA[9:0] / DACE_DATA[7:0]										X		
DACF_DATA (セクション 8.6.4)	0Dh	X	DACF_DATA[9:0] / DACF_DATA[7:0]										X		
DACG_DATA (セクション 8.6.4)	0Eh	X	DACG_DATA[9:0] / DACG_DATA[7:0]										X		
DACH_DATA (セクション 8.6.4)	0Fh	X	DACH_DATA[9:0] / DACH_DATA[7:0]										X		

表 8-3. Register Section/Block Access Type Codes

Access Type	Code	Description
W	W	Write only
W	X	Don't care
-n		Value after reset or the default value

8.6.1 DEVICE_CONFIG Register (address = 01h) [reset = 00FFh]

図 8-3. DEVICE_CONFIG Register

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
X				RESERVED			PDN-All	PDNH	PDNG	PDNF	PDNE	PDND	PDNC	PDNB	PDNA
W-0h				W-0h			W-0b			W-FFh					

表 8-4. DEVICE_CONFIG Register Field Descriptions

BIT	FIELD	TYPE	RESET	DESCRIPTION
15-12	X	W	0h	Don't care
11-9	RESERVED	W	00	Reserved
8	PDN-All	W	0	Global power down bit: 0: Normal operation 1: All DAC channels and internal biasing blocks are powered down.
7-0	PDNx	W	FFh	Channel-specific power down bits: 0: DACx powered up 1: DACx powered down with 10 kΩ pulldown resistor to A _{GND} .

8.6.2 STATUS_TRIGGER Register (address = 02h) [reset = 0000h]

図 8-4. STATUS_TRIGGER Register

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
X												SW_RST			
W-000h												W-0h			

表 8-5. STATUS_TRIGGER Register Field Descriptions

BIT	FIELD	TYPE	RESET	DESCRIPTION
15-4	X	W	000h	Don't care
3-0	SW_RST	W	0h	Device resets to default value when this bit field is set to 1010. Other values do not have any impact.

8.6.3 BRDCAST Register (address = 03h) [reset = 0000h]

図 8-5. BRDCAST Register

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
X				BRDCAST_DATA[9:0] / BRDCAST_DATA[7:0]										X	
W-0h				W-000h										W-00b	

表 8-6. BRDCAST Register Field Descriptions

BIT	FIELD	TYPE	RESET	DESCRIPTION
15-12	X	W	0h	Don't care
11-2	BRDCAST_DATA[9:0] / BRDCAST_DATA[7:0]	W	000h	Writing to the BRDCAST register forces the DAC channel to update the active register data to BRDCAST_DATA. Data are MSB-aligned in straight-binary format and follow the format below: DAC53508: { DATA[9:0] } DAC43508: { DATA[7:0], x, x } x – Don't care bits
1-0	X	W	00	Don't care

8.6.4 DACn_DATA Register (address = 08h to 0Fh) [reset = 0000h]

図 8-6. DACn_DATA Register

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
X				DACn_DATA[9:0] / DACn_DATA[7:0]										X	
W-0h				W-000h										W-00b	

表 8-7. DACn_DATA Register Field Descriptions

BIT	FIELD	TYPE	RESET	DESCRIPTION
15-12	X	W	0h	Don't care
11-2	DACn_DATA[9:0] / DACn_DATA[7:0]	W	000h	Writing to the DACn_DATA register forces the respective DAC channel to update the active register data to the DACn_DATA. Data are MSB-aligned in straight-binary format and follow the format below: DAC53508: { DATA[9:0] } DAC43508: { DATA[7:0], x, x } x – Don't care bits
1-0	X	W	00	Don't care

9 Application and Implementation

注

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

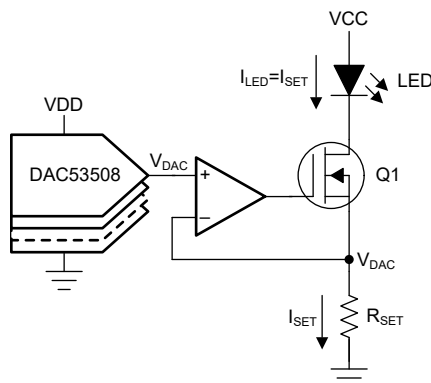
9.1 Application Information

The DACx3508 is a buffered output, eight-channel, low-power DAC available in a tiny 3-mm x 3-mm package. The multichannel, low power, and small package makes this DAC an excellent choice for general-purpose applications in wide range of end equipment. Some of the most-common applications for these devices are LED biasing-in multifunction printers, power-supply supervision with programmable comparators, offset and gain trimming in precision circuits, and power-supply margining.

