

# 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)
  - 单粒子门锁为 120MeV-cm<sup>2</sup>/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 ( $f_{IN} = 70\text{MHz}$ ) 70.1dBFS (典型值)
  - SFDR ( $f_{IN} = 70\text{MHz}$ ) 82.3dBFS (典型值)
  - ENOB ( $f_{IN} = 70\text{MHz}$ ) 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

## 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。

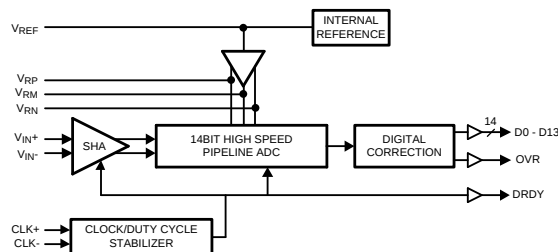
器件信息<sup>(1)</sup>

| 器件编号            | 等级                             | 封装        |
|-----------------|--------------------------------|-----------|
| 5962R0626201VXC | QMLV RHA (SMD 器件)<br>[100krad] | CQFP (48) |
| ADC14155W-MLS   | 飞行 RHA (非 SMD 器件)<br>[100krad] | CQFP (48) |
| ADC14155W-MPR   | 工程样片 <sup>(2)</sup>            | 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。

框图



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## 4 修订历史记录

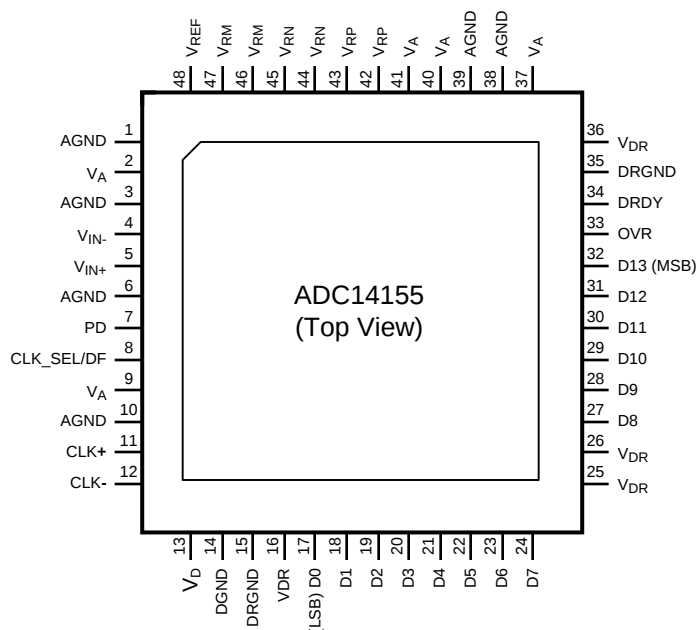
注：之前版本的页码可能与当前版本有所不同。

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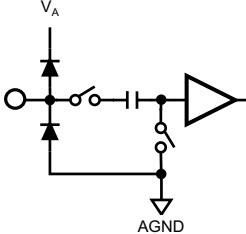
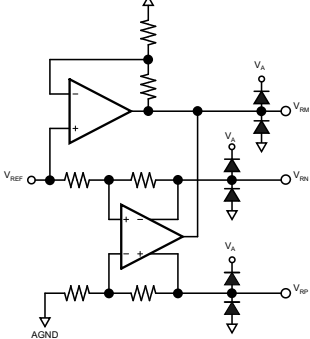
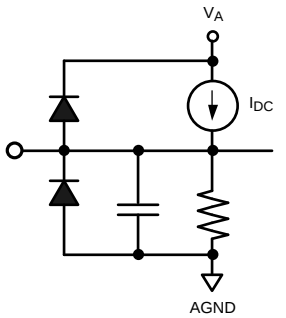
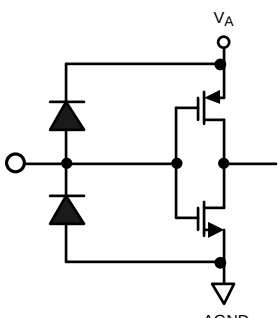
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| 已添加 添加了器件信息表、ESD 额定值表、特性说明部分，器件功能模式部分，应用和实施部分，电源相关建议部分，布局部分，器件和文档支持部分以及机械、封装和可订购信息部分 ..... | 1    |
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## 5 Pin Configuration and Functions

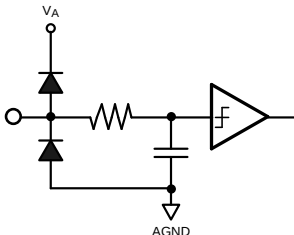
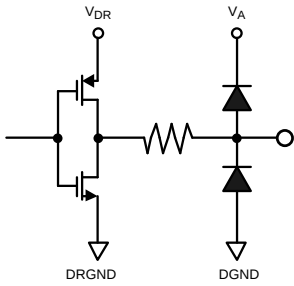
**NBA Package  
48-Pin CFP  
Top View**



