ADC14155QML-SP 耐辐射、14 位、155MSPS、1.1GHz 带宽模数转换器

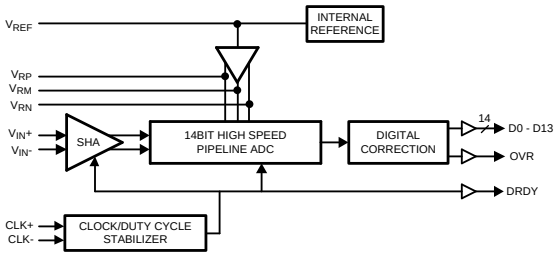
1 特性

- 5962R0626201VXC
  - 总电离剂量 (TID) 为 100krad(Si)
  - 单粒子闩锁为 120MeV-cm^2/mg（请参阅辐射报告）
- 1.1GHz 全功率带宽
- 内部采样保持电路
- 低功耗
- 内部精密 1V 基准
- 单端或差分时钟模式
- 数据就绪输出时钟
- 时钟占空比稳定器
- 由 3.3V 和 1.8V 双电源供电 (±10%)
- 断电模式
- 偏移二进制或二进制补码输出数据格式
- 48 引脚 CFP 封装（11.5mm × 11.5mm，0.635mm 引脚间距）
- 主要规格
  - 分辨率：14 位
  - 转换速率：155MSPS
  - SNR (f_{IN} = 70MHz) 70.1dBFS（典型值）
  - SFDR (f_{IN} = 70MHz) 82.3dBFS（典型值）
  - ENOB (f_{IN} = 70MHz) 11.3 位（典型值）
  - 全功率带宽：1.1GHz（典型值）
  - 功耗：967mW（典型值）

2 应用

- 高中频 (IF) 采样接收器
- 功率放大器线性化
- 多载波、多模式接收器
- 测试和测量设备
- 通信仪器仪表
- 雷达系统

框图



3 说明

ADC14155QML-SP 是一款高性能 CMOS 模数转换器，能够以高达 155MSPS 的速率将模拟输入信号转换为 14 位数字字。该转换器使用具有数字纠错功能的差分流水线架构和片上采样保持电路，以最大程度地降低功耗并减少外部组件数，同时提供出色的动态性能。独特的采样保持级能够产生 1.1GHz 的全功率带宽。ADC14155 由 3.3V 和 1.8V 双电源供电，以 155MSPS 的速率消耗 967mW 的功率。

用于数字输出接口的 1.8V 独立电源能够实现更低的功耗和更低的噪声。断电功能可以在禁用时钟输入的情况下将功耗降至 5mW，同时仍能快速唤醒至全功能运行。差分输入可提供等于基准电压 2 倍的满标量程差分输入摆幅。提供了稳定的 1V 内部电压基准，也可以通过外部基准运行 ADC14155。可通过引脚选择时钟模式（差分与单端）和输出数据格式（偏移二进制与二进制补码）。占空比稳定器可在各种时钟占空比上维持性能。

ADC14155QML-SP 采用 48 引线热增强型多层陶瓷四方封装，可以在 –55°C 至 +125°C 的军用温度范围内运行。

器件信息(1)

器件型号	等级	封装
5962R0626201VXC	QMLV RHA（SMD 器件）[100krad]	CQFP (48)
ADC14155W-MLS	飞行 RHA（非 SMD 器件）[100krad]	CQFP (48)
ADC14155W-MPR	工程样片(2)	CQFP (48)
ADC14155LCVAL	低频陶瓷评估板	—
ADC14155HCVAL	高频陶瓷评估板	—

(1) 如需了解所有可用封装，请参阅数据表末尾的可订购产品附录。

(2) 这些部件仅适用于工程评估。部件按照不合规的流程进行加工处理。这些部件不适用于质检、生产、辐射测试或飞行。这些零部件无法在 –55°C 至 125°C 的完整 MIL 额定温度范围内或运行寿命中保证其性能。

本文档旨在为方便起见，提供有关 TI 产品中文版本的信息，以确认产品的概要。 有关适用的官方英文版本的最新信息，请访问 www.ti.com，其内容始终优先。 TI 不保证翻译的准确性和有效性。 在实际设计之前，请务必参考最新版本的英文版本。

目录

1 特性 ... 1
2 应用 ... 1
3 说明 ... 1
4 修订历史记录 ... 2
5 **Pin Configuration and Functions** ... 3
6 **Specifications** ... 6
6.1 Absolute Maximum Ratings ... 6
6.2 ESD Ratings ... 6
6.3 Recommended Operating Conditions ... 6
6.4 Thermal Information ... 6
6.5 ADC14155 Converter Electrical Characteristics DC Parameters ... 7
6.6 ADC14155 Converter Electrical Characteristics (Continued) DYNAMIC Parameters(1) ... 8
6.7 ADC14155 Converter Electrical Characteristics (Continued) Logic and Power Supply Electrical Characteristics(1) ... 10
6.8 ADC14155 Converter Electrical Characteristics (Continued) Timing and AC Characteristics(1) ... 11
6.9 Timing Diagram ... 12
6.10 Transfer Characteristic ... 12
6.11 Typical Performance Characteristics, DNL, INL ... 14
6.12 Typical Performance Characteristics, Dynamic Performance ... 15
7 **Detailed Description** ... 18
7.1 Overview ... 18
7.2 Functional Block Diagram ... 18
7.3 Feature Description ... 18
7.4 Device Functional Modes ... 22
8 **Application and Implementation** ... 23
8.1 Application Information ... 23
8.2 Typical Application ... 24
8.3 Radiation Environments ... 25
9 **Power Supply Recommendations** ... 26
10 **Layout** ... 27
10.1 Layout Guidelines ... 27
10.2 Layout Example ... 28
11 器件和文档支持 ... 29
11.1 器件支持 ... 29
11.2 接收文档更新通知 ... 30
11.3 社区资源 ... 30
11.4 商标 ... 30
11.5 静电放电警告 ... 30
11.6 术语表 ... 30
12 机械、封装和可订购信息 ... 30

4 修订历史记录

注：之前版本的页码可能与当前版本有所不同。

Changes from Revision K (September 2018) to Revision L **Page**

- Added Figure 20 ... 17

Changes from Revision J (March 2018) to Revision K **Page**

- Deleted inconsistent footnotes ... 6
- Added standardized thermal values ... 6
- Changed formatting of temperature conditions in the spec tables ... 7
- Added subgroups to all applicable specs ... 7
- Changed location of 12.1-Ω capacitor on V_{IN-} pin in the circuit diagram of the *Typical Application* section ... 24

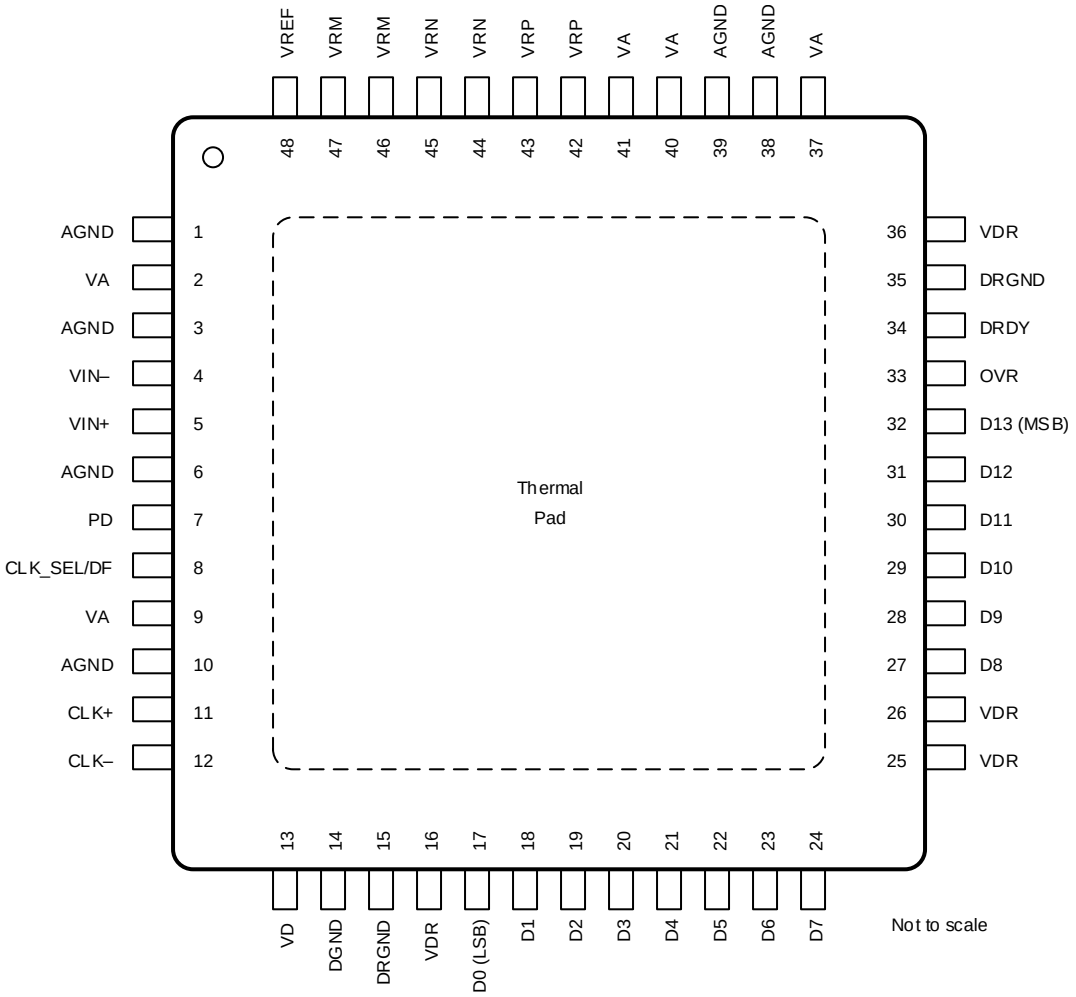
Changes from Revision I (March 2013) to Revision J **Page**

- 已添加 添加了*器件信息* 表、*ESD* *额定值*表、*特性* *说明*部分，*器件功能模式*部分，*应用和实施*部分，*电源相关建议*部分，*布局*部分，*器件和文档支持*部分以及*机械、封装和可订购信息*部分 ... 1
- Deleted DYNAMIC CONVERTER CHARACTERISTICS, A_{IN} = –1 dBFS duplicate specs ... 9

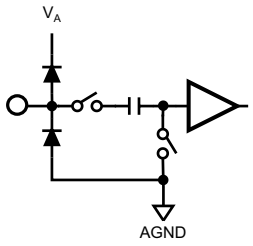
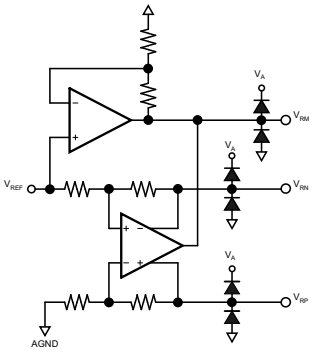
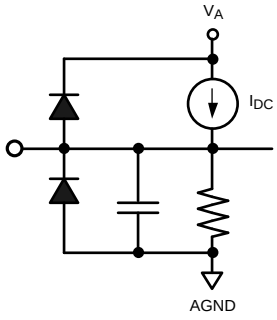
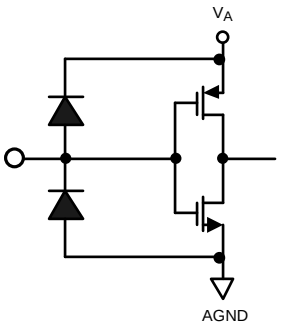
Copyright © 2008–2019, Texas Instruments Incorporated

5 Pin Configuration and Functions

NBA Package
48-Pin CFP
Top View

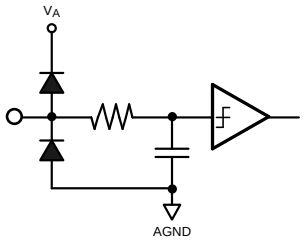
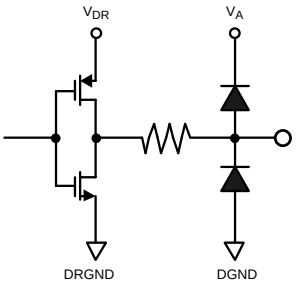