9.2 Typical Applications

9.2.1 Programmable LED Biasing

End equipments such as multifunction printers, projectors and electronic point-of-sale (EPOS) require a steady luminous intensity from the LED.  9-1 shows a simplified circuit diagram for biasing an LED using the DAC53508.



 9-1. Programmable LED Biasing

9.2.1.1 Design Requirements

- Programmable constant current through an LED tied to a power supply on one end
- DAC output range: 0 V to 5 V
- LED current range: 0 mA to 20 mA

9.2.1.2 Detailed Design Procedure

The DAC is used to set the source current of a MOSFET using a unity-gain buffer, as shown in [Figure 9-1](#). Connect the LED between the power supply and the drain of the MOSFET. This configuration allows the DAC to control or set the amount of current through the LED. The buffer following the DAC controls the gate-source voltage of the MOSFET inside the feedback loop, thus compensating this drop and corresponding drift due to temperature, current, and ageing of the MOSFET. The current set by the DAC that flows through the LED is calculated with [Equation 2](#). To generate 0 mA to 20 mA from a 0 V to 5 V DAC output range, a 250-Ω R_{SET} is required.

$$I_{SET} = \frac{V_{DAC}}{R_{SET}} \quad (2)$$

The following pseudocode is provided to help get started with the LED biasing application:

```
//SYNTAX: WRITE <REGISTER NAME(Hex Code)>, <DATA>
//Power-up the device and channels
WRITE DEVICE_CONFIG(0x01), 0x0000
//Program mid code (or the desired voltage) on all channels
WRITE DACA_DATA(0x08), 0x07FC //10-bit MSB aligned
WRITE DACB_DATA(0x09), 0x07FC //10-bit MSB aligned
WRITE DACC_DATA(0x0A), 0x07FC //10-bit MSB aligned
WRITE DACD_DATA(0x0B), 0x07FC //10-bit MSB aligned
WRITE DACE_DATA(0x0C), 0x07FC //10-bit MSB aligned
WRITE DACF_DATA(0x0D), 0x07FC //10-bit MSB aligned
WRITE DACG_DATA(0x0E), 0x07FC //10-bit MSB aligned
WRITE DACH_DATA(0x0F), 0x07FC //10-bit MSB aligned
```

9.2.1.3 Application Curve

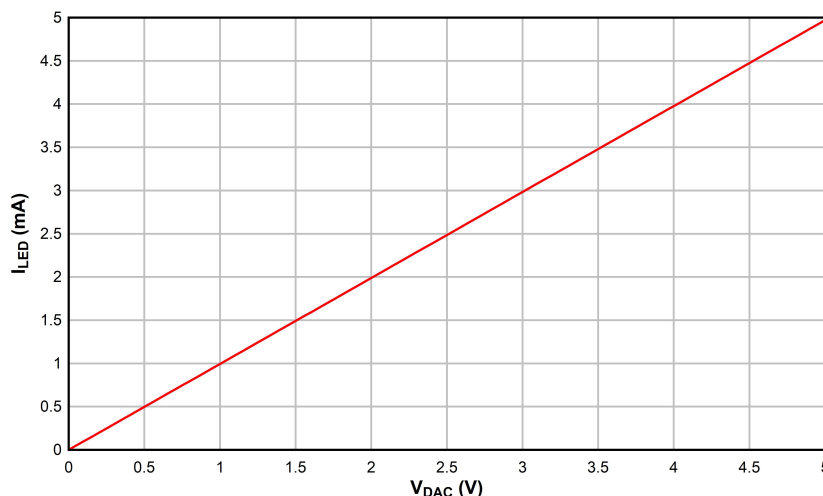


Figure 9-2. DC Transfer Characteristics of LED Biasing Circuit

9.2.2 Programmable Window Comparator

End equipment that use a centralized power supply (such as network servers, optical modules, and others) require the monitoring of power buses to protect the components. This monitoring or supervision is accomplished using a window comparator. A window comparator monitors a signal input for upper- and lower-threshold violations. A trigger signal is generated when the threshold violations occur. Multichannel monitoring is required to supervise all power supplies available in a module. The DACx3508 provides an easy-to-use, low-footprint method to address this requirement. [Figure 9-3](#) shows how the DAC53508 is used to create a programmable window comparator.