### Pin Descriptions And Equivalent Circuits

| PIN NO.            | SYMBOL    | EQUIVALENT CIRCUIT                                                                  | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|--------------------|-----------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>ANALOG I/O</b>  |           |                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 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- $\mu$ F capacitor placed very close to the pin to minimize stray inductance. A 0.1- $\mu$ F capacitor should be placed between $V_{RP}$ and $V_{RN}$ as close to the pins as possible, and a 10- $\mu$ F capacitor should be placed in parallel.<br>$V_{RP}$ and $V_{RN}$ should not be loaded. $V_{RM}$ may be loaded to 1mA for use as a temperature stable 1.5-V reference.<br>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).<br>To use the internal reference, $V_{REF}$ should be decoupled to AGND with a 0.1- $\mu$ F, low equivalent series inductance (ESL) capacitor. In this mode, $V_{REF}$ defaults as the output for the internal 1.0-V reference.<br>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 9k $\Omega$ . Therefore, to overdrive this pin, the impedance of the external reference source should be $\ll$ 9 k $\Omega$ .<br>This pin should not be used to source or sink current.<br>The full scale differential input voltage range is $2 * V_{REF}$ . |
| <b>DIGITAL I/O</b> |           |                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 11                 | CLK+      |  | The clock input pins can be configured to accept either a single-ended or a differential clock input signal.<br>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.<br>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.<br>The analog input is sampled on the falling edge of the clock input.                                                                                                                                                                                                                                                                                                                            |
| 12                 | CLK-      |                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

### Pin Descriptions And Equivalent Circuits (continued)

| PIN NO.                | SYMBOL     | EQUIVALENT CIRCUIT                                                                | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------------------|------------|-----------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 8                      | CLK_SEL/DF |  | <p>This is a four-state pin controlling the input clock mode and output data format.</p> <p>CLK_SEL/DF = <math>V_A</math>, CLK+ and CLK– are configured as a differential clock input. The output data format is 2's complement.</p> <p>CLK_SEL/DF = <math>(2 / 3) * V_A</math>, CLK+ and CLK– are configured as a differential clock input. The output data format is offset binary.</p> <p>CLK_SEL/DF = <math>(1 / 3) * V_A</math>, CLK+ is configured as a single-ended clock input and CLK– should be tied to AGND. The output data format is 2's complement.</p> <p>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.</p> |
| 7                      | PD         |                                                                                   | <p>This is a two-state input controlling Power Down.</p> <p>PD = <math>V_A</math>, Power Down is enabled. In the Power Down state only the reference voltage circuitry remains active and power dissipation is reduced.</p> <p>PD = AGND, Normal operation.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 17-24,<br>27-32        | D0–D13     |  | <p>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.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 33                     | OVR        |                                                                                   | <p>Over-Range Indicator. This output is set HIGH when the input amplitude exceeds the 14-bit conversion range (0 to 16383).</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 34                     | DRDY       |                                                                                   | <p>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.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| ANALOG POWER           |            |                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 2, 9, 37, 40,<br>41    | $V_A$      |                                                                                   | <p>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-<math>\mu</math>F capacitors located close to the power pins.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 1, 3, 6, 10,<br>38, 39 | AGND       |                                                                                   | <p>The ground return for the analog supply.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| DIGITAL POWER          |            |                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 13                     | $V_D$      |                                                                                   | <p>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-<math>\mu</math>F capacitor located close to the power pin.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 14                     | DGND       |                                                                                   | <p>The ground return for the digital supply.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 16, 25, 26,<br>36      | $V_{DR}$   |                                                                                   | <p>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-<math>\mu</math>F capacitors located close to the power pins.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 15, 35                 | DRGND      |                                                                                   | <p>The ground return for the digital output driver supply. These pins should be connected to the system digital ground. See <a href="#">Layout Guidelines</a> (Layout and Grounding) for more details.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

## 6 Specifications

### 6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)<sup>(1)(2)</sup>

|                                                  | 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 <sup>(1)</sup> | ±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)<sup>(1)</sup>

|                                   | 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 $ <sup>(2)</sup>    |       |     | 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 | UNIT |
|----------------------------------------|----------------------------------------------|-------------|------|
|                                        |                                              | NBA (CFP)   |      |
|                                        |                                              | 48 PINS     |      |
| $R_{\theta JA}$                        | 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 |
| $\Psi_{JT}$                            | Junction-to-top characterization parameter   | 4.6         | °C/W |
| $\Psi_{JB}$                            | Junction-to-board characterization parameter | 11.1        | °C/W |
| $R_{\theta JC(bottom)}$ <sup>(1)</sup> | Junction-to-case (bottom) thermal resistance | 3.0         | °C/W |

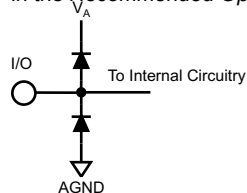
- (1) For more information about traditional and new thermal metrics, see the [Semiconductor and IC Package Thermal Metrics](#) application report.

## 6.5 ADC14155 Converter Electrical Characteristics DC Parameters<sup>(1)</sup>

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  $T_A = 25^\circ\text{C}$ . <sup>(2)(3)(4)(5)</sup>

| PARAMETER                                             | TEST CONDITIONS                                      | NOTES              | TYP <sup>(6)</sup> | MIN   | MAX   | UNITS   | SUB-GROUPS |
|-------------------------------------------------------|------------------------------------------------------|--------------------|--------------------|-------|-------|---------|------------|
| <b>STATIC CONVERTER CHARACTERISTICS</b>               |                                                      |                    |                    |       |       |         |            |
| Resolution with no missing codes                      |                                                      |                    | 14                 |       |       | Bits    | [1, 2, 3]  |
| INL Integral non linearity                            |                                                      | See <sup>(7)</sup> | 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                               | $-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$ |                    | 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                      | $-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$ |                    | 0.0001             |       |       | Δ%FS/°C |            |
| Under range output code                               |                                                      |                    | 0                  | 0     | 0     |         |            |
| Over range output code                                |                                                      |                    | 16383              | 16383 | 16383 |         |            |
| <b>REFERENCE AND ANALOG INPUT CHARACTERISTICS</b>     |                                                      |                    |                    |       |       |         |            |
| $V_{CM}$ 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 <sup>(8)</sup> | 9                  |       |       | pF      |            |
|                                                       | $V_{IN} = 1.5$ Vdc ± 0.5 V (CLK HIGH)                | See <sup>(8)</sup> | 6                  |       |       | pF      |            |
| $V_{REF}$ Reference voltage                           |                                                      | See <sup>(9)</sup> | 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  $|V_A - V_D| \leq 100$  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  $\mu\text{V}$ .
- (5) When the input voltage at any pin exceeds the power supplies (that is,  $V_{IN} < \text{AGND}$ , or  $V_{IN} > V_A$ ), the current at that pin should be limited to  $\pm 5$  mA. The  $\pm 50$ -mA maximum package input current rating limits the number of pins that can safely exceed the power supplies with an input current of  $\pm 5$  mA to 10.
- (6) Typical figures are at  $T_A = 25^\circ\text{C}$  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.