Pin Descriptions and Equivalent Circuits

PIN NO.	SYMBOL	EQUIVALENT CIRCUIT	DESCRIPTION
ANALOG I/O			
4	V_{IN-}		Differential analog input pins. The differential full-scale input signal level is two times the reference voltage with each input pin signal centered on a common mode voltage, V_{CM}.
5	V_{IN+}		
42, 43	V_{RP}		These pins should each be bypassed to AGND with a low ESL (equivalent series inductance) 0.1-µF capacitor placed very close to the pin to minimize stray inductance. A 0.1-µF capacitor should be placed between V_{RP} and V_{RN} as close to the pins as possible, and a 10-µF capacitor should be placed in parallel. V_{RP} and V_{RN} should not be loaded. V_{RM} may be loaded to 1mA for use as a temperature stable 1.5-V reference. It is recommended to use V_{RM} to provide the common mode voltage, V_{CM}, for the differential analog inputs, V_{IN}+ and V_{IN}–.
46, 47	V_{RM}		
44, 45	V_{RN}		
48	V_{REF}		This pin can be used as either the 1-V internal reference voltage output (internal reference operation) or as the external reference voltage input (external reference operation). To use the internal reference, V_{REF} should be decoupled to AGND with a 0.1-µF, low equivalent series inductance (ESL) capacitor. In this mode, V_{REF} defaults as the output for the internal 1.0-V reference. To use an external reference, overdrive this pin with a low noise external reference voltage. The output impedance of the internal reference at this pin is 9kΩ. Therefore, to overdrive this pin, the impedance of the external reference source should be << 9 kΩ. This pin should not be used to source or sink current. The full scale differential input voltage range is 2 * V_{REF}.
DIGITAL I/O			
11	CLK+		The clock input pins can be configured to accept either a single-ended or a differential clock input signal. When the single-ended clock mode is selected through CLK_SEL/DF (pin 8), connect the clock input signal to the CLK+ pin and connect the CLK– pin to AGND. When the differential clock mode is selected through CLK_SEL/DF (pin 8), connect the positive and negative clock inputs to the CLK+ and CLK– pins, respectively. The analog input is sampled on the falling edge of the clock input.
12	CLK–		

Copyright © 2008–2019, Texas Instruments Incorporated

Pin Descriptions and Equivalent Circuits (continued)

PIN NO.	SYMBOL	EQUIVALENT CIRCUIT	DESCRIPTION
8	CLK_SEL/DF		This is a four-state pin controlling the input clock mode and output data format. CLK_SEL/DF = V_A, CLK+ and CLK– are configured as a differential clock input. The output data format is 2's complement. CLK_SEL/DF = (2 / 3) * V_A, CLK+ and CLK– are configured as a differential clock input. The output data format is offset binary. CLK_SEL/DF = (1 / 3) * V_A, CLK+ is configured as a single-ended clock input and CLK– should be tied to AGND. The output data format is 2's complement. CLK_SEL/DF = AGND, CLK+ is configured as a single-ended clock input and CLK– should be tied to AGND. The output data format is offset binary.
7	PD		This is a two-state input controlling Power Down. PD = V_A, Power Down is enabled. In the Power Down state only the reference voltage circuitry remains active and power dissipation is reduced. PD = AGND, Normal operation.
17-24, 27-32	D0–D13		Digital data output pins that make up the 14-bit conversion result. D0 (pin 17) is the LSB, while D13 (pin 32) is the MSB of the output word. Output levels are CMOS compatible.
33	OVR		Over-Range Indicator. This output is set HIGH when the input amplitude exceeds the 14-bit conversion range (0 to 16383).
34	DRDY		Data Ready Strobe. This pin is used to clock the output data. It has the same frequency as the sampling clock. One word of data is output in each cycle of this signal. The rising edge of this signal should be used to capture the output data.
ANALOG POWER			
2, 9, 37, 40, 41	V_A		Positive analog supply pins. These pins should be connected to a quiet 3.3-V source and be bypassed to AGND with 100-pF and 0.1-µF capacitors located close to the power pins.
1, 3, 6, 10, 38, 39	AGND		The ground return for the analog supply.
DIGITAL POWER			
13	V_D		Positive digital supply pin. This pin should be connected to a quiet 3.3-V source and be bypassed to DGND with a 100-pF and 0.1-µF capacitor located close to the power pin.
14	DGND		The ground return for the digital supply.
16, 25, 26, 36	V_{DR}		Positive driver supply pin for the output drivers. This pin should be connected to a quiet voltage source of 1.8 V and be bypassed to DRGND with 100-pF and 0.1-µF capacitors located close to the power pins.
15, 35	DRGND		The ground return for the digital output driver supply. These pins should be connected to the system digital ground. See Layout Guidelines (Layout and Grounding) for more details.

Copyright © 2008–2019, Texas Instruments Incorporated

6 Specifications

6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)(1)(2)

	MIN	MAX	UNIT
Supply voltage (V_A, V_D)	–0.3	4.2	V
Supply voltage (V_{DR})	–0.3	2.35	V
$\|V_A–V_D\|$		100	mV
Voltage on any input pin (not to exceed 4.2 V)	–0.3	V_A + 0.3	V
Voltage on any output pin (not to exceed 2.35 V)	–0.3	V_{DR} + 0.2	V
Input current at any pin other than supply pins	–5	5	mA
Package input current	–50	50	mA
Max junction temperature, T_J		150	°C
Storage temperature, T_{stg}	–65	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) All voltages are measured with respect to GND = AGND = DGND = DRGND = 0 V, unless otherwise specified.

6.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)	±2500	V

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

6.3 Recommended Operating Conditions

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

	MIN	NOM	MAX	UNIT
Operating temperature	–55		125	°C
Supply voltage (V_A, V_D)	3		3.6	V
Output driver supply (V_{DR})	1.6		2	V
CLK	–0.05		V_A + 0.05	V
Clock duty cycle	30%		70%	
Analog input pins	0		2.6	V
V_{CM}	1.4		1.6	V
|AGND-DGND|(2)			100	mV

(1) All voltages are measured with respect to GND = AGND = DGND = DRGND = 0 V, unless otherwise specified.
(2) All GND voltages should be within 100mv of each other.

6.4 Thermal Information

THERMAL METRIC		ADC14155QML NBA (CFP) 48 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	27.5	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	11.7	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	11.4	°C/W
ψ_{JT}	Junction-to-top characterization parameter	4.6	°C/W
ψ_{JB}	Junction-to-board characterization parameter	11.1	°C/W
$R_{\theta JC(bottom)}$(1)	Junction-to-case (bottom) thermal resistance	3.0	°C/W

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

Copyright © 2008–2019, Texas Instruments Incorporated

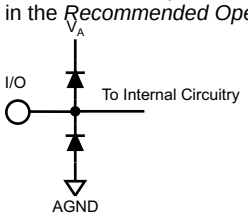
6.5 ADC14155 Converter Electrical Characteristics DC Parameters(1)

Unless otherwise specified, the following specifications apply: AGND = DGND = DRGND = 0 V, V_A = V_D = 3.3 V, V_{DR} = 1.8 V, Internal V_{REF} = 1 V, f_{CLK} = 155 MHz, V_{CM} = V_{RM}, C_L = 5 pF/pin, Differential Analog Input, Single-Ended Clock Mode, Offset Binary Format. Typical values are for T_A = 25°C. (2)(3)(4)(5)

PARAMETER		TEST CONDITIONS	NOTES	TYP(6)	MIN	MAX	UNITS	SUB-GROUPS
STATIC CONVERTER CHARACTERISTICS								
	Resolution with no missing codes				14		Bits	[1, 2, 3]
INL	Integral non linearity		See(7)	2.3	–5.0	5.0	LSB	[1, 2, 3]
DNL	Differential non linearity			±0.5	–0.9	1.1	LSB	[1, 2, 3]
PGE	Maximum positive gain error			0.1	–3.3	3.5	%FS	[1, 2, 3]
NGE	Maximum negative gain error			0.3	–3.3	3.9	%FS	[1, 2, 3]
TC GE	Gain error tempco	–55°C ≤ T_A ≤ +125°C		0.007			Δ%FS/°C	
V_{OFF}	Offset error (V_{IN+} = $V_{IN–}$)			–0.1	0.7	–0.9	%FS	[1, 2, 3]
TC V_{OFF}	Offset error tempco	–55°C ≤ T_A ≤ +125°C		0.0001			Δ%FS/°C	
	Under range output code			0	0	0		
	Over range output code			16383	16383	16383		
REFERENCE AND ANALOG INPUT CHARACTERISTICS								
V_{CM}	Common mode input voltage			1.5			V	
V_{RM}	Reference ladder midpoint output voltage	Output load = 1 mA		1.5			V	
C_{IN}	V_{IN} input capacitance (each pin to GND)	V_{IN} = 1.5 Vdc ± 0.5 V(CLK LOW)	See(8)	9			pF	
		V_{IN} = 1.5 Vdc ± 0.5 V(CLK HIGH)	See(8)	6			pF	
V_{REF}	Reference voltage		See(9)	1.00			V	
	Reference input resistance			9			kΩ	

(1) Pre and post irradiation limits are identical to those listed in the *Electrical Characteristics* tables. Radiation testing is performed per MIL-STD-883, Test Method 1019.

(2) The inputs are protected as shown below. Input voltage magnitudes above V_A or below GND will not damage this device, provided current is limited per Note 5. However, errors in the A/D conversion can occur if the input goes above 2.6 V or below GND as described in the *Recommended Operating Conditions* section.



(3) To ensure accuracy, it is required that $|V_A – V_D|$ ≤ 100 mV and separate bypass capacitors are used at each power supply pin.

(4) With the test condition for V_{REF} = 1 V (2-V_{P-P} differential input), the 14-bit LSB is 122.1 µV.

(5) When the input voltage at any pin exceeds the power supplies (that is, V_{IN} < AGND, or V_{IN} > V_A), the current at that pin should be limited to ±5 mA. The ±50-mA maximum package input current rating limits the number of pins that can safely exceed the power supplies with an input current of ±5 mA to 10.

(6) Typical figures are at T_A = 25°C and represent most likely parametric norms at the time of product characterization. The typical specifications are not ensured.

(7) Integral Non Linearity is defined as the deviation of the analog value, expressed in LSBs, from the straight line that passes through positive and negative full-scale.

(8) The input capacitance is the sum of the package/pin capacitance and the sample and hold circuit capacitance.

(9) Optimum performance will be obtained by keeping the reference input in the 0.9-V to 1.1-V range. The LM4051CIM3-ADJ (SOT-23 package) is recommended for external reference applications.

