

ADS54J64 四通道、14 位、1GSPS、2 倍过采样模数转换器

1 特性

- 四通道、14 位分辨率
- 最大采样率：1GSPS
- 最大输出采样率：500MSPS
- 高阻抗模拟输入缓冲器
- 模拟输入带宽 (–3 dB)：1GHz
- 输出选项：
 - 使用 16 位 NCO 的数字下变频器
 - 全速率输出高达 500MSPS 的 DDC 旁路
- 差分满量程输入：1.1V_{PP}
- JESD204B 接口：
 - 支持子类 1
 - 每个 ADC 一条信道，速率高达 10Gsp/s
 - 专用于通道对的 SYNC 引脚
- 支持多芯片同步
- 频谱性能：
 - $f_{IN} = 190\text{-MHz IF}$ (–1dBFS 时)：
 - 信噪比 (SNR)：69dBFS
 - 噪声频谱密度 (NSD)：–153dBFS/Hz
 - 无杂散动态范围 (SFDR)：86dBc (HD2, HD3)，95dBFS (非 HD2, HD3)
 - $f_{IN} = 370\text{-MHz IF}$ (–3dBFS 时)：
 - SNR：68.5dBFS
 - NSD：–152.5dBFS/Hz
 - SFDR：80dBc (HD2, HD3)，86dBFS (非 HD2, HD3)
- 72 引脚 VQFN 封装 (10mm × 10mm)
- 功耗：625 mW/通道，共 2.5W
- 电源：1.15V、1.15V、1.9V

2 应用

- 多载波多模式 GSM 蜂窝基础设施基站
- 电信接收器
- 雷达和天线阵列
- 电缆 CMTS, DOCSIS 3.1 接收器
- 通信测试设备
- 微波接收器
- 软件定义无线电 (SDR)
- 数字转换器
- 医疗成像和诊断功能

3 说明

ADS54J64 器件是四通道、14 位、1GSPS 模数转换器 (ADC)，提供宽带宽、2 倍过采样和高 SNR。ADS54J64 支持 JESD204B 串行接口，每个通道上具有 1 条信道，数据速率高达 10Gbps。经缓冲的模拟输入可在较宽频率范围内提供一致的阻抗，并最大程度降低采样保持干扰能量。ADS54J64 以超低功耗在较大输入频率范围内提供出色的无杂散动态范围 (SFDR)。数字信号处理块包含复频混频器，后接低通滤波器，低通滤波器具有 2 倍抽取率和 4 倍抽取率两个选项，支持高达 200MHz 的接收带宽。ADS54J64 还支持 DDC 旁路模式的 14 位、500MSPS 输出。

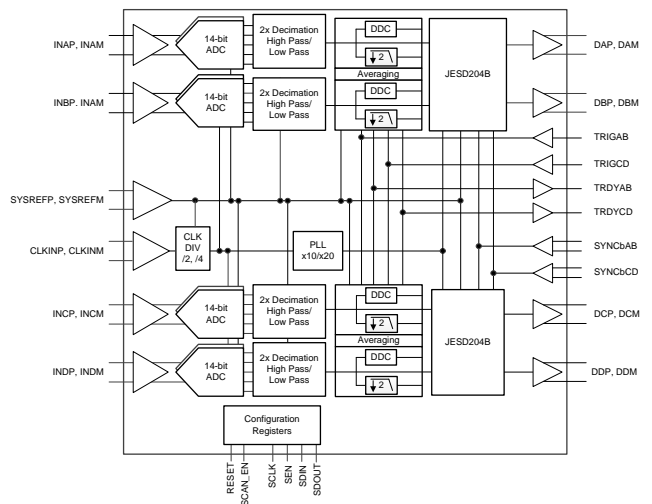
四通道 JESD204B 接口简化了连接，可实现高系统集成密度。内部锁相环 (PLL) 会将传入的 ADC 采样时钟加倍，以获得串行输出各通道的 14 位数据时所使用的位时钟。

器件信息(1)

器件型号	封装	封装尺寸 (标称值)
ADS54J64	VQFN (72)	10.00mm x 10.00mm

(1) 如需了解所有可用封装，请参阅产品说明书末尾的可订购产品附录。

简化框图



Copyright © 2017, Texas Instruments Incorporated



目录

1	特性	1	7.2	Functional Block Diagram	21
2	应用	1	7.3	Feature Description	22
3	说明	1	7.4	Device Functional Modes	23
4	修订历史记录	2	7.5	Programming	31
5	Pin Configuration and Functions	3	7.6	Register Maps	38
6	Specifications	5	8	Application and Implementation	64
6.1	Absolute Maximum Ratings	5	8.1	Application Information	64
6.2	ESD Ratings	5	8.2	Typical Application	71
6.3	Recommended Operating Conditions	5	9	Power Supply Recommendations	72
6.4	Thermal Information	6	10	Layout	73
6.5	Electrical Characteristics	7	10.1	Layout Guidelines	73
6.6	AC Performance	8	10.2	Layout Example	73
6.7	Digital Characteristics	10	11	器件和文档支持	74
6.8	Timing Characteristics	11	11.1	接收文档更新通知	74
6.9	Typical Characteristics: DDC Bypass Mode	12	11.2	社区资源	74
6.10	Typical Characteristics: Mode 2	18	11.3	商标	74
6.11	Typical Characteristics: Mode 0	19	11.4	静电放电警告	74
6.12	Typical Characteristics: Dual ADC Mode	20	11.5	Glossary	74
7	Detailed Description	21	12	机械、封装和可订购信息	74
7.1	Overview	21			

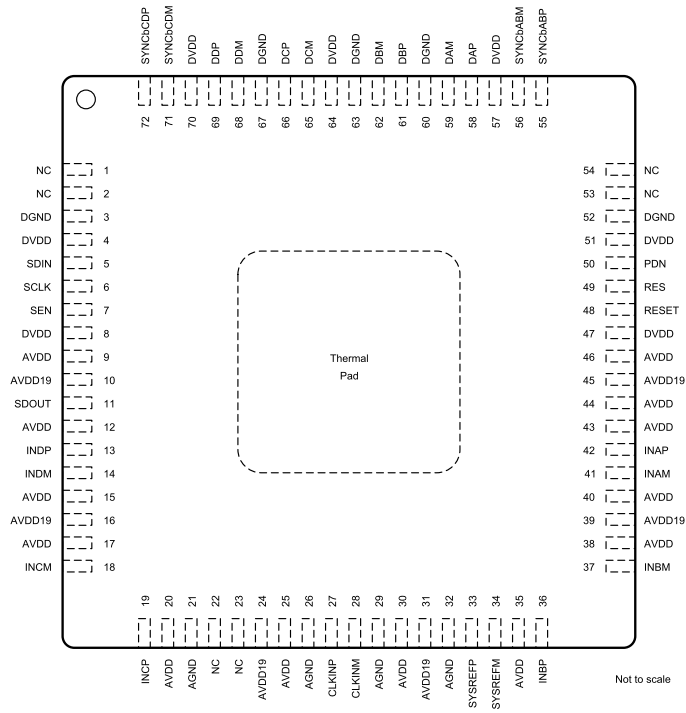
4 修订历史记录

注：之前版本的页码可能与当前版本有所不同。

日期	修订版本	说明
2017 年 10 月	*	初始发行版。

5 Pin Configuration and Functions

**RMP Package
72-Pin VQFN
Top View**



Pin Functions

PIN		I/O	DESCRIPTION
NAME	NO.		
INPUT, REFERENCE			
INAM	41	I	Differential analog input pin for channel A, internal bias via a 2-kΩ resistor to V_{CM}
INAP	42		
INBM	37	I	Differential analog input pin for channel B, internal bias via a 2-kΩ resistor to V_{CM}
INBP	36		
INCM	18	I	Differential analog input pin for channel C, internal bias via a 2-kΩ resistor to V_{CM}
INCP	19		
INDM	14	I	Differential analog input pin for channel D, internal bias via a 2-kΩ resistor to V_{CM}
INDP	13		
CLOCK, SYNC			
CLKINM	28	I	Differential clock input pin for the ADC with internal 100-Ω differential termination; requires external ac coupling
CLKINP	27		
SYSREFM	34	I	External SYSREF input; requires dc coupling and external termination
SYSREFP	33		

Pin Functions (continued)

PIN		I/O	DESCRIPTION
NAME	NO.		
CONTROL, SERIAL			
NC	1, 2, 22, 23, 53, 54	—	No connection
PDN	50	I/O	Power down. This pin can be configured via an SPI register setting. This pin has an internal 10-k Ω pulldown resistor.
RES	49	—	Reserved pin, connect to GND
RESET	48	I	Hardware reset; active high. This pin has an internal 10-k Ω pulldown resistor.
SCLK	6	I	Serial interface clock input. This pin has an internal 10-k Ω pulldown resistor.
SDIN	5	I	Serial interface data input. This pin has an internal 10-k Ω pulldown resistor.
SDOUT	11	O	1.8-V logic serial interface data output
SEN	7	I	Serial interface enable. This pin has an internal 10-k Ω pullup resistor to DVDD.
DATA INTERFACE			
DAM	59	O	JESD204B serial data output pin for channel A
DAP	58		
DBM	62	O	JESD204B serial data output pin for channel B
DBP	61		
DCM	65	O	JESD204B serial data output pin for channel C
DCP	66		
DDM	68	O	JESD204B serial data output pin for channel D
DDP	69		
SYNCbABM	56	I	Synchronization input pin for JESD204B port channels A and B. This pin can be configured via SPI to a SYNCb signal for all four channels. This pin has an internal differential termination of 100 Ω .
SYNCbABP	55		
SYNCbCDM	71	I	Synchronization input pin for JESD204B port channels C and D. This pin can be configured via SPI to a SYNCb signal for all four channels. This pin has an internal differential termination of 100 Ω .
SYNCbCDP	72		
POWER SUPPLY			
AGND	21, 26, 29, 32	I	Analog ground
AVDD	9, 12, 15, 17, 20, 25, 30, 35, 38, 40, 43, 44, 46	I	Analog 1.15-V power supply
AVDD19	10, 16, 24, 31, 39, 45	I	Analog 1.9-V supply for analog buffer
DGND	3, 52, 60, 63, 67	I	Digital ground
DVDD	4, 8, 47, 51, 57, 64, 70	I	Digital 1.15-V power supply
Thermal pad	Pad	—	Connect to GND

6 Specifications

6.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT
Supply voltage	AVDD19	-0.3	2.1	V
	AVDD	-0.3	1.4	
	DVDD	-0.3	1.4	
Voltage between AGND and DGND		-0.3	0.3	V
Voltage applied to input pins	INAP, INBP, INAM, INBM, INCP, INDP, INCM, INDM	-0.3	2.1	V
	CLKINP, CLKINM	-0.3	AVDD + 0.3	
	SYSREFP, SYSREFM	-0.3	1.9	
	SCLK, SEN, SDIN, RESET, SYNCbABP, SYNCbABM, SYNCbCDP, SYNCbCDM, PDN, TRIGAB, TRIGCD	-0.2	AVDD19 + 0.3	
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.

6.2 ESD Ratings

			VALUE	UNIT
V _(ESD)	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	±2000	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)

		MIN	NOM	MAX	UNIT
Supply voltage range	AVDD19	1.8	1.9	2	V
	AVDD	1.1	1.15	1.2	
	DVDD	1.1	1.15	1.2	
Analog inputs	Differential input voltage range	1.1			V _{PP}
	Input common-mode voltage (VCM)	1.3			V
Clock inputs	Input clock frequency, device clock frequency		400	1000	MHz
	Input clock amplitude differential (V _{CLKP} – V _{CLKM})	Sine wave, ac-coupled		1.5	V _{PP}
		LVPECL, ac-coupled		1.6	
		LVDS, ac-coupled		0.7	
Input device clock duty cycle, default after reset		45%	50%	55%	
Temperature	Operating free-air, T _A		-40	100 ⁽¹⁾	°C
	Operating junction, T _J		105 ⁽²⁾		
	Specified maximum, measured at the device footprint thermal pad on the printed circuit board, T _{P-MAX}		104.5 ⁽³⁾		

- (1) Assumes system thermal design meets the T_J specification.
(2) Prolonged use above this junction temperature can increase the device failure-in-time (FIT) rate.
(3) The recommended maximum temperature at the PCB footprint thermal pad assumes the junction-to-package bottom thermal resistance, R_{θJC(bot)} = 0.2°C/W, the thermal resistance of the device thermal pad connection to the PCB footprint is negligible, and the device power consumption is 2.5 W.

6.4 Thermal Information

THERMAL METRIC ⁽¹⁾		ADS54J64	UNIT
		RMP (VQFN ^P)	
		72 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance ⁽²⁾	22.3	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance ⁽³⁾	5.1	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance ⁽³⁾	2.4	°C/W
ψ_{JT}	Junction-to-top characterization parameter ⁽⁴⁾	0.1	°C/W
ψ_{JB}	Junction-to-board characterization parameter ⁽⁵⁾	2.3	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance ⁽⁶⁾	0.2	°C/W

- (1) For more information about traditional and new thermal metrics, see the [Semiconductor and IC Package Thermal Metrics](#) application report.
- (2) The junction-to-ambient thermal resistance under natural convection is obtained in a simulation on a JEDEC-standard, high-K board, as specified in JESD51-7, in an environment described in JESD51-2a.
- (3) The junction-to-case (top) thermal resistance is obtained by simulating a cold plate test on the package top. No specific JEDEC-standard test exists, but a close description can be found in the ANSI SEMI standard G30-88.
- (4) The junction-to-board thermal resistance is obtained by simulating in an environment with a ring cold plate fixture to control the PCB temperature, as described in JESD51-8.
- (5) The junction-to-top characterization parameter, ψ_{JT} , estimates the junction temperature of a device in a real system and is extracted from the simulation data for obtaining θ_{JA} , using a procedure described in JESD51-2a (sections 6 and 7).
- (6) The junction-to-board characterization parameter, ψ_{JB} , estimates the junction temperature of a device in a real system and is extracted from the simulation data for obtaining θ_{JA} , using a procedure described in JESD51-2a (sections 6 and 7).

6.5 Electrical Characteristics

typical values are at $T_A = 25^\circ\text{C}$, full temperature range is from $T_{\text{MIN}} = -40^\circ\text{C}$ to $T_{\text{MAX}} = +100^\circ\text{C}$, input clock frequency = 1 GHz, 50% clock duty cycle, output sample rate = 500 MSPS, $\text{AVDD19} = 1.9\text{ V}$, $\text{AVDD} = \text{DVDD} = 1.15\text{ V}$, -1-dBFS differential input, and $f_{\text{IN}} = 190\text{ MHz}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
GENERAL						
ADC sampling rate					1	GPS
Resolution			14			Bits
POWER SUPPLY						
AVDD19	1.9-V analog supply		1.85	1.9	1.95	V
AVDD	1.15-V analog supply		1.1	1.15	1.2	V
DVDD	1.15-V digital supply		1.1	1.15	1.2	V
I_{AVDD19}	1.9-V analog supply current	100-MHz, full-scale input on all four channels		618		mA
I_{AVDD}	1.15-V analog supply current	100-MHz, full-scale input on all four channels		415		mA
I_{DVDD}	1.15-V digital supply current	DDC bypass mode (mode 8), 100-MHz, full-scale input on all four channels		629		mA
		Mode 3, 100-MHz, full-scale input on all four channels		730		
		Mode 0 and 2, 100-MHz, full-scale input on all four channels		674		
		Mode 1, 4, 6, and 7, 100-MHz, full-scale input on all four channels		703		
P_{DIS}	Total power dissipation	DDC bypass mode (mode 8), 100-MHz, full-scale input on all four channels		2.37		W
		Mode 3, 100-MHz, full-scale input on all four channels		2.49		
		Mode 0 and 2, 100-MHz, full-scale input on all four channels		2.42		
		Mode 1, 4, 6, and 7, 100-MHz, full-scale input on all four channels		2.46		
Global power-down power dissipation		Full-scale input on all four channels		120		mW
ANALOG INPUTS						
Differential input full-scale voltage				1.1		V_{PP}
Input common-mode voltage				1.3		V
Differential input resistance		At $f_{\text{IN}} = \text{dc}$		4		$\text{k}\Omega$
Differential input capacitance				2.5		pF
Analog input bandwidth (3 dB)				1000		MHz
ISOLATION						
Crosstalk ⁽¹⁾ isolation between near channels (channels A and B are near to each other, channels C and D are near to each other)	$f_{\text{IN}} = 10\text{ MHz}$			75		dBFS
	$f_{\text{IN}} = 100\text{ MHz}$			75		
	$f_{\text{IN}} = 170\text{ MHz}$			74		
	$f_{\text{IN}} = 270\text{ MHz}$			72		
	$f_{\text{IN}} = 370\text{ MHz}$			71		
	$f_{\text{IN}} = 470\text{ MHz}$			70		
Crosstalk ⁽¹⁾ isolation between far channels (channels A and B are far from channels C and D)	$f_{\text{IN}} = 10\text{ MHz}$			110		dBFS
	$f_{\text{IN}} = 100\text{ MHz}$			110		
	$f_{\text{IN}} = 170\text{ MHz}$			110		
	$f_{\text{IN}} = 270\text{ MHz}$			110		
	$f_{\text{IN}} = 370\text{ MHz}$			110		
	$f_{\text{IN}} = 470\text{ MHz}$			110		

(1) Crosstalk is measured with a -1-dBFS input signal on the aggressor channel and no input on the victim channel.

Electrical Characteristics (continued)

typical values are at $T_A = 25^\circ\text{C}$, full temperature range is from $T_{\text{MIN}} = -40^\circ\text{C}$ to $T_{\text{MAX}} = +100^\circ\text{C}$, input clock frequency = 1 GHz, 50% clock duty cycle, output sample rate = 500 MSPS, AVDD19 = 1.9 V, AVDD = DVDD = 1.15 V, -1-dBFS differential input, and $f_{\text{IN}} = 190\text{ MHz}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
CLOCK INPUT					
Internal clock biasing	CLKINP and CLKINM pins are connected to the internal biasing voltage through a 5-k Ω resistor		0.7		V

6.6 AC Performance

typical values are at $T_A = 25^\circ\text{C}$, full temperature range is from $T_{\text{MIN}} = -40^\circ\text{C}$ to $T_{\text{MAX}} = +100^\circ\text{C}$, input clock frequency = 1 GHz, 50% clock duty cycle, output sample rate = 500 MSPS, AVDD19 = 1.9 V, AVDD = DVDD = 1.15 V, -1-dBFS differential input, and $f_{\text{IN}} = 190\text{ MHz}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	UNIT	
		DDC BYPASS MODE			DECIMATE-BY-4 (DDC Mode 2)				
SNR	Signal-to-noise ratio	$f_{\text{IN}} = 10\text{ MHz}, A_{\text{IN}} = -1\text{ dBFS}$		69.9	72.2			dBFS	
		$f_{\text{IN}} = 70\text{ MHz}, A_{\text{IN}} = -1\text{ dBFS}$		69.6	71.8				
		$f_{\text{IN}} = 190\text{ MHz}, A_{\text{IN}} = -1\text{ dBFS}$		69.2	71.8				
		$f_{\text{IN}} = 190\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$		66.5	69.6	71			
		$f_{\text{IN}} = 300\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$		69.3		71.7			
		$f_{\text{IN}} = 370\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$		68.7		71.3			
		$f_{\text{IN}} = 470\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$		68.4		69.8			
NSD	Noise spectral density	$f_{\text{IN}} = 10\text{ MHz}, A_{\text{IN}} = -1\text{ dBFS}$		-153.9	-153.2			dBFS/Hz	
		$f_{\text{IN}} = 70\text{ MHz}, A_{\text{IN}} = -1\text{ dBFS}$		-153.6	-152.8				
		$f_{\text{IN}} = 190\text{ MHz}, A_{\text{IN}} = -1\text{ dBFS}$		-153.2	-152.7				
		$f_{\text{IN}} = 190\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$		-150.5	-153.6	-153.2			
		$f_{\text{IN}} = 300\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$		-152.8		-152.7			
		$f_{\text{IN}} = 370\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$		-152.5		-152.2			
		$f_{\text{IN}} = 470\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$		-151.5		-151			
SFDR ⁽¹⁾	Spurious-free dynamic range	$f_{\text{IN}} = 10\text{ MHz}, A_{\text{IN}} = -1\text{ dBFS}$		83	83			dBc	
		$f_{\text{IN}} = 70\text{ MHz}, A_{\text{IN}} = -1\text{ dBFS}$		81	100				
		$f_{\text{IN}} = 190\text{ MHz}, A_{\text{IN}} = -1\text{ dBFS}$		87	100				
		$f_{\text{IN}} = 190\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$		78	88	98			
		$f_{\text{IN}} = 300\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$		79		98			
		$f_{\text{IN}} = 370\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$, input clock frequency = 983.04 MHz		82		70			
		$f_{\text{IN}} = 470\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$		78		76			
SINAD	Signal-to-noise and distortion ratio	$f_{\text{IN}} = 10\text{ MHz}, A_{\text{IN}} = -1\text{ dBFS}$		68.5	70.6			dBFS	
		$f_{\text{IN}} = 70\text{ MHz}, A_{\text{IN}} = -1\text{ dBFS}$		68.5	70.6				
		$f_{\text{IN}} = 190\text{ MHz}, A_{\text{IN}} = -1\text{ dBFS}$		68.2	72.2				
		$f_{\text{IN}} = 190\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$		68.5	73				
		$f_{\text{IN}} = 300\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$		68.9		72.3			
		$f_{\text{IN}} = 370\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$		68		68.2			
		$f_{\text{IN}} = 470\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$		68		69			

(1) Harmonic distortion performance can be significantly improved by using the frequency planning explained in the [Frequency Planning](#) section.

AC Performance (continued)

typical values are at $T_A = 25^\circ\text{C}$, full temperature range is from $T_{\text{MIN}} = -40^\circ\text{C}$ to $T_{\text{MAX}} = +100^\circ\text{C}$, input clock frequency = 1 GHz, 50% clock duty cycle, output sample rate = 500 MSPS, AVDD19 = 1.9 V, AVDD = DVDD = 1.15 V, -1-dBFS differential input, and $f_{\text{IN}} = 190\text{ MHz}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
		DDC BYPASS MODE			DECIMATE-BY-4 (DDC Mode 2)			
HD2 ⁽¹⁾	Second-order harmonic distortion	$f_{\text{IN}} = 10\text{ MHz}, A_{\text{IN}} = -1\text{ dBFS}$		-83		-90		dBc
		$f_{\text{IN}} = 70\text{ MHz}, A_{\text{IN}} = -1\text{ dBFS}$		-82		-100		
		$f_{\text{IN}} = 190\text{ MHz}, A_{\text{IN}} = -1\text{ dBFS}$		-85		-98		
		$f_{\text{IN}} = 190\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$	-78	-86		-100		
		$f_{\text{IN}} = 300\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$		-82		-100		
		$f_{\text{IN}} = 370\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$ input clock frequency = 983.04 MHz		-82		-69		
		$f_{\text{IN}} = 470\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$		-100		-94		
HD3 ⁽¹⁾	Third-order harmonic distortion	$f_{\text{IN}} = 10\text{ MHz}, A_{\text{IN}} = -1\text{ dBFS}$		-83		-85		dBc
		$f_{\text{IN}} = 70\text{ MHz}, A_{\text{IN}} = -1\text{ dBFS}$		-81		-100		
		$f_{\text{IN}} = 190\text{ MHz}, A_{\text{IN}} = -1\text{ dBFS}$		-92		-100		
		$f_{\text{IN}} = 190\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$	-78	-92		-100		
		$f_{\text{IN}} = 300\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$		-90		-100		
		$f_{\text{IN}} = 370\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$		-90		-100		
		$f_{\text{IN}} = 470\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$		-80		-79		
Non HD2, HD3	Spurious-free dynamic range (excluding HD2, HD3)	$f_{\text{IN}} = 10\text{ MHz}, A_{\text{IN}} = -1\text{ dBFS}$		95		-100		dBFS
		$f_{\text{IN}} = 70\text{ MHz}, A_{\text{IN}} = -1\text{ dBFS}$		95		-92		
		$f_{\text{IN}} = 190\text{ MHz}, A_{\text{IN}} = -1\text{ dBFS}$		95		-100		
		$f_{\text{IN}} = 190\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$	87	95		-98		
		$f_{\text{IN}} = 300\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$		95		-100		
		$f_{\text{IN}} = 370\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$		95		-100		
		$f_{\text{IN}} = 470\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$		93		-100		
THD ⁽¹⁾	Total harmonic distortion	$f_{\text{IN}} = 10\text{ MHz}, A_{\text{IN}} = -1\text{ dBFS}$		-81		-83		dBc
		$f_{\text{IN}} = 70\text{ MHz}, A_{\text{IN}} = -1\text{ dBFS}$		-79		-100		
		$f_{\text{IN}} = 190\text{ MHz}, A_{\text{IN}} = -1\text{ dBFS}$		-83		-100		
		$f_{\text{IN}} = 190\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$		-85		-100		
		$f_{\text{IN}} = 300\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$		-81		-100		
		$f_{\text{IN}} = 370\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$		-76		-68		
		$f_{\text{IN}} = 470\text{ MHz}, A_{\text{IN}} = -3\text{ dBFS}$		-82		-80		
IMD3	Two-tone, third-order intermodulation distortion	$f_1 = 185\text{ MHz}, f_2 = 190\text{ MHz}, A_{\text{IN}} = -10\text{ dBFS}$		-90		-87		dBFS
		$f_1 = 365\text{ MHz}, f_2 = 370\text{ MHz}, A_{\text{IN}} = -10\text{ dBFS}$		-90		-94		
		$f_1 = 465\text{ MHz}, f_2 = 470\text{ MHz}, A_{\text{IN}} = -10\text{ dBFS}$		-85		-85		

6.7 Digital Characteristics

typical values are at $T_A = 25^\circ\text{C}$, full temperature range is from $T_{\text{MIN}} = -40^\circ\text{C}$ to $T_{\text{MAX}} = +100^\circ\text{C}$, input clock frequency = 1 GHz, 50% clock duty cycle, output sample rate = 500 MSPS, $\text{AVDD19} = 1.9\text{ V}$, $\text{AVDD} = \text{DVDD} = 1.15\text{ V}$, -1-dBFS differential input, and $f_{\text{IN}} = 190\text{ MHz}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
DIGITAL INPUTS (RESET, SCLK, SEN, SDIN, PDN, TRIGAB, TRIGCD)⁽¹⁾						
V_{IH}	High-level input voltage	All digital inputs support 1.2-V and 1.8-V logic levels	0.8			V
V_{IL}	Low-level input voltage	All digital inputs support 1.2-V and 1.8-V logic levels			0.4	V
I_{IH}	High-level input current	SEN		0		μA
		RESET, SCLK, SDIN, PDN, TRIGAB, TRIGCD		50		
I_{IL}	Low-level input current	SEN		50		μA
		RESET, SCLK, SDIN, PDN, TRIGAB, TRIGCD		0		
	Input capacitance			4		pF
DIGITAL INPUTS						
V_{D}	Differential input voltage	SYSREFP, SYSREFM	0.35	0.45	0.55	V
		SYNCbABM, SYNCbABP, SYNCbCDM, SYNCbCDP	0.35	0.45	0.8	
$V_{\text{(CM_DIG)}}$	Common-mode voltage for SYSREF	SYSREFP, SYSREFM	0.9	1.2	1.4	V
		SYNCbABM, SYNCbABP, SYNCbCDM, SYNCbCDP	0.9	1.2	1.4	
DIGITAL OUTPUTS (SDOUT, TRDYAB, TRDYCD)						
V_{OH}	High-level output voltage	100- μA current	$\text{AVDD19} - 0.2$			V
V_{OL}	Low-level output voltage	100- μA current				0.2
DIGITAL OUTPUTS (JESD204B Interface: DxP, DxM)⁽²⁾						
V_{OD}	Output differential voltage	With default swing setting	700			mV _{PP}
V_{OC}	Output common-mode voltage		450			mV
	Transmitter short-circuit current	Transmitter pins shorted to any voltage between -0.25 V and 1.45 V	-100	100		mA
Z_{os}	Single-ended output impedance		50			Ω
	Output capacitance	Output capacitance inside the device, from either output to ground	2			pF

(1) The RESET, SCLK, SDIN, and PDN pins have a 10-k Ω (typical) internal pulldown resistor to ground, and the SEN pin has a 10-k Ω (typical) pullup resistor to DVDD.

(2) 50- Ω , single-ended external termination to DVDD.