# ADC14155QML-SP

ZHCSHX9K – NOVEMBER 2008 – REVISED SEPTEMBER 2018

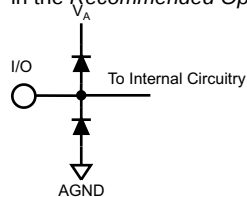
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## 6.6 ADC14155 Converter Electrical Characteristics (Continued) DYNAMIC Parameters<sup>(1)</sup>

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  $T_A = 25^\circ\text{C}$ . <sup>(2)(3)(4)(5)</sup>

| PARAMETER                                                               | TEST CONDITIONS                  | NOTES                       | TYP <sup>(6)</sup> | MIN  | MAX | UNITS | SUB-GROUPS |
|-------------------------------------------------------------------------|----------------------------------|-----------------------------|--------------------|------|-----|-------|------------|
| <b>DYNAMIC CONVERTER CHARACTERISTICS, <math>A_{IN} = -1</math> dBFS</b> |                                  |                             |                    |      |     |       |            |
| 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 distortion        | $f_{IN} = 10$ 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  $\mu\text{V}$ .
- (5) When the input voltage at any pin exceeds the power supplies (that is,  $V_{IN} < \text{AGND}$ , or  $V_{IN} > V_A$ ), the current at that pin should be limited to  $\pm 5$  mA. The  $\pm 50$  mA maximum package input current rating limits the number of pins that can safely exceed the power supplies with an input current of  $\pm 5$  mA to 10.
- (6) Typical figures are at  $T_A = 25^\circ\text{C}$  and represent most likely parametric norms at the time of product characterization. The typical specifications are not ensured.

**ADC14155 Converter Electrical Characteristics (Continued) DYNAMIC Parameters<sup>(1)</sup> (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  $T_A = 25^\circ\text{C}$ . <sup>(2)(3)(4)(5)</sup>

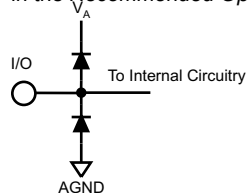
| PARAMETER |                                      | TEST CONDITIONS    | NOTES | TYP <sup>(6)</sup> | MIN  | MAX | UNITS | SUB-GROUPS                |
|-----------|--------------------------------------|--------------------|-------|--------------------|------|-----|-------|---------------------------|
| HD3       | Third-order harmonic distortion      | $f_{IN} = 10$ MHz  |       | –81.6              |      |     | dBFS  |                           |
|           |                                      | $f_{IN} = 70$ MHz  |       | –82.3              |      | –68 | dBFS  | <a href="#">[4, 5, 6]</a> |
|           |                                      | $f_{IN} = 169$ 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  | <a href="#">[4, 5, 6]</a> |
|           |                                      | $f_{IN} = 169$ MHz |       | 68.3               |      |     | dBFS  |                           |
|           |                                      | $f_{IN} = 238$ MHz |       | 67.8               |      |     | dBFS  |                           |
|           |                                      | $f_{IN} = 398$ MHz |       | 61.5               |      |     | dBFS  |                           |

## 6.7 ADC14155 Converter Electrical Characteristics (Continued) Logic and Power Supply Electrical Characteristics<sup>(1)</sup>

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  $T_A = 25^\circ\text{C}$ . Timing measurements are taken at 50% of the signal amplitude. <sup>(2)(3)(4)(5)</sup>

| PARAMETER                                                      | TEST CONDITIONS                     | NOTES                                 | TYP <sup>(6)</sup> | MIN  | MAX  | UNITS | SUB-GROUPS |
|----------------------------------------------------------------|-------------------------------------|---------------------------------------|--------------------|------|------|-------|------------|
| <b>DIGITAL INPUT CHARACTERISTICS (CLK, PD/DCS, CLK_SEL/DF)</b> |                                     |                                       |                    |      |      |       |            |
| $V_{IN(1)}$                                                    | Logical "1" input voltage           | $V_D = 3.6$ V                         | See <sup>(7)</sup> | 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    |            |
| <b>DIGITAL OUTPUT CHARACTERISTICS (D0–D13, DRDY, OVR)</b>      |                                     |                                       |                    |      |      |       |            |
| $V_{OH}$                                                       | Output logic high                   | $I_{OUT} = -0.5$ mA, $V_{DR} = 1.8$ V | See <sup>(7)</sup> | 1.55 | 1.2  | V     | [1, 2, 3]  |
| $V_{OL}$                                                       | Output logic low                    | $I_{OUT} = 1.6$ mA, $V_{DR} = 1.8$ V  | See <sup>(7)</sup> | 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    |            |
| <b>POWER SUPPLY CHARACTERISTICS</b>                            |                                     |                                       |                    |      |      |       |            |
| $I_A$                                                          | 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 <sup>(8)</sup> | 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.