Copyright © 2008–2019, Texas Instruments Incorporated

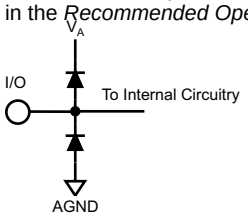
6.6 ADC14155 Converter Electrical Characteristics (Continued) DYNAMIC Parameters(1)

Unless otherwise specified, the following specifications apply: AGND = DGND = DRGND = 0 V, V_A = V_D = 3.3 V, V_{DR} = 1.8 V, Internal V_{REF} = 1 V, f_{CLK} = 155 MHz, V_{CM} = V_{RM}, C_L = 5 pF/pin, Differential Analog Input, Single-Ended Clock Mode, Offset Binary Format. Typical values are for T_A = 25°C. (2)(3)(4)(5)

PARAMETER		TEST CONDITIONS	NOTES	TYP(6)	MIN	MAX	UNITS	SUB-GROUPS
DYNAMIC CONVERTER CHARACTERISTICS, A_{IN} = -1 dBFS								
FPBW	Full power bandwidth	-1 dBFS Input, -3 dB Corner		1.1			GHz	
SNR	Signal-to-noise ratio	f_{IN} = 10 MHz		69			dBFS	
		f_{IN} = 70 MHz		70.1	66.7		dBFS	[4, 5, 6]
		f_{IN} = 169 MHz		68.5			dBFS	
		f_{IN} = 238 MHz		68.5			dBFS	
		f_{IN} = 398 MHz		66.4			dBFS	
SFDR	Spurious free dynamic range	f_{IN} = 10 MHz		82			dBFS	
		f_{IN} = 70 MHz		82.3	68.2		dBFS	[4, 5, 6]
		f_{IN} = 169 MHz		80.5			dBFS	
		f_{IN} = 238 MHz		77.3			dBFS	
		f_{IN} = 398 MHz		63.5			dBFS	
ENOB	Effective number of bits	f_{IN} = 10 MHz		11.3			Bits	
		f_{IN} = 70 MHz		11.3	10.7		Bits	[4, 5, 6]
		f_{IN} = 169 MHz		11.0			Bits	
		f_{IN} = 238 MHz		11.0			Bits	
		f_{IN} = 398 MHz		10.0			Bits	
THD	Total harmonic disortion	f_{IN} = 10 MHz		–81			dBFS	
		f_{IN} = 70 MHz		–79.9		–67	dBFS	[4, 5, 6]
		f_{IN} = 169 MHz		–82.4			dBFS	
		f_{IN} = 238 MHz		–76.6			dBFS	
		f_{IN} = 398 MHz		–63.2			dBFS	
HD2	Second-order harmonic distortion	f_{IN} = 10 MHz		–95.4			dBFS	
		f_{IN} = 70 MHz		–88.5		–70	dBFS	[4, 5, 6]
		f_{IN} = 169 MHz		–88.3			dBFS	
		f_{IN} = 238 MHz		–77.3			dBFS	
		f_{IN} = 398 MHz		–60.9			dBFS	

(1) Pre and post irradiation limits are identical to those listed in the *Electrical Characteristics* tables. Radiation testing is performed per MIL-STD-883, Test Method 1019.

(2) The inputs are protected as shown below. Input voltage magnitudes above V_A or below GND will not damage this device, provided current is limited per Note 5. However, errors in the A/D conversion can occur if the input goes above 2.6V or below GND as described in the *Recommended Operating Conditions* section.



(3) To ensure accuracy, it is required that $|V_A – V_D| \leq 100$ mV and separate bypass capacitors are used at each power supply pin.

(4) With the test condition for V_{REF} = 1 V (2-V_{P-P} differential input), the 14-bit LSB is 122.1 µV.

(5) When the input voltage at any pin exceeds the power supplies (that is, V_{IN} < AGND, or V_{IN} > V_A), the current at that pin should be limited to ±5 mA. The ±50 mA maximum package input current rating limits the number of pins that can safely exceed the power supplies with an input current of ±5 mA to 10.

(6) Typical figures are at T_A = 25°C and represent most likely parametric norms at the time of product characterization. The typical specifications are not ensured.

Copyright © 2008–2019, Texas Instruments Incorporated

ADC14155 Converter Electrical Characteristics (Continued) DYNAMIC Parameters[1] (continued)

Unless otherwise specified, the following specifications apply: AGND = DGND = DRGND = 0 V, V_A = V_D = 3.3 V, V_{DR} = 1.8 V, Internal V_{REF} = 1 V, f_{CLK} = 155 MHz, V_{CM} = V_{RM}, C_L = 5 pF/pin, Differential Analog Input, Single-Ended Clock Mode, Offset Binary Format. Typical values are for T_A = 25°C. [2][3][4][5]

PARAMETER		TEST CONDITIONS	NOTES	TYP[6]	MIN	MAX	UNITS	SUB-GROUPS
HD3	Third-order harmonic distortion	f_{IN} = 10 MHz		–81.6			dBFS	
		f_{IN} = 70 MHz		–82.3		–68	dBFS	[4, 5, 6]
		f_{IN} = 169 MHz		–86.4			dBFS	
		f_{IN} = 238 MHz		–89.0			dBFS	
		f_{IN} = 398 MHz		–80.5			dBFS	
SINAD	Signal-to-noise and distortion ratio	f_{IN} = 10 MHz		68.2			dBFS	
		f_{IN} = 70 MHz		69.9	66.2		dBFS	[4, 5, 6]
		f_{IN} = 169 MHz		68.3			dBFS	
		f_{IN} = 238 MHz		67.8			dBFS	
		f_{IN} = 398 MHz		61.5			dBFS	

Copyright © 2008–2019, Texas Instruments Incorporated

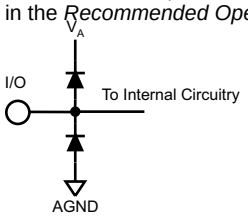
6.7 ADC14155 Converter Electrical Characteristics (Continued) Logic and Power Supply Electrical Characteristics[1]

Unless otherwise specified, the following specifications apply: AGND = DGND = DRGND = 0 V, V_A = V_D = 3.3 V, V_{DR} = 1.8 V, Internal V_{REF} = 1 V, f_{CLK} = 155 MHz, V_{CM} = V_{RM}, C_L = 5 pF/pin, Differential Analog Input, Single-Ended Clock Mode, Offset Binary Format. Typical values are for T_A = 25°C. Timing measurements are taken at 50% of the signal amplitude. [2][3][4][5]

PARAMETER		TEST CONDITIONS	NOTES	TYP[6]	MIN	MAX	UNITS	SUB-GROUPS
DIGITAL INPUT CHARACTERISTICS (CLK, PD/DCS, CLK_SEL/DF)								
$V_{IN(1)}$	Logical “1” input voltage	V_D = 3.6 V	See[7]		2.0		V	[1, 2, 3]
$V_{IN(0)}$	Logical “0” input voltage	V_D = 3.0 V				0.8	V	[1, 2, 3]
$I_{IN(1)}$	Logical “1” input current	V_{IN} = 3.3 V		10			µA	
$I_{IN(0)}$	Logical “0” input current	V_{IN} = 0 V		–10			µA	
C_{IN}	Digital input capacitance			5			pF	
DIGITAL OUTPUT CHARACTERISTICS (D0–D13, DRDY, OVR)								
V_{OH}	Output logic high	I_{OUT} = –0.5 mA , V_{DR} = 1.8 V	See[7]	1.55	1.2		V	[1, 2, 3]
V_{OL}	Output logic low	I_{OUT} = 1.6 mA, V_{DR} = 1.8 V	See[7]	0.15		0.4	V	[1, 2, 3]
$+I_{SC}$	Output short circuit source current	V_{OUT} = 0 V		–10			mA	
$–I_{SC}$	Output short circuit sink current	V_{OUT} = V_{DR}		10			mA	
C_{OUT}	Digital output capacitance			5			pF	
POWER SUPPLY CHARACTERISTICS								
I_A	Analog supply current	Full operation		283		350	mA	[1, 2, 3]
I_D	Digital supply current	Full operation		10		11	mA	[1, 2, 3]
I_{DR}	Digital output supply current	Full operation	See[8]	15			mA	
	Power consumption	Excludes I_{DR}		967		1170	mW	[1, 2, 3]
	Power down power consumption	Clock disabled		5			mW	

(1) Pre and post irradiation limits are identical to those listed in the *Electrical Characteristics* tables. Radiation testing is performed per MIL-STD-883, Test Method 1019.

(2) The inputs are protected as shown below. Input voltage magnitudes above V_A or below GND will not damage this device, provided current is limited per Note 5. However, errors in the A/D conversion can occur if the input goes above 2.6 V or below GND as described in the *Recommended Operating Conditions* section.



(3) To ensure accuracy, it is required that $|V_A – V_D|$ ≤ 100 mV and separate bypass capacitors are used at each power supply pin.

(4) With the test condition for V_{REF} = 1 V (2-V_{P-P} differential input), the 14-bit LSB is 122.1 µV.

(5) When the input voltage at any pin exceeds the power supplies (that is, V_{IN} < AGND, or V_{IN} > V_A), the current at that pin should be limited to ±5 mA. The ±50-mA maximum package input current rating limits the number of pins that can safely exceed the power supplies with an input current of ±5 mA to 10.

(6) Typical figures are at T_A = 25°C and represent most likely parametric norms at the time of product characterization. The typical specifications are not ensured.

(7) Specified by characterization.

(8) I_{DR} is the current consumed by the switching of the output drivers and is primarily determined by load capacitance on the output pins, the supply voltage, V_{DR}, and the rate at which the outputs are switching (which is signal dependent). I_{DR} = V_{DR}(C_0 × f_0 + C_1 × f_1 +....C_{11} × f_{11}) where V_{DR} is the output driver power supply voltage, C_n is total capacitance on the output pin, and f_n is the average frequency at which that pin is toggling.

Copyright © 2008–2019, Texas Instruments Incorporated

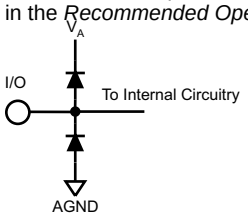
6.8 ADC14155 Converter Electrical Characteristics (Continued) Timing and AC Characteristics[1]

Unless otherwise specified, the following specifications apply: AGND = DGND = DRGND = 0 V, V_A = V_D = 3.3 V, V_{DR} = 1.8 V, Internal V_{REF} = 1 V, f_{CLK} = 155 MHz, V_{CM} = V_{RM}, C_L = 5 pF/pin, Differential Analog Input, Single-Ended Clock Mode, Offset Binary Format. Typical values are for T_A = 25°C. Timing measurements are taken at 50% of the signal amplitude. **Boldface limits apply for $T_{MIN} \le T_A \le T_{MAX}$.** All other limits apply for T_A = 25°C[2][3][4][5]

PARAMETER		TEST CONDITIONS	NOTES	TYP[6]	MIN	MAX	UNITS	SUB-GROUPS
	Maximum clock frequency					155	MHz	[7, 8A, 8B]
	Minimum clock frequency				5		MHz	
	Clock high time			3.0			ns	
	Clock low time			3.0			ns	
	Conversion latency		See[7]			8	Clock cycles	[4, 5, 6]
t_{OD}	Output delay of CLK to DATA	Relative to falling edge of CLK		2.0			ns	
t_{SU}	Data output setup time	Relative to DRDY	See[8]	2.1	**1.22**		ns	
t_H	Data output hold time	Relative to DRDY	See[8]	2.1	**1.83**		ns	
t_{AD}	Aperture delay			0.5			ns	
t_{AJ}	Aperture jitter			0.08			ps rms	
	Power down recovery time	0.1 µF to GND on pins 43, 44; 10 µF and 0.1 µF between pins 43, 44; 0.1 µF and 10 µF to GND on pins 47, 48		3.0			ms	

(1) Pre and post irradiation limits are identical to those listed in the *Electrical Characteristics* tables. Radiation testing is performed per MIL-STD-883, Test Method 1019.

(2) The inputs are protected as shown below. Input voltage magnitudes above V_A or below GND will not damage this device, provided current is limited per Note 5. However, errors in the A/D conversion can occur if the input goes above 2.6 V or below GND as described in the *Recommended Operating Conditions* section.



(3) To ensure accuracy, it is required that $|V_A - V_D| \le 100$ mV and separate bypass capacitors are used at each power supply pin.

(4) With the test condition for V_{REF} = 1 V (2-V_{P-P} differential input), the 14-bit LSB is 122.1 µV.

(5) When the input voltage at any pin exceeds the power supplies (that is, V_{IN} < AGND, or V_{IN} > V_A), the current at that pin should be limited to ±5 mA. The ±50 mA maximum package input current rating limits the number of pins that can safely exceed the power supplies with an input current of ±5 mA to 10.

(6) Typical figures are at T_A = 25°C and represent most likely parametric norms at the time of product characterization. The typical specifications are not ensured.

(7) Specified by design.

(8) Specified by characterization.