6.8 Timing Characteristics

typical values are at $T_A = 25^\circ\text{C}$, full temperature range is from $T_{\text{MIN}} = -40^\circ\text{C}$ to $T_{\text{MAX}} = +100^\circ\text{C}$, input clock frequency = 1 GHz, 50% clock duty cycle, output sample rate = 500 MSPS, $\text{AVDD19} = 1.9\text{ V}$, $\text{AVDD} = \text{DVDD} = 1.15\text{ V}$, -1-dBFS differential input, and $f_{\text{IN}} = 190\text{ MHz}$ (unless otherwise noted)

		MIN	TYP	MAX	UNITS
SAMPLE TIMING CHARACTERISTICS					
Aperture delay		0.55		0.92	ns
Aperture delay matching between two channels on the same device			± 100		ps
Aperture delay matching between two devices at the same temperature and supply voltage			± 100		ps
Aperture jitter			100		f_s rms
Wake-up time	Global power-down		10		ms
	Pin power-down (fast power-down)		5		μs
Data latency: ADC sample to digital output	DDC bypass mode		116		Input clock cycles
	DDC mode 0		204		
$t_{\text{SU_SYSREF}}$	Setup time for SYSREF, referenced to input clock rising edge	350		900	ps
$t_{\text{H_SYSREF}}$	Hold time for SYSREF, referenced to input clock rising edge	100			ps
JESD OUTPUT INTERFACE TIMING CHARACTERISTICS					
Unit interval		100			ps
Serial output data rate				10	Gbps
Total jitter for BER of $1\text{E-}15$ and lane rate = 10 Gbps			24		ps
Random jitter for BER of $1\text{E-}15$ and lane rate = 10 Gbps			0.95		ps rms
Deterministic jitter for BER of $1\text{E-}15$ and lane rate = 10 Gbps			8.8		ps, pk-pk
$t_{\text{R}}, t_{\text{F}}$	Data rise time, data fall time: rise and fall times measured from 20% to 80%, differential output waveform, $2.5\text{ Gbps} \leq \text{bit rate} \leq 10\text{ Gbps}$		35		ps

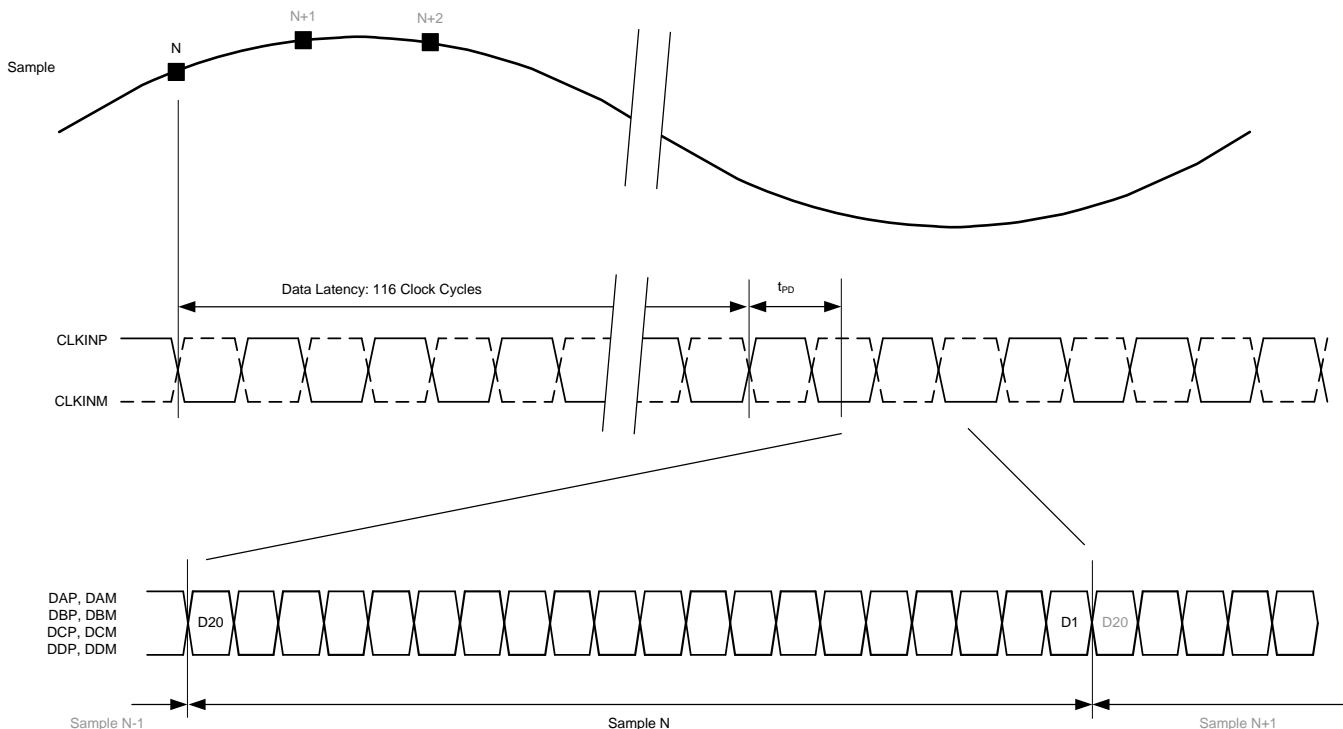


图 1. Latency Timing Diagram in DDC Bypass Mode

6.9 Typical Characteristics: DDC Bypass Mode

typical values are at $T_A = 25^\circ\text{C}$, full temperature range is from $T_{\text{MIN}} = -40^\circ\text{C}$ to $T_{\text{MAX}} = +100^\circ\text{C}$, device sampling frequency = 1 GSPS, 50% clock duty cycle, output sample rate = 500 MSPS, AVDD19 = 1.9 V, AVDD = DVDD = 1.15 V, -1-dBFS differential input, and $f_{\text{IN}} = 190\text{ MHz}$ (unless otherwise noted)

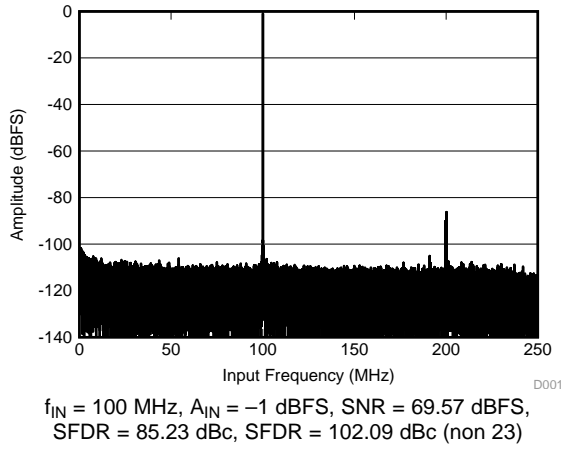


图 2. FFT for 100-MHz Input Signal

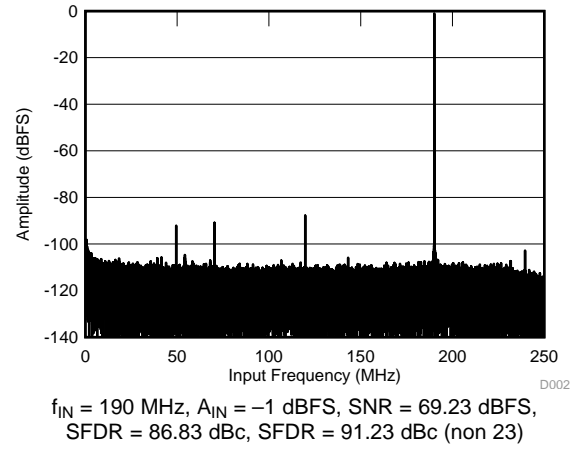


图 3. FFT for 190-MHz Input Signal

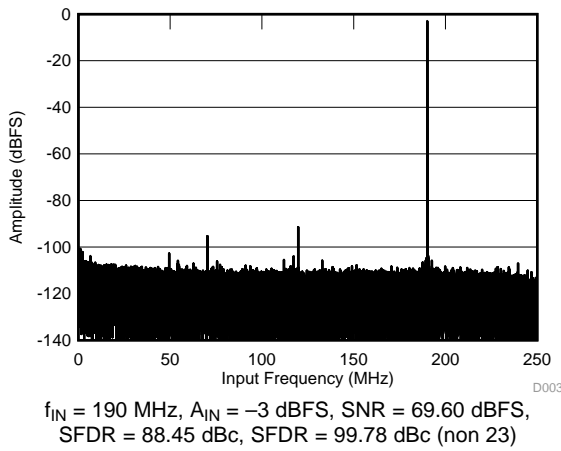


图 4. FFT for 190-MHz Input Signal

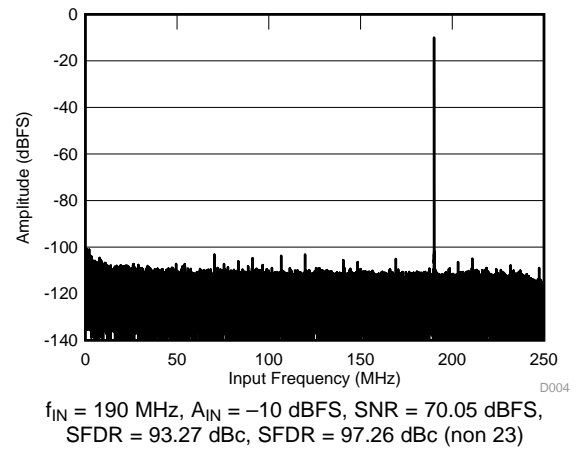


图 5. FFT for 190-MHz Input Signal

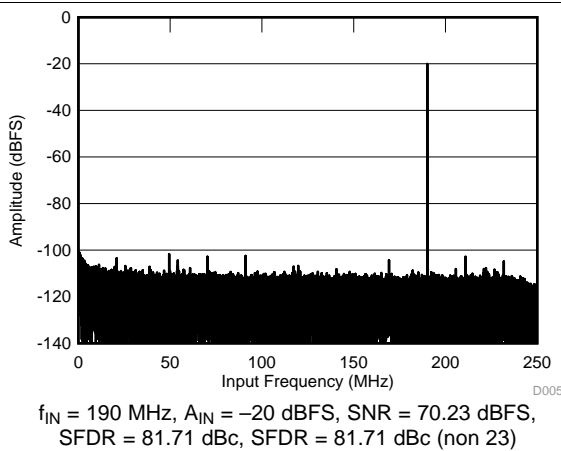


图 6. FFT for 190-MHz Input Signal

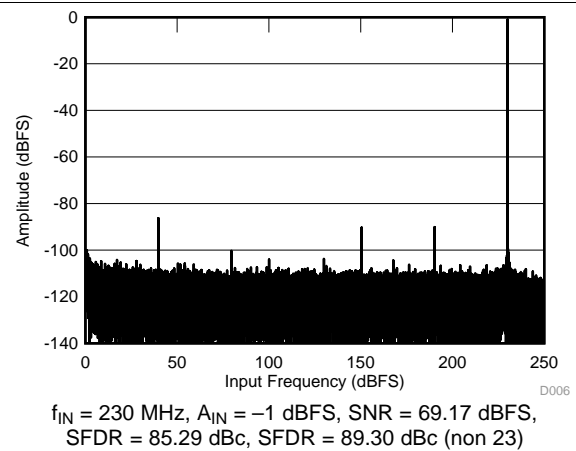
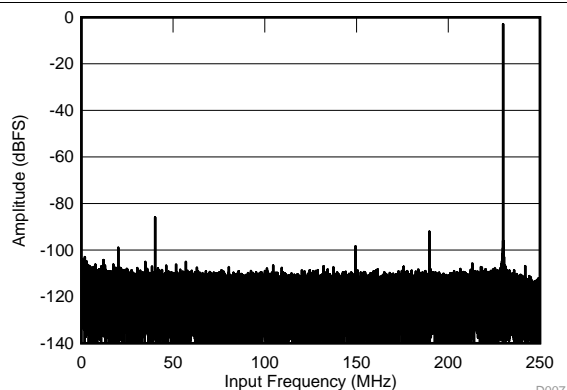


图 7. FFT for 230-MHz Input Signal

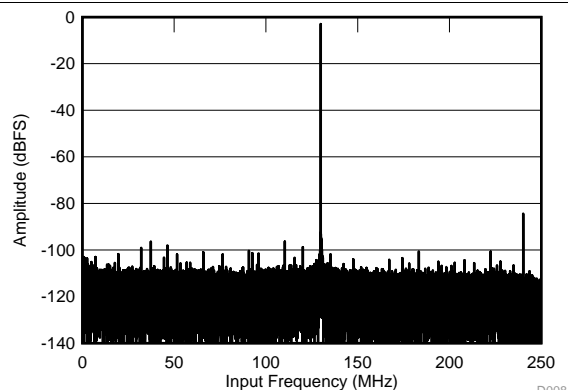
Typical Characteristics: DDC Bypass Mode (接下页)

typical values are at $T_A = 25^\circ\text{C}$, full temperature range is from $T_{\text{MIN}} = -40^\circ\text{C}$ to $T_{\text{MAX}} = +100^\circ\text{C}$, device sampling frequency = 1 GSPS, 50% clock duty cycle, output sample rate = 500 MSPS, $AVDD19 = 1.9\text{ V}$, $AVDD = DVDD = 1.15\text{ V}$, -1-dBFS differential input, and $f_{\text{IN}} = 190\text{ MHz}$ (unless otherwise noted)



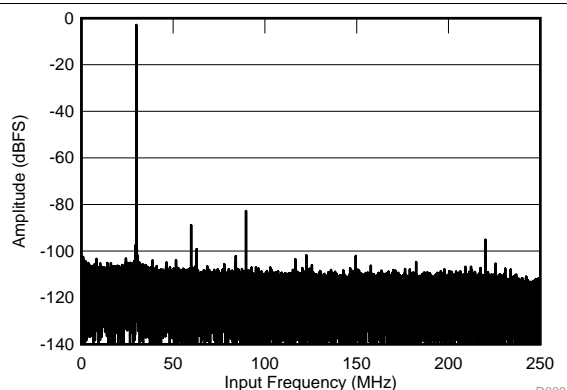
$f_{\text{IN}} = 270\text{ MHz}$, $A_{\text{IN}} = -3\text{ dBFS}$, $\text{SNR} = 69.27\text{ dBFS}$,
 $\text{SFDR} = 82.98\text{ dBc}$, $\text{SFDR} = 95.4\text{ dBc}$ (non 23)

图 8. FFT for 270-MHz Input Signal



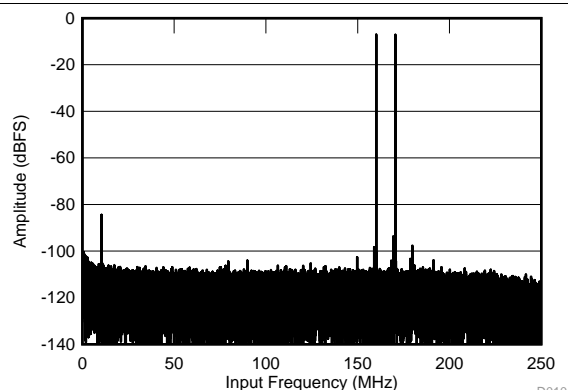
$f_{\text{IN}} = 370\text{ MHz}$, $A_{\text{IN}} = -3\text{ dBFS}$, $\text{SNR} = 68.36\text{ dBFS}$,
 $\text{SFDR} = 81.37\text{ dBc}$, $\text{SFDR} = 97.28\text{ dBc}$ (non 23)

图 9. FFT for 370-MHz Input Signal



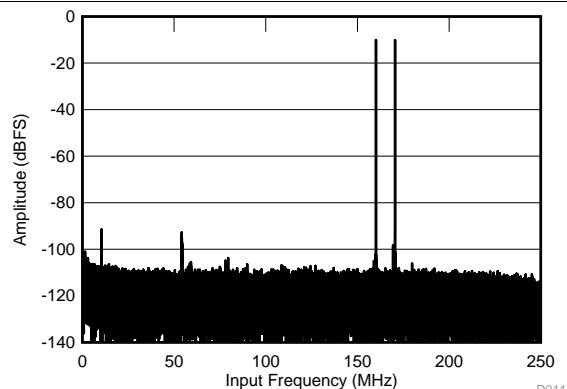
$f_{\text{IN}} = 470\text{ MHz}$, $A_{\text{IN}} = -3\text{ dBFS}$, $\text{SNR} = 68.21\text{ dBFS}$,
 $\text{SFDR} = 79.85\text{ dBc}$, $\text{SFDR} = 99.12\text{ dBc}$ (non 23)

图 10. FFT for 470-MHz Input Signal



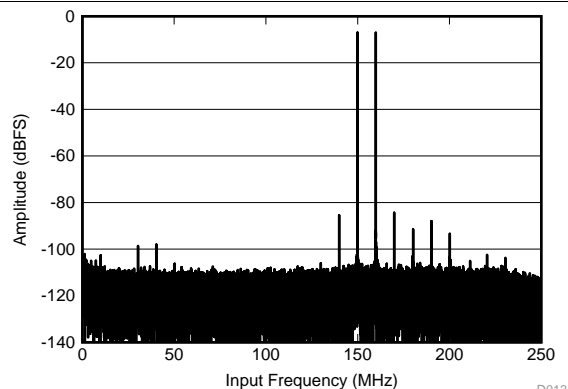
$f_{\text{IN1}} = 160\text{ MHz}$, $f_{\text{IN2}} = 170\text{ MHz}$, $\text{IMD} = 102.68\text{ dBFS}$,
each tone at -7 dBFS

图 11. FFT for Two-Tone Input Signal



$f_{\text{IN1}} = 160\text{ MHz}$, $f_{\text{IN2}} = 170\text{ MHz}$, $\text{IMD} = 103.44\text{ dBFS}$,
each tone at -10 dBFS

图 12. FFT for Two-Tone Input Signal



$f_{\text{IN1}} = 340\text{ MHz}$, $f_{\text{IN2}} = 350\text{ MHz}$, $\text{IMD} = 84.34\text{ dBFS}$,
each tone at -7 dBFS

图 13. FFT for Two-Tone Input Signal

Typical Characteristics: DDC Bypass Mode (接下页)

typical values are at $T_A = 25^\circ\text{C}$, full temperature range is from $T_{\text{MIN}} = -40^\circ\text{C}$ to $T_{\text{MAX}} = +100^\circ\text{C}$, device sampling frequency = 1 GSPS, 50% clock duty cycle, output sample rate = 500 MSPS, $AVDD19 = 1.9\text{ V}$, $AVDD = DVDD = 1.15\text{ V}$, -1-dBFS differential input, and $f_{\text{IN}} = 190\text{ MHz}$ (unless otherwise noted)

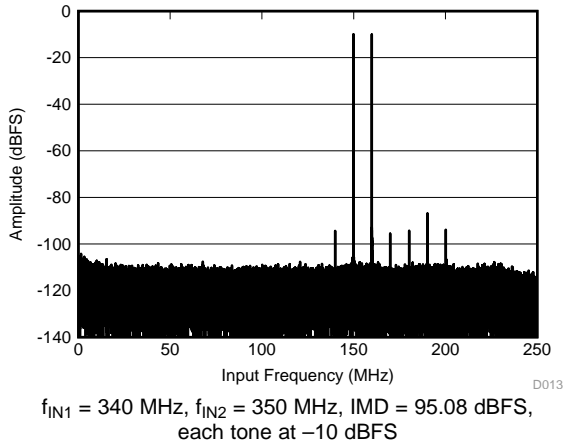


图 14. FFT for Two-Tone Input Signal

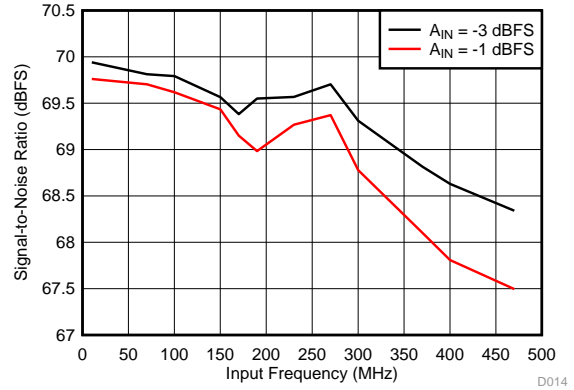


图 15. SNR vs Input Frequency

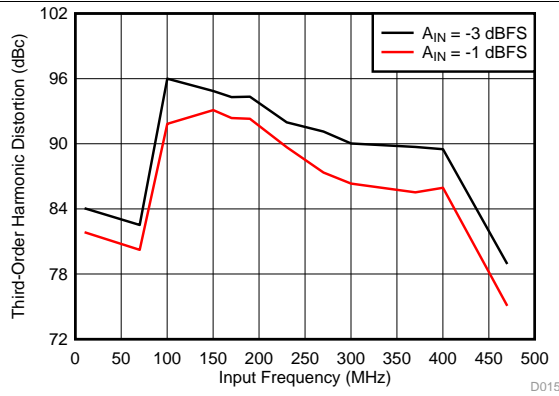


图 16. HD3 vs Input Frequency

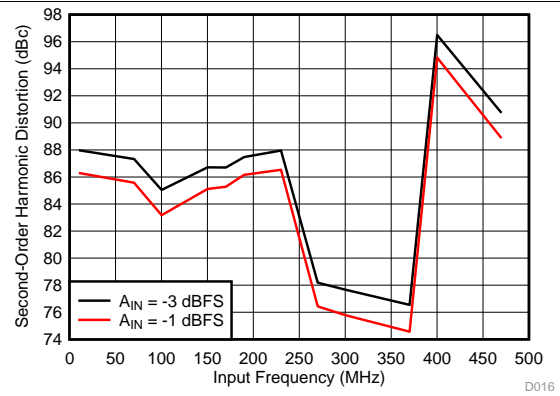


图 17. HD2 vs Input Frequency

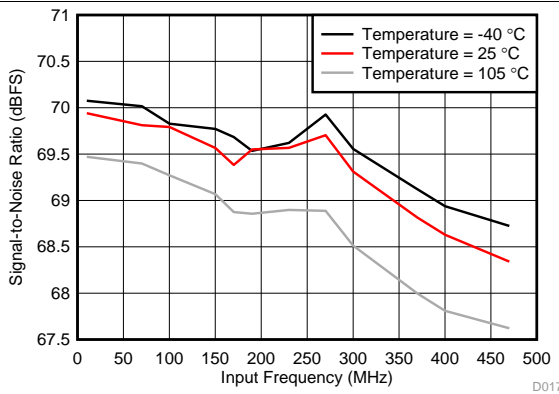


图 18. SNR vs Input Frequency and Temperature

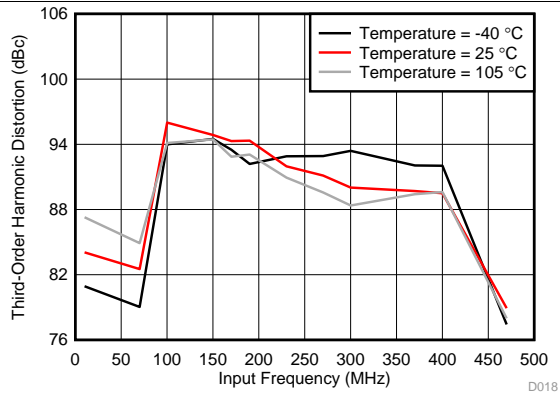
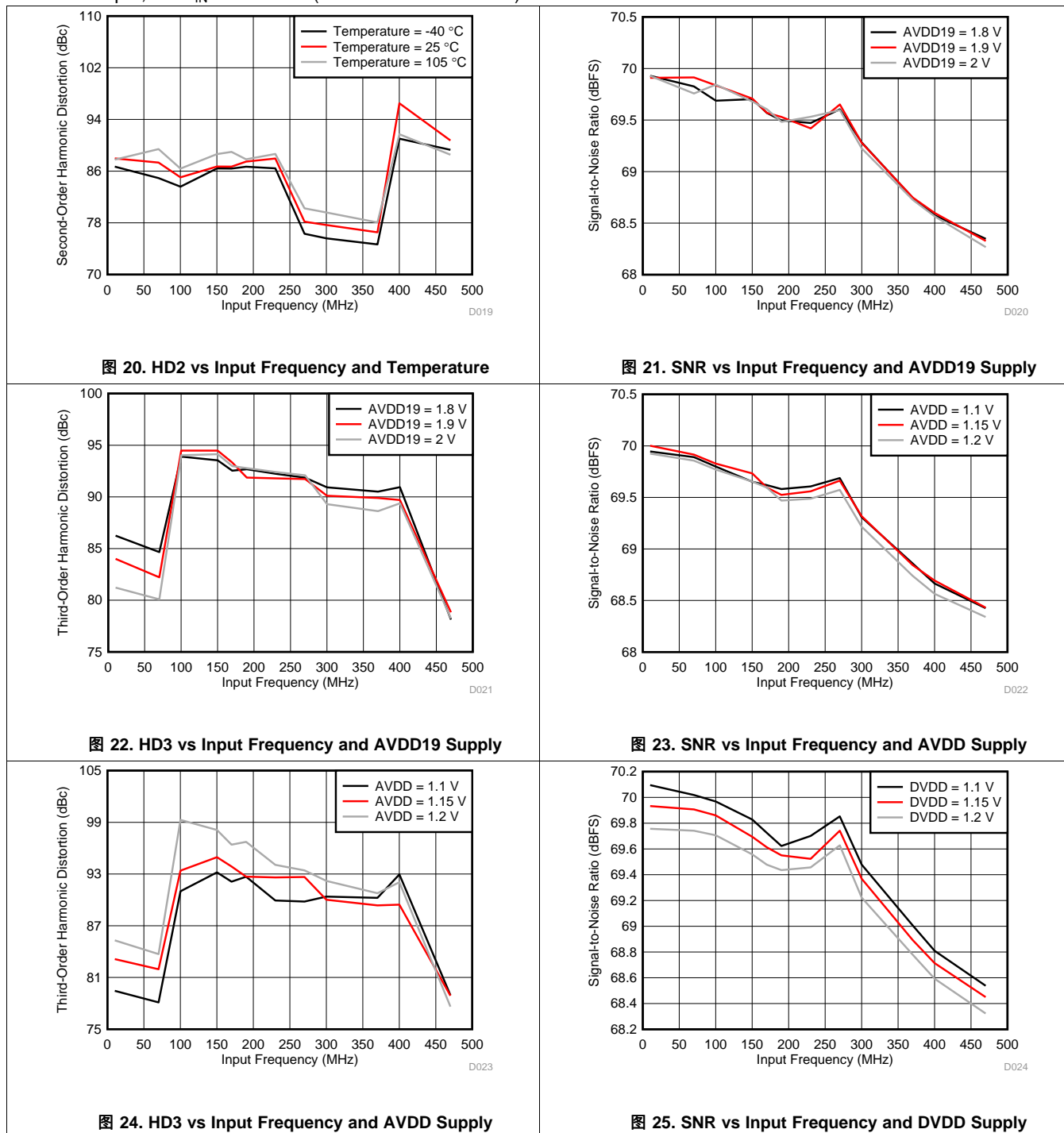


图 19. HD3 vs Input Frequency and Temperature

Typical Characteristics: DDC Bypass Mode (接下页)

typical values are at $T_A = 25^\circ\text{C}$, full temperature range is from $T_{\text{MIN}} = -40^\circ\text{C}$ to $T_{\text{MAX}} = +100^\circ\text{C}$, device sampling frequency = 1 GSPS, 50% clock duty cycle, output sample rate = 500 MSPS, $\text{AVDD19} = 1.9\text{ V}$, $\text{AVDD} = \text{DVDD} = 1.15\text{ V}$, -1-dBFS differential input, and $f_{\text{IN}} = 190\text{ MHz}$ (unless otherwise noted)



Typical Characteristics: DDC Bypass Mode (接下页)

typical values are at $T_A = 25^\circ\text{C}$, full temperature range is from $T_{\text{MIN}} = -40^\circ\text{C}$ to $T_{\text{MAX}} = +100^\circ\text{C}$, device sampling frequency = 1 GSPS, 50% clock duty cycle, output sample rate = 500 MSPS, $\text{AVDD} = 1.9\text{ V}$, $\text{AVDD} = \text{DVDD} = 1.15\text{ V}$, -1-dBFS differential input, and $f_{\text{IN}} = 190\text{ MHz}$ (unless otherwise noted)