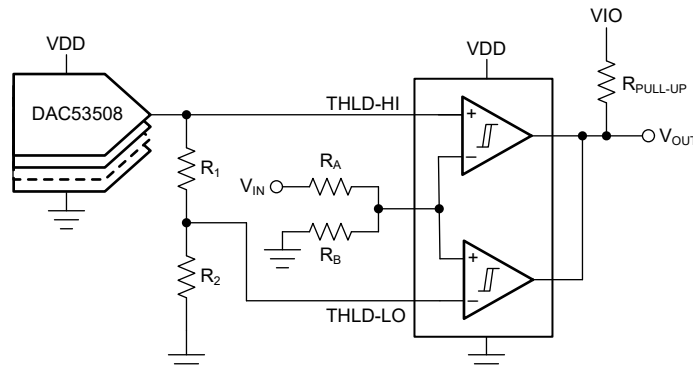


Figure 9-3. Programmable Window Comparator

9.2.2.1 Design Requirements

- Voltage to be monitored: 5 V
- High threshold: 5 V + 10%
- Low threshold: 5 V – 10%
- Trigger output: 3.3-V open-drain single output

9.2.2.2 Detailed Design Procedure

[Figure 9-3](#) provides an example in which single DAC channel is used to compare both high and low thresholds. A dual comparator is used per DAC channel, as shown. A voltage divider formed by resistors R_A and R_B are used in order to bring the signal level within the DAC range. Another pair of resistors, R_1 and R_2 , are used to settle the low threshold as a factor of the high threshold. This configuration allows the use of a single DAC channel to monitor both the high- and low-threshold levels. Use open-drain comparators to provide the following advantages.

- Generate a logic output level appropriate for the monitoring processor
- Allow shorting of the two outputs to generate a single trigger

In the circuit depicted in [Figure 9-3](#), the output of the circuit remains high as long as the signal input remains within the high- and low-threshold levels. Upon violation of any one threshold, the output goes low. [Equation 3](#) provides the derivation of the low threshold voltage from the high threshold set by the DAC.

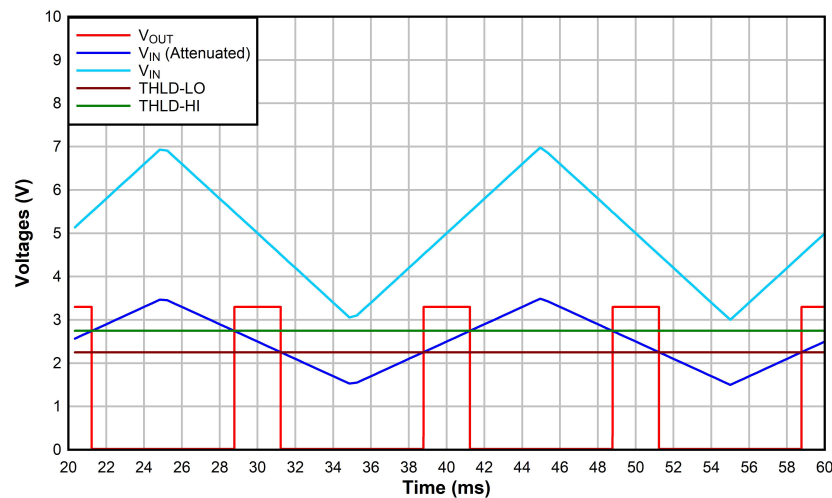
$$V_{\text{THLD-LO}} = V_{\text{DAC}} \times \left(\frac{R_2}{R_1 + R_2} \right) \quad (3)$$

To monitor a power supply of 5 V within $\pm 10\%$, place the nominal value at the DAC midcode. The output range of the DACx3508 is 0 V to 5 V, thus the midcode voltage output is 2.5 V. Therefore, R_A and R_B are chosen so that the voltage to be compared is 2.5 V. For this example, R_A equals R_B ; use 10-k Ω resistors for both. One channel of the DACx3508 must be programmed to $V_{THLD-HI}$ (for example, 2.5 V + 5% = 2.625 V). This result corresponds to a 10-bit DAC code of $(2^{10} / 5 \text{ V}) \times 2.625 \text{ V} = 537.6$ (0x21Ah). To generate $V_{THLD-LO}$ (for example, 2.5 V – 5% = 2.405 V) from 2.625 V, the values of R_1 and R_2 are calculated as 7.5 k Ω and 82 k Ω , respectively, using 式 3.