Copyright © 2008–2019, Texas Instruments Incorporated

6.9 Timing Diagram

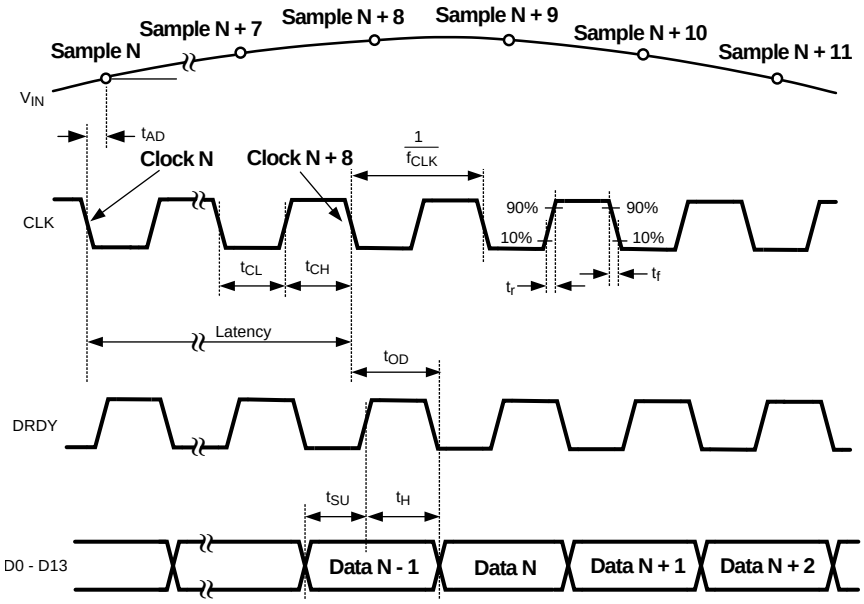


Figure 1. Output Timing

6.10 Transfer Characteristic

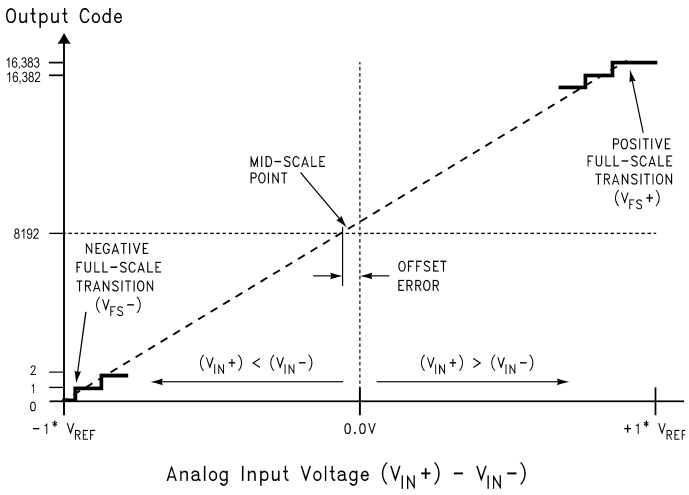


Figure 2. Transfer Characteristic

Copyright © 2008–2019, Texas Instruments Incorporated

Transfer Characteristic (continued)

Table 1. Quality Conformance Inspection(1)

Subgroup	Description	Temp (°C)
1	Static tests at	25
2	Static tests at	125
3	Static tests at	–55
4	Dynamic tests at	25
5	Dynamic tests at	125
6	Dynamic tests at	–55
7	Functional tests at	25
8A	Functional tests at	125
8B	Functional tests at	–55
9	Switching tests at	25
10	Switching tests at	125
11	Switching tests at	–55

(1) MIL-STD-883, Method 5005 - Group A

Copyright © 2008–2019, Texas Instruments Incorporated

6.11 Typical Performance Characteristics, DNL, INL

Unless otherwise specified, the following specifications apply: AGND = DGND = DRGND = 0 V, V_A = V_D = 3.3 V, V_{DR} = 1.8 V, Internal V_{REF} = 1 V, f_{CLK} = 155 MHz, V_{CM} = V_{RM}, C_L = 5 pF/pin, Differential Analog Input, Single-Ended Clock Mode, Offset Binary Format. Typical values are for TA = 25°C.(1)(2)(3)

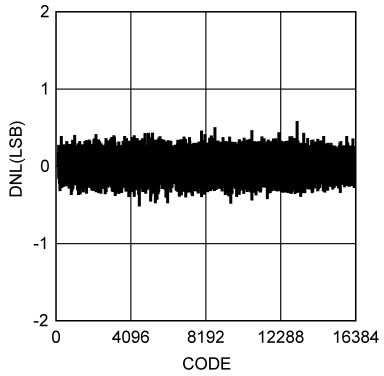


Figure 3. DNL

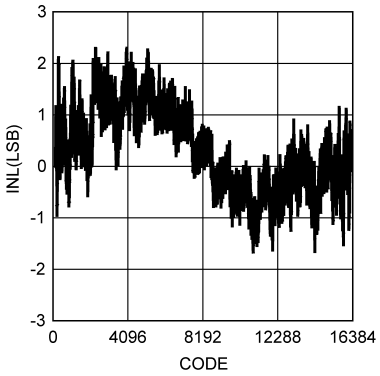
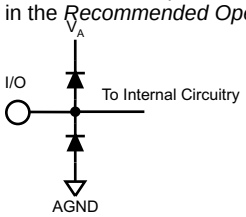


Figure 4. INL

(1) The inputs are protected as shown below. Input voltage magnitudes above V_A or below GND will not damage this device, provided current is limited per Note 5. However, errors in the A/D conversion can occur if the input goes above 2.6 V or below GND as described in the *Recommended Operating Conditions* section.



(2) To ensure accuracy, it is required that $|V_A – V_D| \leq 100$ mV and separate bypass capacitors are used at each power supply pin.
(3) With the test condition for V_{REF} = 1 V (2-V_{P-P} differential input), the 14-bit LSB is 122.1 µV.

Copyright © 2008–2019, Texas Instruments Incorporated

6.12 Typical Performance Characteristics, Dynamic Performance

Unless otherwise specified, the following specifications apply: AGND = DGND = DRGND = 0 V, V_A = V_D = 3.3 V, V_{DR} = 1.8 V, Internal V_{REF} = 1 V, f_{CLK} = 155 MHz, V_{CM} = V_{RM}, C_L = 5 pF/pin, Differential Analog Input, Single-Ended Clock Mode, Offset Binary Format. Typical values are for TA = 25°C

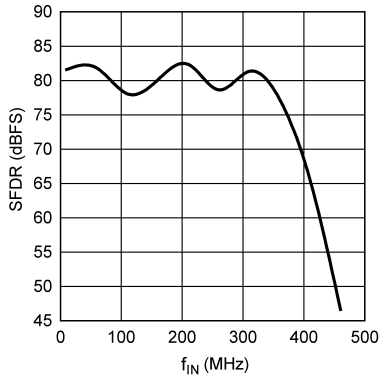


Figure 5. SFDR vs f_{IN}

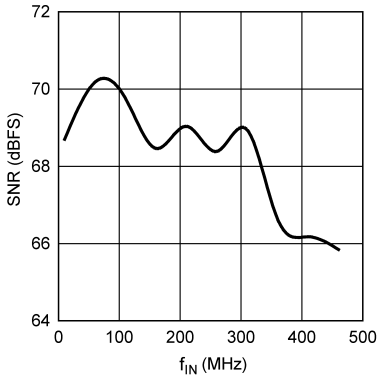


Figure 6. SNR vs f_{IN}

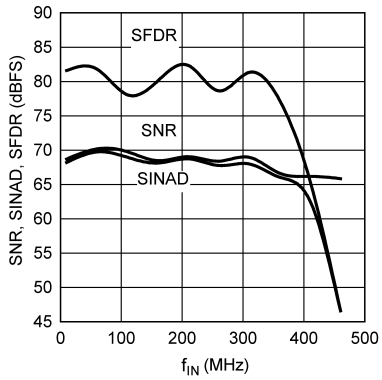


Figure 7. SNR, SINAD, SFDR vs f_{IN}

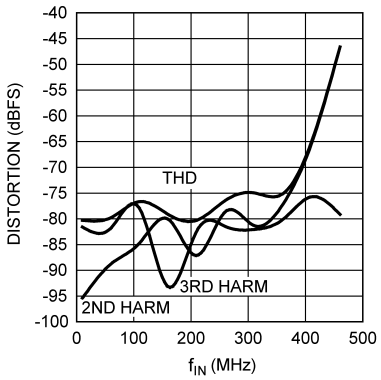


Figure 8. Distortion vs f_{IN}

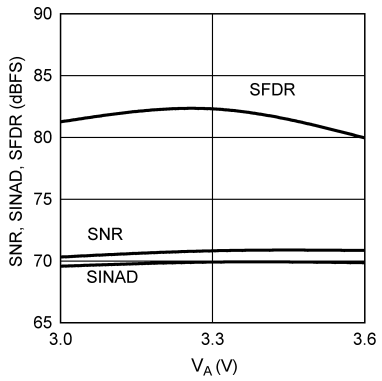


Figure 9. SNR, SINAD, SFDR vs V_A

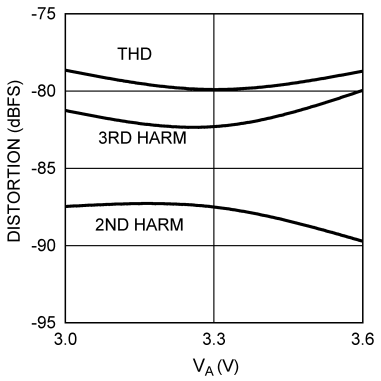


Figure 10. Distortion vs V_A

Copyright © 2008–2019, Texas Instruments Incorporated

Typical Performance Characteristics, Dynamic Performance (continued)

Unless otherwise specified, the following specifications apply: AGND = DGND = DRGND = 0 V, V_A = V_D = 3.3 V, V_{DR} = 1.8 V, Internal V_{REF} = 1 V, f_{CLK} = 155 MHz, V_{CM} = V_{RM}, C_L = 5 pF/pin, Differential Analog Input, Single-Ended Clock Mode, Offset Binary Format. Typical values are for TA = 25°C

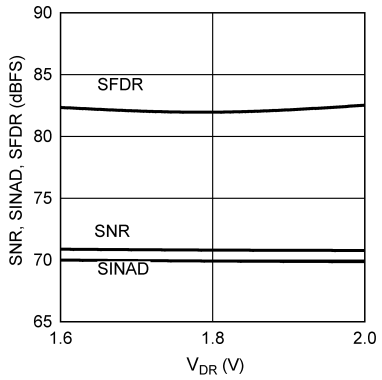


Figure 11. SNR, SINAD, SFDR vs V_{DR}

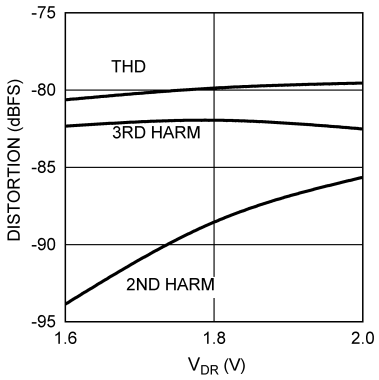


Figure 12. Distortion vs V_{DR}

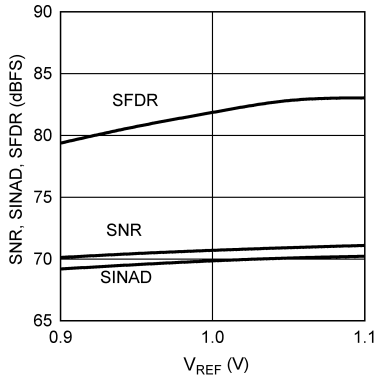


Figure 13. SNR, SINAD, SFDR vs V_{REF}

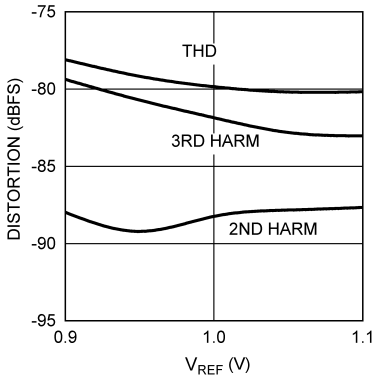


Figure 14. Distortion vs V_{REF}

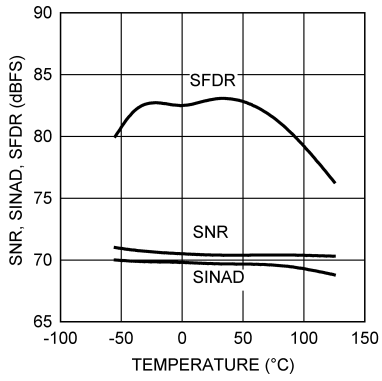


Figure 15. SNR, SINAD, SFDR vs Temperature

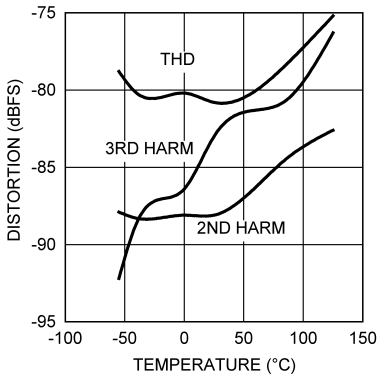


Figure 16. Distortion vs Temperature

Copyright © 2008–2019, Texas Instruments Incorporated

Typical Performance Characteristics, Dynamic Performance (continued)