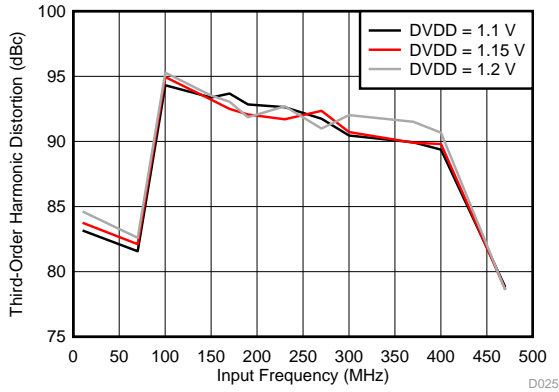


图 26. HD3 vs Input Frequency and DVDD Supply

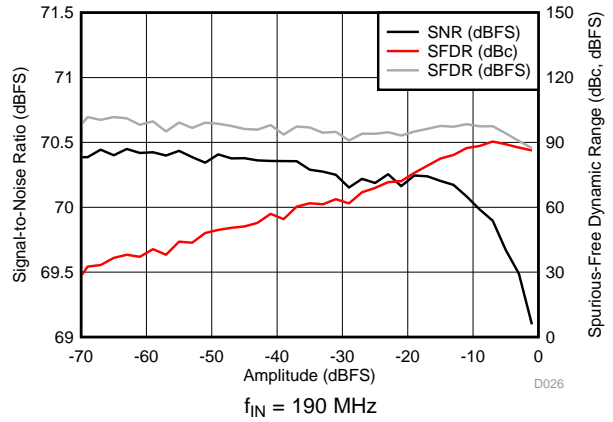


图 27. Performance vs Input Signal Amplitude

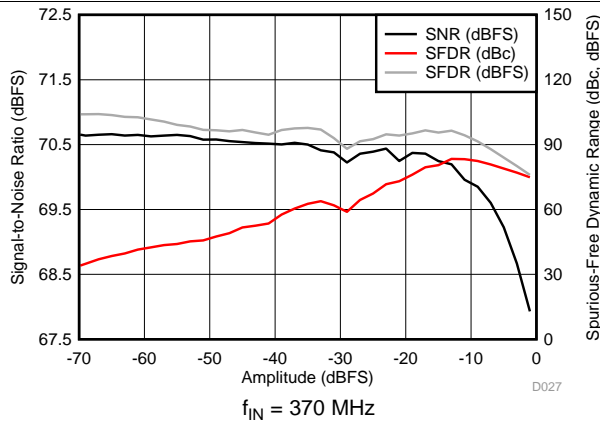


图 28. Performance vs Input Signal Amplitude

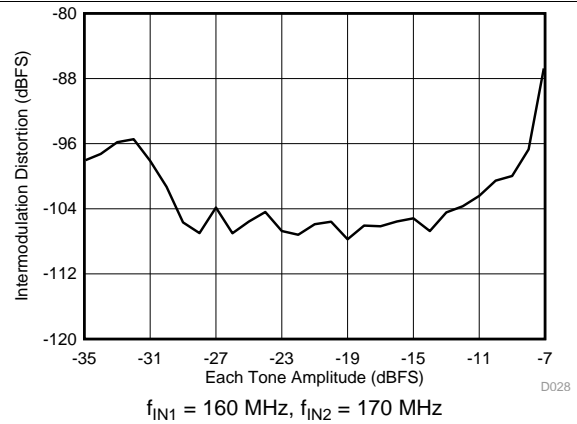


图 29. IMD vs Input Amplitude

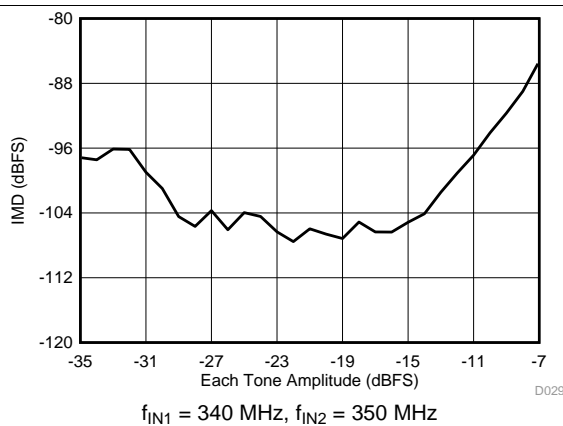


图 30. IMD vs Input Amplitude

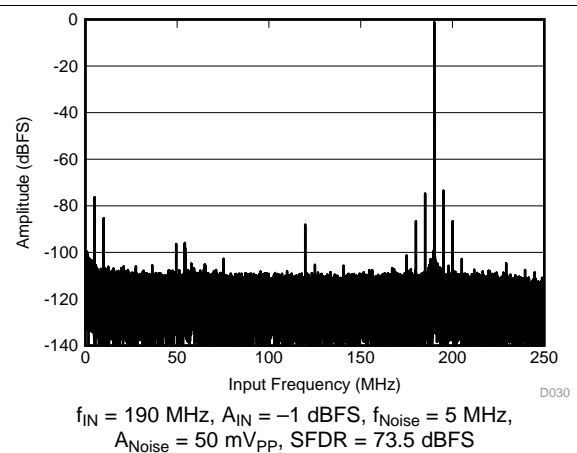
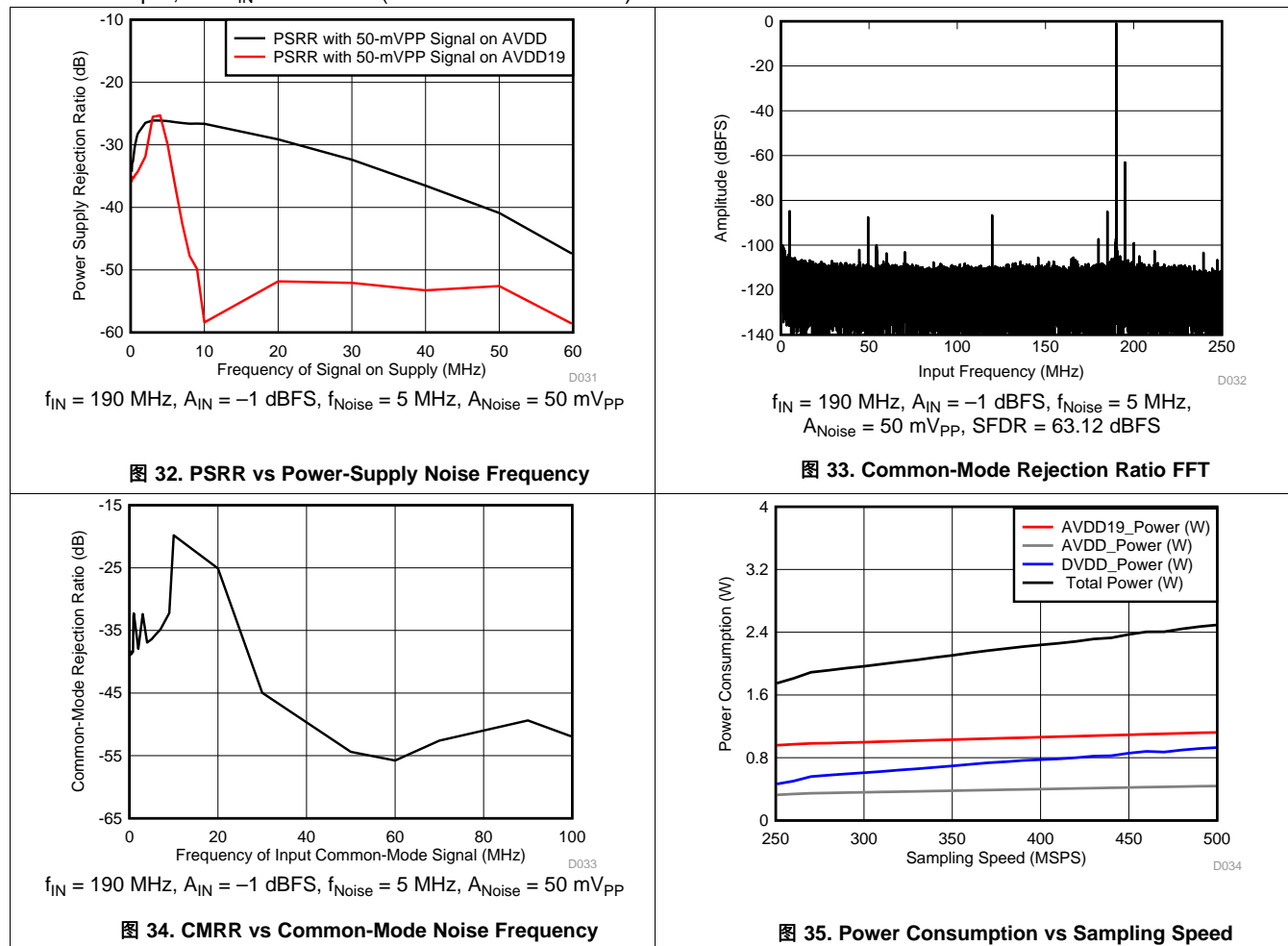


图 31. Power-Supply Rejection Ratio FFT for 50-mV Noise on AVDD Supply

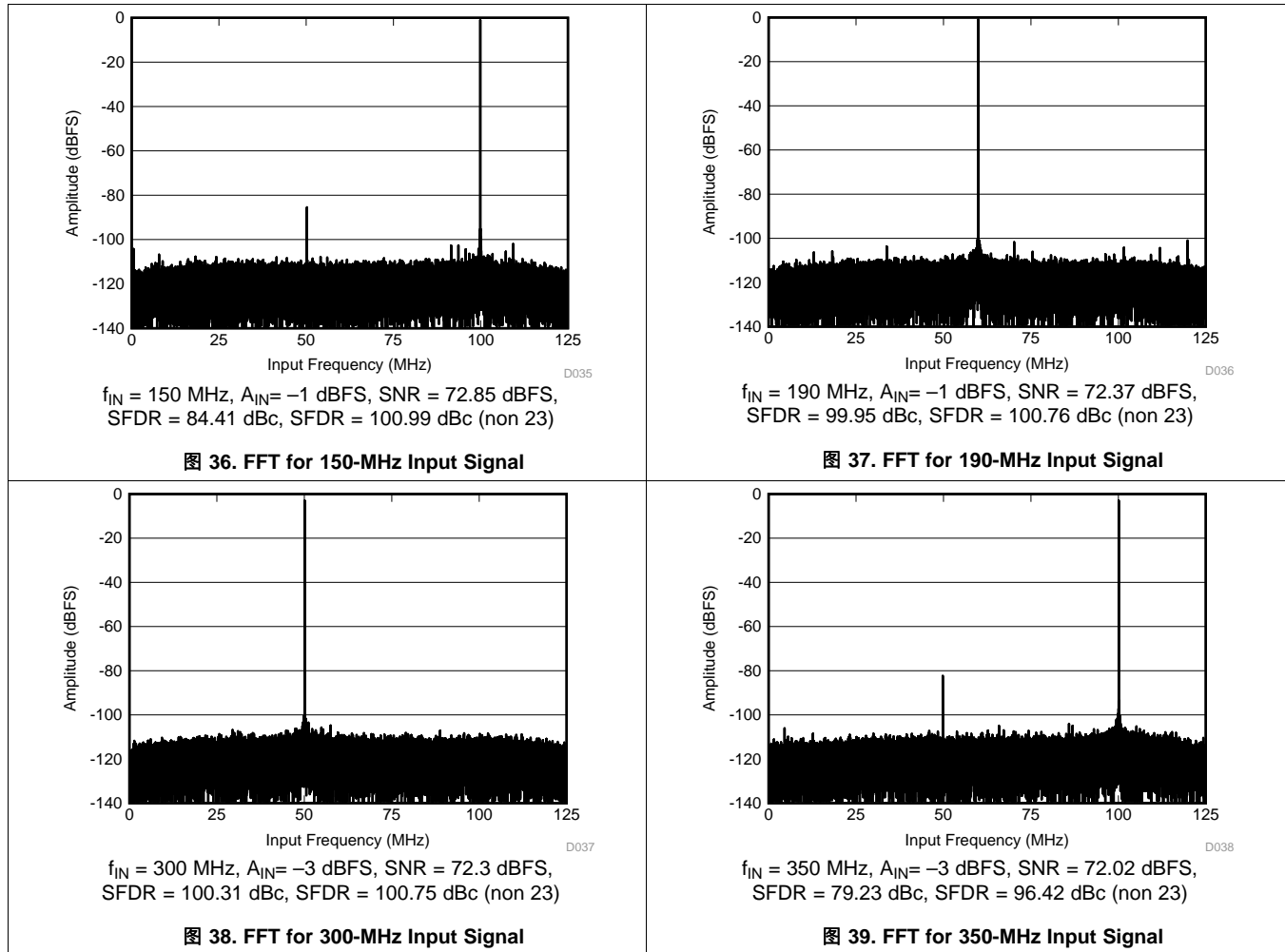
Typical Characteristics: DDC Bypass Mode (接下页)

typical values are at $T_A = 25^\circ\text{C}$, full temperature range is from $T_{\text{MIN}} = -40^\circ\text{C}$ to $T_{\text{MAX}} = +100^\circ\text{C}$, device sampling frequency = 1 GSPS, 50% clock duty cycle, output sample rate = 500 MSPS, $AVDD19 = 1.9\text{ V}$, $AVDD = DVDD = 1.15\text{ V}$, -1-dBFS differential input, and $f_{\text{IN}} = 190\text{ MHz}$ (unless otherwise noted)



6.10 Typical Characteristics: Mode 2

typical values are at $T_A = 25^\circ\text{C}$, full temperature range is from $T_{\text{MIN}} = -40^\circ\text{C}$ to $T_{\text{MAX}} = +100^\circ\text{C}$, device sampling frequency = 1 GSPS, 50% clock duty cycle, $AVDD19 = 1.9\text{ V}$, $AVDD = DVDD = 1.15\text{ V}$, -1-dBFS differential input, and $f_{\text{IN}} = 190\text{ MHz}$ (unless otherwise noted)



6.11 Typical Characteristics: Mode 0

typical values are at $T_A = 25^\circ\text{C}$, full temperature range is from $T_{\text{MIN}} = -40^\circ\text{C}$ to $T_{\text{MAX}} = +100^\circ\text{C}$, device sampling frequency = 1 GSPS, 50% clock duty cycle, $AV_{\text{DD19}} = 1.9\text{ V}$, $AV_{\text{DD}} = DV_{\text{DD}} = 1.15\text{ V}$, -1-dBFS differential input, and $f_{\text{IN}} = 190\text{ MHz}$ (unless otherwise noted)

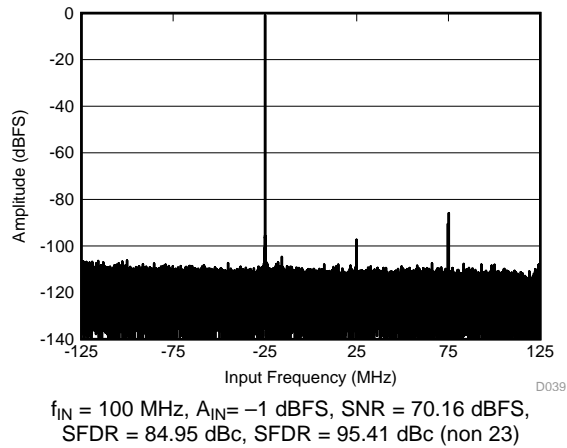


图 40. FFT for 100-MHz Input Signal

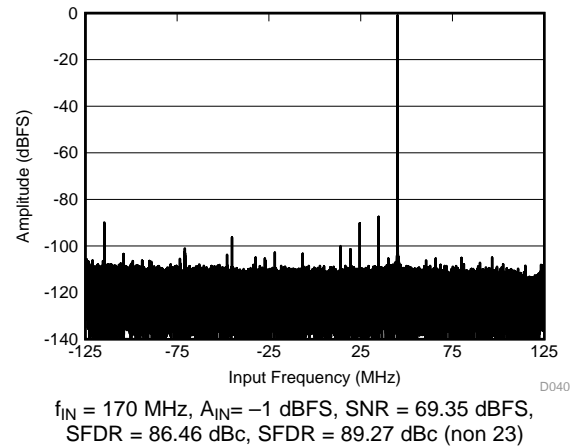


图 41. FFT for 170-MHz Input Signal

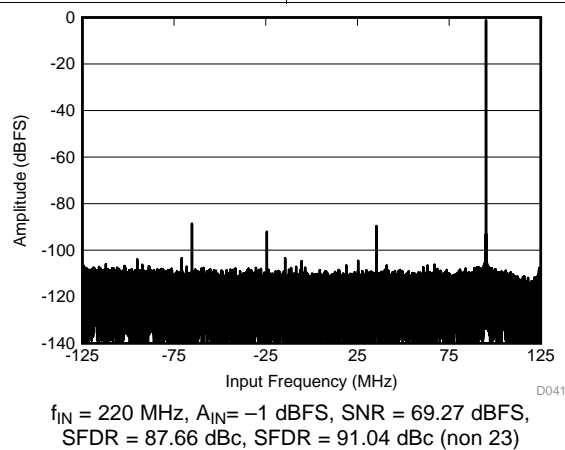


图 42. FFT for 220-MHz Input Signal

6.12 Typical Characteristics: Dual ADC Mode

typical values are at $T_A = 25^\circ\text{C}$, full temperature range is from $T_{\text{MIN}} = -40^\circ\text{C}$ to $T_{\text{MAX}} = +100^\circ\text{C}$, device sampling frequency = 1 GSPS, 50% clock duty cycle, $AV_{\text{DD19}} = 1.9\text{ V}$, $AV_{\text{DD}} = DV_{\text{DD}} = 1.15\text{ V}$, -1-dBFS differential input, and $f_{\text{IN}} = 190\text{ MHz}$ (unless otherwise noted)

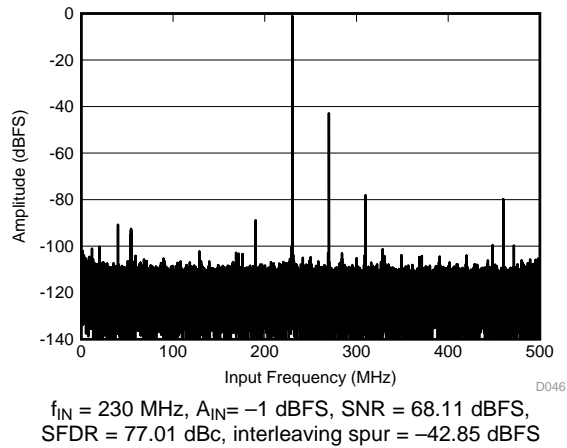


图 43. FFT for 230-MHz Input Signal

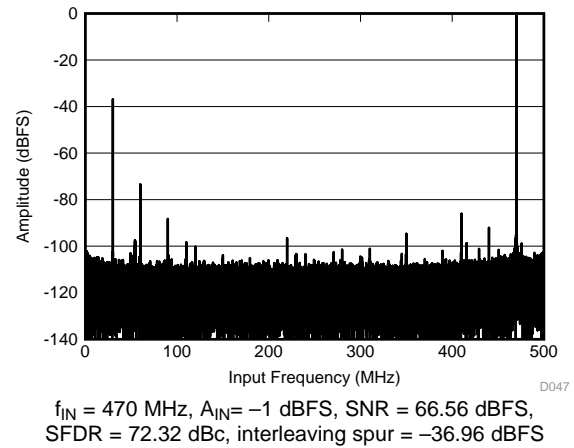


图 44. FFT for 470-MHz Input Signal

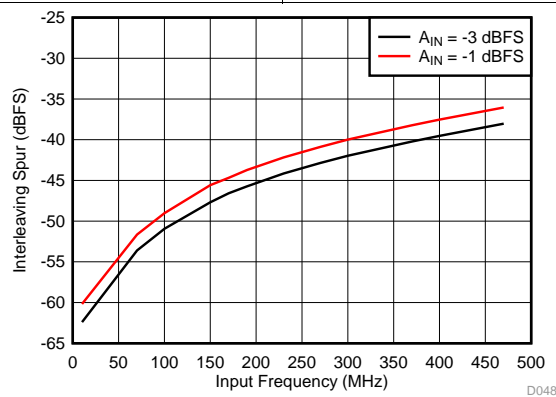


图 45. Interleaving Spur vs Input Frequency

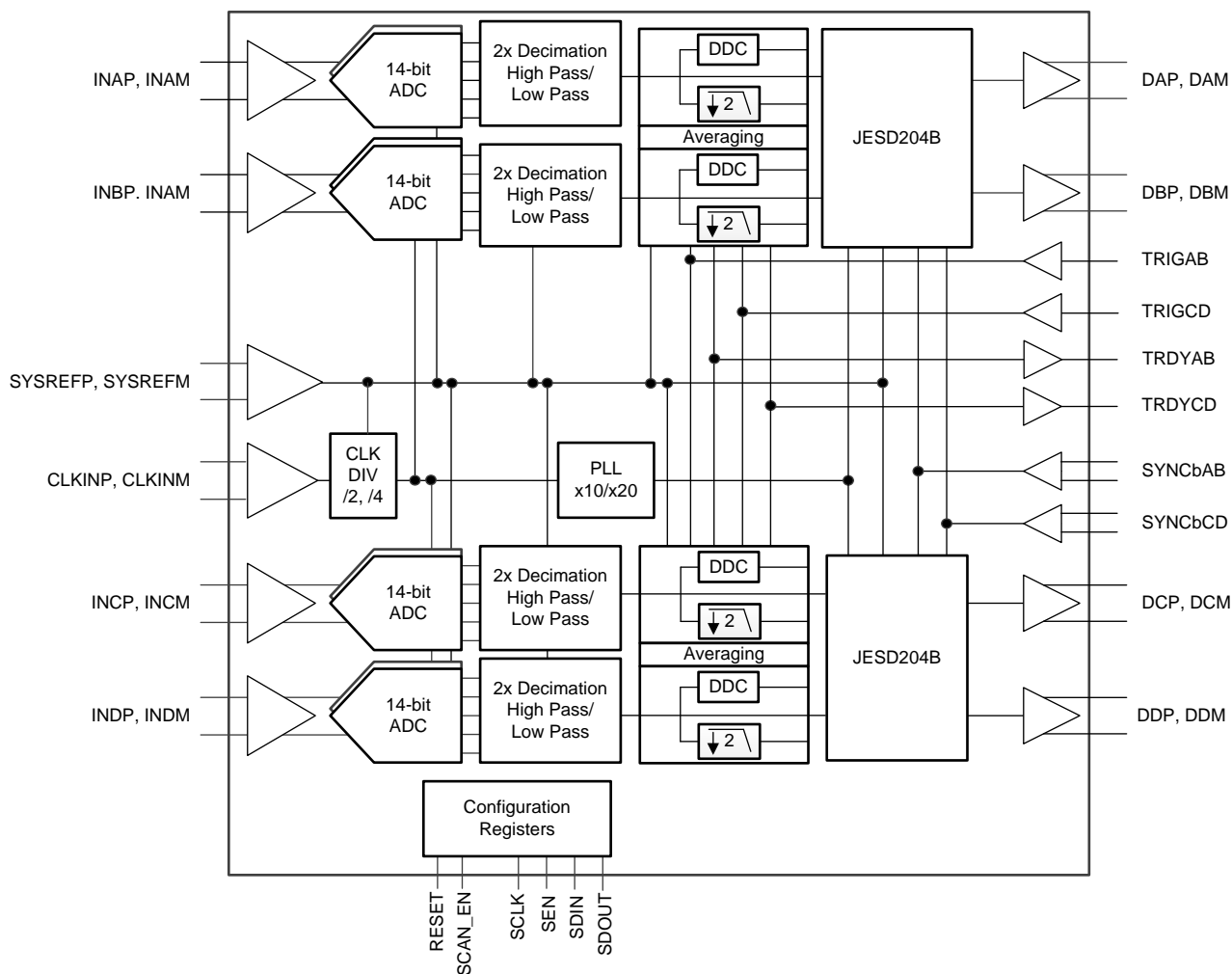
7 Detailed Description

7.1 Overview

The ADS54J64 is a quad-channel device with a complex digital down-converter (DDC) and digital decimation to allow flexible signal processing to suit different usage cases. Each channel is composed of two interleaved analog-to-digital converters (ADCs) sampling at half the input clock rate. The 2x interleaved data are decimated by 2 to provide a processing gain of 3 dB. The decimation filter has a programmable option to be configured as low pass (default) or high pass. In default mode, the device operates in DDC mode 0, where the input is mixed with a constant frequency of $-f_s / 4$ and transmitted as complex IQ. In DDC bypass mode (mode 8), the DDC is bypassed and the 2x decimated data are available on the JESD output. The different operational modes of the ADS54J64 are listed in [表 1](#).

The ADS54J64 can also be operated in a dual-channel interleaved mode (dual mode), in which two channels are averaged and the 2x interleaved and averaged data are available directly at the JESD output.

7.2 Functional Block Diagram



Copyright © 2017, Texas Instruments Incorporated

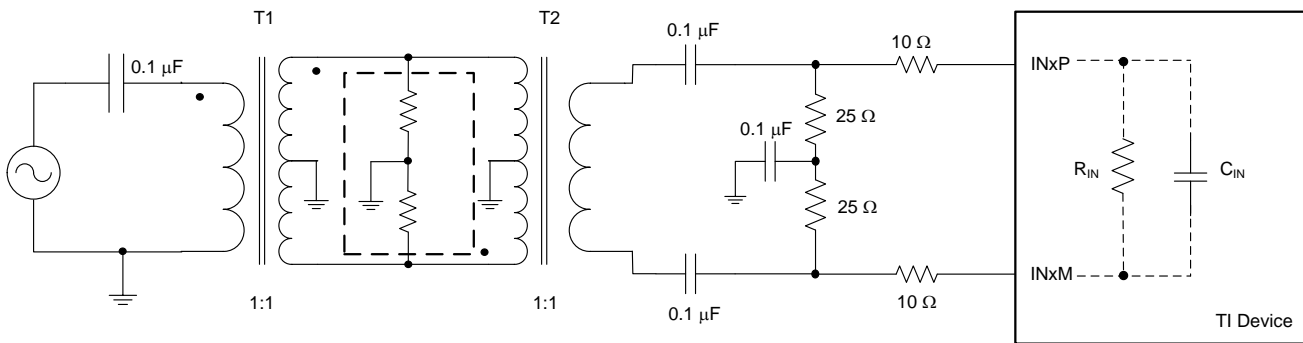
7.3 Feature Description

7.3.1 Analog Inputs

The ADS54J64 analog signal inputs are designed to be driven differentially. The analog input pins have internal analog buffers that drive the sampling circuit. As a result of the analog buffer, the input pins present a high-impedance input across a very wide frequency range to the external driving source that enables great flexibility in the external analog filter design as well as excellent 50-Ω matching for RF applications. The buffer also helps isolate the external driving circuit from the internal switching currents of the sampling circuit, resulting in a more constant SFDR performance across input frequencies. The common-mode voltage of the signal inputs is internally biased to 1.3 V using 2-kΩ resistors to allow for ac-coupling of the input drive network. Each input pin (INP, INM) must swing symmetrically between ($V_{CM} + 0.275\text{ V}$) and ($V_{CM} - 0.275\text{ V}$), resulting in a 1.1- V_{PP} (default) differential input swing. The input sampling circuit has a 3-dB bandwidth that extends up to 1000 MHz.

7.3.2 Recommended Input Circuit

In order to achieve optimum ac performance, the following circuitry (shown in 图 46) is recommended at the analog inputs.

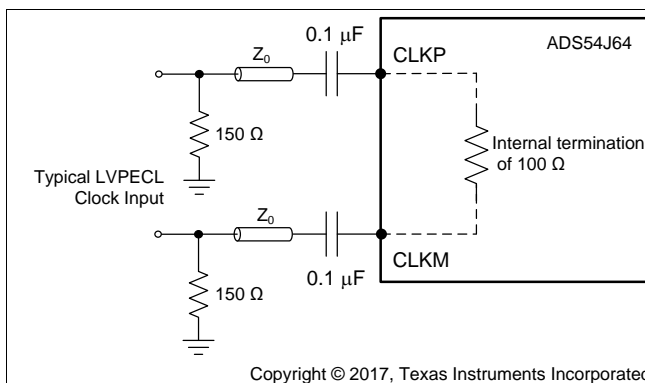


Copyright © 2017, Texas Instruments Incorporated

图 46. Analog Input Driving Circuit

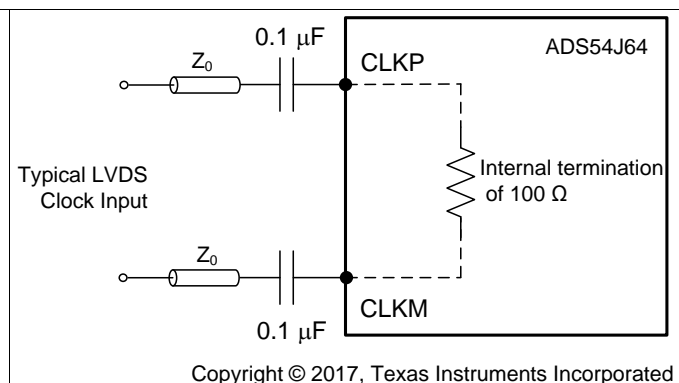
7.3.3 Clock Input

The clock inputs of the ADS54J64 supports LVDS and LVPECL standards. The CLKP, CLKM inputs have an internal termination of 100 Ω. The clock inputs must be ac-coupled, as shown in 图 47 and 图 48, because the input pins are self-biased to a common-mode voltage of 0.7 V.