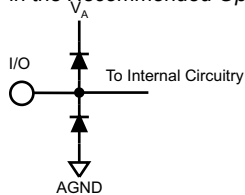
- (3) To ensure accuracy, it is required that  $|V_A - V_D| \leq 100$  mV and separate bypass capacitors are used at each power supply pin.
- (4) With the test condition for  $V_{REF} = 1$  V ( $2 \cdot V_{P-P}$  differential input), the 14-bit LSB is 122.1 μV.
- (5) When the input voltage at any pin exceeds the power supplies (that is,  $V_{IN} < \text{AGND}$ , 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  $T_A = 25^\circ\text{C}$  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).  $I_{DR} = V_{DR}(C_0 \times f_0 + C_1 \times f_1 + \dots + C_{11} \times f_{11})$  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.

## 6.8 ADC14155 Converter Electrical Characteristics (Continued) Timing and AC Characteristics<sup>(1)</sup>

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  $T_A = 25^\circ\text{C}$ . Timing measurements are taken at 50% of the signal amplitude. **Boldface limits apply for  $T_{MIN} \leq T_A \leq T_{MAX}$ .** All other limits apply for  $T_A = 25^\circ\text{C}$ <sup>(2)(3)(4)(5)</sup>

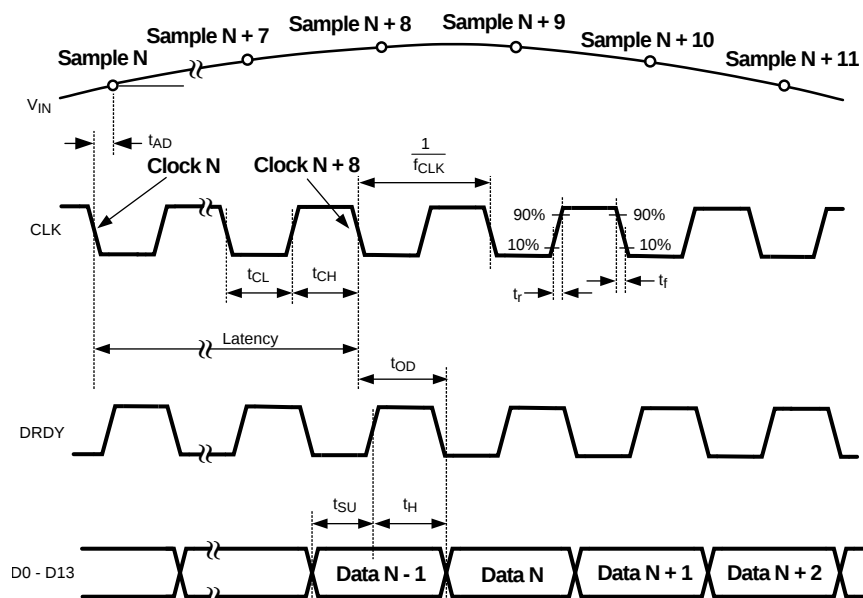
| PARAMETER                            | TEST CONDITIONS                                                                                                                                                   | NOTES              | TYP <sup>(6)</sup> | MIN         | MAX | UNITS        | SUB-GROUPS  |
|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|--------------------|-------------|-----|--------------|-------------|
| 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 <sup>(7)</sup> |                    |             | 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 <sup>(8)</sup> | 2.1                | <b>1.22</b> |     | ns           |             |
| $t_H$ Data output hold time          | Relative to DRDY                                                                                                                                                  | See <sup>(8)</sup> | 2.1                | <b>1.83</b> |     | ns           |             |
| $t_{AD}$ Aperture delay              |                                                                                                                                                                   |                    | 0.5                |             |     | ns           |             |
| $t_{AJ}$ Aperture jitter             |                                                                                                                                                                   |                    | 0.08               |             |     | ps rms       |             |
| Power down recovery time             | 0.1 $\mu\text{F}$ to GND on pins 43, 44; 10 $\mu\text{F}$ and 0.1 $\mu\text{F}$ between pins 43, 44; 0.1 $\mu\text{F}$ and 10 $\mu\text{F}$ 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.



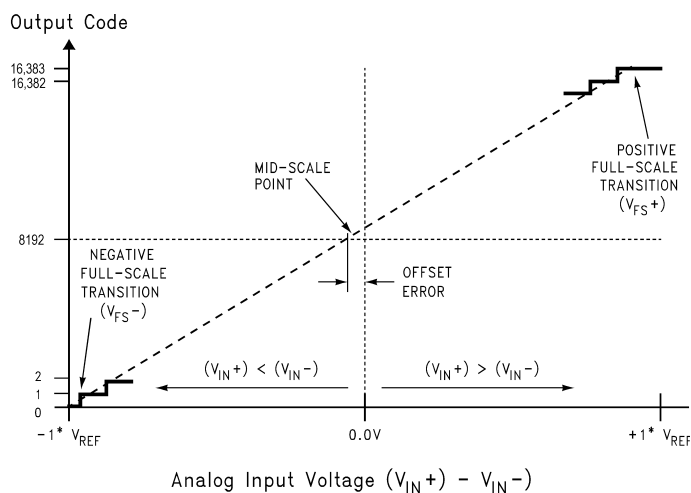
- (3) To ensure accuracy, it is required that  $|V_A - V_D| \leq 100$  mV and separate bypass capacitors are used at each power supply pin.
- (4) With the test condition for  $V_{REF} = 1$  V ( $2 \cdot V_{P-P}$  differential input), the 14-bit LSB is 122.1  $\mu\text{V}$ .
- (5) When the input voltage at any pin exceeds the power supplies (that is,  $V_{IN} < \text{AGND}$ , or  $V_{IN} > V_A$ ), the current at that pin should be limited to  $\pm 5$  mA. The  $\pm 50$  mA maximum package input current rating limits the number of pins that can safely exceed the power supplies with an input current of  $\pm 5$  mA to 10.
- (6) Typical figures are at  $T_A = 25^\circ\text{C}$  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.