Unless otherwise specified, the following specifications apply: AGND = DGND = DRGND = 0 V, V_A = V_D = 3.3 V, V_{DR} = 1.8 V, Internal V_{REF} = 1 V, f_{CLK} = 155 MHz, V_{CM} = V_{RM}, C_L = 5 pF/pin, Differential Analog Input, Single-Ended Clock Mode, Offset Binary Format. Typical values are for TA = 25°C

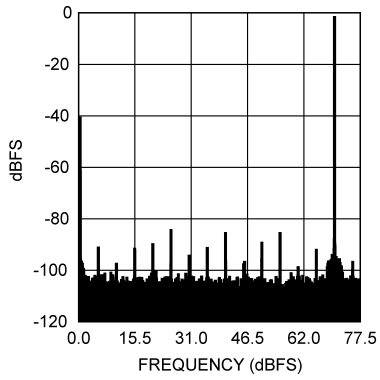


Figure 17. Spectral Response at 70-MHz Input

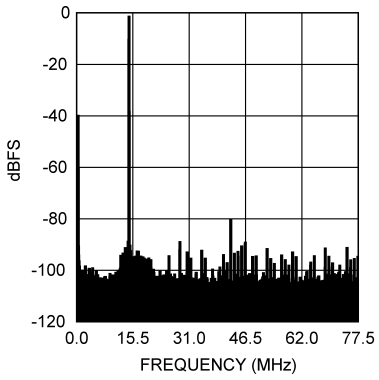


Figure 18. Spectral Response at 169-MHz Input

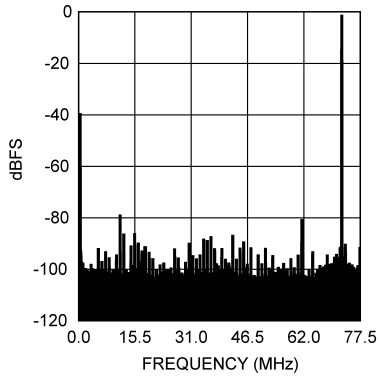


Figure 19. Spectral Response at 238-MHz Input

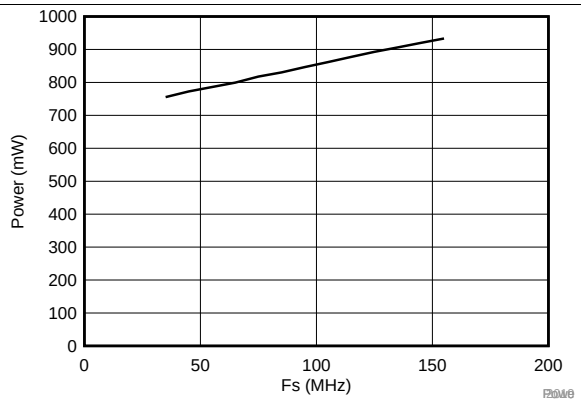


Figure 20. Power vs Sample Rate

7 Detailed Description

7.1 Overview

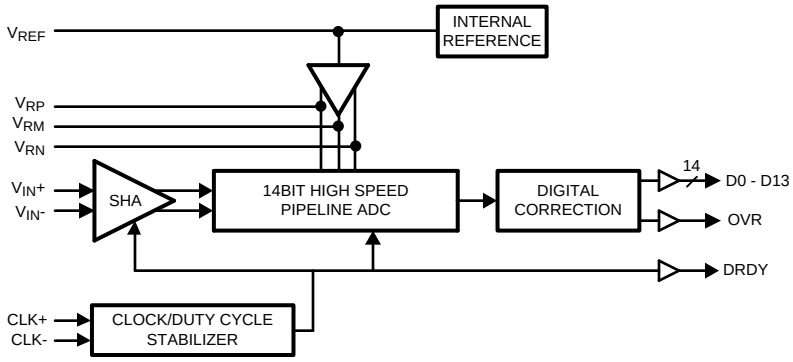
Operating on dual 3.3-V and 1.8-V supplies, the ADC14155 digitizes a differential analog input signal to 14 bits, using a differential pipelined architecture with error correction circuitry and an on-chip sample-and-hold circuit to ensure maximum performance.

The user has the choice of using an internal 1-V stable reference, or using an external reference. The ADC14155 will accept an external reference between 0.9 V and 1.1 V (1-V recommended) which is buffered on-chip to ease the task of driving that pin. The 1.8-V output driver supply reduces power consumption and decreases the noise at the output of the converter.

The quad state function pin CLK_SEL/DF (pin 8) allows the user to choose between using a single-ended or a differential clock input and between offset binary or 2's complement output data format. The digital outputs are CMOS compatible signals that are clocked by a synchronous data ready output signal (DRDY, pin 34) at the same rate as the clock input. For the ADC14155 the clock frequency can be between 5 MSPS and 155 MSPS with fully specified performance at 155 MSPS. The analog input is acquired at the falling edge of the clock and the digital data for a given sample is output on the falling edge of the DRDY signal and is delayed by the pipeline for 8 clock cycles. The data should be captured on the rising edge of the DRDY signal.

Power-down is selectable using the PD pin (pin 7). A logic high on the PD pin disables everything except the voltage reference circuitry and reduces the converter power consumption to 5 mW with no clock running. For normal operation, the PD pin should be connected to the analog ground (AGND). A duty cycle stabilizer maintains performance over a wide range of clock duty cycles.

7.2 Functional Block Diagram



7.3 Feature Description

7.3.1 Analog Inputs

7.3.1.1 Differential Analog Input Pins

The ADC14155QML-SP has one pair of analog signal input pins, V_{IN+} and $V_{IN–}$, which form a differential input pair. The input signal, V_{IN}, is defined as

$$V_{IN} = (V_{IN+}) – (V_{IN–}) \quad (1)$$

Figure 21 shows the expected input signal range. Note that the common mode input voltage, V_{CM}, should be 1.5 V. Using V_{RM} (pin 46 or 47) for V_{CM} will ensure the proper input common mode level for the analog input signal. The peaks of the individual input signals should each never exceed 2.6 V. Each analog input pin of the differential pair should have a peak-to-peak voltage equal to the reference voltage, V_{REF}, be 180° out of phase with each other and be centered around V_{CM}.The peak-to-peak voltage swing at each analog input pin should not exceed the value of the reference voltage or the output data will be clipped.

Copyright © 2008–2019, Texas Instruments Incorporated

Feature Description (continued)

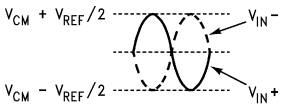


Figure 21. Expected Input Signal Range

For single frequency sine waves the full scale error, E_{FS}, in LSB can be described as approximately

$$E_{FS} = 16384 (1 – \sin (90° + dev)) \quad (2)$$

Where dev is the angular difference in degrees between the two signals having a 180° relative phase relationship to each other (see Figure 22). For single frequency inputs, angular errors result in a reduction of the effective full scale input. For complex waveforms, however, angular errors will result in distortion.

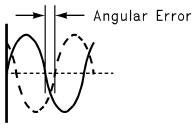


Figure 22. Angular Errors Between The Two Input Signals Will Reduce The Output Level Or Cause Distortion

It is recommended to drive the analog inputs with a source impedance less than 100 Ω. Matching the source impedance for the differential inputs will improve even ordered harmonic performance (particularly second harmonic).

Table 2 indicates the input to output relationship of the ADC14155.

Table 2. Input To Output Relationship

V_{IN+}	$V_{IN–}$	Binary Output	2's Complement Output	
$V_{CM} – V_{REF} / 2$	$V_{CM} + V_{REF} / 2$	00 0000 0000 0000	10 0000 0000 0000	Negative Full-Scale
$V_{CM} – V_{REF} / 4$	$V_{CM} + V_{REF} / 4$	01 0000 0000 0000	11 0000 0000 0000	
V_{CM}	V_{CM}	10 0000 0000 0000	00 0000 0000 0000	Mid-Scale
$V_{CM} + V_{REF} / 4$	$V_{CM} – V_{REF} / 4$	11 0000 0000 0000	01 0000 0000 0000	
$V_{CM} + V_{REF} / 2$	$V_{CM} – V_{REF} / 2$	11 1111 1111 1111	01 1111 1111 1111	Positive Full-Scale

7.3.1.2 Driving The Analog Inputs

The V_{IN+} and the $V_{IN–}$ inputs of the ADC14155QML-SP have an internal sample-and-hold circuit which consists of an analog switch followed by a switched-capacitor amplifier. The analog inputs are connected to the sampling capacitors through NMOS switches, and each analog input has parasitic capacitances associated with it.

When the clock is high, the converter is in the sample phase. The analog inputs are connected to the sampling capacitor through the NMOS switches, which causes the capacitance at the analog input pins to appear as the pin capacitance plus the internal sample and hold circuit capacitance (approximately 9 pF). While the clock level remains high, the sampling capacitor will track the changing analog input voltage. When the clock transitions from high to low, the converter enters the hold phase, during which the analog inputs are disconnected from the sampling capacitor. The last voltage that appeared at the analog input before the clock transition will be held on the sampling capacitor and will be sent to the ADC core. The capacitance seen at the analog input during the hold phase appears as the sum of the pin capacitance and the parasitic capacitances associated with the sample and hold circuit of each analog input (approximately 6 pF). Once the clock signal transitions from low to high, the analog inputs will be reconnected to the sampling capacitor to capture the next sample. Usually, there will be a difference between the held voltage on the sampling capacitor and the new voltage at the analog input. This will cause a charging glitch that is proportional to the voltage difference between the two samples to appear at the analog input pin. The input circuitry must be fast enough to allow the sampling capacitor to fully charge before the clock signal goes high again, as incomplete settling can degrade the SFDR performance.

Copyright © 2008–2019, Texas Instruments Incorporated

A single-ended to differential conversion circuit is shown in Figure 24. A transformer is preferred for high frequency input signals. Terminating the transformer on the secondary side provides two advantages. First, it presents a real broadband impedance to the ADC inputs and second, it provides a common path for the charging glitches from each side of the differential sample-and-hold circuit.

One short-coming of using a transformer to achieve the single-ended to differential conversion is that most RF transformers have poor low frequency performance. A differential amplifier can be used to drive the analog inputs for low frequency applications. The amplifier must be fast enough to settle from the charging glitches on the analog input resulting from the sample-and-hold operation before the clock goes high and the sample is passed to the ADC core.

The SFDR performance of the converter depends on the external signal conditioning circuity used, as this affects how quickly the sample-and-hold charging glitch will settle. An external resistor and capacitor network as shown in Figure 24 should be used to isolate the charging glitches at the ADC input from the external driving circuit and to filter the wideband noise at the converter input. These filtering components should be placed close to the ADC inputs in order to absorb the sampling glitches as close to the source of the glitches as possible. For Nyquist applications the RC pole should be at the ADC sample rate. The ADC input capacitance in the sample mode should be considered when setting the RC pole. For wideband undersampling applications, the RC pole should be set at about 1.5 to 2 times the maximum input frequency to maintain a linear delay response.