Copyright © 2017, Texas Instruments Incorporated

图 47. LVPECL Clock Driving Circuit



Copyright © 2017, Texas Instruments Incorporated

图 48. LVDS Clock Driving Circuit

7.4 Device Functional Modes

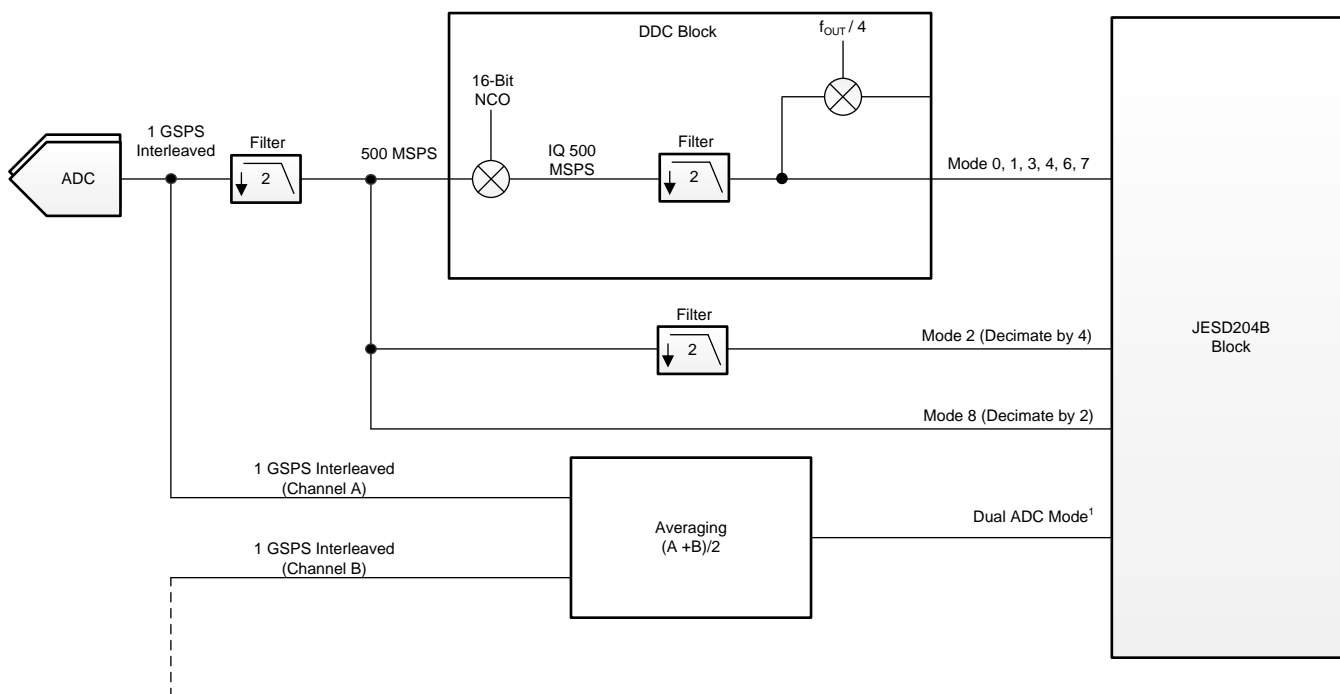
7.4.1 Digital Functions

图 49 shows the various operational modes available in the ADS54J64. In quad mode, the maximum output rate is half the sampling rate. The 2x interleaved data are filtered using a half-band filter (HBF) that can be configured as a low-pass or high-pass filter using register writes. In dual mode, the device can be operated at a full sampling rate with 2x interleaving and averaging of two channels.

Quad mode supports a maximum complex and a real bandwidth of 200 MHz. The HBF output can be brought directly on the JESD lines at half rate. The complex data are obtained through a digital down-converter (DDC) that is comprised of a 16-bit numerically controlled oscillator (NCO) and a 100-MHz or 200-MHz filter. The DDC also has a real output mode where the data are decimated by 2 and mixed to $f_{OUT} / 4$ to support a bandwidth of 100 MHz. In addition to the DDC modes, the HBF output can be decimated by 2 to obtain an overall decimation by 4 on the 2x interleaved data.

Dual mode supports a maximum sampling rate of 1 GSPS. The 2x interleaved data from channel A and channel B (and likewise channels C and D) can be averaged and given on the JESD lanes.

表 1 lists all modes of operation with the maximum bandwidth provided at a sample rate of 491.52 MSPS and 368.64 MSPS.



Copyright © 2017, Texas Instruments Incorporated

(1) 1-GSPS data are transmitted using two JESD lanes.

图 49. ADS54J64 Channel Operating Modes

Device Functional Modes (接下页)

表 1. ADS54J64 Operating Modes

OPERATING MODE	DESCRIPTION	1ST-STAGE DECIMATION	DIGITAL MIXER	2ND-STAGE DECIMATION	BANDWIDTH AT 491.52 MSPS	BANDWIDTH AT 368.64 MSPS	OUTPUT MIXER	OUTPUT FORMAT	MAX OUTPUT RATE
0	Decimation	2	$\pm f_s / 4$	2	200 MHz	150 MHz	—	Complex	250 MSPS
1		2	16-bit NCO	2	200 MHz	150 MHz	—	Complex	250 MSPS
2		2	—	2	100 MHz (LP, LP or HP, HP), 75 MHz (HP, LP or LP, HP)	75 MHz, 56.25 MHz	—	Real	250 MSPS
3		2	16-bit NCO	Bypass	200 MHz	150 MHz	$f_{out} / 4$	Real	500 MSPS
4		2	16-bit NCO	2	100 MHz	75 MHz	$f_{out} / 4$	Real	250 MSPS
5		Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
6		2	16-bit NCO	4	100 MHz	75 MHz	—	Complex	125 MSPS
7		2	16-bit NCO	2	100 MHz	75 MHz	$f_{out} / 4$	Real with zero insertion	500 MSPS
8	DDC bypass mode	2	—	—	223 MHz	167 MHz	—	Real	500 MSPS
8	Dual ADC mode	—	—	—	—	—	—	—	1000 MSPS

7.4.1.1 Numerically Controlled Oscillators (NCOs) and Mixers

The ADS54J64 is equipped with a complex numerically-controlled oscillator. The oscillator generates a complex exponential sequence: $x[n] = e^{j\omega n}$. The frequency (ω) is specified by the 16-bit register setting. The complex exponential sequence is multiplied by the real input from the ADC to mix the desired carrier down to 0 Hz.

The NCO frequency setting is set by the 16-bit register value, NCO_FREQ[n]:

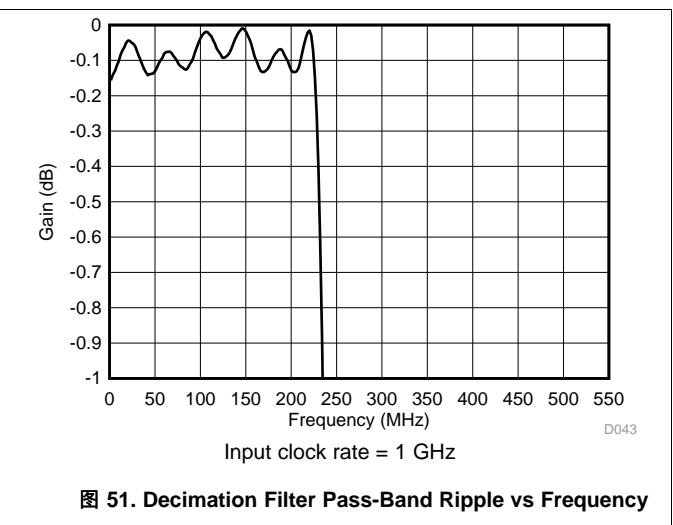
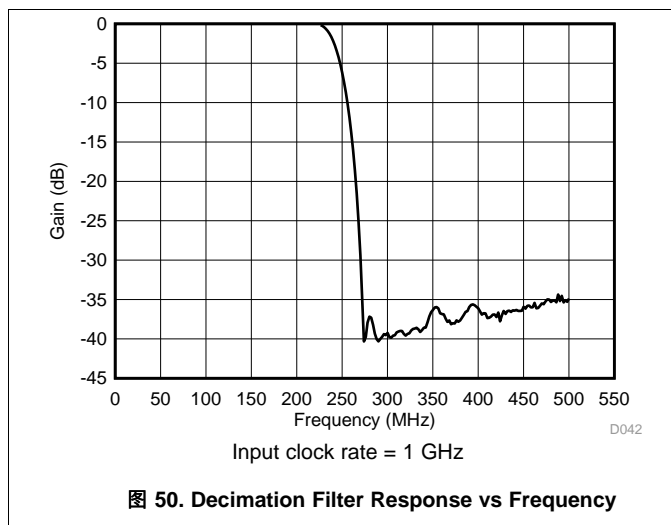
$$f_{NCO} = \frac{\text{NCO Frequency [n]} \times f_s}{2^{16}} \tag{1}$$

7.4.1.2 Decimation Filter

The ADS54J64 has two decimation filters (decimate-by-2) in the data path. The first stage of the decimation filter is non-programmable and is used in all functional modes. The second stage of decimation, available in DDC mode 2 and 6, can be used to obtain noise and linearity improvement for low bandwidth applications.

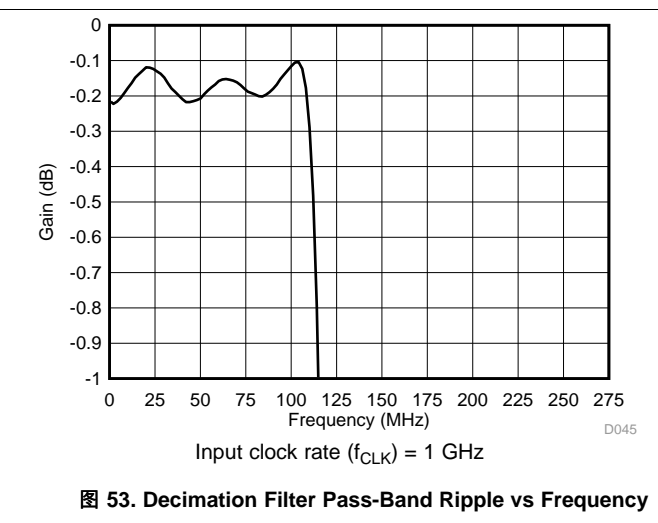
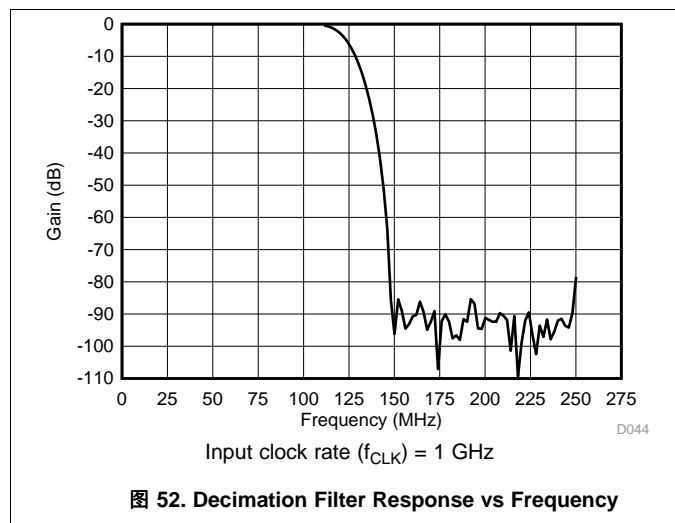
7.4.1.2.1 Stage-1 Filter

The first-stage filter is used for decimation of the 2x interleaved data from f_{CLK} to $f_{CLK} / 2$. 图 50 and 图 51 show the frequency response and pass-band ripple of the first-stage decimation filter, respectively.



7.4.1.2.2 Stage-2 Filter

The second-stage filter is used for decimating the data from a sample rate of $f_{CLK} / 2$ to $f_{CLK} / 4$. 图 52 and 图 53 show the frequency response and pass-band ripple of the second-stage filter, respectively.



7.4.1.3 Mode 0: Decimate-by-4 With IQ Outputs and $f_S / 4$ Mixer

In mode 0, the DDC block includes a fixed frequency $\pm f_S / 4$ complex digital mixer preceding the second-stage decimation filters. 图 54 shows that the IQ pass band is approximately ± 100 MHz centered at $f_S / 8$ or $3f_S / 8$.

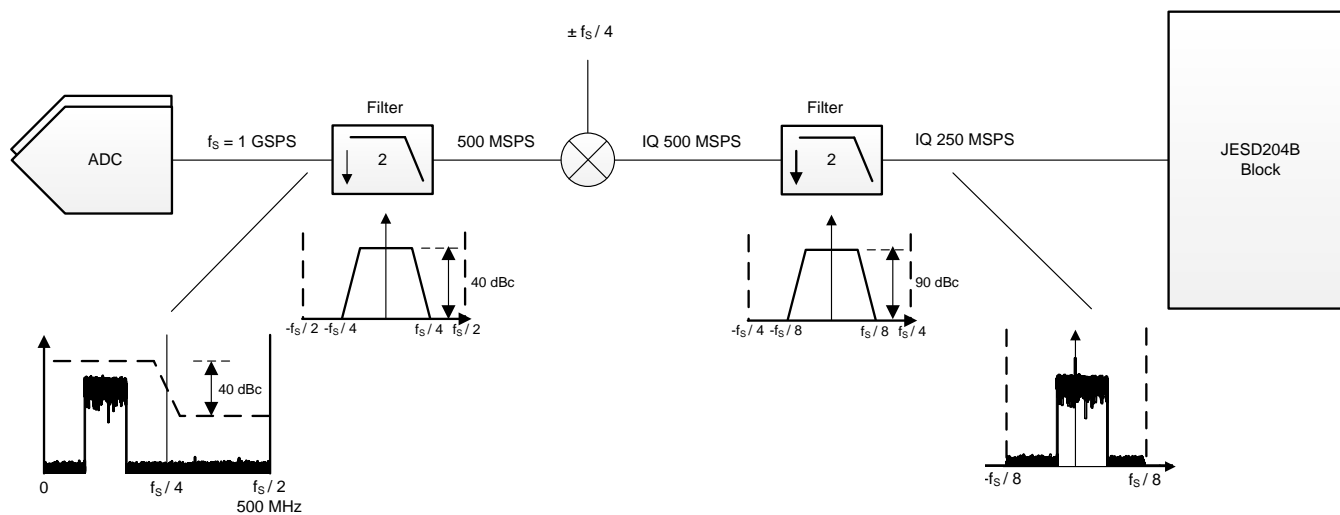


图 54. Operating Mode 0

7.4.1.4 Mode 1: Decimate-by-4 With IQ Outputs and 16-Bit NCO

In mode 1, the DDC block includes a 16-bit frequency resolution complex digital mixer, as shown in 图 55, preceding the second-stage decimation filters.

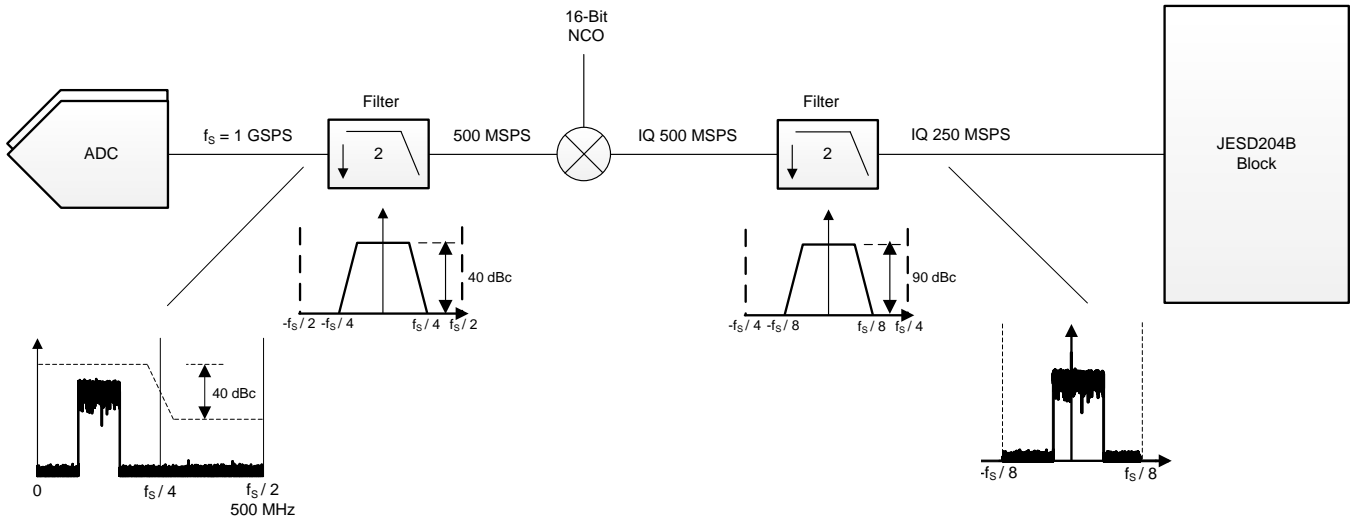


图 55. Operating Mode 1

7.4.1.5 Mode 2: Decimate-by-4 With Real Output

In mode 2, the DDC block cascades two decimate-by-2 filters. Each filter can be configured as low pass (LP) or high pass (HP), as shown in 表 2, to allow down conversion of different frequency ranges. 图 56 shows that the LP, HP and HP, LP output spectra are inverted.

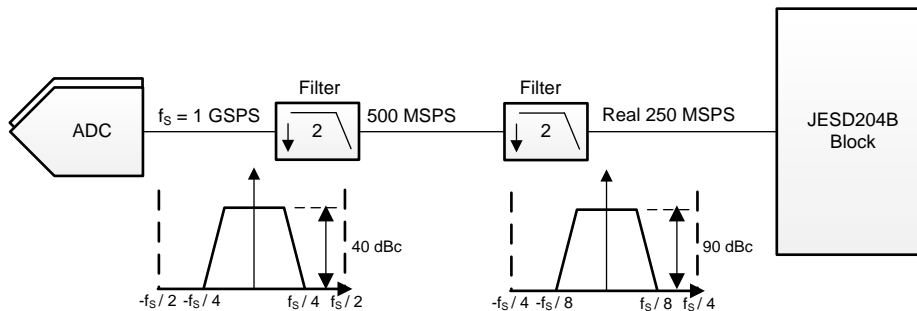


图 56. Operating in Mode 2

表 2. ADS54J64 Operating Mode 2, Down-Converted Frequency Ranges

1ST-STAGE FILTER	2ND-STAGE FILTER	FREQUENCY RANGE WITH CLOCK RATE OF 983.04 MHz	BANDWIDTH WITH CLOCK RATE OF 983.04 MHz	FREQUENCY RANGE WITH CLOCK RATE OF 737.28 MHz	BANDWIDTH WITH CLOCK RATE OF 737.28 MHz
LP	LP	0 MHz–100 MHz	100 MHz	0 MHz–75 MHz	75 MHz
LP	HP	150 MHz–223 MHz	73 MHz	112.5 MHz–167.25 MHz	54.75 MHz
HP	LP	268.52 MHz–341.52 MHz	73 MHz	201.39 MHz–256.14 MHz	54.75 MHz
HP	HP	391.52 MHz–491.52 MHz	100 MHz	293.64 MHz–368.64 MHz	75 MHz

7.4.1.6 Mode 3: Decimate-by-2 Real Output With Frequency Shift

In mode 3, the DDC block includes a 16-bit complex NCO digital mixer followed by a $f_s / 4$ mixer with a real output to center the band at $f_s / 4$. As shown in Figure 57, the NCO must be set to a value different from $\pm f_s / 4$, or else the samples are zeroed.

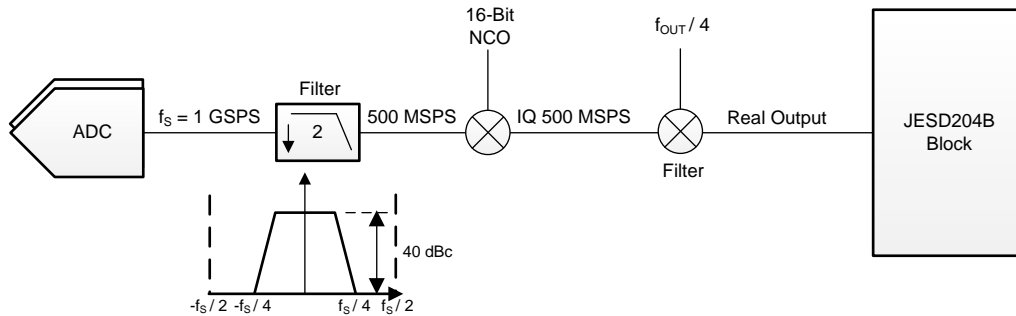


图 57. Operating Mode 3

7.4.1.7 Mode 4: Decimate-by-4 With Real Output

In mode 4, the DDC block includes a 16-bit complex NCO digital mixer preceding the second-stage decimation filter. As shown in Figure 58, the signal is then mixed with $f_{OUT} / 4$ to generate a real output. The bandwidth available in this mode is 100 MHz.

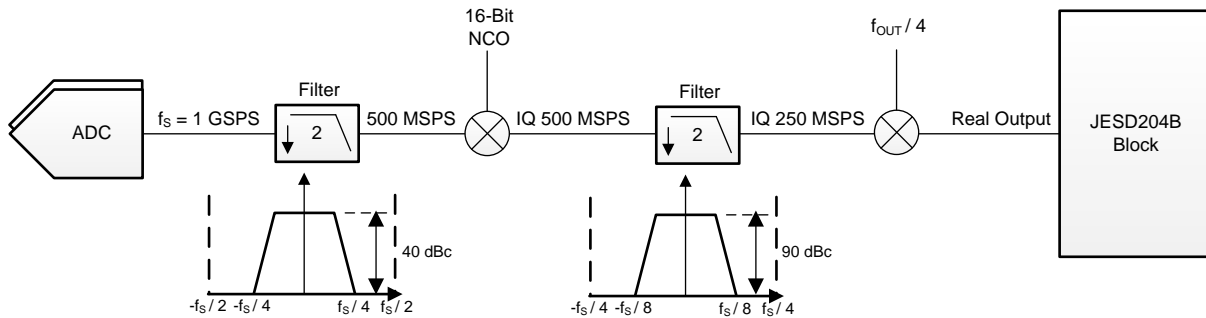


图 58. Operating Mode 4

7.4.1.8 Mode 6: Decimate-by-4 With IQ Outputs for Up to 110 MHz of IQ Bandwidth

In mode 6, the DDC block shown in 图 59 includes a 16-bit complex NCO digital mixer preceding a second-stage filter with a decimate-by-4 complex, generating a complex output at $f_s / 8$.

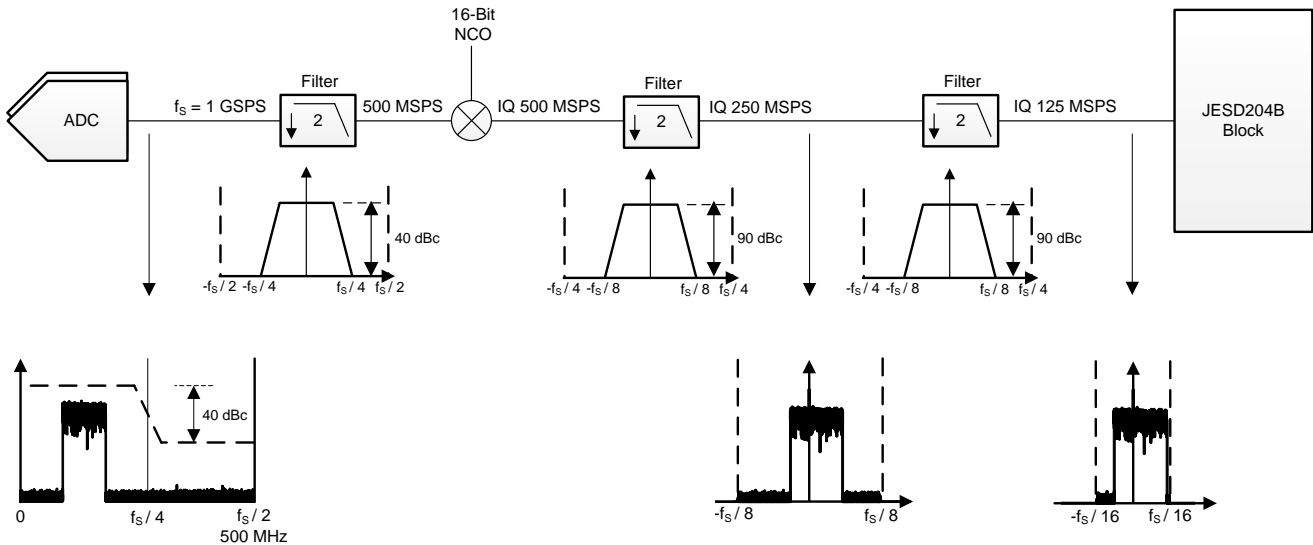


图 59. Operating Mode 6

7.4.1.9 Mode 7: Decimate-by-4 With Real Output and Zero Stuffing

In mode 7, the DDC block includes a 16-bit complex NCO digital mixer preceding the second-stage decimation filter. The signal is then mixed with $f_{OUT} / 4$, as shown in 图 60, to generate a real output that is then doubled in sample rate by zero-stuffing every other sample. The bandwidth available in this mode is 100 MHz.

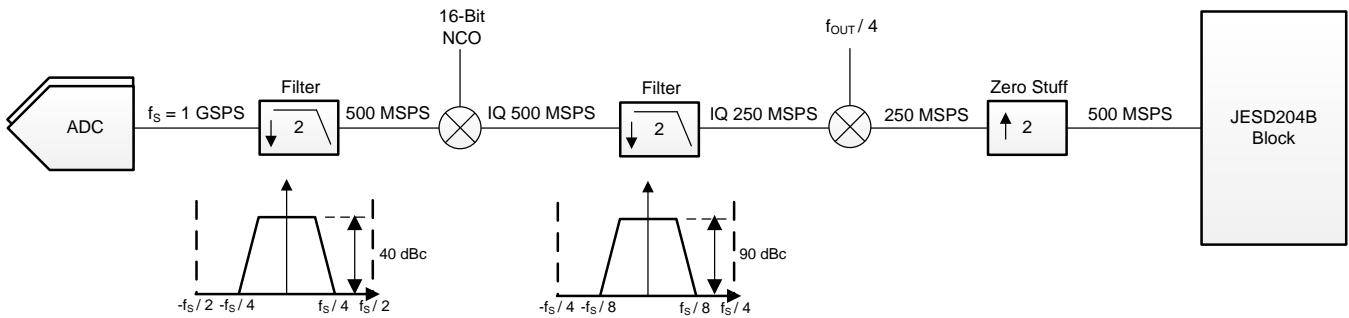
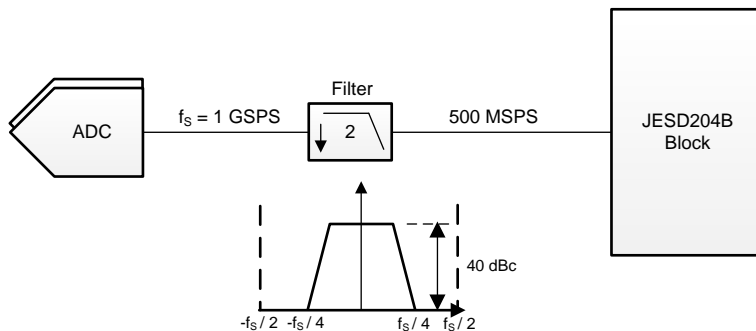


图 60. Operating Mode 7

7.4.1.10 Mode 8: DDC Bypass Mode

In mode 8, the DDC block is bypassed as shown in 图 61 and the 2x decimated data are available on the JESD output. The decimation filter can be configured to be high pass or low pass using an SPI register bit. The stop-band attenuation is approximately 40 dB and the available bandwidth is 225 MHz. The decimation filter response is illustrated in 图 50 and 图 51.

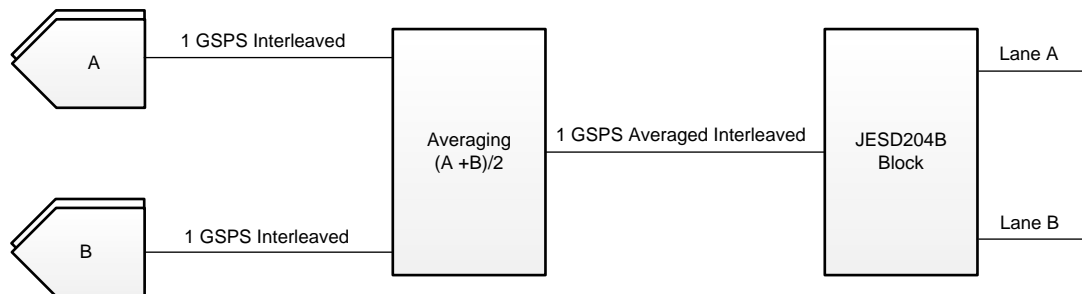


Copyright © 2017, Texas Instruments Incorporated

图 61. Operating Mode 8

7.4.1.11 Averaging Mode

In dual ADC mode, two channels (channels A, B and C, D) are averaged and given out as a single output. As a result, the device operates in a dual-channel mode with 2x interleaved sample rate. For a 1-GSPS input clock, the averaged output at 1 GSPS is available on two JESD lanes, each operating at 10 Gbps. 图 62 shows the device supporting an averaging of channels A and B. An identical averaging path is available for channels C and D. Configure the device in mode 8 before enabling dual ADC mode through SPI register writes.



Copyright © 2017, Texas Instruments Incorporated

图 62. Averaging Mode for Channels A and B (C and D Averaging is Identical)

7.4.1.12 Overrange Indication

The ADS54J64 provides a fast overrange indication that can be presented in the digital output data stream via SPI configuration. When the FOVR indication is embedded in the output data stream as shown in [图 63](#), this indication replaces the LSB (D0) of the 16 bits going to the 8b, 10b encode.