The following pseudocode is provided to help get started with the programmable window comparator application at the desired DAC value.

```
//SYNTAX: WRITE <REGISTER NAME(Hex Code)>, <DATA>
//Power-up the device and channels
WRITE_DEVICE_CONFIG(0x01), 0x0000
//Program 2.625V on channel A
WRITE_DACA_DATA(0x08), 0x0868 //10-bit MSB aligned
```

9.2.2.3 Application Curve



9-4. Programmable Comparator Output Waveform

10 Power Supply Recommendations

The DACx3508 family of devices does not require specific supply sequencing. These devices require a single power supply, V_{DD} . A 0.1- μF decoupling capacitor is recommended for the V_{DD} pin.

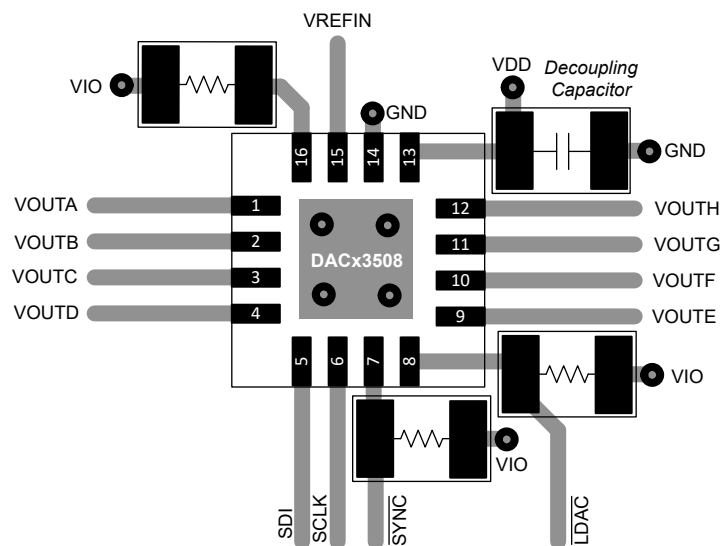
11 Layout

11.1 Layout Guidelines

The DACx3508 pinout separates the analog, digital, and power pins for an optimized layout. For signal integrity, separate digital and analog traces and place decoupling capacitors close to the device pins.

11.2 Layout Example

✕ 11-1 shows an example layout drawing with decoupling capacitors and pullup resistors.



✕ 11-1. Layout Example

12 Device and Documentation Support

12.1 Documentation Support

12.1.1 Related Documentation

For related documentation see the following: Texas Instruments, [DAC53608EVM user's guide](#)

12.2 ドキュメントの更新通知を受け取る方法

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

12.3 サポート・リソース

[TI E2E™ サポート・フォーラム](#)は、エンジニアが検証済みの回答と設計に関するヒントをエキスパートから迅速かつ直接得ることができる場所です。既存の回答を検索したり、独自の質問をしたりすることで、設計に必要な支援を迅速に得ることができます。

リンクされているコンテンツは、該当する貢献者により、現状のまま提供されるものです。これらは TI の仕様を構成するものではなく、必ずしも TI の見解を反映したものではありません。TI の[使用条件](#)を参照してください。

12.4 Trademarks

TI E2E™ is a trademark of Texas Instruments.

すべての商標は、それぞれの所有者に帰属します。

12.5 静電気放電に関する注意事項



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

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

12.6 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。

13 Mechanical, Packaging, and Orderable Information

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

PACKAGING INFORMATION

Orderable 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
DAC43508RTER	ACTIVE	WQFN	RTE	16	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	D43508	Samples
DAC53508RTER	ACTIVE	WQFN	RTE	16	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	D53508	Samples
DAC53508RTET	ACTIVE	WQFN	RTE	16	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	D53508	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.

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.