7.3.1.3 Input Common Mode Voltage

The input common mode voltage, V_{CM}, should be in the range of 1.4 V to 1.6 V and be a value such that the peak excursions of the analog signal do not go more negative than ground or more positive than 2.6 V. It is recommended to use V_{RM} (pin 46 or 47) as the input common mode voltage.

7.3.2 Reference Pins

The ADC14155QML-SP is designed to operate with an internal 1-V reference, or an external 1-V reference, but performs well with external reference voltages in the range of 0.9 V to 1.1 V. The internal 1-V reference is the default condition when no external reference input is applied to the V_{REF} pin. If a voltage in the range of 0.9 V to 1.1 V is applied to the V_{REF} pin, then that voltage is used for the reference. The V_{REF} pin should always be bypassed to ground with a 0.1-µF capacitor close to the reference input pin. Lower reference voltages will decrease the signal-to-noise ratio (SNR) of the ADC14155. Increasing the reference voltage (and the input signal swing) beyond 1.1-V may degrade THD for a full-scale input, especially at higher input frequencies.

It is important that all grounds associated with the reference voltage and the analog input signal make connection to the ground plane at a single, quiet point to minimize the effects of noise currents in the ground path.

The Reference Bypass Pins (V_{RP}, V_{RM}, and V_{RN}) are made available for bypass purposes. Each of these pins should be bypassed to ground with a 0.1-µF capacitor. A 0.1-µF and a 10-µF capacitor should be placed between the V_{RP} and V_{RN} pins, as shown in Figure 24. This configuration is necessary to avoid reference oscillation, which could result in reduced SFDR and/or SNR. V_{RM} may be loaded to 1 mA for use as a temperature stable 1.5-V reference. The V_{RP} and V_{RN} pins should not be loaded.

Smaller capacitor values than those specified will allow faster recovery from the power down mode, but may result in degraded noise performance. Loading any of these pins, other than V_{RM}, may result in performance degradation.

The nominal voltages for the reference bypass pins are as follows:

$V_{RM} = 1.5$ V

$V_{RP} = V_{RM} + V_{REF} / 2$

$V_{RN} = V_{RM} – V_{REF} / 2$

7.3.3 Digital Inputs

Digital CMOS compatible inputs consist of CLK+, CLK–, PD and CLK_SEL/DF.

Copyright © 2008–2019, Texas Instruments Incorporated

7.3.3.1 Clock Inputs

The CLK+ and CLK– signals control the timing of the sampling process. The CLK_SEL/DF pin (pin 8) allows the user to configure the ADC for either differential or single-ended clock mode (see Clock Mode Select/Data Format (CLK_SEL/DF)). In differential clock mode, the two clock signals should be exactly 180° out of phase from each other and of the same amplitude. In the single-ended clock mode, the clock signal should be routed to the CLK+ input and the CLK– input should be tied to AGND in combination with the correct setting from Table 4.

To achieve the optimum noise performance, the clock inputs should be driven with a stable, low jitter clock signal. The clock input signal should also have a short transition region. This can be achieved by passing a low-jitter sinusoidal clock source through a high speed buffer gate. This configuration is shown in Figure 24. The trace carrying the clock signal should be as short as possible and should not cross any other signal line, analog or digital, not even at 90°. Figure 24 shows the recommended clock input circuit.

The clock signal also drives an internal state machine. If the clock is interrupted, or its frequency is too low, the charge on the internal capacitors can dissipate to the point where the accuracy of the output data will degrade. This will limit the minimum sample rate.

The clock line should be terminated at its source in the characteristic impedance of that line. Care should be taken to maintain a constant clock line impedance throughout the length of the line. Refer to Application Note AN-905 (SNLA035) for information on setting characteristic impedance.

It is highly desirable that the source driving the ADC clock pins only drive that pin. However, if that source is used to drive other devices, then each driven pin should be AC terminated with a series RC to ground, such that the resistor value is equal to the characteristic impedance of the clock line and the capacitor value is

$$C \geq \frac{4 \times t_{PD} \times L}{Z_o} \tag{3}$$

where t_{PD} is the signal propagation rate down the clock line, "L" is the line length and Z_O is the characteristic impedance of the clock line. This termination should be as close as possible to the ADC clock pin but beyond it as seen from the clock source. Typical t_{PD} is about 150 ps/in (60 ps/cm) on FR-4 board material. The units of "L" and t_{PD} should be the same (inches or centimeters).

The duty cycle of the clock signal can affect the performance of the A/D Converter. Because achieving a precise duty cycle is difficult, the ADC14155 has a Duty Cycle Stabilizer. It is designed to maintain performance over a clock duty cycle range of 30% to 70%.

7.3.3.2 Power-Down (PD)

Power-down can be enabled through this two-state input pin. Table 3 shows how to power-down the ADC14155.

Table 3. Power Down Selection Table

PD Input Voltage	Power State
V_A	Power-down
AGND	On

The power-down mode allows the user to conserve power when the converter is not being used. In the power-down state all bias currents of the analog circuitry, excluding the reference are shut down which reduces the power consumption to 5 mW with no clock running. The output data pins are undefined and the data in the pipeline is corrupted while in the power-down mode.

The Power-down Mode Exit Cycle time is determined by the value of the capacitors on the V_{RP} (pin 42, 43), V_{RM} (pin 46, 47) and V_{RN} (pin 44, 45) reference bypass pins (pins 43, 44 and 45) and is approximately 3 ms with the recommended component values. These capacitors lose their charge in the power-down mode and must be recharged by on-chip circuitry before conversions can be accurate. Smaller capacitor values allow slightly faster recovery from the power down mode, but can result in a reduction in SNR, SINAD and ENOB performance.

Copyright © 2008–2019, Texas Instruments Incorporated

7.3.3.3 Clock Mode Select/Data Format (CLK_SEL/DF)

Single-ended versus differential clock mode and output data format are selectable using this quad-state function pin. Table 4 shows how to select between the clock modes and the output data formats.

Table 4. Clock Mode And Data Format Selection Table

CLK_SEL/DF Input Voltage	Clock Mode	Output Data Format
V_A	Differential	2's Complement
(2 / 3) * V_A	Differential	Offset Binary
(1 / 3) * V_A	Single-Ended	2's Complement
AGND	Single-Ended	Offset Binary

7.4 Device Functional Modes

This devices has no specific functional modes.

Copyright © 2008–2019, Texas Instruments Incorporated

8 Application and Implementation

NOTE

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

8.1 Application Information

To achieve the best dynamic performance, the clock source driving the CLK input must have a sharp transition region and be free of jitter. Isolate the ADC clock from any digital circuitry with buffers, as with the clock tree shown in Figure 23. The gates used in the clock tree must be capable of operating at frequencies much higher than those used if added jitter is to be prevented. Best performance will be obtained with a differential clock input drive, compared with a single-ended drive.

As mentioned in Power Supply Recommendations, it is good practice to keep the ADC clock line as short as possible and to keep it well away from any other signals. Other signals can introduce jitter into the clock signal, which can lead to reduced SNR performance, and the clock can introduce noise into other lines. Even lines with 90° crossings have capacitive coupling, so try to avoid even these 90° crossings of the clock line.

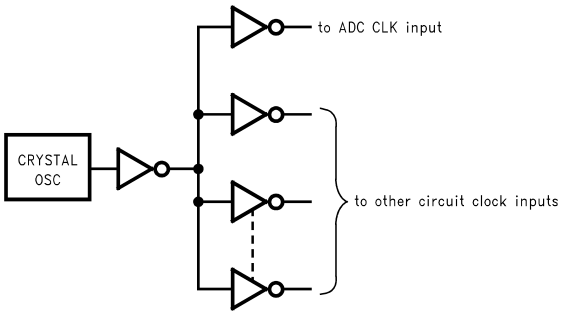


Figure 23. Isolating the ADC Clock From Other Circuitry With a Clock Tree

Copyright © 2008–2019, Texas Instruments Incorporated

8.2 Typical Application

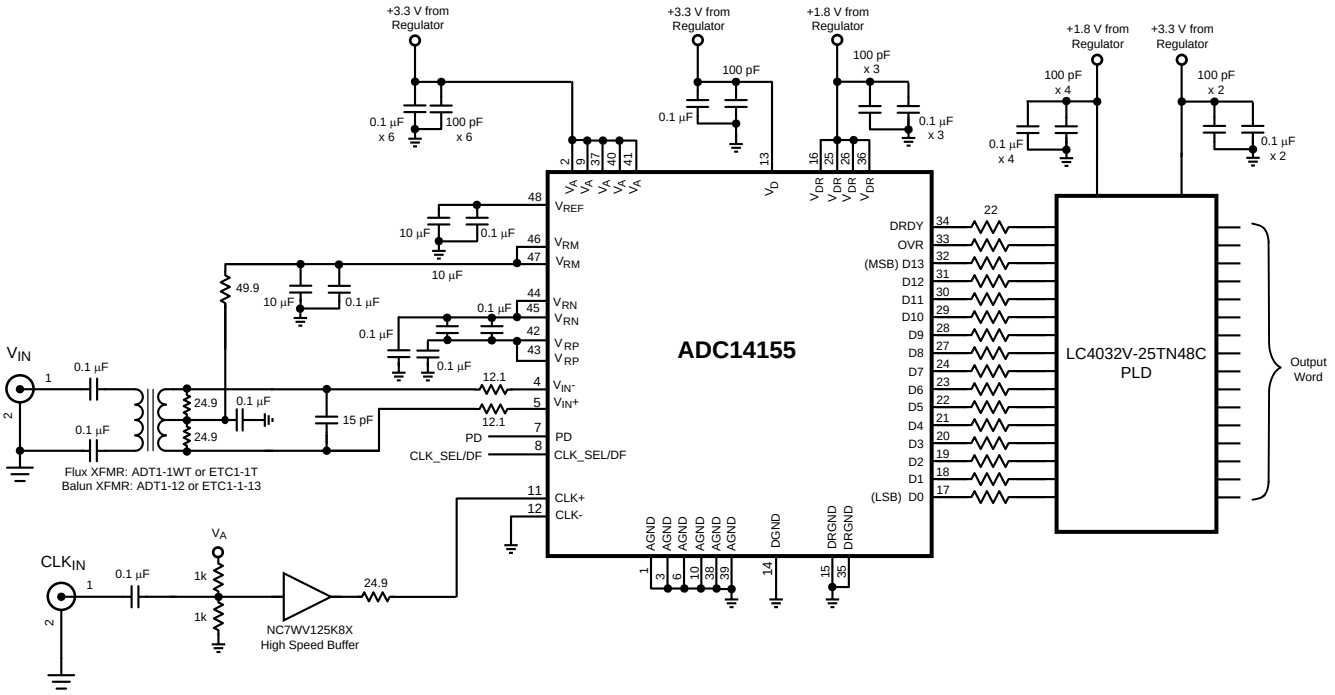


Figure 24. Application Circuit Using Transformer Drive Circuit

8.2.1 Design Requirements

We recommend that the following conditions be observed for operation of the ADC14155:

$3\ V \le V_A \le 3.6\ V$

$V_D = V_A$

$V_{DR} = 1.8\ V$

$5\ MHz \le f_{CLK} \le 155\ MHz$

1-V internal reference

$0.9\ V \le V_{REF} \le 1.1\ V$ (for an external reference)

$V_{CM} = 1.5\ V$ (from V_{RM})

8.2.2 Detailed Design Procedure

Digital outputs consist of the 1.8 V CMOS signals D0-D13, DRDY and OVR.

The ADC14155 has 16 CMOS compatible data output pins: 14 data output bits corresponding to the converted input value, a data ready (DRDY) signal that should be used to capture the output data and an over-range indicator (OVR) which is set high when the sample amplitude exceeds the 14-bit conversion range. Valid data is present at these outputs while the PD pin is low.

Data should be captured and latched with the rising edge of the DRDY signal. Depending on the setup and hold time requirements of the receiving circuit (ASIC), either the rising edge or the falling edge of the DRDY signal can be used to latch the data. Generally, rising-edge capture would maximize setup time with minimal hold time; while falling-edge-capture would maximize hold time with minimal setup time. However, actual timing for the falling-edge case depends greatly on the CLK frequency and both cases also depend on the delays inside the ASIC. Refer to the *ADC14155 Converter Electrical Characteristics (Continued) Timing and AC Characteristics*(1) table.