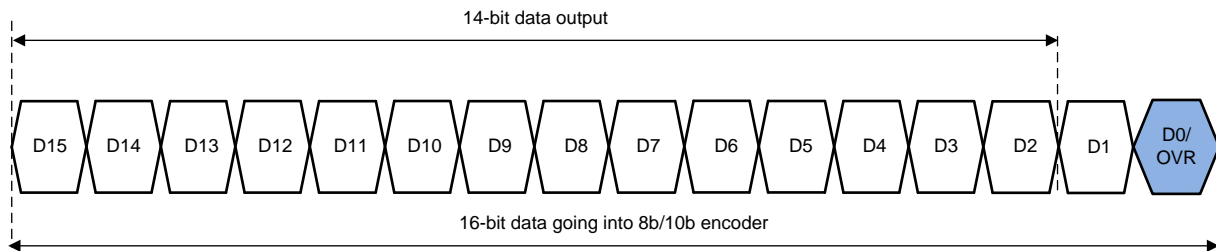


图 63. FOVR Timing Diagram

The fast overrange feature of the ADS54J64 is configured using an upper (FOVR Hi) and a lower (FOVR Lo) 8-bit threshold that are compared against the partial ADC output of the initial pipeline stages. [图 64](#) shows the FOVR high and FOVR low thresholds.

The two thresholds are configured via the SPI register where a setting of 136 maps to the maximum ADC code for a high FOVR, and a setting of 8 maps to the minimum ADC code for a low FOVR.

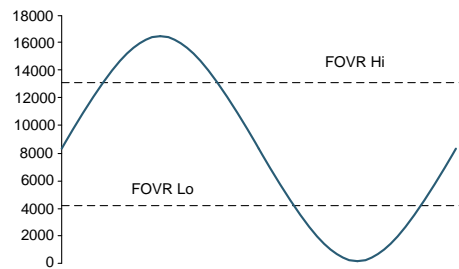


图 64. FOVR High and FOVR Low Thresholds

[公式 2](#) calculates the FOVR threshold from a full-scale input based on the ADC code:

$$\text{FOVR (dBFS)} = 20 \log \left| \frac{\text{FOVR High or FOVR Low} - 72}{64} \right| \quad (2)$$

Therefore, a threshold of -0.5 dBFS from full-scale can be set with:

- FOVR high = 132 (27h, 84h)
- FOVR low = 12 (28h, 0Ch)

7.5 Programming

7.5.1 JESD204B Interface

The ADS54J64 supports device subclass 1 with a maximum output data rate of 10 Gbps for each serial transmitter.

图 65 shows that an external SYSREF signal is used to align all internal clock phases and the local multi-frame clock to a specific sampling clock edge. A common SYSREF signal allows synchronization of multiple devices in a system and minimizes timing and alignment uncertainty. The ADS54J64 supports single (for all four JESD links) or dual (for channels A, B and C, D) SYNCb inputs and can be configured via the SPI.

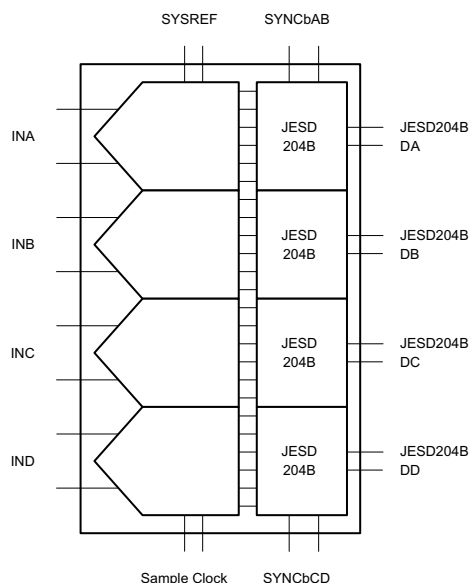


图 65. JESD204B Transmitter Block

Depending on the ADC sampling rate, the JESD204B output interface can be operated with one lane per channel. The JESD204B setup and configuration of the frame assembly parameters is handled via the SPI interface.

The JESD204B transmitter block shown in 图 66 consists of the transport layer, the data scrambler, and the link layer. The transport layer maps the ADC output data into the selected JESD204B frame data format and manages if the ADC output data or test patterns are being transmitted. The link layer performs the 8b, 10b data encoding as well as the synchronization and initial lane alignment using the SYNC input signal. Optionally, data from the transport layer can be scrambled.

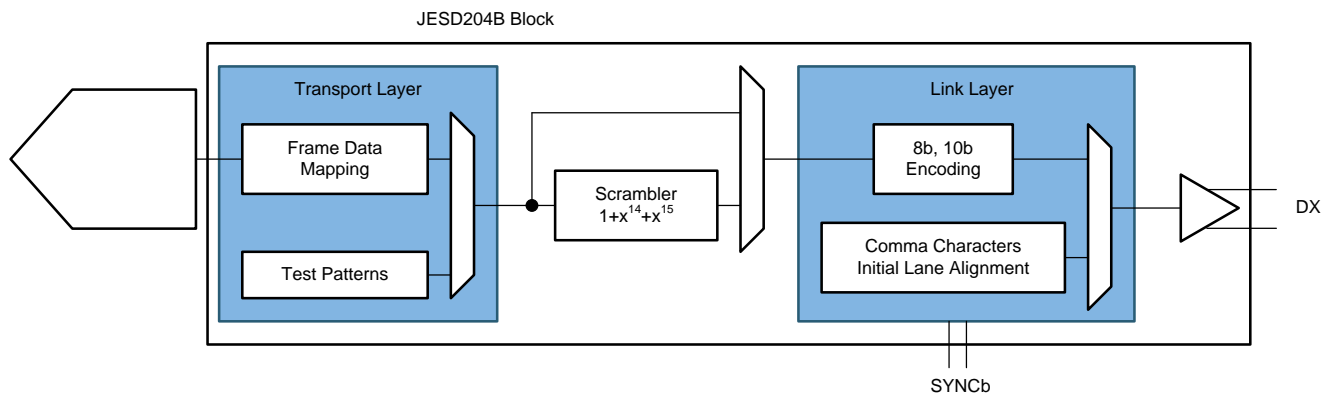


图 66. JESD Interface Block Diagram

Programming (接下页)

7.5.2 JESD204B Initial Lane Alignment (ILA)

The initial lane alignment process is started by the receiving device by deasserting the SYNCb signal. When a logic low is detected on the SYNC input pins, as shown in 图 67, the ADS54J64 starts transmitting comma (K28.5) characters to establish code group synchronization.

When synchronization is complete, the receiving device reasserts the SYNCb signal and the ADS54J64 starts the initial lane alignment sequence with the next local multi-frame clock boundary. The ADS54J64 transmits four multi-frames, each containing K frames (K is SPI programmable). Each of the multi-frames contains the frame start and end symbols and the second multi-frame also contains the JESD204 link configuration data.

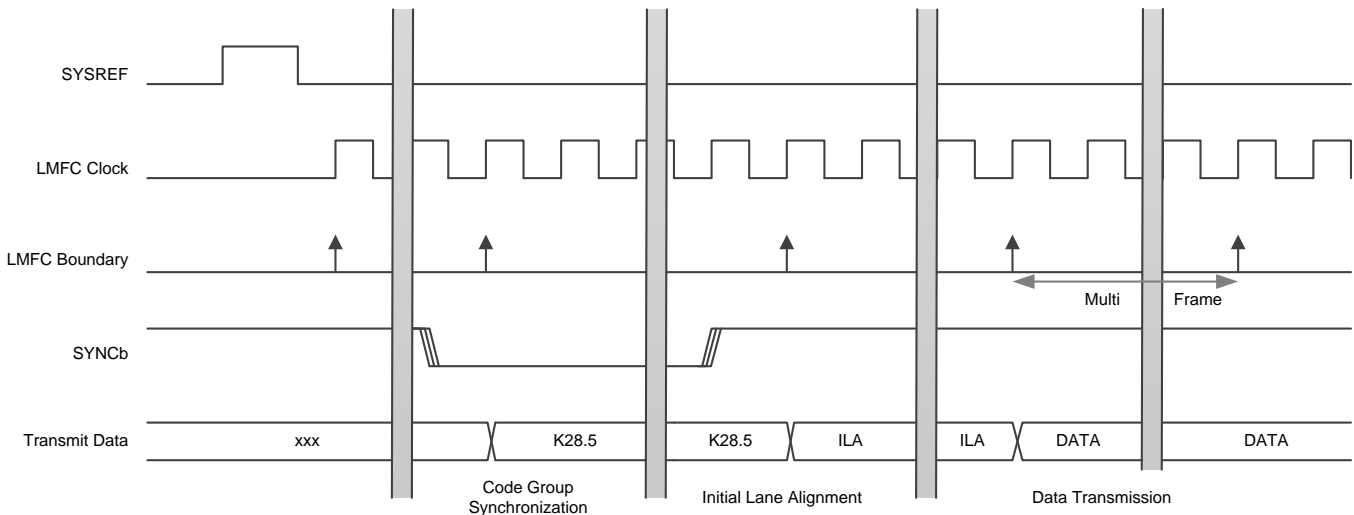


图 67. ILA Sequence

Programming (接下页)

7.5.3 JESD204B Frame Assembly

The JESD204B standard defines the following parameters:

- L is the number of lanes per link
- M is the number of converters per device
- F is the number of octets per frame clock period
- S is the number of samples per frame

表 3 lists the available JESD204B formats and valid ranges for the ADS54J64. The ranges are limited by the SerDes line rate and the maximum ADC sample frequency.

表 3. Available JESD204B Formats and Valid Ranges for the ADS54J64

L	M	F	S	OPERATING MODE	DIGITAL MODE	OUTPUT FORMAT	MAX ADC OUTPUT RATE (MSPS)	MAX f_{SerDes} (Gbps)	JESD PLL REGISTER CONFIGURATION
4	8	4	1	0, 1	2x decimation	Complex	250	10.0	—
4	4	2	1	2, 4	2x decimation	Real	250	5.0	CTRL_SER_MODE = 1, SerDes_MODE = 1
2	4	4	1	2, 4	2x decimation	Real	250	10.0	—
4	8	4	1	6	4x decimation	Complex	125	5.0	—
2	8	8	1	6	4x decimation	Complex	125	10.0	CTRL_SER_MODE = 1, SerDes_MODE = 3
4	4	2	1	7	2x decimation with 0-pad	Real	500	10.0	—
4	4	2	1	3, 8	DDC bypass	Real	500	10.0	—
4	2	1	1	8	DDC bypass dual ADC	Real	1000	10.0	—

表 4, 表 5, and 表 6 show the detailed frame assembly for various LMFS settings.

表 4. Detailed Frame Assembly for Four-Lane Modes (Modes 0, 1, 3, 6, 7, and 8)

OUTPUT LANE	LMFS = 4841				LMFS = 4421				LMFS = 4421			
DA	A ₀ [15:8]	A ₀ [7:0]	AQ ₀ [15:8]	AQ ₀ [7:0]	A ₀ [15:8]	A ₀ [7:0]	A ₁ [15:8]	A ₁ [7:0]	A ₀ [15:8]	A ₀ [7:0]	0000 0000	0000 0000
DB	B ₀ [15:8]	B ₀ [7:0]	BQ ₀ [15:8]	BQ ₀ [7:0]	B ₀ [15:8]	B ₀ [7:0]	B ₁ [15:8]	B ₁ [7:0]	B ₀ [15:8]	B ₀ [7:0]	0000 0000	0000 0000
DC	C ₀ [15:8]	C ₀ [7:0]	CQ ₀ [15:8]	CQ ₀ [7:0]	C ₀ [15:8]	C ₀ [7:0]	C ₁ [15:8]	C ₁ [7:0]	C ₀ [15:8]	C ₀ [7:0]	0000 0000	0000 0000
DD	D ₀ [15:8]	D ₀ [7:0]	DQ ₀ [15:8]	DQ ₀ [7:0]	D ₀ [15:8]	D ₀ [7:0]	D ₁ [15:8]	D ₁ [7:0]	D ₀ [15:8]	D ₀ [7:0]	0000 0000	0000 0000

表 5. Detailed Frame Assembly for Two-Lane Modes (Modes 2 and 4)

OUTPUT LANE	LMFS = 2441				LMFS = 2881							
DB	A ₀ [15:8]	A ₀ [7:0]	B ₀ [15:8]	B ₀ [7:0]	A ₀ [15:8]	A ₀ [7:0]	AQ ₀ [15:8]	AQ ₀ [7:0]	B ₀ [15:8]	B ₀ [7:0]	BQ ₀ [15:8]	BQ ₀ [7:0]
DC	C ₀ [15:8]	C ₀ [7:0]	D ₀ [15:8]	D ₀ [7:0]	C ₀ [15:8]	C ₀ [7:0]	CQ ₀ [15:8]	CQ ₀ [7:0]	D ₀ [15:8]	D ₀ [7:0]	DQ ₀ [15:8]	DQ ₀ [7:0]

表 6. Detailed Frame Assembly for Four-Lane Mode (2x Interleaved Dual ADC)

OUTPUT LANE	LMFS = 4211			
DA	AB ⁽¹⁾ ₀ [15:8]	AB ₁ [15:8]	AB ₂ [15:8]	AB ₃ [15:8]
DB	AB ₀ [7:0]	AB ₁ [7:0]	AB ₂ [7:0]	AB ₃ [7:0]
DC	CD ⁽²⁾ ₀ [15:8]	CD ₁ [15:8]	CD ₂ [15:8]	CD ₃ [15:8]
DD	CD ₀ [7:0]	CD ₁ [7:0]	CD ₂ [7:0]	CD ₃ [7:0]

- (1) AB corresponds to the average output of channel A and channel B.
(2) CD corresponds to the average output of channel C and channel D.

7.5.4 JESD Output Switch

To ease layout constraints, the ADS54J64 provides a digital cross-point switch in the JESD204B block (as shown in [图 68](#)) that allows internal routing of any output of the two ADCs within one channel pair to any of the two JESD204B serial transmitters. The cross-point switch routing is configured via the SPI (address 41h in the SERDES_XX digital page).

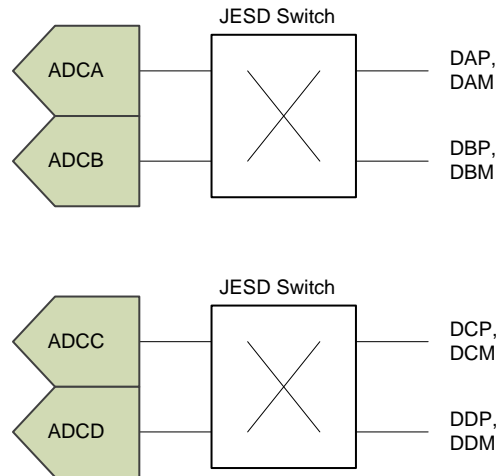


图 68. Switching the Output Lanes

7.5.4.1 SerDes Transmitter Interface

As shown in [图 69](#), each 10-Gbps SerDes transmitter output requires ac-coupling between the transmitter and receiver. Terminate the differential pair with $100\ \Omega$ as close to the receiving device as possible to avoid unwanted reflections and signal degradation.

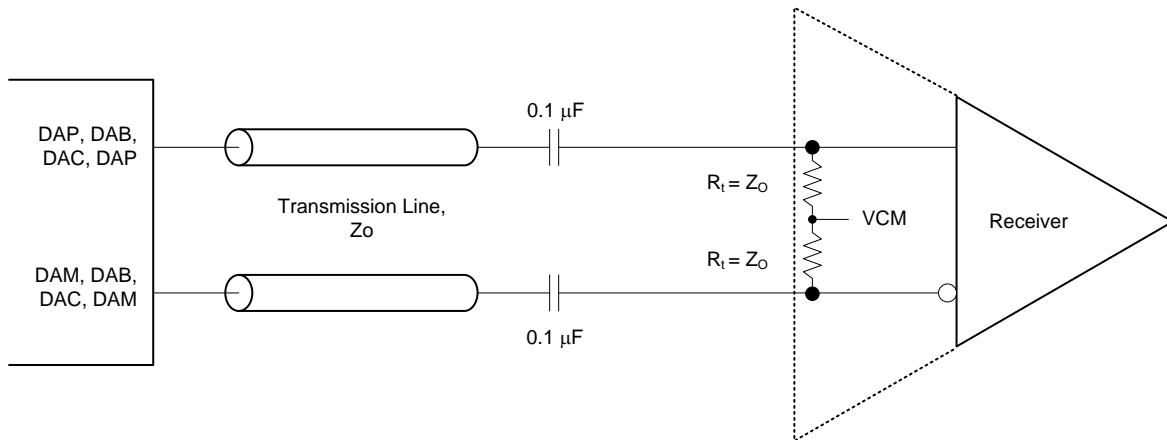


图 69. SerDes Transmitter Connection to Receiver

7.5.4.2 SYNCb Interface

The ADS54J64 supports single SYNCb control (where the SYNCb input controls all four JESD204B links) or dual SYNCb control (where one SYNCb input controls two JESD204B lanes: DA, DB and DC, DD). When using the single SYNCb control, connect the unused input to a differential logic high (SYNCbxxP = DVDD, SYNCbxxM = 0 V).

7.5.4.3 Eye Diagram

图 70 到 图 73 显示 ADS54J64 在 7.5 Gbps 和 10 Gbps 下的默认和增加输出电压摆幅的串行输出眼图，相对于 JESD204B 掩模。

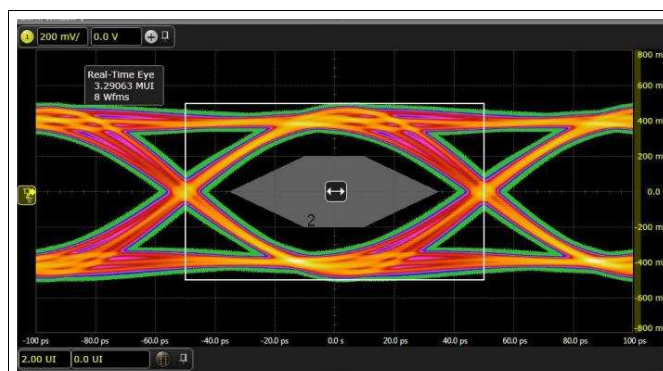


图 70. Eye at 10-Gbps Bit Rate With Default Output Swing

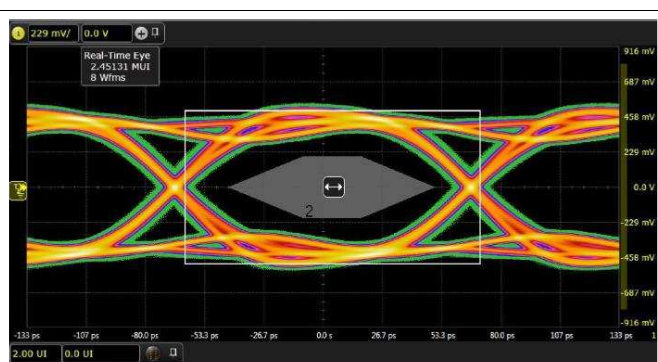


图 71. Eye at 7.5-Gbps Bit Rate With Default Output Swing

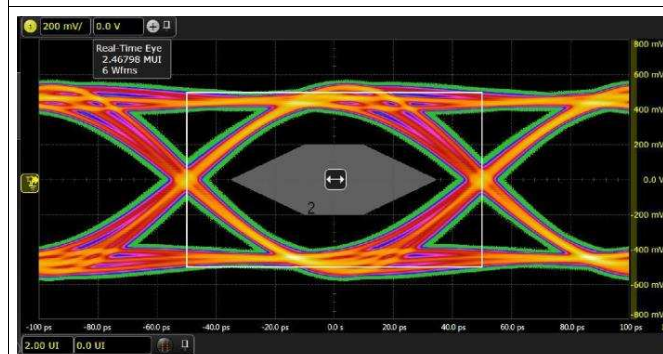


图 72. Eye at 10-Gbps Bit Rate With Increased Output Swing

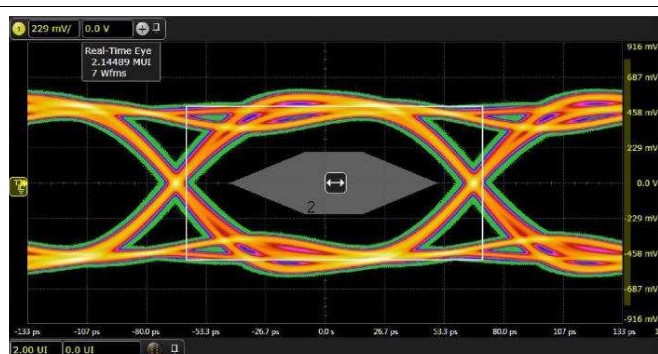


图 73. Eye at 7.5-Gbps Bit Rate With Increased Output Swing

7.5.5 Device Configuration

The ADS54J64 can be configured using a serial programming interface, as described in the [Register Maps](#) section. In addition, the device has one dedicated parallel pin (PDN) for controlling the power-down modes. The ADS54J64 supports a 24-bit (16-bit address, 8-bit data) SPI operation and uses paging to access all register bits.

7.5.5.1 Details of the Serial Interface

The ADC has a set of internal registers that can be accessed by the serial interface formed by the SEN (serial interface enable), SCLK (serial interface clock), SDIN (serial data input data), and SDOUT (serial data output) pins. Serially shifting bits into the device is enabled when SEN is low. SDIN serial data are latched at every SCLK rising edge when SEN is active (low). Data can be loaded in multiples of 24-bit words within a single active SEN pulse. The first 16 bits form the register address and the remaining eight bits are the register data. The interface can work with SCLK frequencies from 10 MHz down to very low speeds (of a few hertz) and also with a non-50% SCLK duty cycle.

7.5.5.1.1 Register Initialization

After power-up, the internal registers must be initialized to the default values. This initialization can be accomplished in one hardware reset by applying a high pulse on the RESET pin.

7.5.5.2 Serial Register Write

The internal registers of the ADS54J64 can be programmed (as shown in 图 74) by:

1. Driving the SEN pin low
2. Setting the R/W bit = 0
3. Initiating a serial interface cycle specifying the address of the register (A[14:0]) whose content must be written
4. Writing the 8-bit data that is latched in on the SCLK rising edge

The ADS54J64 has several different register pages (page selection in address 11h, 12h). Specify the register page before writing to the desired address. The register page only must be set one time for continuous writes to the same page.

During the write operation, the SDOOUT pin is in a high-impedance mode and must float.

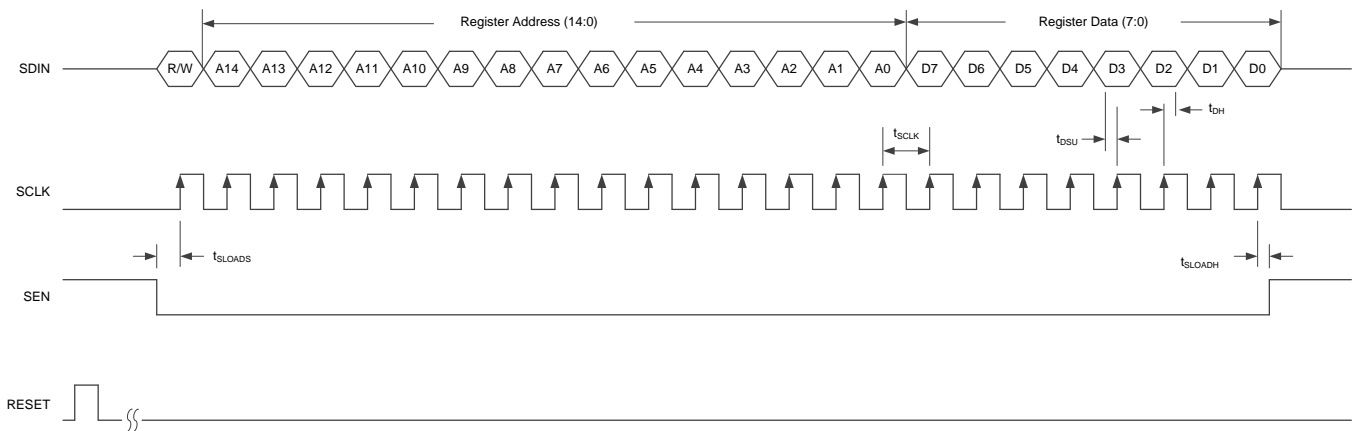


图 74. Serial Interface Write Timing Diagram

7.5.5.3 Serial Read

图 75 shows a typical 4-wire serial register readout. In the default 4-pin configuration, the SDIN pin is the data output from the ADS54J64 during the data transfer cycle when SDOUT is in a high-impedance state. The internal registers of the ADS54J64 can be read out by:

1. Driving the SEN pin low
2. Setting the R/W bit to 1 to enable read back
3. Specifying the address of the register (A[14:0]) whose content must be read back
4. The device outputs the contents (D[7:0]) of the selected register on the SDOUT pin (pin 51)
5. The external controller can latch the contents at the SCLK rising edge

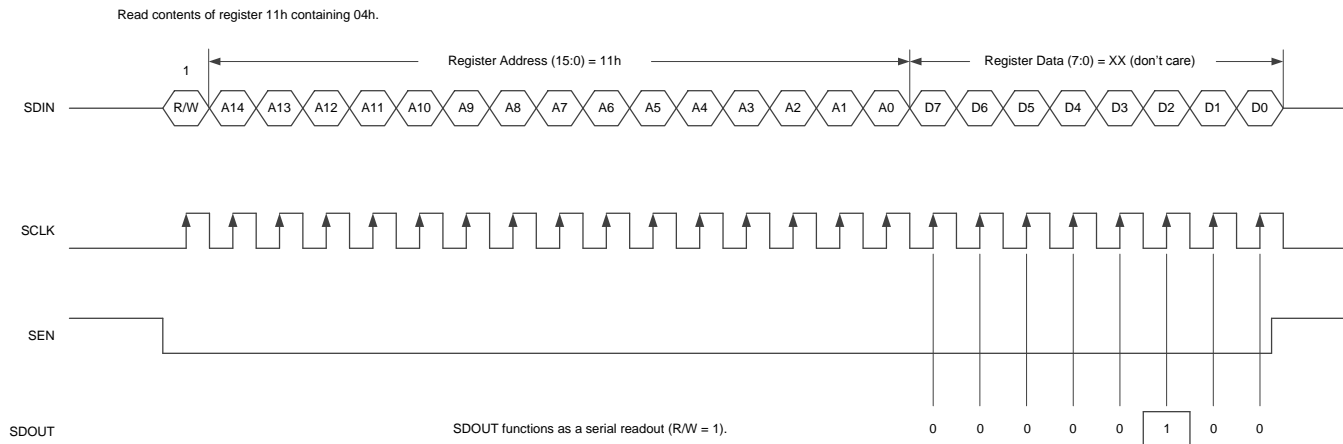


图 75. Serial Interface 4-Wire Read Timing Diagram

7.6 Register Maps

7.6.1 Register Map

The ADS54J64 registers are organized on different pages depending on their internal functions. The pages are accessed by selecting the page in the master pages 11h–13h. The page selection must only be written one time for a continuous update of registers for that page.