GENERIC PACKAGE VIEW

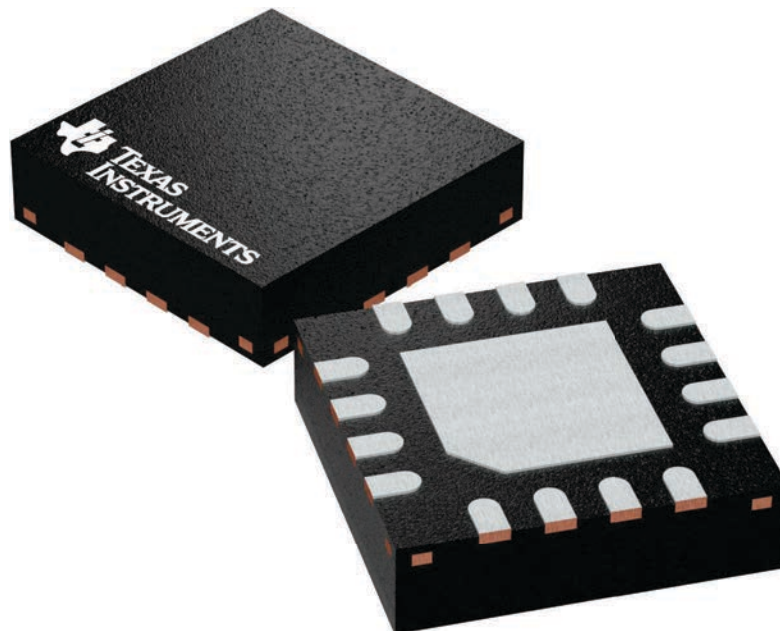
RTE 16

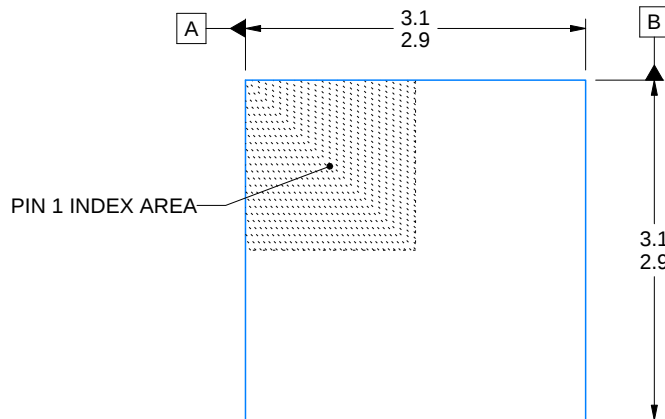
WQFN - 0.8 mm max height

3 x 3, 0.5 mm pitch

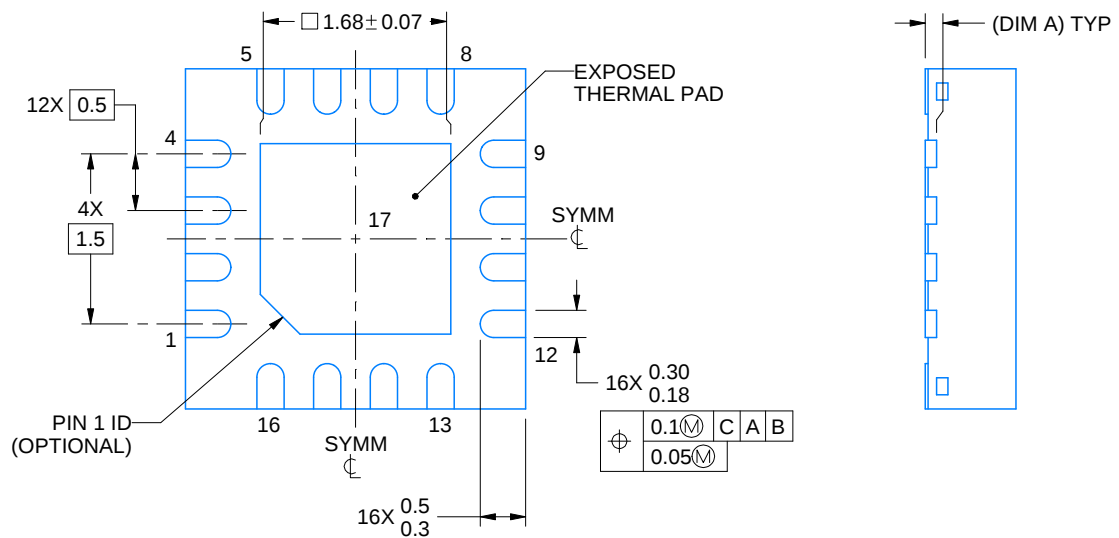
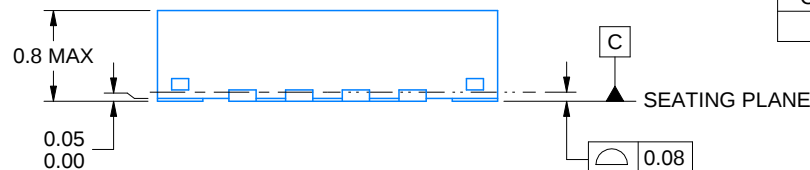
PLASTIC QUAD FLATPACK - NO LEAD