## 6.9 Timing Diagram



**Figure 1. Output Timing**

## 6.10 Transfer Characteristic



**Figure 2. Transfer Characteristic**

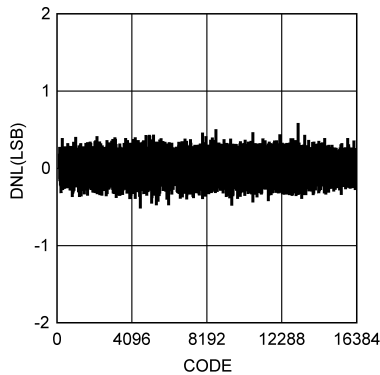
**Transfer Characteristic (continued)**
**Table 1. Quality Conformance Inspection<sup>(1)</sup>**

| 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       |

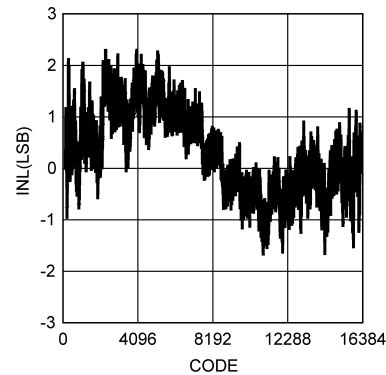
(1) MIL-STD-883, Method 5005 - Group A

## 6.11 Typical Performance Characteristics, DNL, INL

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

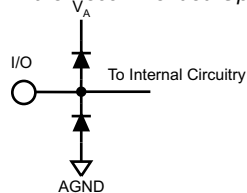


**Figure 3. DNL**



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

## 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

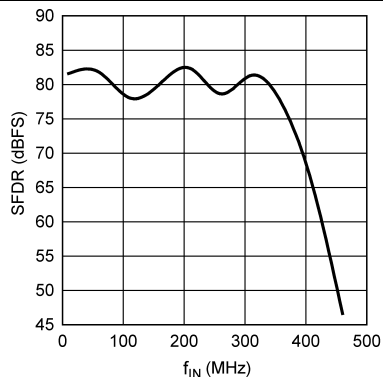


Figure 5. SFDR vs  $f_{IN}$

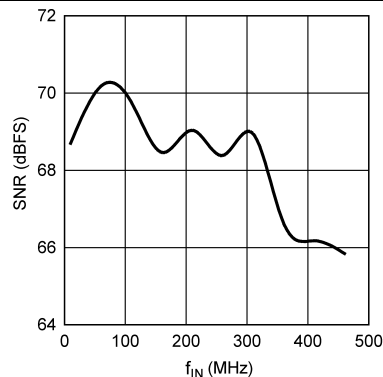


Figure 6. SNR vs  $f_{IN}$

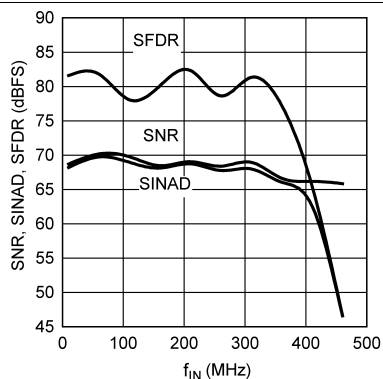


Figure 7. SNR, SINAD, SFDR vs  $f_{IN}$

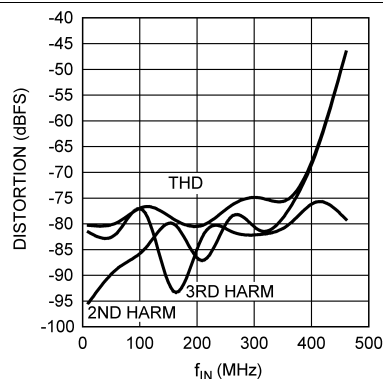


Figure 8. Distortion vs  $f_{IN}$

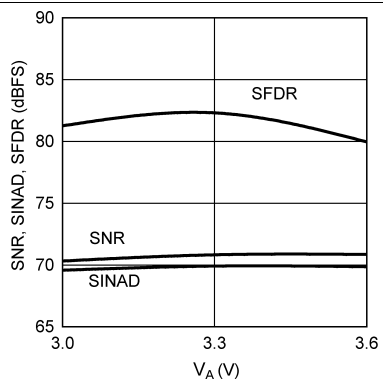


Figure 9. SNR, SINAD, SFDR vs  $V_A$

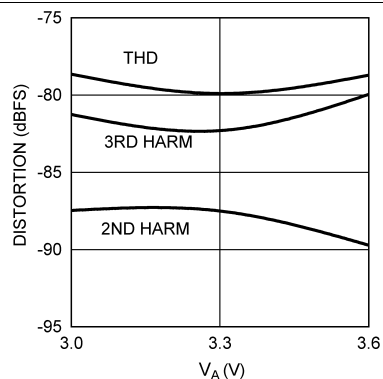
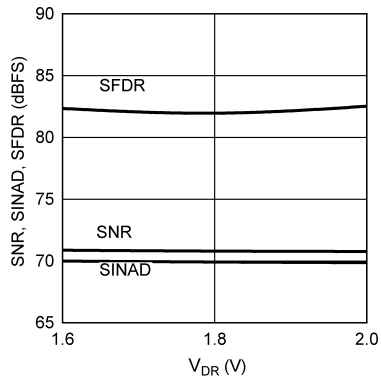