There are six different SPI banks (see [图 76](#) and [表 7](#)) that group together different functions:

- GLOBAL: contains controls for accessing other SPI banks
- DIGTOP: top-level digital functions
- ANALOG: registers controlling power-down and analog functions
- SERDES_XX: registers controlling JESD204B functions
- CHX: registers controlling channel-specific functions, including DDC
- ADCXX: register page for one of the eight interleaved ADCs

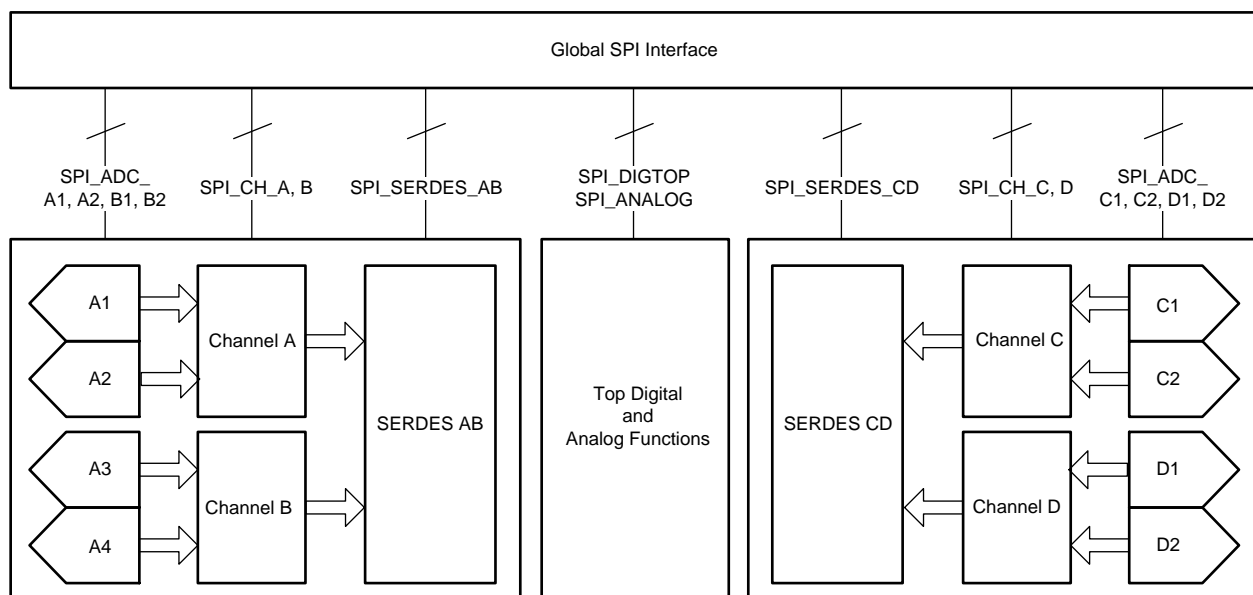


图 76. SPI Register Block Diagram

表 7. Serial Interface Register Map

ADDRESS (Hex)	7	6	5	4	3	2	1	0
GLOBAL PAGE								
00h	WRITE_1	0	0	0	0	0	0	SW_RESET
04h	VERSION_ID							
11h	SPL_D2	SPL_D1	SPL_C2	SPL_C1	SPL_B2	SPL_B1	SPL_A2	SPL_A1
12h	0	SPI_SERDES_CD	SPI_SERDES_AB	SPI_CHD	SPI_CHC	SPI_CHB	SPI_CHA	SPI_DIGTOP
13h	0	0	0	0	0	0	0	SPI_ANALOG
DIGTOP PAGE								
64h	0	0	0	0	0	0	FS_375_500	0
8Dh	CUSTOMPATTERN1[7:0]							
8Eh	CUSTOMPATTERN1[15:8]							
8Fh	CUSTOMPATTERN2[7:0]							
90h	CUSTOMPATTERN2[15:8]							
91h	TESTPATTERNSELECT				TESTPATTERNENCHD	TESTPATTERNENCHC	TESTPATTERNENCHB	TESTPATTERNENCHA
A5h	0	0	0	0	0	0	CH_CD_AVG_EN	CH_AB_AVG_EN
A6h	0	0	AVG_ENABLE	OVR_ON_LSB	GAIN_WORD_ENABLE	0	0	0
ABh	0	0	0	0	0	0	INTERLEAVE_A	SPECIALMODE0
ACCh	0	0	0	0	0	0	INTERLEAVE_C	SPECIALMODE1
ADh	0	0	0	0	DDCMODEAB			
AEh	0	0	0	0	DDCMODECD			
B7h	0	0	0	0	0	0	0	LOAD_TRIMS
8Ch	0	0	0	0	0	0	ENABLE_LOAD_TRIMS	0
ANALOG PAGE								
6Ah	0	0	0	0	0	0	DIS_SYSREF	0
6Fh	0	JESD_SWING			0	0	0	0
71h	EMP_LANE_B[5:4]		EMP_LANE_A					
72h	0	0	0	0	EMP_LANE_B[3:0]			
93h	EMP_LANE_D[5:4]		EMP_LANE_C					
94h	0	0	0	0	EMP_LANE_D[3:0]			
9Bh	0	0	0	SYSREF_PDN	0	0	0	0
9Dh	PDN_CHA	PDN_CHB	0	0	PDN_CHD	PDN_CHC	0	0
9Eh	0	0	0	PDN_SYNCAB	0	0	0	PDN_GLOBAL
9Fh	0	0	0	0	0	0	PIN_PDN_MODE	FAST_PDN
AFh	0	0	0	0	0	0	PDN_SYNCDD	0
SERDES_XX PAGE								
20h	CTRL_K	CTRL_SER_MODE	0	TRANS_TEST_EN	0	LANE_ALIGN	FRAME_ALIGN	TX_ILA_DIS
21h	SYNC_REQ	OPT_SYNC_REQ	SYNCB_SEL_AB_CD	0	0	0	SERDES_MODE	
22h	LINK_LAYER_TESTMODE_SEL			RPAT_SET_DISP	LMFC_MASK_RESET	0	0	0
23h	FORCE_LMFC_COUNT	LMFC_CNT_INIT				RELEASE_ILANE_REQ		
25h	SCR_EN	0	0	0	0	0	0	0
26h	0	0	0	K_NO_OF_FRAMES_PER_MULTIFRAME				

表 7. Serial Interface Register Map (接下页)

ADDRESS (Hex)	7	6	5	4	3	2	1	0
28h	0	0	0	0	CTRL_LID	0	0	0
2Dh	LID1				LID2			
36h	PRBS_MODE		0	0	0	0	0	0
41h	LANE_BONA				LANE_AONB			
42h	0	0	0	0	INVERT_AC		INVERT_BD	
CHX PAGE								
26h	0	0	0	0	0	0	GAINWORD	
27h	OVR_ENABLE	OVR_FAST_SEL	0	0	OVR_LSB1	0	OVR_LSB0	0
2Dh	0	0	0	0	0	0	NYQUIST_SELECT	0
78h	0	0	0	0	0	FS4_SIGN	NYQ_SEL_MODE02	NYQ_SEL
7Ah	NCO_WORD[15:8]							
7Bh	NCO_WORD[7:0]							
7Eh	0	0	0	0	0	MODE467_GAIN	MODE0_GAIN	MODE13_GAIN
ADCXX PAGE								
07h	FAST_OVR_THRESHOLD_HIGH							
08h	FAST_OVR_THRESHOLD_LOW							
D5h	0	0	0	0	CAL_EN	0	0	0
2Ah	0	0	0	0	0	0	0	ADC_TRIM1
CFh	ADC_TRIM2				0	0	0	0

7.6.1.1 Register Description

表 8 lists the access codes for the ADS54J64 registers.

表 8. ADS54J64 Access Type Codes

Access Type	Code	Description
R	R	Read
R/W	R-W	Read or Write
W	W	Write
-n		Value after reset or the default value

7.6.1.1.1 GLOBAL Page Register Description

7.6.1.1.1.1 Register 00h (address = 00h) [reset = 0h], GLOBAL Page

图 77. Register 0h

7	6	5	4	3	2	1	0
WRITE_1	0	0	0	0	0	0	SW_RESET
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h

表 9. Register 00h Field Descriptions

Bit	Field	Type	Reset	Description
7	WRITE_1	R/W	0h	Always write 1
6-1	0	R/W	0h	Must read or write 0
0	SW_RESET	R/W	0h	This bit rests the device.

7.6.1.1.1.2 Register 04h (address = 04h) [reset = 0h], GLOBAL Page

图 78. Register 4h

7	6	5	4	3	2	1	0
VERSION_ID							
R-0h							

表 10. Register 04h Field Descriptions

Bit	Field	Type	Reset	Description
7-0	VERSION_ID	R	0h	These bits set the version ID of the device. 16 : PG 1.0 32 : PG 2.0 48 : PG 3.0

7.6.1.1.3 Register 11h (address = 11h) [reset = 0h], GLOBAL Page
图 79. Register 11h

7	6	5	4	3	2	1	0
SPI_D2	SPI_D1	SPI_C2	SPI_C1	SPI_B2	SPI_B1	SPI_A2	SPI_A1
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h

表 11. Register 11h Field Descriptions

Bit	Field	Type	Reset	Description
7	SPI_D2	R/W	0h	This bit selects the ADC D2 SPI. 0 : ADC D2 SPI is disabled 1 : ADC D2 SPI is enabled
6	SPI_D1	R/W	0h	This bit selects the ADC D1 SPI. 0 : ADC D1 SPI is disabled 1 : ADC D1 SPI is enabled
5	SPI_C2	R/W	0h	This bit selects the ADC C2 SPI. 0 : ADC C2 SPI is disabled 1 : ADC C2 SPI is enabled
4	SPI_C1	R/W	0h	This bit selects the ADC C1 SPI. 0 : ADC C1 SPI is disabled 1 : ADC C1 SPI is enabled
3	SPI_B2	R/W	0h	This bit selects the ADC B2 SPI. 0 : ADC B2 SPI is disabled 1 : ADC B2 SPI is enabled
2	SPI_B1	R/W	0h	This bit selects the ADC B1 SPI. 0 : ADC B1 SPI is disabled 1 : ADC B1 SPI is enabled
1	SPI_A2	R/W	0h	This bit selects the ADC A2 SPI. 0 : ADC A2 SPI is disabled 1 : ADC A2 SPI is enabled
0	SPI_A1	R/W	0h	This bit selects the ADC A1 SPI. 0 : ADC A1 SPI is disabled 1 : ADC A1 SPI is enabled

7.6.1.1.1.4 Register 12h (address = 12h) [reset = 0h], GLOBAL Page
图 80. Register 12h

7	6	5	4	3	2	1	0
0	SPI_SERDES_CD	SPI_SERDES_AB	SPI_CHD	SPI_CHC	SPI_CHB	SPI_CHA	SPI_DIGTOP
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h

表 12. Register 12h Field Descriptions

Bit	Field	Type	Reset	Description
7	0	R/W	0h	Must read or write 0
6	SPI_SERDES_CD	R/W	0h	This bit selects the channel CD SerDes SPI. 0 : Channel CD SerDes SPI is disabled 1 : Channel CD SerDes SPI is enabled
5	SPI_SERDES_AB	R/W	0h	This bit selects the channel AB SerDes SPI. 0 : Channel AB SerDes is disabled 1 : Channel AB SerDes is enabled
4	SPI_CHD	R/W	0h	This bit selects the channel D SPI. 0 : Channel D SPI is disabled 1 : Channel D SPI is enabled
3	SPI_CHC	R/W	0h	This bit selects the channel C SPI. 0 : Channel C SPI is disabled 1 : Channel C SPI is enabled
2	SPI_CHB	R/W	0h	This bit selects the channel B SPI. 0 : Channel B SPI is disabled 1 : Channel B SPI is enabled
1	SPI_CHA	R/W	0h	This bit selects the channel A SPI. 0 : Channel A SPI is disabled 1 : Channel A SPI is enabled
0	SPI_DIGTOP	R/W	0h	This bit selects the DIGTOP SPI. 0 : DIGTOP SPI is disabled 1 : DIGTOP SPI is enabled

7.6.1.1.1.5 Register 13h (address = 13h) [reset = 0h], GLOBAL Page
图 81. Register 13h

7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	SPI_ANALOG
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h

表 13. Register 13h Field Descriptions

Bit	Field	Type	Reset	Description
7-1	0	R/W	0h	Must read or write 0
0	SPI_ANALOG	R/W	0h	This bit selects the analog SPI. 0 : Analog SPI is disabled 1 : Analog SPI is enabled

7.6.1.1.2 DIGTOP Page Register Description
7.6.1.1.2.1 Register 64h (address = 64h) [reset = 0h], DIGTOP Page
图 82. Register 64h

7	6	5	4	3	2	1	0
0	0	0	0	0	0	FS_375_500	0
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h

表 14. Register 64h Field Descriptions

Bit	Field	Type	Reset	Description
7-2	0	R/W	0h	Must read or write 0
1	FS_375_500	R/W	0h	This bit selects the clock rate for loading trims. 0 : 375 MSPS 1 : 500 MSPS
0	0	R/W	0h	Must read or write 0

7.6.1.1.2.2 Register 8Dh (address = 8Dh) [reset = 0h], DIGTOP Page
图 83. Register 8Dh

7	6	5	4	3	2	1	0
CUSTOMPATTERN1[7:0]							
R/W-0h							

表 15. Register 8Dh Field Descriptions

Bit	Field	Type	Reset	Description
7-0	CUSTOMPATTERN1[7:0]	R/W	0h	These bits set the custom pattern 1 that is used when the test pattern is enabled and set to a single or dual test pattern.

7.6.1.1.2.3 Register 8Eh (address = 8Eh) [reset = 0h], DIGTOP Page
图 84. Register 8Eh

7	6	5	4	3	2	1	0
CUSTOMPATTERN1[15:8]							
R/W-0h							

表 16. Register 8Eh Field Descriptions

Bit	Field	Type	Reset	Description
7-0	CUSTOMPATTERN1[15:8]	R/W	0h	These bits set the custom pattern 1 that is used when the test pattern is enabled and set to a single or dual test pattern.

7.6.1.1.2.4 Register 8Fh (address = 8Fh) [reset = 0h], DIGTOP Page

图 85. Register 8Fh

7	6	5	4	3	2	1	0
CUSTOMPATTERN2[7:0]							
R/W-0h							

表 17. Register 8Fh Field Descriptions

Bit	Field	Type	Reset	Description
7-0	CUSTOMPATTERN2[7:0]	R/W	0h	These bits set the custom pattern 2 that is used when the test pattern select is set to dual pattern mode.

7.6.1.1.2.5 Register 90h (address = 90h) [reset = 0h], DIGTOP Page

图 86. Register 90h

7	6	5	4	3	2	1	0
CUSTOMPATTERN2[15:8]							
R/W-0h							

表 18. Register 90h Field Descriptions

Bit	Field	Type	Reset	Description
7-0	CUSTOMPATTERN2[15:8]	R/W	0h	These bits set the custom pattern 2 that is used when the test pattern select is set to dual pattern mode.

7.6.1.1.2.6 Register 91h (address = 91h) [reset = 0h], DIGTOP Page

图 87. Register 91h

7	6	5	4	3	2	1	0	
TESTPATTERNSELECT		TESTPATTERNENCHD		TESTPATTERNENCHC		TESTPATTERNENCHB		TESTPATTERNENCHA
R/W-0h		R/W-0h		R/W-0h		R/W-0h		R/W-0h

表 19. Register 91h Field Descriptions

Bit	Field	Type	Reset	Description
7-4	TESTPATTERNSELECT	R/W	0h	These bits select the test pattern on the output when the test pattern is enabled for a suitable channel. 0 : Default 1 : All zeros 2 : All ones 3 : Toggle pattern 4 : Ramp pattern 6 : Custom pattern 1 7 : Toggle between custom pattern 1 and custom pattern 2 8 : Deskew pattern (0xAAAA)
3	TESTPATTERNENCHD	R/W	0h	This bit enables the channel D test pattern. 0 : Default data on channel D 1 : Enable test pattern on channel D
2	TESTPATTERNENCHC	R/W	0h	This bit enables the channel C test pattern. 0 : Default data on channel C 1 : Enable test pattern on channel C
1	TESTPATTERNENCHB	R/W	0h	This bit enables the channel B test pattern. 0 : Default data on channel B 1 : Enable test pattern on channel B
0	TESTPATTERNENCHA	R/W	0h	This bit enables the channel A test pattern. 0 : Default data on channel A 1 : Enable test pattern on channel A

7.6.1.1.2.7 Register A5h (address = A5h) [reset = 0h], DIGTOP Page
图 88. Register A5h

7	6	5	4	3	2	1	0
0	0	0	0	0	0	CH_CD_AVG_EN	CH_AB_AVG_EN
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h

表 20. Register A5h Field Descriptions

Bit	Field	Type	Reset	Description
7-2	0	R/W	0h	Must read or write 0
1	CH_CD_AVG_EN	R/W	0h	0: Averaging is disabled for channels C, D 1: Averaging is enabled for channels C, D; set AVG_ENABLE in Register A6h (address = A6h) [reset = 0h], DIGTOP Page to 1 if using this option
0	CH_AB_AVG_EN	R/W	0h	0: Averaging is disabled for channels A, B 1: Averaging is enabled for channels A, B; set AVG_ENABLE in Register A6h (address = A6h) [reset = 0h], DIGTOP Page to 1 if using this option

7.6.1.1.2.8 Register A6h (address = A6h) [reset = 0h], DIGTOP Page
图 89. Register A6h

7	6	5	4	3	2	1	0
0	0	AVG_ENABLE	OVR_ON_LSB	GAIN_WORD_ENABLE	0	0	0
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h

表 21. Register A6h Field Descriptions

Bit	Field	Type	Reset	Description
7-6	0	R/W	0h	Must read or write 0
5	AVG_ENABLE	R/W	0h	0: Default operation 1: Enable averaging option for the AB and CD channel pairs
4	OVR_ON_LSB	R/W	0h	This bit enables the overrange indicator (OVR) on the LSB1 and LSB0 bits. OVR_LSB1 and OVR_LSB0 must be configured in register 27h of the CHX page. 0 : Default data 1 : OVR on LSB1 and LSB0 bits
3	GAIN_WORD_ENABLE	R/W	0h	This bit enables the digital gain. Gain can be programmed using the GAINWORD bits in register 26h of the CHX page. 0 : Disable digital gain 1 : Enable digital gain
2-0	0	R/W	0h	Must read or write 0

7.6.1.1.2.9 Register ABh (address = ABh) [reset = 0h], DIGTOP Page
图 90. Register ABh

7	6	5	4	3	2	1	0
0	0	0	0	0	0	INTERLEAVE_A	SPECIALMODE0
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h

表 22. Register ABh Field Descriptions

Bit	Field	Type	Reset	Description
7-2	0	R/W	0h	Must read or write 0
1	INTERLEAVE_A	R/W	0h	0: Default operation 1: 2x interleaved data enable; this bit is used in dual ADC mode to bring the average data of channels A and B on the JESD outputs; averaging mode is enabled by setting CH_AB_AVG_EN to 1 (see register A5h)
0	SPECIALMODE0	R/W	0h	Always write 1

7.6.1.1.2.10 Register ACh (address = ACh) [reset = 0h], DIGTOP Page
图 91. Register ACh

7	6	5	4	3	2	1	0
0	0	0	0	0	0	INTERLEAVE_C	SPECIALMODE1
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h

表 23. Register ACh Field Descriptions

Bit	Field	Type	Reset	Description
7-2	0	R/W	0h	Must read or write 0
1	INTERLEAVE_C	R/W	0h	0: Default operation 1: 2x interleaved data enable; this bit is used in dual ADC mode to bring the average data of channels C and D on the JESD outputs; averaging mode is enabled by setting CH_CD_AVG_EN to 1 (see register A5h)
0	SPECIALMODE1	R/W	0h	Always write 1

7.6.1.1.2.11 Register ADh (address = ADh) [reset = 0h], DIGTOP Page
图 92. Register ADh

7	6	5	4	3	2	1	0
0	0	0	0			DDCMODEAB	
R/W-0h	R/W-0h	R/W-0h	R/W-0h			R/W-0h	

表 24. Register ADh Field Descriptions

Bit	Field	Type	Reset	Description
7-4	0	R/W	0h	Must read or write 0
3-0	DDCMODEAB	R/W	0h	These bits select the DDC mode for the AB channel pair. 0 : Mode 0 1 : Mode 1 2 : Mode 2 3 : Mode 3 4 : Mode 4 6 : Mode 6 7 : Mode 7 8 : Mode 8

7.6.1.1.2.12 Register AEh (address = AEh) [reset = 0h], DIGTOP Page
图 93. Register AEh

7	6	5	4	3	2	1	0
0	0	0	0	DDCMODECD			
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h			

表 25. Register AEh Field Descriptions

Bit	Field	Type	Reset	Description
7-4	0	R/W	0h	Must read or write 0
3-0	DDCMODECD	R/W	0h	These bits select the DDC mode for the CD channel pair. 0 : Mode 0 1 : Mode 1 2 : Mode 2 3 : Mode 3 4 : Mode 4 6 : Mode 6 7 : Mode 7 8 : Mode 8

7.6.1.1.2.13 Register B7h (address = B7h) [reset = 0h], DIGTOP Page
图 94. Register B7h

7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	LOAD_TRIMS
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h

表 26. Register B7h Field Descriptions

Bit	Field	Type	Reset	Description
7-1	0	R/W	0h	Must read or write 0
0	LOAD_TRIMS	R/W	0h	This bit load trims the device.

7.6.1.1.2.14 Register 8Ch (address = 8Ch) [reset = 0h], DIGTOP Page
图 95. Register 8Ch

7	6	5	4	3	2	1	0
0	0	0	0	0	0	ENABLE_LOAD_TRIMS	0
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h

表 27. Register 8Ch Field Descriptions

Bit	Field	Type	Reset	Description
7-2	0	R/W	0h	Must read or write 0
1	ENABLE_LOAD_TRIMS	R/W	0h	0: Trim loading is disabled 1: Trim loading is enabled (recommended)
0	0	R/W	0h	Must read or write 0

7.6.1.1.3 ANALOG Page Register Description
7.6.1.1.3.1 Register 6Ah (address = 6Ah) [reset = 0h], ANALOG Page
图 96. Register 6Ah

7	6	5	4	3	2	1	0
0	0	0	0	0	0	DIS_SYSREF	0
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h

表 28. Register 6Ah Field Descriptions

Bit	Field	Type	Reset	Description
7-2	0	R/W	0h	Must read or write 0
1	DIS_SYSREF	R/W	0h	This bit masks the SYSREF input. 0 : SYSREF input is not masked 1 : SYSREF input is masked
0	0	R/W	0h	Must read or write 0

7.6.1.1.3.2 Register 6Fh (address = 6Fh) [reset = 0h], ANALOG Page
图 97. Register 6Fh

7	6	5	4	3	2	1	0
0	JESD_SWING			0	0	0	0
R/W-0h	R/W-0h			R/W-0h	R/W-0h	R/W-0h	R/W-0h

表 29. Register 6Fh Field Descriptions

Bit	Field	Type	Reset	Description
7	0	R/W	0h	Must read or write 0
6-4	JESD_SWING	R/W	0h	These bits control the JESD swing. 0 : 860 mV _{PP} 1 : 810 mV _{PP} 2 : 770 mV _{PP} 3 : 745 mV _{PP} 4 : 960 mV _{PP} 5 : 930 mV _{PP} 6 : 905 mV _{PP} 7 : 880 mV _{PP}
3-0	0	R/W	0h	Must read or write 0

7.6.1.1.3.3 Register 71h (address = 71h) [reset = 0h], ANALOG Page
图 98. Register 71h

7	6	5	4	3	2	1	0
EMP_LANE_B[5:4]			EMP_LANE_A				
R/W-0h			R/W-0h				

表 30. Register 71h Field Descriptions

Bit	Field	Type	Reset	Description
7-6	EMP_LANE_B[5:4]	R/W	0h	These bits along with bits 3-0 of register 72h set the de-emphasis for lane B. These bits select the amount of de-emphasis for the JESD output transmitter. The de-emphasis value in decibels (dB) is measured as the ratio between the peak value after the signal transitions to the settled value of the voltage in one bit period. 0 : 0 dB 1 : -1 dB 3 : -2 dB 7 : -4.1 dB 15 : -6.2 dB 31 : -8.2 dB 63 : -11.5 dB Others: Do not use
5-0	EMP_LANE_A	R/W	0h	These bits set the de-emphasis for lane A. These bits select the amount of de-emphasis for the JESD output transmitter. The de-emphasis value in dB is measured as the ratio between the peak value after the signal transitions to the settled value of the voltage in one bit period. 0 : 0 dB 1 : -1 dB 3 : -2 dB 7 : -4.1 dB 15 : -6.2 dB 31 : -8.2 dB 63 : -11.5 dB Others: Do not use

7.6.1.1.3.4 Register 72h (address = 72h) [reset = 0h], ANALOG Page
图 99. Register 72h

7	6	5	4	3	2	1	0
0	0	0	0	EMP_LANE_B[3:0]			
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h			

表 31. Register 72h Field Descriptions

Bit	Field	Type	Reset	Description
7-4	0	R/W	0h	Must read or write 0
3-0	EMP_LANE_B[3:0]	R/W	0h	These bits along with bits 7-6 of register 71h set the de-emphasis for lane B. These bits select the amount of de-emphasis for the JESD output transmitter. The de-emphasis value in dB is measured as the ratio between the peak value after the signal transitions to the settled value of the voltage in one bit period. 0 : 0 dB 1 : -1 dB 3 : -2 dB 7 : -4.1 dB 15 : -6.2 dB 31 : -8.2 dB 63 : -11.5 dB Others: Do not use

7.6.1.1.3.5 Register 93h (address = 93h) [reset = 0h], ANALOG Page

图 100. Register 93h

7	6	5	4	3	2	1	0
EMP_LANE_D[5:4]			EMP_LANE_C				
R/W-0h			R/W-0h				

表 32. Register 93h Field Descriptions

Bit	Field	Type	Reset	Description
7-6	EMP_LANE_D[5:4]	R/W	0h	<p>These bits along with bits 3-0 of register 94h set the de-emphasis for lane D.</p> <p>These bits select the amount of de-emphasis for the JESD output transmitter. The de-emphasis value in dB is measured as the ratio between the peak value after the signal transitions to the settled value of the voltage in one bit period.</p> <p>0 : 0 dB 1 : -1 dB 3 : -2 dB 7 : -4.1 dB 15 : -6.2 dB 31 : -8.2 dB 63 : -11.5 dB Others: Do not use</p>
5-0	EMP_LANE_C	R/W	0h	<p>These bits set the de-emphasis for lane C.</p> <p>These bits select the amount of de-emphasis for the JESD output transmitter. The de-emphasis value in dB is measured as the ratio between the peak value after the signal transitions to the settled value of the voltage in one bit period.</p> <p>0 : 0 dB 1 : -1 dB 3 : -2 dB 7 : -4.1 dB 15 : -6.2 dB 31 : -8.2 dB 63 : -11.5 dB Others: Do not use</p>

7.6.1.1.3.6 Register 94h (address = 94h) [reset = 0h], ANALOG Page

图 101. Register 94h

7	6	5	4	3	2	1	0
0	0	0	0	EMP_LANE_D[3:0]			
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h			

表 33. Register 94h Field Descriptions

Bit	Field	Type	Reset	Description
7-4	0	R/W	0h	Must read or write 0
3-0	EMP_LANE_D[3:0]	R/W	0h	<p>These bits along with bits 7-4 of register 93h set the de-emphasis for lane D.</p> <p>These bits select the amount of de-emphasis for the JESD output transmitter. The de-emphasis value in dB is measured as the ratio between the peak value after the signal transitions to the settled value of the voltage in one bit period.</p> <p>0 : 0 dB 1 : -1 dB 3 : -2 dB 7 : -4.1 dB 15 : -6.2 dB 31 : -8.2 dB 63 : -11.5 dB Others: Do not use</p>

7.6.1.1.3.7 Register 9Bh (address = 9Bh) [reset = 0h], ANALOG Page
图 102. Register 9Bh

7	6	5	4	3	2	1	0
0	0	0	SYSREF_PDN	0	0	0	0
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h

表 34. Register 9Bh Field Descriptions

Bit	Field	Type	Reset	Description
7-5	0	R/W	0h	Must read or write 0
4	SYSREF_PDN	R/W	0h	This bit powers down the SYSREF buffer. 0 : SYSREF buffer is powered up 1 : SYSREF buffer is powered down
3-0	0	R/W	0h	Must read or write 0

7.6.1.1.3.8 Register 9Dh (address = 9Dh) [reset = 0h], ANALOG Page
图 103. Register 9Dh

7	6	5	4	3	2	1	0
PDN_CHA	PDN_CHB	0	0	PDN_CHD	PDN_CHC	0	0
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h

表 35. Register 9Dh Field Descriptions

Bit	Field	Type	Reset	Description
7	PDN_CHA	R/W	0h	This bit powers down channel A. 0 : Normal operation 1 : Channel A is powered down
6	PDN_CHB	R/W	0h	This bit powers down channel B. 0 : Normal operation 1 : Channel B is powered down
5-4	0	R/W	0h	Must read or write 0
3	PDN_CHD	R/W	0h	This bit powers down channel D. 0 : Normal operation 1 : Channel D is powered down
2	PDN_CHC	R/W	0h	This bit powers down channel C. 0 : Normal operation 1 : Channel C is powered down
1-0	0	R/W	0h	Must read or write 0

7.6.1.1.3.9 Register 9Eh (address = 9Eh) [reset = 0h], ANALOG Page
图 104. Register 9Eh

7	6	5	4	3	2	1	0
0	0	0	PDN_SYNCAB	0	0	0	PDN_GLOBAL
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h

表 36. Register 9Eh Field Descriptions

Bit	Field	Type	Reset	Description
7-5	0	R/W	0h	Must read or write 0
4	PDN_SYNCAB	R/W	0h	This bit controls the STNCAB buffer power-down. 0 : SYNCAB buffer is powered up 1 : SYNCAB buffer is powered down
3-1	0	R/W	0h	Must read or write 0
0	PDN_GLOBAL	R/W	0h	This bit controls the global power-down. 0 : Global power-up 1 : Global power-down

7.6.1.1.3.10 Register 9Fh (address = 9Fh) [reset = 0h], ANALOG Page
图 105. Register 9Fh

7	6	5	4	3	2	1	0
0	0	0	0	0	0	PIN_PDN_MODE	FAST_PDN
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h

表 37. Register 9Fh Field Descriptions

Bit	Field	Type	Reset	Description
7-2	0	R/W	0h	Must read or write 0
1	PIN_PDN_MODE	R/W	0h	This bit selects the pin power-down mode. 0 : PDN pin is configured to fast power-down 1 : PDN pin is configured to global power-down
0	FAST_PDN	R/W	0h	This bit controls the fast power-down. 0 : Device powered up 1 : Fast power down

7.6.1.1.3.11 Register AFh (address = AFh) [reset = 0h], ANALOG Page
图 106. Register AFh

7	6	5	4	3	2	1	0
0	0	0	0	0	0	PDN_SYNCCD	0
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h

表 38. Register AFh Field Descriptions

Bit	Field	Type	Reset	Description
7-2	0	R/W	0h	Must read or write 0
1	PDN_SYNCCD	R/W	0h	This bit controls the SYNCCD buffer power-down. 0 : SYNCCD buffer is powered up 1 : SYNCCD buffer is powered down
0	0	R/W	0h	Must read or write 0

7.6.1.1.4 SERDES_XX Page Register Description
7.6.1.1.4.1 Register 20h (address = 20h) [reset = 0h], SERDES_XX Page
图 107. Register 20h

7	6	5	4	3	2	1	0
CTRL_K	CTRL_SER_MODE	0	TRANS_TEST_EN	0	LANE_ALIGN	FRAME_ALIGN	TX_ILA_DIS
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h

表 39. Register 20h Field Descriptions

Bit	Field	Type	Reset	Description
7	CTRL_K	R/W	0h	This bit is the enable bit for programming the number of frames per multi-frame. 0 : Five frames per multi-frame (default) 1 : Frames per multi-frame can be programmed using register 26h
6	CTRL_SER_MODE	R/W	0h	This bit allows the SERDES_MODE setting in register 21h (bits 1-0) to be changed. 0 : Disabled 1 : Enables SERDES_MODE setting
5	0	R/W	0h	Must read or write 0
4	TRANS_TEST_EN	R/W	0h	This bit generates the long transport layer test pattern mode, as per section 5.1.6.3 of the JESD204B specification. 0 : Test mode is disabled 1 : Test mode is enabled
3	0	R/W	0h	Must read or write 0
2	LANE_ALIGN	R/W	0h	This bit inserts the lane-alignment character (K28.3) for the receiver to align to the lane boundary, as per section 5.3.3.5 of the JESD204B specification. 0 : Normal operation 1 : Inserts lane-alignment characters
1	FRAME_ALIGN	R/W	0h	This bit inserts the frame-alignment character (K28.7) for the receiver to align to the lane boundary, as per section 5.3.3.5 of the JESD204B specification. 0 : Normal operation 1 : Inserts frame-alignment characters
0	TX_ILA_DIS	R/W	0h	This bit disables sending the initial link alignment (ILA) sequence when SYNC is deasserted. 0 = Normal operation 1 = Disables ILA

7.6.1.1.4.2 Register 21h (address = 21h) [reset = 0h], SERDES_XX Page
图 108. Register 21h

7	6	5	4	3	2	1	0
SYNC_REQ	OPT_SYNC_REQ	SYNCB_SEL_AB_CD	0	0	0	SERDES_MODE	
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	

表 40. Register 21h Field Descriptions

Bit	Field	Type	Reset	Description
7	SYNC_REQ	R/W	0h	This bit controls the SYNC register (bit 6 must be enabled). 0 : Normal operation 1 : ADC output data are replaced with K28.5 characters
6	OPT_SYNC_REQ	R/W	0h	This bit enables SYNC operation. 0 : Normal operation 1 : Enables SYNC from the SYNC_REQ register bit
5	SYNCB_SEL_AB_CD	R/W	0h	This bit selects which SYNCb input controls the JESD interface. 0 : Use the SYNCbAB, SYNCbCD pins 1 : When set in the SerDes AB SPI, SYNCbCD is used for the SerDes AB and CD; when set in the SerDes CD SPI, SYNCbAB is used for the SerDes AB and CD
4-2	0	R/W	0h	Must read or write 0
1-0	SerDes_MODE	R/W	0h	These bits set the JESD output parameters. The CTRL_SER_MODE bit (register 20h, bit 6) must also be set to control these bits. These bits are auto configured for modes 0, 1, 3, and 7, but must be configured for modes 2, 4, and 6.