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





SIDE WALL METAL THICKNESS DIM A	
OPTION 1	OPTION 2
0.1	0.2



4219117/B 04/2022

NOTES:

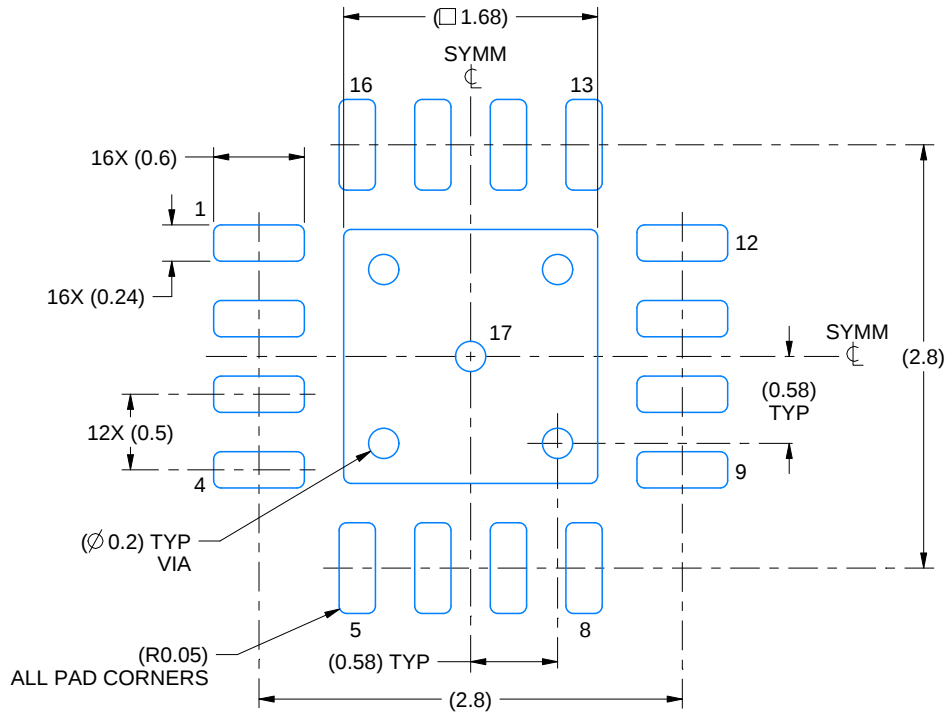
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

EXAMPLE BOARD LAYOUT

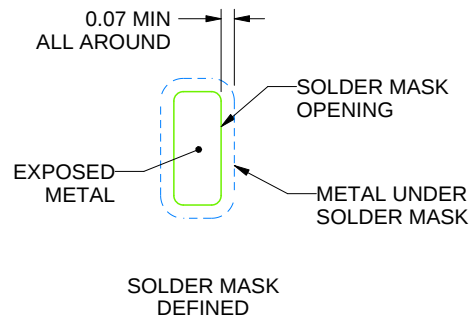
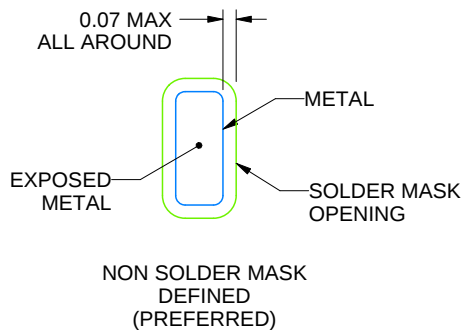
RTE0016C