(1) Pre and post irradiation limits are identical to those listed in the *Electrical Characteristics* tables. Radiation testing is performed per MIL-STD-883, Test Method 1019.

Copyright © 2008–2019, Texas Instruments Incorporated

Typical Application (continued)

Be very careful when driving a high capacitance bus. The more capacitance the output drivers must charge for each conversion, the more instantaneous digital current flows through V_{DR} and DRGND. These large charging current spikes can cause on-chip ground noise and couple into the analog circuitry, degrading dynamic performance. Adequate bypassing, limiting output capacitance and careful attention to the ground plane will reduce this problem. Additionally, bus capacitance beyond the specified 5 pF/pin will cause t_{OD} to increase, reducing the setup and hold time of the ADC output data. The result could be an apparent reduction in dynamic performance.

To minimize noise due to output switching, the load currents at the digital outputs should be minimized. This can be done by using a programmable logic device (PLD) such as the LC4032V-25TN48C to level translate the ADC output data from 1.8 V to 3.3 V for use by any other circuitry. Only one load should be connected to each output pin. Additionally, inserting series resistors of about 22 Ω at the digital outputs, close to the ADC pins, will isolate the outputs from trace and other circuit capacitances and limit the output currents, which could otherwise result in performance degradation. See Figure 24.

8.2.3 Application Curve

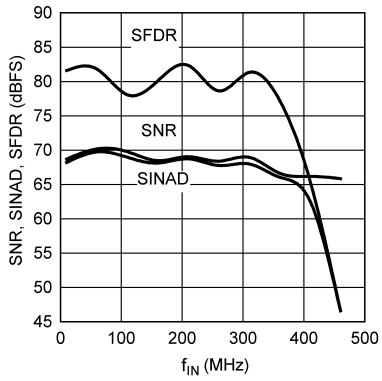


Figure 25. SNR, SINAD, SFDR vs f_{IN}

8.3 Radiation Environments

Careful consideration should be given to environmental conditions when using a product in a radiation environment.

8.3.1 Total Ionizing Dose (TID)

Radiation hardness assured (RHA) products are those part numbers with a total ionizing dose (TID) level specified in the table on the front page. Testing and qualification of these products is done according to MIL-STD-883, Test Method 1019. Additional information on how to download lot-specific TID data can be found in SBOA140 "QML Class V/Q and Enhanced Products Lot Documents".

8.3.2 Single Event Effects

One time single event latch-up testing (SEL) was preformed according to EIA/JEDEC Standard, EIA/JEDEC57. The linear energy transfer threshold (LET_{th}) shown in the Key Specifications table on the front page is the maximum LET tested. Test reports are available on the TI estore at SNAA153 and SNAA183.

Copyright © 2008–2019, Texas Instruments Incorporated

9 Power Supply Recommendations

The power supply pins should be bypassed with a 0.1-µF capacitor and with a 100-pF ceramic chip capacitor close to each power pin. Leadless chip capacitors are preferred because they have low series inductance.

As is the case with all high-speed converters, the ADC14155 is sensitive to power supply noise. Accordingly, the noise on the analog supply pin should be kept below 100 mV_{P-P}.

The V_{DR} pin provides power for the output drivers and may be operated from a supply in the range of 1.6 V to 2 V. This enables lower power operation, reduces the noise coupling effects from the digital outputs to the analog circuitry and simplifies interfacing to lower voltage devices and systems. Note, however, that t_{OD} increases with reduced V_{DR}. A level translator may be required to interface the digital output signals of the ADC14155 to non-1.8-V CMOS devices.

Care should be taken to avoid extremely rapid power supply ramp up rate. Excessive power supply ramp up rate may damage the device.

Copyright © 2008–2019, Texas Instruments Incorporated

10 Layout

10.1 Layout Guidelines

For best dynamic performance, the center die attach pad of the device should be connected to ground with low inductive path.

Proper grounding and proper routing of all signals are essential to ensure accurate conversion. Maintaining separate analog and digital areas of the board, with the ADC14155 between these areas, is required to achieve specified performance.

The ground return for the data outputs (DRGND) carries the ground current for the output drivers. The output current can exhibit high transients that could add noise to the conversion process. To prevent this from happening, it is recommended to use a single common ground plane with managed return current paths instead of a split ground plane. The key is to make sure that the supply current in the ground plane does not return under a sensitive node (e.g., caps to ground in the analog input network). This is done by routing a trace from the ADC to the regulator / bulk capacitor for the supply so that it does not run under a critical node.

Capacitive coupling between the typically noisy digital circuitry and the sensitive analog circuitry can lead to poor performance. The solution is to keep the analog circuitry separated from the digital circuitry, and to keep the clock line as short as possible.

The effects of the noise generated from the ADC output switching can be minimized through the use of 22-Ω resistors in series with each data output line. Locate these resistors as close to the ADC output pins as possible.

Since digital switching transients are composed largely of high frequency components, total ground plane copper weight will have little effect upon the logic-generated noise. This is because of the skin effect. Total surface area is more important than is total ground plane area.

Generally, analog and digital lines should cross each other at 90° to avoid crosstalk. To maximize accuracy in high speed, high resolution systems, however, avoid crossing analog and digital lines altogether. It is important to keep clock lines as short as possible and isolated from ALL other lines, including other digital lines. Even the generally accepted 90° crossing should be avoided with the clock line as even a little coupling can cause problems at high frequencies. This is because other lines can introduce jitter into the clock line, which can lead to degradation of SNR. Also, the high speed clock can introduce noise into the analog chain.

Best performance at high frequencies and at high resolution is obtained with a straight signal path. That is, the signal path through all components should form a straight line wherever possible.

Be especially careful with the layout of inductors and transformers. Mutual inductance can change the characteristics of the circuit in which they are used. Inductors and transformers should *not* be placed side by side, even with just a small part of their bodies beside each other. For instance, place transformers for the analog input and the clock input at 90° to one another to avoid magnetic coupling.

The analog input should be isolated from noisy signal traces to avoid coupling of spurious signals into the input. Any external component (e.g., a filter capacitor) connected between the converter's input pins and ground or to the reference input pin and ground should be connected to a very clean point in the ground plane.

All analog circuitry (input amplifiers, filters, reference components, etc.) should be placed in the analog area of the board. All digital circuitry and dynamic I/O lines should be placed in the digital area of the board. The ADC14155 should be between these two areas. Furthermore, all components in the reference circuitry and the input signal chain that are connected to ground should be connected together with short traces and enter the ground plane at a single, quiet point. All ground connections should have a low inductance path to ground.

Copyright © 2008–2019, Texas Instruments Incorporated

10.2 Layout Example

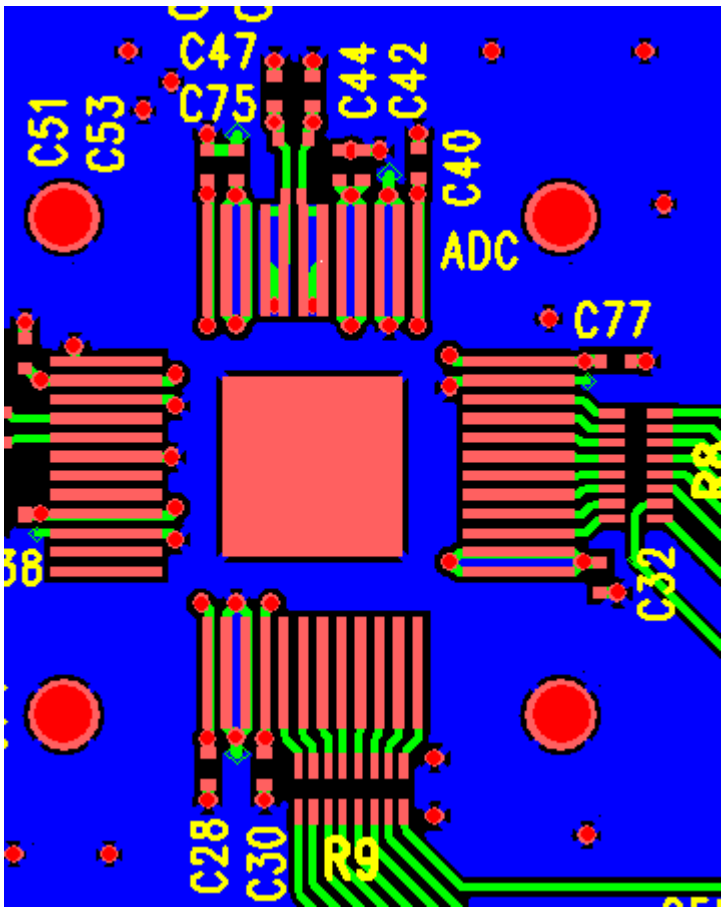


Figure 26. ADC14155QML Layout

版权 © 2008–2019, Texas Instruments Incorporated

11 器件和文档支持

11.1 器件支持

11.1.1 器件命名规则

孔径延迟是时钟下降沿之后到采集或保持输入信号以进行转换的时间。

孔径抖动（孔径不确定性）是样本之间孔径延迟的变化。孔径抖动在输出中表现为噪声。

时钟占空比一个周期内重复数字波形为高电平的时间与一个周期总时长的比值。这里的规格是指 ADC 时钟输入信号。

共模电压 (V_{CM}) 是施加到 ADC 的两个输入端子上的共用直流电压。

转换延迟是开始转换与数据出现在输出驱动器级中之间的时钟周期数。在获取样本之后，可以在输出引脚上获取任何给定样本的数据（流水线延迟和输出延迟）。可以在每个时钟周期获取新数据，但数据会将转换滞后流水线延迟的时间。

微分非线性 (DNL) 是对相对于理想步长 (1LSB) 的最大偏差的度量。

有效位数（ENOB 或有效位）是另一种用于指定信号噪声失真比或 SINAD 的方法。ENOB 定义为 (SINAD – 1.76) /6.02，表明转换器等效于具有该位数 (ENOB) 的理想 ADC。

全功率带宽是一个频率测量值，在此频率下，重构的输出基频会降至满标量程输入的低频值以下 3dB。

增益误差是指相对于传递函数理想斜率的偏差。可按以下方式来计算它：

增益误差 = 正满标量程误差 – 负满标量程误差 (4)

它还可以表示为正增益误差和负增益误差，计算方式如下：

PGE = 正满标量程误差 – 偏移误差 NGE = 偏移误差 – 负满标量程误差 (5)

积分非线性 (INL) 表示每个单独代码相对于从负满标量程（第一个代码转换之下 ½ LSB）到正满标量程（最后一个代码转之上 ½ LSB）画出的线的偏差。任意指定代码相对于该直线的偏差从该代码值的中心进行测量。

互调失真 (IMD) 是由于两个正弦频率同时被施加到 ADC 输入上所产生的额外频谱分量。它定义为互调产物中的功率与原始频率中的总功率之比。IMD 通常以 dBFS 为单位。

LSB（最低有效位）是所有位中具有最小值或最低权重的位。该值为$V_{FS}/2^n$，其中“V_{FS}”是满标量程输入电压，“n”是以位为单位的 ADC 分辨率。

缺失的代码是永远不会显示在 ADC 输出中的输出代码。ADC14155QML 保证不会有任何缺失的代码。

MSB（最高有效位）是具有最大值或最高权重的位。它的值是满量程的一半。

负满标量程误差是实际第一个代码转换与它的理想值（负满标量程之上 ½ LSB）之间的差值。

偏移误差是导致从代码 8191 到 8192 的转换所需的两个输入电压之间的差值 [(V_{IN}+) – (V_{IN}–)]。

输出延迟是在时钟的下降沿之后、输出引脚上出现数据更新之前的时间延迟。

流水线延迟 (LATENCY) 请参阅“转换延迟”。

正满标量程误差是实际最后一个代码转换与它的理想值（正满标量程之下 1½ LSB）之间的差值。

电源抑制比 (PSRR) 是对 ADC 抑制电源电压变化的能力的度量。PSRR 是电源处于直流电源下限的 ADC 满标量程输出与电源处于直流电源上限的 ADC 满标量程输出之比，以 dB 为单位。