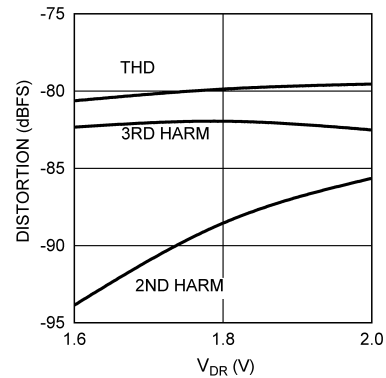
Figure 10. Distortion vs  $V_A$

## Typical Performance Characteristics, Dynamic Performance (continued)

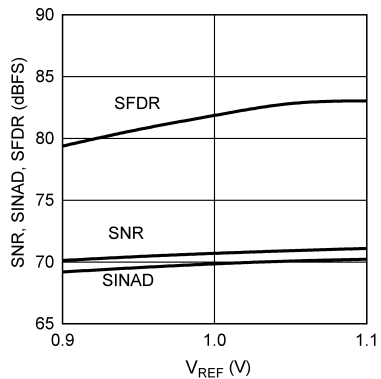
Unless otherwise specified, the following specifications apply:  $AGND = DGND = DRGND = 0\text{ V}$ ,  $V_A = V_D = 3.3\text{ V}$ ,  $V_{DR} = 1.8\text{ V}$ , Internal  $V_{REF} = 1\text{ V}$ ,  $f_{CLK} = 155\text{ MHz}$ ,  $V_{CM} = V_{RM}$ ,  $C_L = 5\text{ pF/pin}$ , Differential Analog Input, Single-Ended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



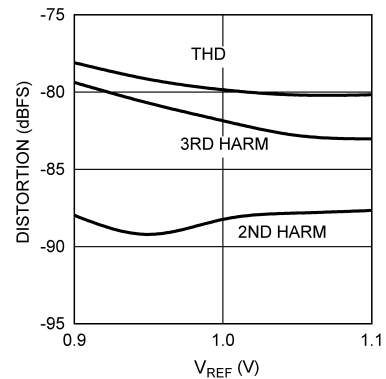
**Figure 11. SNR, SINAD, SFDR vs  $V_{DR}$**



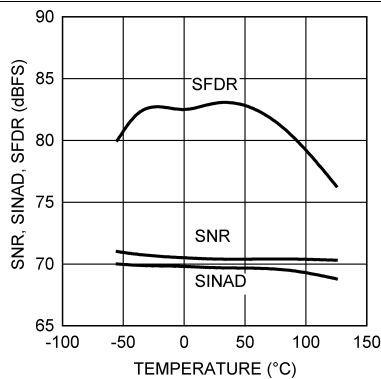
**Figure 12. Distortion vs  $V_{DR}$**



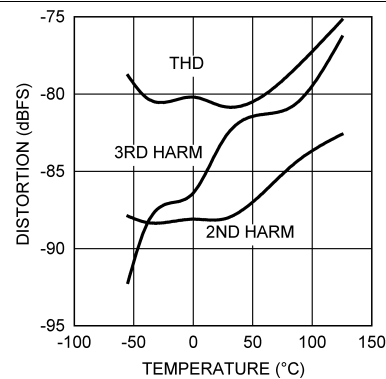
**Figure 13. SNR, SINAD, SFDR vs  $V_{REF}$**



**Figure 14. Distortion vs  $V_{REF}$**



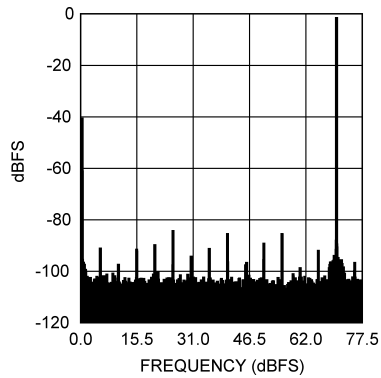
**Figure 15. SNR, SINAD, SFDR vs Temperature**



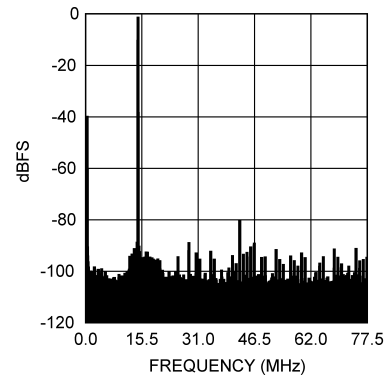
**Figure 16. Distortion vs Temperature**

## Typical Performance Characteristics, Dynamic Performance (continued)

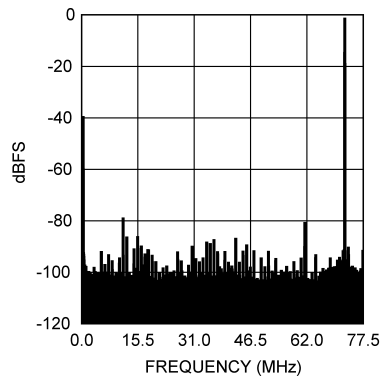
Unless otherwise specified, the following specifications apply: AGND = DGND = DRGND = 0 V,  $V_A = V_D = 3.3$  V,  $V_{DR} = 1.8$  V, Internal  $V_{REF} = 1$  V,  $f_{CLK} = 155$  MHz,  $V_{CM} = V_{RM}$ ,  $C_L = 5$  pF/pin, Differential Analog Input, Single-Ended Clock Mode, Offset Binary Format. Typical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