7.6.1.1.4.3 Register 22h (address = 22h) [reset = 0h], SERDES_XX Page
图 109. Register 22h

7	6	5	4	3	2	1	0
LINK_LAYER_TESTMODE_SEL		RPAT_SET_DISP		LMFC_MASK_RESET	0	0	0
R/W-0h		R/W-0h		R/W-0h	R/W-0h	R/W-0h	R/W-0h

表 41. Register 22h Field Descriptions

Bit	Field	Type	Reset	Description
7-5	LINK_LAYER_TESTMODE_SEL	R/W	0h	These bits generate a pattern as per section 5.3.3.8.2 of the JESD204B document. 0 : Normal ADC data 1 : D21.5 (high-frequency jitter pattern) 2 : K28.5 (mixed-frequency jitter pattern) 3 : Repeat the initial lane alignment (generates a K28.5 character and continuously repeats lane alignment sequences) 4 : 12-octet RPAT jitter pattern 6 : PRBS pattern (PRBS7, 15, 23, 31); use PRBS_MODE (register 36h, bits 7-6) to select the PRBS pattern
4	RPAT_SET_DISP	R/W	0h	This bit changes the running disparity in the modified RPAT pattern test mode (only when the link layer test mode = 100). 0 : Normal operation 1 : Changes disparity
3	LMFC_MASK_RESET	R/W	0h	0 : Default 1 : Resets the LMFC mask
2-0	0	R/W	0h	Must read or write 0

7.6.1.1.4.4 Register 23h (address = 23h) [reset = 0h], SERDES_XX Page
图 110. Register 23h

7	6	5	4	3	2	1	0
FORCE_LMFC_COUNT	LMFC_CNT_INIT				RELEASE_ILANE_REQ		
R/W-0h	R/W-0h				R/W-0h		

表 42. Register 23h Field Descriptions

Bit	Field	Type	Reset	Description
7	FORCE_LMFC_COUNT	R/W	0h	This bit forces an LMFC count. 0 : Normal operation 1 : Enables using a different starting value for the LMFC counter
6-2	LMFC_CNT_INIT	R/W	0h	These bits set the initial value to which the LMFC count resets. The FORCE_LMFC_COUNT register bit must be enabled.
1-0	RELEASE_ILANE_REQ	R/W	0h	These bits delay the generation of the lane alignment sequence by 0, 1, 2, or 3 multi-frames after the code group synchronization. 0 : 0 multi-frames 1 : 1 multi-frame 2 : 2 multi-frames 3 : 3 multi-frames

7.6.1.1.4.5 Register 25h (address = 25h) [reset = 0h], SERDES_XX Page
图 111. Register 25h

7	6	5	4	3	2	1	0
SCR_EN	0	0	0	0	0	0	0
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h

表 43. Register 25h Field Descriptions

Bit	Field	Type	Reset	Description
7	SCR_EN	R/W	0h	This bit is the scramble enable bit in the JESD204B interface. 0 : Scrambling is disabled 1 : Scrambling is enabled
6-0	0	R/W	0h	Must read or write 0

7.6.1.1.4.6 Register 26h (address = 26h) [reset = 0h], SERDES_XX Page
图 112. Register 26h

7	6	5	4	3	2	1	0
0	0	0	K_NO_OF_FRAMES_PER_MULTIFRAME				
R/W-0h	R/W-0h	R/W-0h	R/W-0h				

表 44. Register 26h Field Descriptions

Bit	Field	Type	Reset	Description
7-5	0	R/W	0h	Must read or write 0
4-0	K_NO_OF_FRAMES_PER_MULTIFRAME	R/W	0h	These bits set the number of frames per multi-frame. The K value used is set value + 1 (for example, if the set value is 0xF, then K = 16).

7.6.1.1.4.7 Register 28h (address = 28h) [reset = 0h], SERDES_XX Page
图 113. Register 28h

7	6	5	4	3	2	1	0
0	0	0	0	CTRL_LID	0	0	0
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h

表 45. Register 28h Field Descriptions

Bit	Field	Type	Reset	Description
7-4	0	R/W	0h	Must read or write 0
3	CTRL_LID	R/W	0h	This bit is the enable bit to program the lane ID (LID). 0 : Default LID 1 : Enable LID programming
2-0	0	R/W	0h	Must read or write 0

7.6.1.1.4.8 Register 2Dh (address = 2Dh) [reset = 0h], SERDES_XX Page
图 114. Register 2Dh

7	6	5	4	3	2	1	0
LID1				LID2			
R/W-0h				R/W-0h			

表 46. Register 2Dh Field Descriptions

Bit	Field	Type	Reset	Description
7-4	LID1	R/W	0h	Lane ID for channels A, C. Select SerDes AB for channel A and SerDes CD for channel C. Valid only when CTRL_LID = 1.
3-0	LID2	R/W	0h	Lane ID for channels B, D. Select SerDes AB for channel B and SerDes CD for channel D.

7.6.1.1.4.9 Register 36h (address = 36h) [reset = 0h], SERDES_XX Page
图 115. Register 36h

7	6	5	4	3	2	1	0
PRBS_MODE		0	0	0	0	0	0
R-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h

表 47. Register 36h Field Descriptions

Bit	Field	Type	Reset	Description
7-6	PRBS_MODE	R	0h	These bits select the PRBS polynomial in the PRBS pattern mode. 0 : PRBS7 1 : PRBS15 2 : PRBS23 3 : PRBS31
5-0	0	R/W	0h	Must read or write 0

7.6.1.1.4.10 Register 41h (address = 41h) [reset = 0h], SERDES_XX Page
图 116. Register 41h

7	6	5	4	3	2	1	0
LANE_BONA				LANE_AONB			
R/W-0h				R/W-0h			

表 48. Register 41h Field Descriptions

Bit	Field	Type	Reset	Description
7-4	LANE_BONA	R/W	0h	These bits enable lane swap. 0 : Default 10 : For SerDes AB, channel B on lane A; for SerDes CD, channel D on lane C Others: Do not use
3-0	LANE_AONB	R/W	0h	These bits enable lane swap. 0 : Default 10 : For SerDes AB, channel A on lane B; for SerDes CD, channel C on lane D Others: Do not use

7.6.1.1.4.11 Register 42h (address = 42h) [reset = 0h], SERDES_XX Page
图 117. Register 42h

7	6	5	4	3	2	1	0
0	0	0	0	INVERT_AC		INVERT_BD	
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h		R/W-0h	

表 49. Register 42h Field Descriptions

Bit	Field	Type	Reset	Description
7-4	0	R/W	0h	Must read or write 0
3-2	INVERT_AC	R/W	0h	These bits invert lanes A and C. 0 : No inversion 3 : Data inversion on lane A, C Others: Do not use
1-0	INVERT_BD	R/W	0h	These bits invert lanes B and D. 0 : No inversion 3 : Data inversion on lane B, D Others: Do not use

7.6.1.1.5 CHX Page Register Description
7.6.1.1.5.1 Register 26h (address = 26h) [reset = 0h], CHX Page
图 118. Register 26h

7	6	5	4	3	2	1	0
0	0	0	0	0	0	GAINWORD	
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	

表 50. Register 26h Field Descriptions

Bit	Field	Type	Reset	Description
7-2	0	R/W	0h	Must read or write 0
1-0	GAINWORD	R/W	0h	These bits control the channel A gain word. 0 : 0 dB 1 : 1 dB 2 : 2 dB 3 : 3 dB

7.6.1.1.5.2 Register 27h (address = 27h) [reset = 0h], CHX Page
图 119. Register 27h

7	6	5	4	3	2	1	0
OVR_ENABLE	OVR_FAST_SEL	0	0	OVR_LSB1	0	OVR_LSB0	0
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h

表 51. Register 27h Field Descriptions

Bit	Field	Type	Reset	Description
7	OVR_ENABLE	R/W	0h	This bit enables or disables the OVR on the JESD lanes. 0 : Disables OVR 1 : Enables OVR
6	OVR_FAST_SEL	R/W	0h	This bit selects the fast or delay-matched OVR. 0 : Delay-matched OVR 1 : Fast OVR
5-4	0	R/W	0h	Must read or write 0
3	OVR_LSB1	R/W	0h	This bit selects either data or OVR on LSB1. 0 : Data selected 1 : OVR or FOVR selected
2	0	R/W	0h	Must read or write 0
1	OVR_LSB0	R/W	0h	This bit selects either data or OVR on LSB0. 0 : Data selected 1 : OVR or FOVR selected
0	0	R/W	0h	Must read or write 0

7.6.1.1.5.3 Register 2Dh (address = 2Dh) [reset = 0h], CHX Page
图 120. Register 2Dh

7	6	5	4	3	2	1	0
0	0	0	0	0	0	NYQUIST_SELECT	0
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h

表 52. Register 2Dh Field Descriptions

Bit	Field	Type	Reset	Description
7-2	0	R/W	0h	Must read or write 0
1	NYQUIST_SELECT	R/W	0h	This bit selects the Nyquist zone of operation for trim loading. 0 : Nyquist 1 1 : Nyquist 2
0	0	R/W	0h	Must read or write 0

7.6.1.1.5.4 Register 78h (address = 78h) [reset = 0h], CHX Page
图 121. Register 78h

7	6	5	4	3	2	1	0
0	0	0	0	0	FS4_SIGN	NYQ_SEL_MODE02	NYQ_SEL
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h

表 53. Register 78h Field Descriptions

Bit	Field	Type	Reset	Description
7-3	0	R/W	0h	Must read or write 0
2	FS4_SIGN	R/W	0h	This bit controls the sign of mixing in mode 0. 0 : Centered at $-f_s / 4$ 1 : Centered at $f_s / 4$
1	NYQ_SEL_MODE02	R/W	0h	This bit selects the pass band of the decimation filter in mode 2. 0 : Low pass 1 : High pass
0	NYQ_SEL	R/W	0h	This bit selects the pass band of the filter before the DDC. 0 : LPF ($0 - f_s / 2$) 1 : HPF ($0 - f_s / 2$)

7.6.1.1.5.5 Register 7Ah (address = 7Ah) [reset = 0h], CHX Page
图 122. Register 7Ah

7	6	5	4	3	2	1	0
NCO_WORD[15:8]							
R/W-0h							

表 54. Register 7Ah Field Descriptions

Bit	Field	Type	Reset	Description
7-0	NCO_WORD[15:8]	R/W	0h	These bits set the NCO frequency word. 0 : $0 \times f_S / 2^{16}$ 1 : $1 \times f_S / 2^{16}$ 2 : $2 \times f_S / 2^{16}$ 3 : $3 \times f_S / 2^{16}$ 5 : $5 \times f_S / 2^{16}$ 6 : $6 \times f_S / 2^{16}$... 65535 : $65535 \times f_S / 2^{16}$

7.6.1.1.5.6 Register 7Bh (address = 7Bh) [reset = 0h], CHX Page
图 123. Register 7Bh

7	6	5	4	3	2	1	0
NCO_WORD[7:0]							
R/W-0h							

表 55. Register 7Bh Field Descriptions

Bit	Field	Type	Reset	Description
7-0	NCO_WORD[7:0]	R/W	0h	These bits set the NCO frequency word. 0 : $0 \times f_S / 2^{16}$ 1 : $1 \times f_S / 2^{16}$ 2 : $2 \times f_S / 2^{16}$ 3 : $3 \times f_S / 2^{16}$ 5 : $5 \times f_S / 2^{16}$ 6 : $6 \times f_S / 2^{16}$... 65535 : $65535 \times f_S / 2^{16}$

7.6.1.1.5.7 Register 7Eh (address = 7Eh) [reset = 3h], CHX Page
图 124. Register 7Eh

7	6	5	4	3	2	1	0
0	0	0	0	0	MODE467_GAIN	MODE0_GAIN	MODE13_GAIN
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-1h	R/W-1h

表 56. Register 7Eh Field Descriptions

Bit	Field	Type	Reset	Description
7-3	0	R/W	0h	Must read or write 0
2	MODE467_GAIN	R/W	0h	This bit sets the mixer loss compensation for modes 4, 6, and 7. 0 : No gain 1 : 6-dB gain
1	MODE0_GAIN	R/W	1h	This bit sets the mixer loss compensation for mode 0. 0 : No gain 1 : 6-dB gain
0	MODE13_GAIN	R/W	1h	This bit sets the mixer loss compensation for modes 1 and 3. 0 : No gain 1 : 6-dB gain

7.6.1.1.6 ADCXX Page Register Description
7.6.1.1.6.1 Register 07h (address = 07h) [reset = FFh], ADCXX Page
图 125. Register 7h

7	6	5	4	3	2	1	0
FAST_OVR_THRESHOLD_HIGH							
R/W-FFh							

表 57. Register 07h Field Descriptions

Bit	Field	Type	Reset	Description
7-0	FAST_OVR_THRESHOLD_HIGH	R/W	FFh	Fast OVR threshold high; see the Overrange Indication section for programming.

7.6.1.1.6.2 Register 08h (address = 08h) [reset = 0h], ADCXX Page
图 126. Register 8h

7	6	5	4	3	2	1	0
FAST_OVR_THRESHOLD_LOW							
R/W-0h							

表 58. Register 08h Field Descriptions

Bit	Field	Type	Reset	Description
7-0	FAST_OVR_THRESHOLD_LOW	R/W	0h	Fast OVR threshold low; see the Overrange Indication section for programming.

7.6.1.1.6.3 Register D5h (address = D5h) [reset = 0h], ADCXX Page
图 127. Register D5h

7	6	5	4	3	2	1	0
0	0	0	0	CAL_EN	0	0	0
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h

表 59. Register D5h Field Descriptions

Bit	Field	Type	Reset	Description
7-4	0	R/W	0h	Must read or write 0
3	CAL_EN	R/W	0h	This bit is the enable calibration bit. This bit must be toggled during the startup sequence. 0 : Disables calibration 1 : Enables calibration
2-0	0	R/W	0h	Must read or write 0

7.6.1.1.6.4 Register 2Ah (address = 2Ah) [reset = 0h], ADCXX Page
图 128. Register 2Ah

7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	ADC_TRIM1
R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h	R/W-0h

表 60. Register 2Ah Field Descriptions

Bit	Field	Type	Reset	Description
7-1	0	R/W	0h	Must read or write 0
0	ADC Trim1	R/W	1h	Always write 0

7.6.1.1.6.5 Register CFh (address = CFh) [reset = 0h], ADCXX Page
图 129. Register CFh

7	6	5	4	3	2	1	0
ADC_TRIM2				0	0	0	0
R/W-0h				R/W-0h	R/W-0h	R/W-0h	R/W-0h

表 61. Register CFh Field Descriptions

Bit	Field	Type	Reset	Description
7-4	ADC_TRIM2	R/W	0h	Always write 5
3-0	0	R/W	0h	Must read or write 0

8 Application and Implementation

注

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

8.1 Application Information

8.1.1 Start-Up Sequence

表 62 lists the recommended start-up sequence for a 500-MSPS, Nyquist 2 operation with DDC mode 8 enabled.

表 62. Recommended Start-Up Sequence for 500-MSPS, Nyquist 2, DDC Bypass Mode (Mode 8) Operation

STEP	DESCRIPTION	REGISTER ADDRESS	REGISTER DATA	COMMENT	
1	Provide a 1.15-V power supply (AVDD, DVDD)	—	—	—	
2	Provide a 1.9-V power supply (AVDD19)	—	—	A 1.15-V supply must be supplied first for proper operation.	
3	Provide a clock to CLKINM, CLKINP and a SYSREF signal to SYSREFM, SYSREFP	—	—	SYSREF must be established before SPI programming.	
4	Pulse a reset (low to high to low) via a hardware reset (pin 48), wait 100 μs	—	—	Hardware reset loads all trim register settings.	
5	Issue a software reset to initialize the registers	00h	81h	—	
6	Set the high SNR mode for channel pairs AB and CD, select trims for 500-MSPS operation	11h	00h	Select the DIGTOP page.	
		12h	01h		
		13h	00h		
		ABh	01h	Set the high SNR mode for channels A and B.	
		ACh	01h	Set the high SNR mode for channels C and D.	
		ADh	08h	Select DDC bypass mode (mode 8) for channels A and B.	
		A Eh	08h	Select DDC bypass mode (mode 8) for channels C and D.	
7	Set up the SerDes configuration	64h	02h	Select trims for 500-MSPS operation.	
		11h	00h	Select the SerDes_AB and SerDes_CD pages.	
		12h	60h		
		13h	00h		
		26h	0Fh	Set the K value to 16 frames per multi-frame.	
20h	80h	Enable the K value from register 26h.			
8	ADC calibration	11h	FFh	Select the ADC_A1, ADC_A2, ADC_B1, ADC_B2, ADC_C1, ADC_C2, ADC_D1, and ADC_D2 pages.	
		12h	00h		
		13h	00h		
		D5h	08h	Enable ADC calibration.	
		Wait 2 ms			ADC calibration time.
		D5h	00h	Disable ADC calibration.	
		2Ah	00h	Internal trims.	
CFh	50h				
9	Select trims for the second Nyquist	11h	00h	Select the channel A, channel B, channel C, and channel D pages.	
		12h	1Eh		
		13h	00h		
		2Dh	02h	Select trims for the second Nyquist.	

Application Information (接下页)
表 62. Recommended Start-Up Sequence for 500-MSPS, Nyquist 2, DDC Bypass Mode (Mode 8) Operation (接下页)

STEP	DESCRIPTION	REGISTER ADDRESS	REGISTER DATA	COMMENT
10	Load linearity trims	11h	00h	Select the DIGTOP page.
		12h	01h	
		13h	00h	
		8Ch	02h	Load linearity trims.
		B7h	01h	
		B7h	00h	
11	Disable SYSREF	11h	00h	Select the ANALOG page.
		12h	00h	
		13h	01h	
		6Ah	02h	Disable SYSREF.

表 63 lists the recommended start-up sequence for a 500-MSPS, Nyquist 2, 2x interleaved dual ADC operation.

表 63. Recommended Start-Up Sequence for 500-MSPS, Nyquist 2, 2x Interleaved Dual ADC Operation

STEP	DESCRIPTION	REGISTER ADDRESS	REGISTER DATA	COMMENT
1	Provide a 1.15-V power supply (AVDD, DVDD)	—	—	—
2	Provide a 1.9-V power supply (AVDD19)	—	—	A 1.15-V supply must be supplied first for proper operation.
3	Provide a clock to CLKINM, CLKINP and a SYSREF signal to SYSREFM, SYSREFP	—	—	SYSREF must be established before SPI programming.
4	Pulse a reset (low to high to low) via a hardware reset (pin 48), wait 100 μ s	—	—	Hardware reset loads all trim register settings.
5	Issue a software reset to initialize the registers	00h	81h	—
6	Set the high SNR mode for channel pairs AB and CD, select trims for 500-MSPS operation	11h	00h	Select the DIGTOP page.
		12h	01h	
		13h	00h	
		A5h	03h	Enable averaging on the AB and CD channel pair.
		A6h	20h	Enable the averaging option.
		ABh	03h	Set the high SNR and interleave mode for channels A and B.
		ACh	03h	Set the high SNR and interleave mode for channels C and D.
		ADh	08h	Select DDC bypass mode (mode 8) for channels A and B.
		A Eh	08h	Select DDC bypass mode (mode 8) for channels C and D.
		64h	02h	Select trims for 500-MSPS operation.
7	Set up the SerDes configuration	11h	00h	Select the SERDES_AB and SERDES_CD pages.
		12h	60h	
		13h	00h	
		26h	0Fh	Set the K value to 16 frames per multi-frame.
		20h	80h	Enable the K value from register 26h.

**表 63. Recommended Start-Up Sequence for 500-MSPS, Nyquist 2, 2x Interleaved Dual ADC Operation (接
下页)**

STEP	DESCRIPTION	REGISTER ADDRESS	REGISTER DATA	COMMENT
8	ADC calibration	11h	FFh	Select the ADC_A1, ADC_A2, ADC_B1, ADC_B2, ADC_C1, ADC_C2, ADC_D1, and ADC_D2 pages.
		12h	00h	
		13h	00h	
		D5h	08h	Enable ADC calibration.
		Wait 2 ms		ADC calibration time.
		D5h	00h	Disable ADC calibration.
		2Ah	00h	Internal trims.
		CFh	50h	
9	Select trims for the second Nyquist	11h	00h	Select the channel A, channel B, channel C, and channel D pages.
		12h	1Eh	
		13h	00h	
		2Dh	02h	Select trims for the second Nyquist.
10	Load linearity trims	11h	00h	Select the DIGTOP page.
		12h	01h	
		13h	00h	
		8Ch	02h	Load linearity trims.
		B7h	01h	
		B7h	00h	
11	Disable SYSREF	11h	00h	Select the ANALOG page.
		12h	00h	
		13h	01h	
		6Ah	02h	Disable SYSREF.

8.1.2 Hardware Reset

图 130 shows the timing information for the hardware reset.

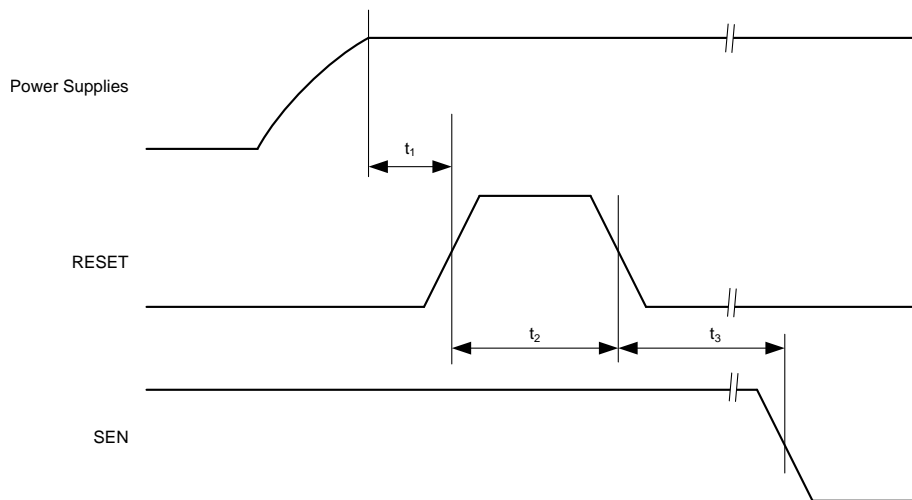


图 130. Hardware Reset Timing Diagram

表 64. Timing Requirements for 图 130

		MIN	TYP	MAX	UNIT
t ₁	Power-on delay from power-up to an active high RESET pulse	1			ms
t ₂	Reset pulse duration: active high RESET pulse duration	10			ns
t ₃	Register write delay from RESET disable to SEN active	100			μs

8.1.3 Frequency Planning

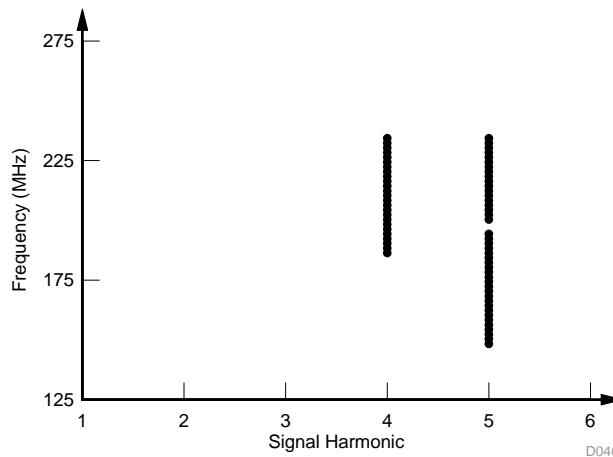
The ADS54J64 uses an architecture where the ADCs are 2x interleaved followed by a digital decimation by 2. The 2x interleaved and decimation architecture comes with a unique advantage of improved linearity resulting from frequency planning. Frequency planning refers to choosing the clock frequency and signal band appropriately such that the harmonic distortion components, resulting from the analog front-end (LNA, PGA), can be made to fall outside the decimation filter pass band. In absence of the 2x interleave and decimation architecture, these components alias back in band and limit the performance of the signal chain. For example, for $f_{CLK} = 983.04$ MHz and $f_{IN} = 184.32$ MHz:

Second-order harmonic distortion (HD2) = $2 \times 184.32 = 368.64$ MHz

Pass band of the 2x decimation filter = 0 MHz to 245.76 MHz (0 to $f_{CLK} / 4$)

The second-order harmonic performance improves by the stop-band attenuation of the filter (approximately 40 dBc) because the second-order harmonic frequency is outside the pass band of the decimation filter.

图 131 shows the harmonic components (HD2–HD5) that fall in the decimation pass band for the input clock rate (f_{CLK}) of the 983.04-MHz and 100-MHz signal band around the center frequency of 184.32 MHz.



NOTE: $f_{CLK} = 983.04$ MHz, signal band = 134.32 MHz to 234.32 MHz.

图 131. In-Band Harmonics for a Frequency Planned System

As shown in 图 131, both HD2 and HD3 are completely out of band. HD4 and HD5 fall in the decimation pass band for some frequencies of the input signal band.

Through proper frequency planning, the specifications of the ADC antialias filter can be relaxed.

8.1.4 SNR and Clock Jitter

The signal-to-noise ratio of the ADC is limited by three different factors (as shown in 公式 3): the quantization noise is typically not noticeable in pipeline converters and is 84 dB for a 14-bit ADC. The thermal noise limits the SNR at low input frequencies and the clock jitter sets the SNR for higher input frequencies.

$$SNR_{ADC} [dBc] = -20 \log \sqrt{\left(10^{-\frac{SNR_{Quantization\ Noise}}{20}}\right)^2 + \left(10^{-\frac{SNR_{Thermal\ Noise}}{20}}\right)^2 + \left(10^{-\frac{SNR_{Jitter}}{20}}\right)^2} \quad (3)$$

公式 4 calculates the SNR limitation resulting from sample clock jitter:

$$SNR_{jitter} [dBc] = -20 \log(2\pi \times f_{in} \times T_{jitter}) \quad (4)$$

The total clock jitter (T_{jitter}) has two components: the internal aperture jitter ($100 f_S$ for the ADS54J64) that is set by the noise of the clock input buffer and the external clock jitter. 公式 5 calculates T_{jitter} :

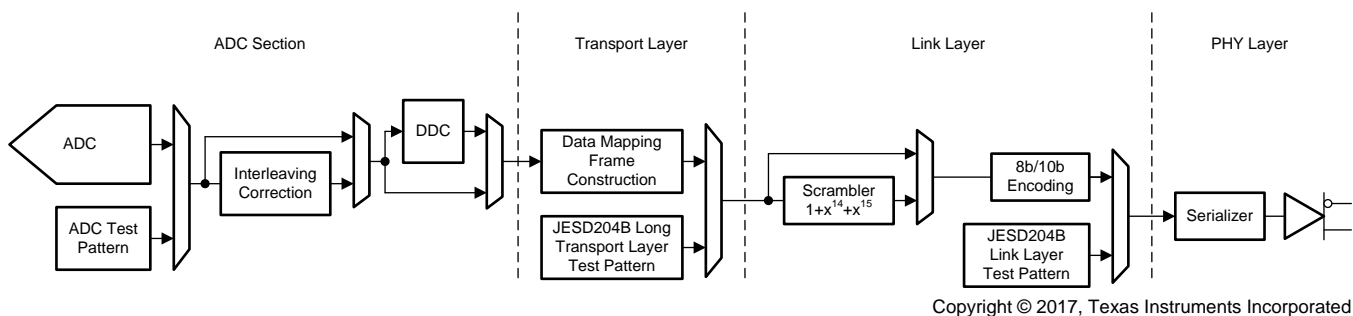
$$T_{jitter} = \sqrt{(T_{jitter, Ext_Clock_Input})^2 + (T_{Aperture_ADC})^2} \quad (5)$$

External clock jitter can be minimized by using high-quality clock sources and jitter cleaners as well as band-pass filters at the clock input; a faster clock slew rate also improves the ADC aperture jitter.