信噪比 (SNR) 是输入信号的 rms 值与低于采样频率一半的所有其他频谱分量（不包括谐波或直流）之和的 rms 值之比，以 dB 为单位。

信号噪声失真比（S/N+D 或 SINAD） 是输入信号的 rms 值与低于时钟频率一半的所有其他频谱分量（包括谐波，但不包括直流）的 rms 值之比，以 dB 为单位。

无杂散动态范围 (SFDR) 是输入信号与杂散信号峰值的 rms 值之间的差值（以 dB 为单位），其中杂散信号是出现在输出频谱中但未出现在输入中的任何信号。

总谐波失真 (THD) 是输出端前九个谐波电平的总 rms 与输出端基波电平之比，以 dB 为单位。THD 的计算方法为

器件支持 (continued)

$$THD = 20 \times \log \sqrt{\frac{f_2^2 + \ldots + f_{10}^2}{f_1^2}} \quad (6)$$

其中 f_1 是基波（输出）频率的 RMS 功率，f_2 到 f_{10} 是输出频谱中前 9 个谐波频率的 RMS 功率。

二次谐波失真 **(2ND HARM)** 是输出端的输入频率中的 RMS 功率与输出端其二次谐波电平中的功率之间的差值，以 dB 为单位。

三次谐波失真 **(3RD HARM)** 是输出端的输入频率中的 RMS 功率与输出端其三次谐波电平中的功率之间的差值，以 dB 为单位。

11.2 接收文档更新通知

要接收文档更新通知，请导航至 TI.com.cn 上的器件产品文件夹。单击右上角的*通知我* 进行注册，即可每周接收产品信息更改摘要。有关更改的详细信息，请查看任何已修订文档中包含的修订历史记录。

11.3 社区资源

下列链接提供到 TI 社区资源的连接。链接的内容由各个分销商“按照原样”提供。这些内容并不构成 TI 技术规范，并且不一定反映 TI 的观点；请参阅 TI 的 《使用条款》。

TI E2E™ Online Community ***TI's Engineer-to-Engineer (E2E) Community.*** Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

Design Support ***TI's Design Support*** Quickly find helpful E2E forums along with design support tools and contact information for technical support.

11.4 商标

E2E is a trademark of Texas Instruments.
All other trademarks are the property of their respective owners.

11.5 静电放电警告

ESD 可能会损坏该集成电路。德州仪器 (TI) 建议通过适当的预防措施处理所有集成电路。如果不遵守正确的处理措施和安装程序，可能会损坏集成电路。

ESD 的损坏小至导致微小的性能降级，大至整个器件故障。 精密的集成电路可能更容易受到损坏，这是因为非常细微的参数更改都可能会导致器件与其发布的规格不相符。

11.6 术语表

SLYZ022 — *TI 术语表*。

这份术语表列出并解释术语、缩写和定义。

12 机械、封装和可订购信息

以下页面包含机械、封装和可订购信息。这些信息是指定器件的最新可用数据。数据如有变更，恕不另行通知，且不会对此文档进行修订。如需获取此数据表的浏览器版本，请查阅左侧的导航栏。

版权 © 2008–2019, Texas Instruments Incorporated

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
5962R0626201VXC	Active	Production	CFP (NBA) | 48	14 | TUBE	-	Call TI	Level-1-NA-UNLIM	-55 to 125	5962 R0626201VXC ADC14155-RHA
5962R0626201VXC.A	Active	Production	CFP (NBA) | 48	14 | TUBE	-	Call TI	Level-1-NA-UNLIM	-55 to 125	5962 R0626201VXC ADC14155-RHA
ADC14155W-MLS	Active	Production	CFP (NBA) | 48	14 | TUBE	-	Call TI	Level-1-NA-UNLIM	-55 to 125	ADC14155W -MLS
ADC14155W-MLS.A	Active	Production	CFP (NBA) | 48	14 | TUBE	-	Call TI	Level-1-NA-UNLIM	-55 to 125	ADC14155W -MLS
ADC14155W-MPR	Active	Production	CFP (NBA) | 48	14 | TUBE	-	Call TI	Level-1-NA-UNLIM	25 to 25	ADC14155W -MPR ES
ADC14155W-MPR.A	Active	Production	CFP (NBA) | 48	14 | TUBE	-	Call TI	Level-1-NA-UNLIM	25 to 25	ADC14155W -MPR ES

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

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

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

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

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

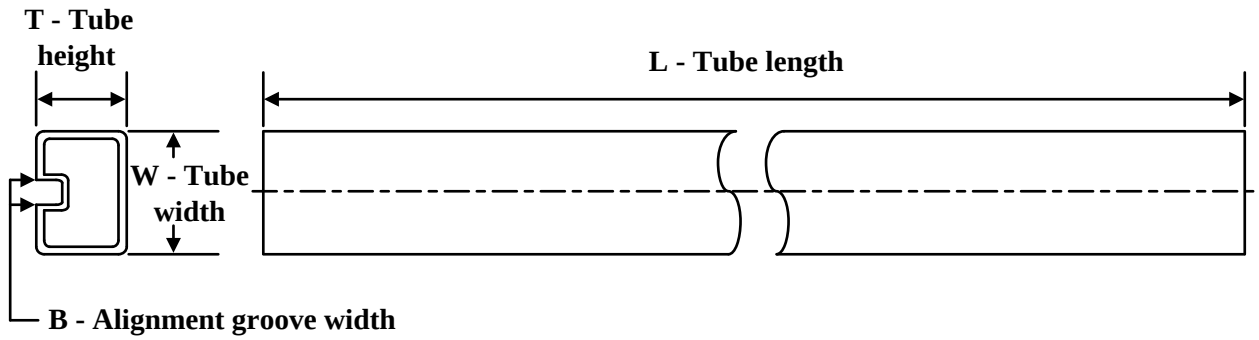
(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

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

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

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

TUBE



*All dimensions are nominal

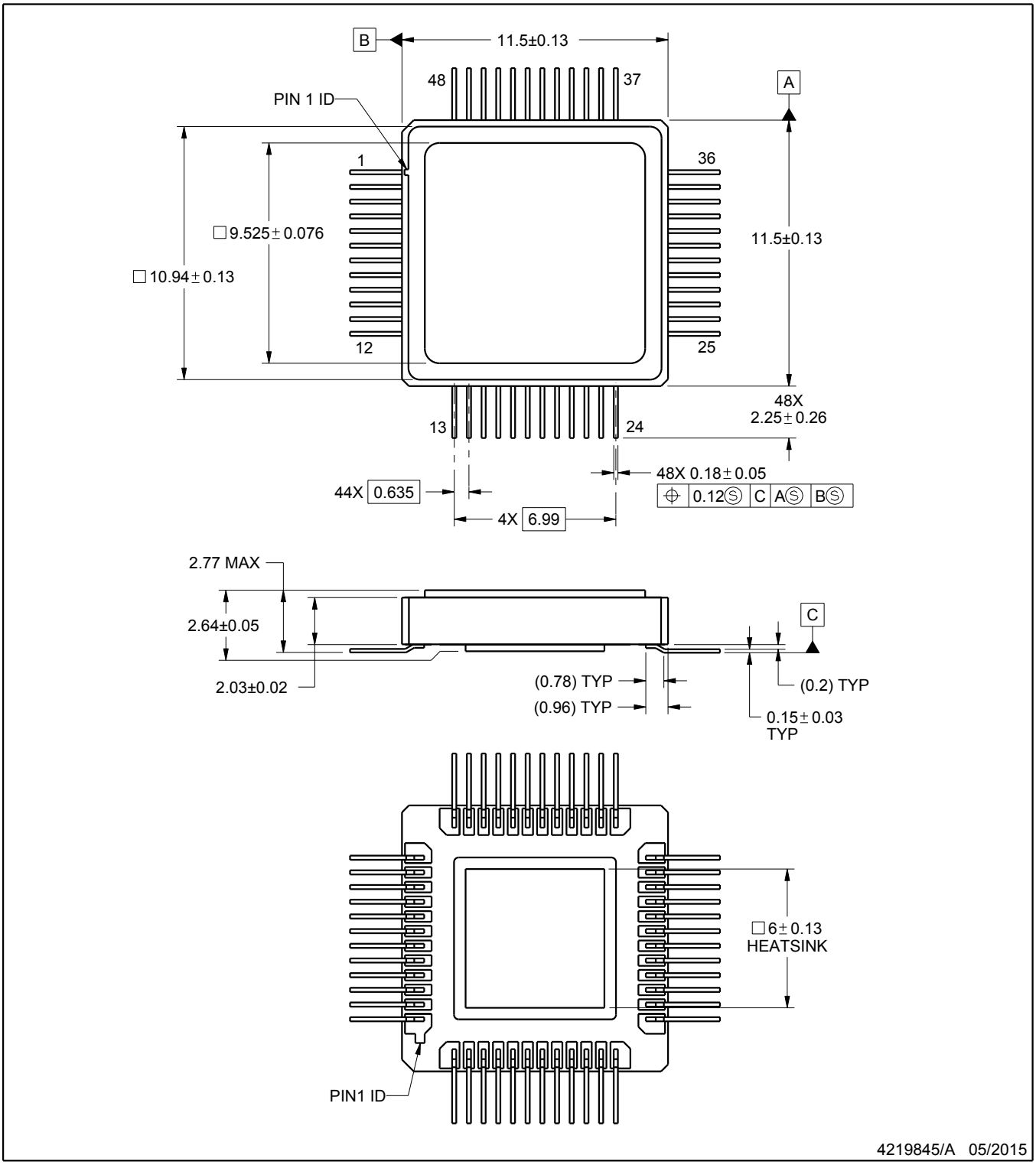
Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
5962R0626201VXC	NBA	CFP	48	14	495	33	11176	16.51
5962R0626201VXC.A	NBA	CFP	48	14	495	33	11176	16.51
ADC14155W-MLS	NBA	CFP	48	14	495	33	11176	16.51
ADC14155W-MLS.A	NBA	CFP	48	14	495	33	11176	16.51
ADC14155W-MPR	NBA	CFP	48	14	495	33	11176	16.51
ADC14155W-MPR.A	NBA	CFP	48	14	495	33	11176	16.51

PACKAGE OUTLINE

NBA0048A

CFP - 2.77 mm max height

CERAMIC FLATPACK



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.

重要通知和免责声明

TI“按原样”提供技术和可靠性数据（包括数据表）、设计资源（包括参考设计）、应用或其他设计建议、网络工具、安全信息和其他资源，不保证没有瑕疵且不做出任何明示或暗示的担保，包括但不限于对适销性、与某特定用途的适用性或不侵犯任何第三方知识产权的暗示担保。

这些资源可供使用 TI 产品进行设计的熟练开发人员使用。您将自行承担以下全部责任：(1) 针对您的应用选择合适的 TI 产品，(2) 设计、验证并测试您的应用，(3) 确保您的应用满足相应标准以及任何其他安全、安保法规或其他要求。

这些资源如有变更，恕不另行通知。TI 授权您仅可将这些资源用于研发本资源所述的 TI 产品的相关应用。严禁以其他方式对这些资源进行复制或展示。您无权使用任何其他 TI 知识产权或任何第三方知识产权。对于因您对这些资源的使用而对 TI 及其代表造成的任何索赔、损害、成本、损失和债务，您将全额赔偿，TI 对此概不负责。

TI 提供的产品受 TI 销售条款)、TI 通用质量指南 或 ti.com 上其他适用条款或 TI 产品随附的其他适用条款的约束。TI 提供这些资源并不会扩展或以其他方式更改 TI 针对 TI 产品发布的适用的担保或担保免责声明。 除非德州仪器 (TI) 明确将某产品指定为定制产品或客户特定产品，否则其产品均为按确定价格收入目录的标准通用器件。

TI 反对并拒绝您可能提出的任何其他或不同的条款。

版权所有 © 2026，德州仪器 (TI) 公司

最后更新日期：2025 年 10 月