**Figure 17. Spectral Response at 70-MHz Input**



**Figure 18. Spectral Response at 169-MHz Input**



**Figure 19. Spectral Response at 238-MHz Input**

## 7 Detailed Description

### 7.1 Overview

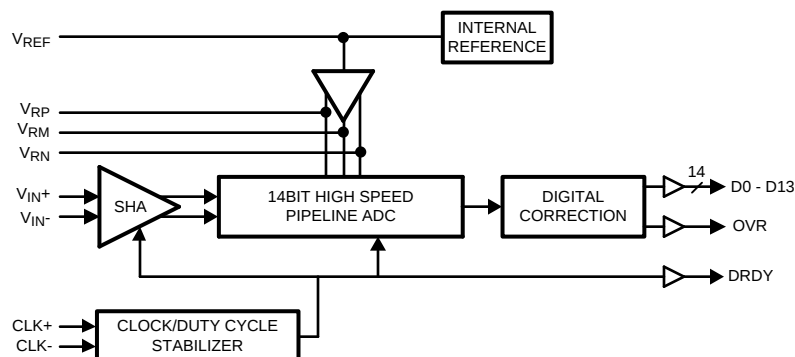
Operating on dual 3.3-V and 1.8-V supplies, the ADC14155 digitizes a differential analog input signal to 14 bits, using a differential pipelined architecture with error correction circuitry and an on-chip sample-and-hold circuit to ensure maximum performance.

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

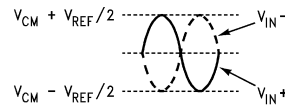
##### 7.3.1.1 Differential Analog Input Pins

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 20 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.

## Feature Description (continued)

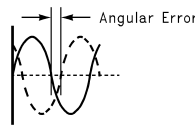


**Figure 20. Expected Input Signal Range**

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

$$E_{FS} = 16384 (1 - \sin(90^\circ + \text{dev})) \quad (2)$$

Where dev is the angular difference in degrees between the two signals having a  $180^\circ$  relative phase relationship to each other (see Figure 21). 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 21. 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  $100 \Omega$ . 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.

A single-ended to differential conversion circuit is shown in [Figure 23](#). 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 circuitry used, as this affects how quickly the sample-and-hold charging glitch will settle. An external resistor and capacitor network as shown in [Figure 23](#) 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- $\mu$ F 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- $\mu$ F capacitor. A 0.1- $\mu$ F and a 10- $\mu$ F capacitor should be placed between the  $V_{RP}$  and  $V_{RN}$  pins, as shown in [Figure 23](#). 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:

$$V_{RM} = 1.5 \text{ V}$$

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

$$V_{RN} = V_{RM} - V_{REF} / 2$$

### 7.3.3 Digital Inputs

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

### 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 23](#). 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 23](#) 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

$$C \geq \frac{4 \times t_{PD} \times L}{Z_0} \quad (3)$$

where  $t_{PD}$  is the signal propagation rate down the clock line, "L" is the line length and  $Z_0$  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.

### 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.

## 8 Application and Implementation

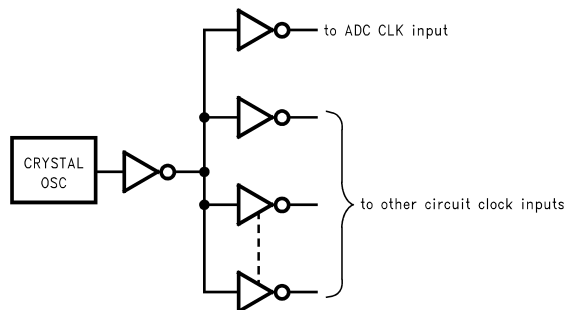
### NOTE

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

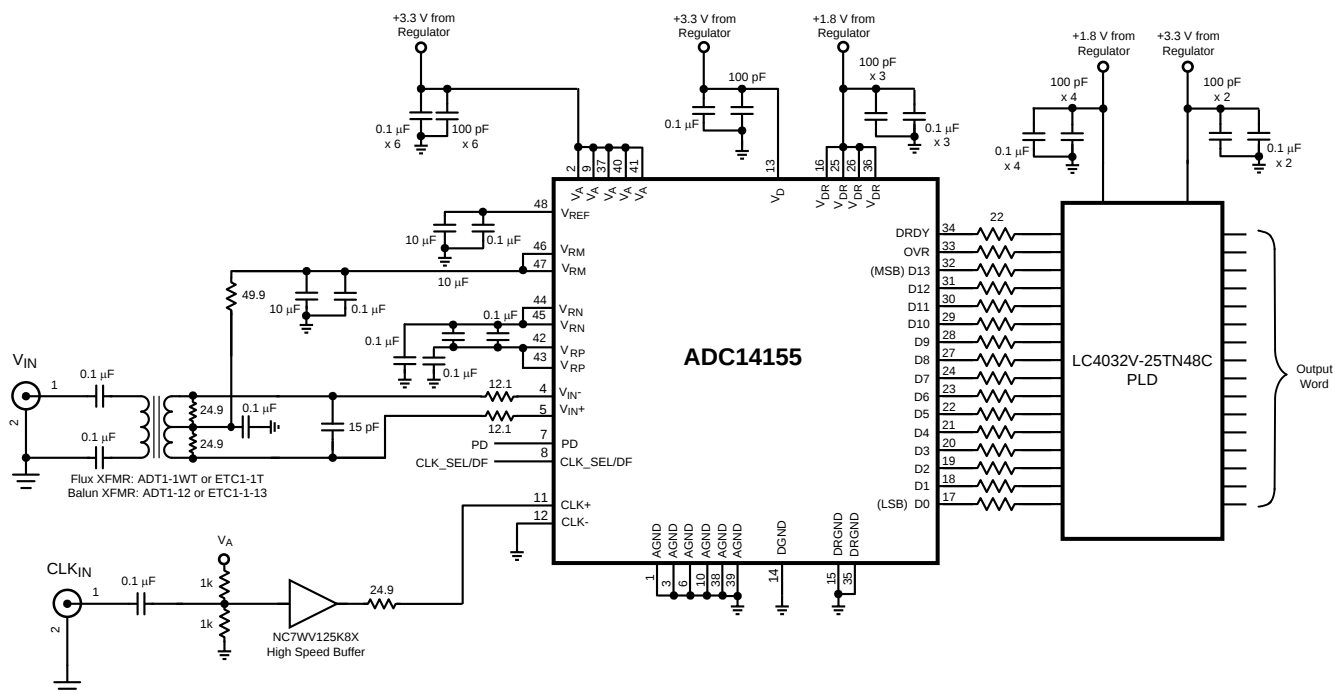
To achieve the best dynamic performance, the clock source driving the CLK input must have a sharp transition region and be free of jitter. Isolate the ADC clock from any digital circuitry with buffers, as with the clock tree shown in [Figure 22](#). The gates used in the clock tree must be capable of 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 22. Isolating the ADC Clock From Other Circuitry With a Clock Tree**