The ADS54J64 has a thermal noise of approximately 70 dBFS and an internal aperture jitter of $100 f_S$.

8.1.5 ADC Test Pattern

The ADS54J64 provides several different options to output test patterns instead of the actual output data of the ADC in order to simplify debugging of the JESD204B digital interface link. 图 132 shows the output data path.



Copyright © 2017, Texas Instruments Incorporated

图 132. ADC Test Pattern

8.1.5.1 ADC Section

The ADC test pattern replaces the actual output data of the ADC. These test patterns can be programmed using register 91h of the DIGTOP page. 表 65 lists the supported test patterns.

表 65. ADC Test Pattern Settings

BIT	NAME	DEFAULT	DESCRIPTION
7-4	TESTPATTERNSELECT	0000	These bits select the test pattern on the output when the test pattern is enabled for a suitable channel. 0 : Default 1 : All zeros 2 : All ones 3 : Toggle pattern 4 : Ramp pattern 6 : Custom pattern 1 7 : Toggles between custom pattern 1 and custom pattern 2 8 : Deskew pattern (AAAAh)

8.1.5.2 Transport Layer Pattern

The transport layer maps the ADC output data into 8-bit octets and constructs the JESD204B frames using the LMFS parameters. Tail bits or 0s are added when needed. Alternatively, as shown in 表 66, the JESD204B long transport layer test pattern can be substituted by programming register 20h.

表 66. Transport Layer Test Mode

BIT	NAME	DEFAULT	DESCRIPTION
4	TRANS_TEST_EN	0	This bit generates the long transport layer test pattern mode according to clause 5.1.6.3 of the JESD204B specification. 0 = Test mode disabled 1 = Test mode enabled

8.1.5.3 Link Layer Pattern

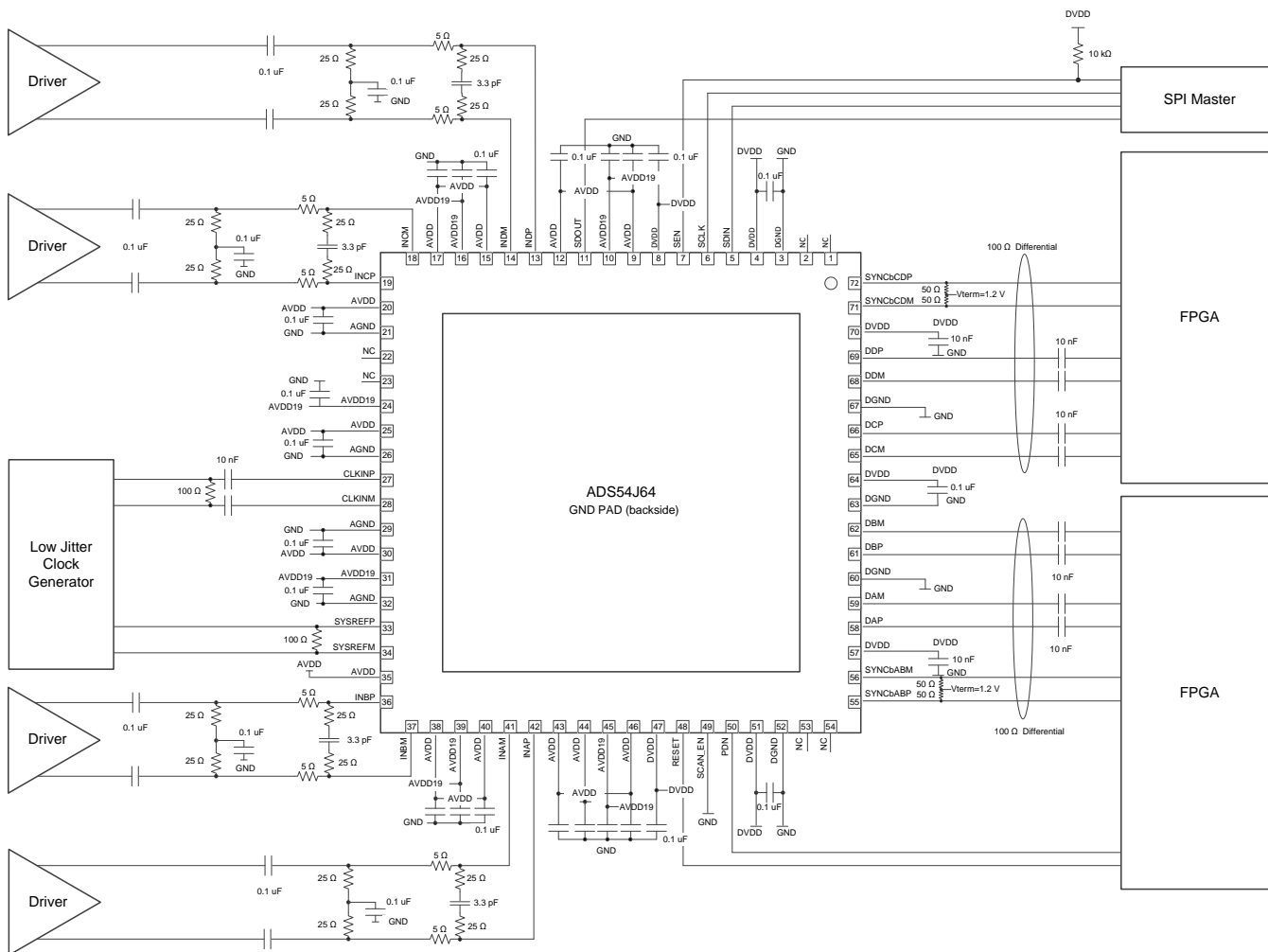
The link layer contains the scrambler and the 8b, 10b encoding of any data passed on from the transport layer. Additionally, the link layer also handles the initial lane alignment sequence that can be manually restarted. The link layer test patterns are intended for testing the quality of the link (jitter testing and so forth). The test patterns do not pass through the 8b, 10b encoder. These test patterns can be used by programming register 22h of the SERDES_XX page. [表 67](#) shows the supported programming options.

表 67. Link Layer Test Mode

BIT	NAME	DEFAULT	DESCRIPTION
7-5	LINK_LAYER_TESTMODE_SEL	000	These bits generate a pattern according to clause 5.3.3.8.2 of the JESD204B document. 0 : Normal ADC data 1 : D21.5 (high-frequency jitter pattern) 2 : K28.5 (mixed-frequency jitter pattern) 3 : Repeats initial lane alignment (generates a K28.5 character and continuously repeats lane alignment sequences) 4 : 12-octet RPAT jitter pattern 6 : PRBS pattern (PRBS7,15,23,31); use PRBS mode (register 36h) to select the PRBS pattern

8.2 Typical Application

The ADS54J64 is designed for wideband receiver applications demanding excellent dynamic range over a large input frequency range. [Figure 133](#) shows a typical schematic for an ac-coupled dual receiver [dual field-programmable gate array (FPGA) with a dual SYNC].



Copyright © 2017, Texas Instruments Incorporated

NOTE: GND = AGND and DGND are connected in the PCB layout.

Figure 133. Application Diagram for the ADS54J64

8.2.1 Design Requirements

By using the simple drive circuit of [Figure 133](#) (when the amplifier drives the ADC) or [Figure 46](#) (when transformers drive the ADC), uniform performance can be obtained over a wide frequency range. The buffers present at the analog inputs of the device help isolate the external drive source from the switching currents of the sampling circuit.

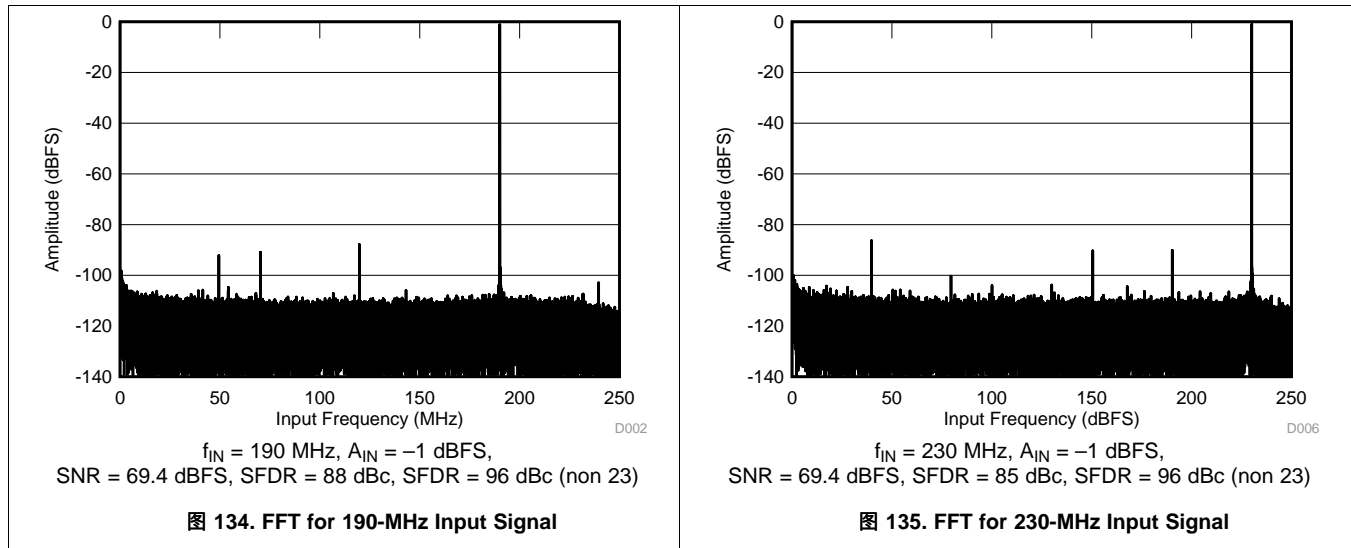
8.2.2 Detailed Design Procedure

For optimum performance, the analog inputs must be driven differentially. This architecture improves the common-mode noise immunity and even-order harmonic rejection. A small resistor (5 Ohm to 10 Ohm) in series with each input pin, as shown in [Figure 133](#), is recommended to damp out ringing caused by package parasitics.

Typical Application (接下页)

8.2.3 Application Curves

图 134 和 图 135 显示典型的性能在 190 MHz 和 230 MHz, 分别。



9 Power Supply Recommendations

The device requires a 1.15-V nominal supply for DVDD, a 1.15-V nominal supply for AVDD, and a 1.9-V nominal supply for AVDD19. AVDD and DVDD are recommended to be powered up the before the AVDD19 supply for reliable loading of factory trims.

10 Layout

10.1 Layout Guidelines

The device evaluation module (EVM) layout can be used as a reference layout to obtain the best performance. [图 136](#) shows a layout diagram of the EVM top layer. A complete layout of the EVM is available at the [ADS54J64 EVM folder](#). Some important points to remember during board layout are:

- Analog inputs are located on opposite sides of the device pinout to ensure minimum crosstalk on the package level. To minimize crosstalk onboard, the analog inputs must exit the pinout in opposite directions, as shown in the reference layout of [图 136](#) as much as possible.
- In the device pinout, the sampling clock is located on a side perpendicular to the analog inputs in order to minimize coupling between them. This configuration is also maintained on the reference layout of [图 136](#) as much as possible.
- Keep digital outputs away from the analog inputs. When these digital outputs exit the pinout, the digital output traces must not be kept parallel to the analog input traces because this configuration can result in coupling from the digital outputs to the analog inputs and degrade performance. All digital output traces to the receiver [such as an FPGA or an application-specific integrated circuit (ASIC)] must be matched in length to avoid skew among outputs.
- At each power-supply pin (AVDD, DVDD, or AVDD19), keep a 0.1- μ F decoupling capacitor close to the device. A separate decoupling capacitor group consisting of a parallel combination of 10- μ F, 1- μ F, and 0.1- μ F capacitors can be kept close to the supply source.

10.2 Layout Example

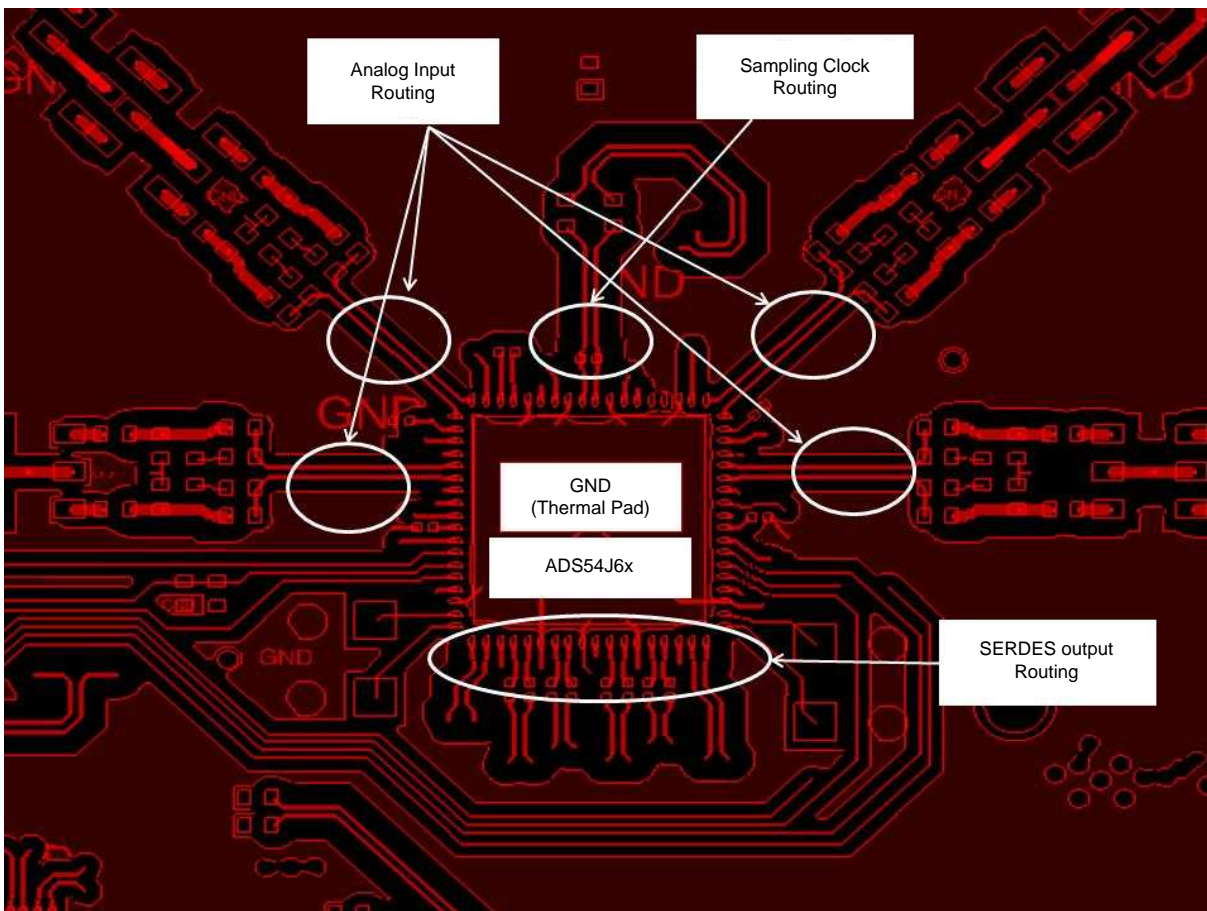


图 136. ADS54J64EVM Layout

11 器件和文档支持

11.1 接收文档更新通知

要接收文档更新通知，请转至 TI.com 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。

11.2 社区资源

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

TI E2E™ 在线社区 [TI 的工程师对工程师 \(E2E\) 社区](#)。此社区的创建目的在于促进工程师之间的协作。在 e2e.ti.com 中，您可以咨询问题、分享知识、拓展思路并与同行工程师一道帮助解决问题。

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。

11.3 商标

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

11.4 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。

11.5 Glossary

[SLYZ022](#) — *TI Glossary*.

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

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。这些数据如有变更，恕不另行通知和修订此文档。如欲获取此产品说明书的浏览器版本，请参阅左侧的导航。

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
ADS54J64IRMP	ACTIVE	VQFN	RMP	72	168	RoHS & Green	NIPDAU	Level-3-260C-168 HR	-40 to 85	AZ54J64	Samples
ADS54J64IRMPT	ACTIVE	VQFN	RMP	72	250	RoHS & Green	NIPDAU	Level-3-260C-168 HR	-40 to 85	AZ54J64	Samples

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

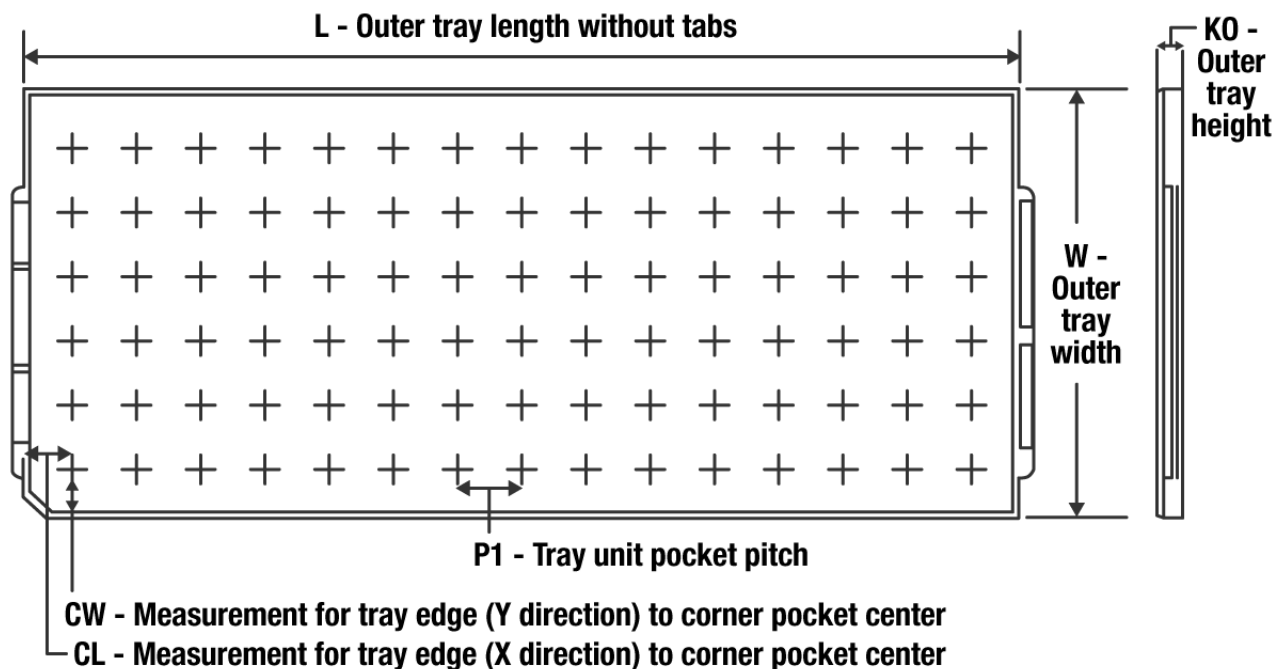
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

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

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

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

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

TRAY


Chamfer on Tray corner indicates Pin 1 orientation of packed units.

*All dimensions are nominal

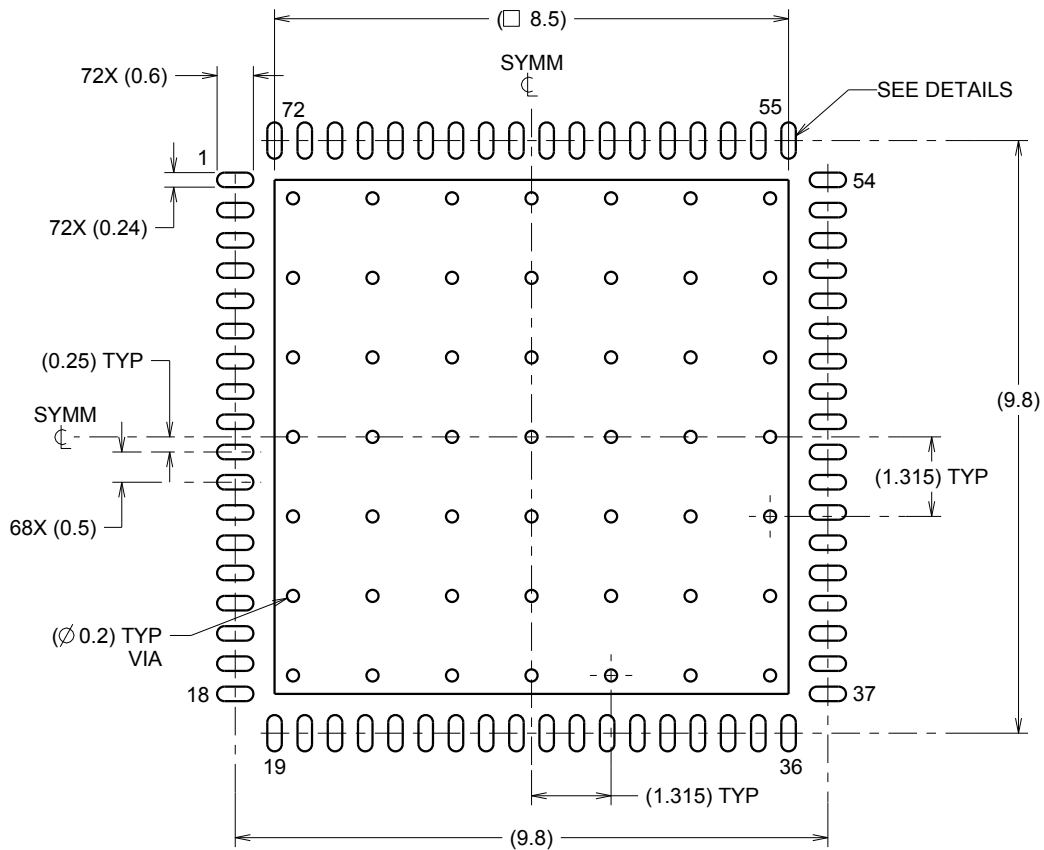
Device	Package Name	Package Type	Pins	SPQ	Unit array matrix	Max temperature (°C)	L (mm)	W (mm)	K0 (µm)	P1 (mm)	CL (mm)	CW (mm)
ADS54J64IRMP	RMP	VQFNP	72	168	8 X 21	150	315	135.9	7620	14.65	11	11.95

EXAMPLE BOARD LAYOUT

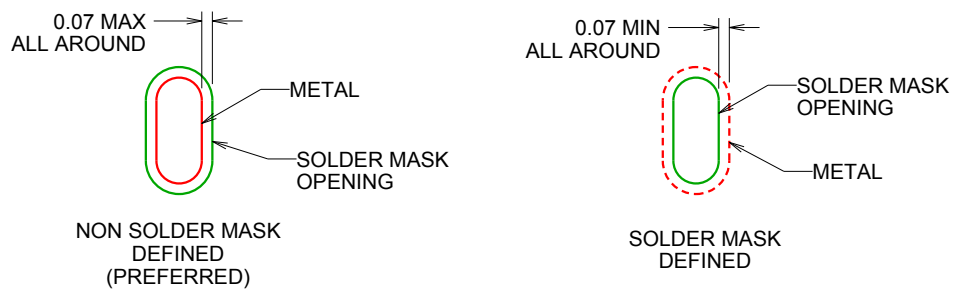
RMP0072A

VQFN - 0.9 mm max height

VQFN



LAND PATTERN EXAMPLE
SCALE:8X



SOLDER MASK DETAILS

4221047/B 02/2014

NOTES: (continued)

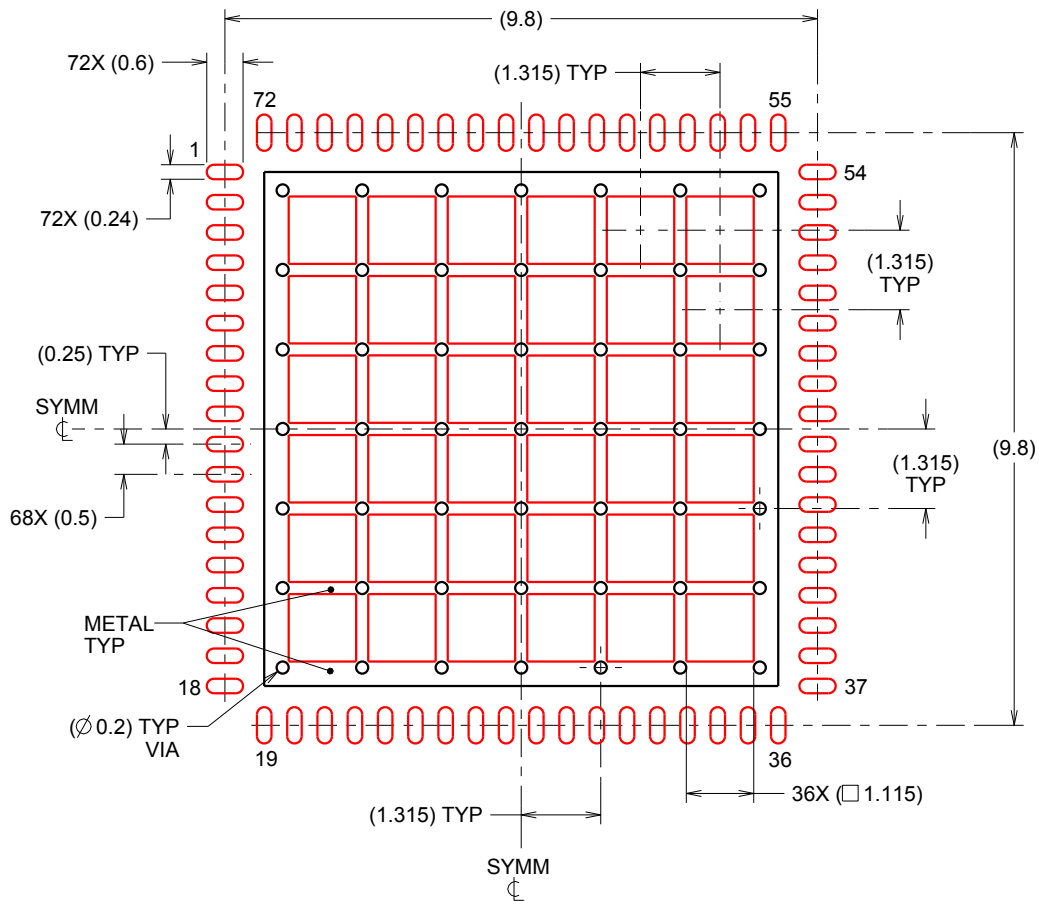
- This package is designed to be soldered to a thermal pad on the board. For more information, see QFN/SON PCB application report in literature No. SLUA271 (www.ti.com/lit/slua271).

EXAMPLE STENCIL DESIGN

RMP0072A

VQFN - 0.9 mm max height

VQFN



SOLDER PASTE EXAMPLE
 BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD
 62% PRINTED SOLDER COVERAGE BY AREA
 SCALE:8X

4221047/B 02/2014

NOTES: (continued)

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

重要声明和免责声明

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

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

这些资源如有变更，恕不另行通知。TI 授权您仅可将这些资源用于研发本资源所述的 TI 产品的应用。严禁对这些资源进行其他复制或展示。您无权使用任何其他 TI 知识产权或任何第三方知识产权。您应全额赔偿因在这些资源的使用中对 TI 及其代表造成的任何索赔、损害、成本、损失和债务，TI 对此概不负责。

TI 提供的产品受 [TI 的销售条款](#) 或 [ti.com](#) 上其他适用条款/TI 产品随附的其他适用条款的约束。TI 提供这些资源并不会扩展或以其他方式更改 TI 针对 TI 产品发布的适用的担保或担保免责声明。

TI 反对并拒绝您可能提出的任何其他或不同的条款。

邮寄地址：Texas Instruments, Post Office Box 655303, Dallas, Texas 75265

Copyright © 2022，德州仪器 (TI) 公司