WQFN - 0.8 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:20X



SOLDER MASK DETAILS

4219117/B 04/2022

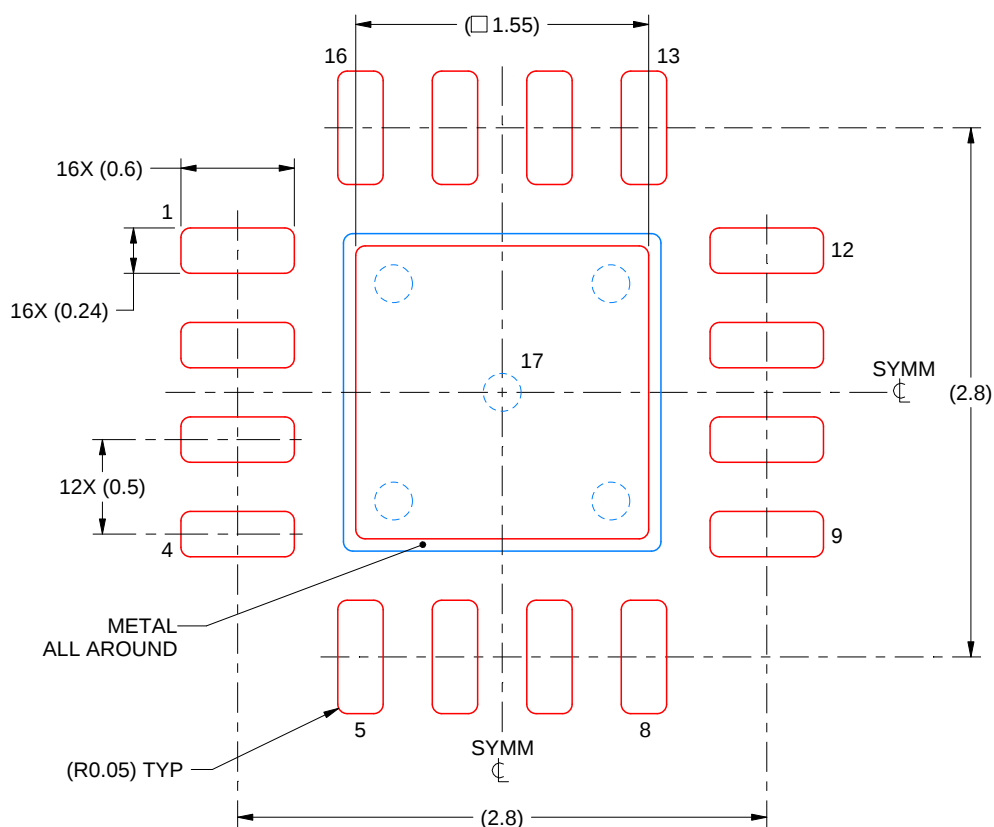
NOTES: (continued)

- This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/sluea271).
- Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

RTE0016C

WQFN - 0.8 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD 17:
85% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE
SCALE:25X

4219117/B 04/2022

NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

重要なお知らせと免責事項

TI は、技術データと信頼性データ (データシートを含みます)、設計リソース (リファレンス・デザインを含みます)、アプリケーションや設計に関する各種アドバイス、Web ツール、安全性情報、その他のリソースを、欠陥が存在する可能性のある「現状のまま」提供しており、商品性および特定目的に対する適合性の黙示保証、第三者の知的財産権の非侵害保証を含むいかなる保証も、明示的または黙示的にかかわらず拒否します。

これらのリソースは、TI 製品を使用する設計の経験を積んだ開発者への提供を意図したものです。(1) お客様のアプリケーションに適した TI 製品の選定、(2) お客様のアプリケーションの設計、検証、試験、(3) お客様のアプリケーションに該当する各種規格や、その他のあらゆる安全性、セキュリティ、規制、または他の要件への確実な適合に関する責任を、お客様のみが単独で負うものとしします。

上記の各種リソースは、予告なく変更される可能性があります。これらのリソースは、リソースで説明されている TI 製品を使用するアプリケーションの開発の目的でのみ、TI はその使用をお客様に許諾します。これらのリソースに関して、他の目的で複製することや掲載することは禁止されています。TI や第三者の知的財産権のライセンスが付与されている訳ではありません。お客様は、これらのリソースを自身で使用した結果発生するあらゆる申し立て、損害、費用、損失、責任について、TI およびその代理人を完全に補償するものとし、TI は一切の責任を拒否します。

TI の製品は、[TI の販売条件](#)、または [ti.com](#) やかかる TI 製品の関連資料などのいずれかを通じて提供する適用可能な条項の下で提供されています。TI がこれらのリソースを提供することは、適用される TI の保証または他の保証の放棄の拡大や変更を意味するものではありません。

お客様がいかなる追加条項または代替条項を提案した場合でも、TI はそれらに異議を唱え、拒否します。

郵送先住所 : Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2023, Texas Instruments Incorporated