## 8.2 Typical Application



**Figure 23. Application Circuit Using Transformer Drive Circuit**

### 8.2.1 Design Requirements

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

$$3 \text{ V} \leq V_A \leq 3.6 \text{ V}$$

$$V_D = V_A$$

$$V_{DB} = 1.8 \text{ V}$$

$$5 \text{ MHz} \leq f_{\text{CLK}} \leq 155 \text{ MHz}$$

1-V internal reference

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

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

### 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<sup>\(1\)</sup>](#) 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.

## 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  $\Omega$  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 23](#).

### 8.2.3 Application Curve

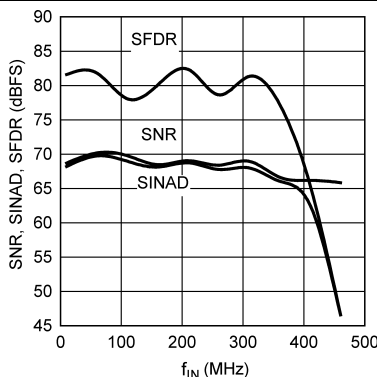


Figure 24. SNR, SINAD, SFDR vs  $f_{IN}$

## 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 performed 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](#).

## 9 Power Supply Recommendations

The power supply pins should be bypassed with a 0.1- $\mu$ F 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<sub>P-P</sub>.

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.

## 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- $\Omega$  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.

## 10.2 Layout Example

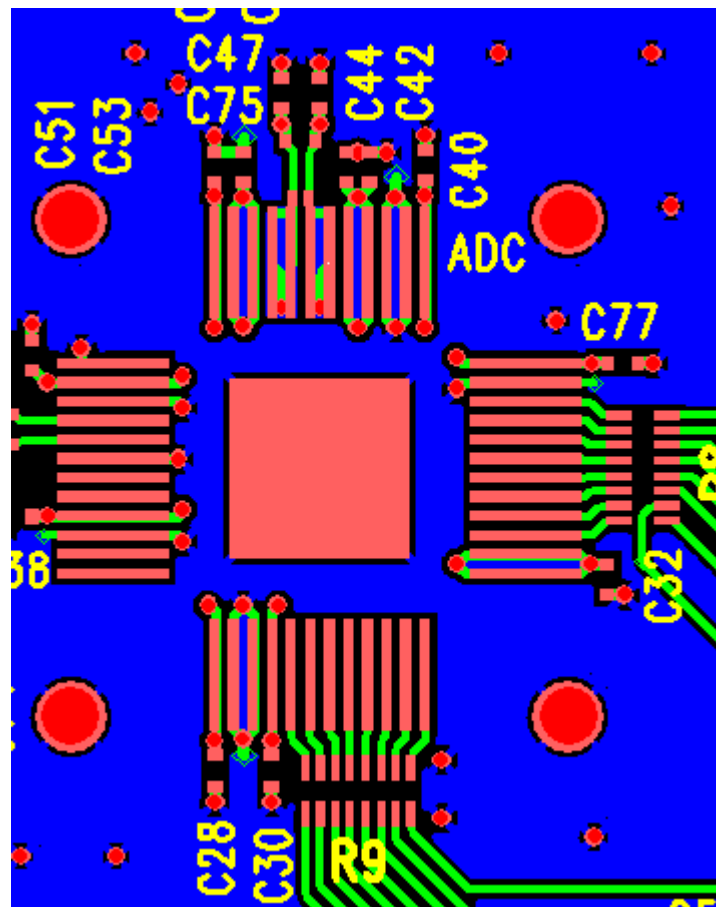


Figure 25. ADC14155QML Layout

## 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：

$$\text{增益误差} = \text{正满标量程误差} - \text{负满标量程误差} \quad (4)$$

它还可以表示为正增益误差和负增益误差，计算方式如下：

$$PGE = \text{正满标量程误差} - \text{偏移误差} \quad NGE = \text{偏移误差} - \text{负满标量程误差} \quad (5)$$

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  $\frac{1}{2}$  LSB）到正满标量程（最后一个代码转之上  $\frac{1}{2}$  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  $\frac{1}{2}$  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  $1\frac{1}{2}$  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)

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

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](http://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》](#)。

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**设计支持** [TI 参考设计支持](#) 可帮助您快速查找有帮助的 E2E 论坛、设计支持工具以及技术支持的联系信息。

### 11.4 商标

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### 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。

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