

具有 SPI 接口和 GPIO 的 TLA2518 小型 8 通道 12 位 ADC

1 特性

- 小封装尺寸：
 - WQFN 3mm × 3mm
- 8 通道，可配置为以下任意组合：
 - 最多 8 个模拟输入、数字输入或数字输出
- 用于 I/O 扩展的 GPIO：
 - 开漏、推挽数字输出
- 宽工作范围：
 - AVDD: 2.35V 至 5.5V
 - DVDD: 1.65V 至 5.5V
 - 温度范围: -40°C 至 +85°C
- 增强型 SPI 数字接口：
 - 高速 60MHz 接口
 - 使用 >13.5MHz SPI 实现最大吞吐量
- 可编程均值滤波器：
 - 用于求平均值的可编程样本大小
 - 利用内部转换求平均值
 - 16 位分辨率

2 应用

- 宏远程无线电单元 (RRU)
- 电池管理系统 (BMS)
- 串式逆变器
- 中央逆变器

3 说明

TLA2518 是一款易于使用的 8 通道多路复用 12 位 1MSPS 逐次逼近寄存器模数转换器 (SAR ADC)。8 个通道可独立配置为模拟输入、数字输入或数字输出。该器件具有一个用于执行 ADC 转换过程的内部振荡器。

TLA2518 通过兼容 SPI 的接口进行通信，并支持通过单次转换启动对多个数据样本求平均值。内置的可编程平均滤波器有助于降低来自模拟输入的噪声，并减少主机需要读取的数据样本数量。

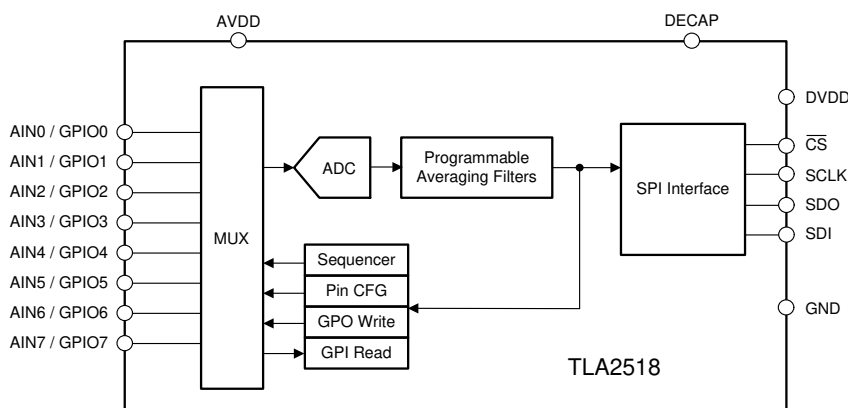
器件信息⁽¹⁾

器件型号	封装	封装尺寸 (标称值)
TLA2518	WQFN (16)	3.00mm × 3.00mm

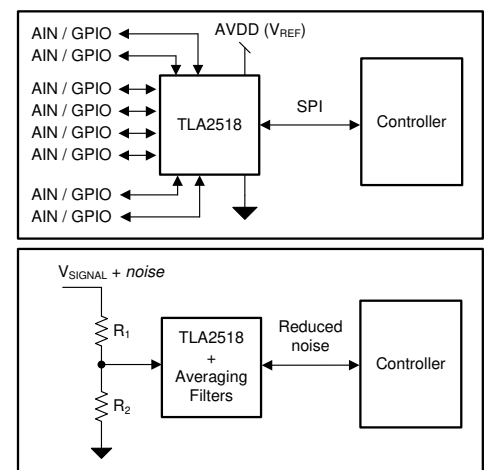
(1) 如需了解所有可用封装，请参阅数据表末尾的可订购产品附录。

TLA2518 方框图和应用

Device Block Diagram



Example Applications



目录

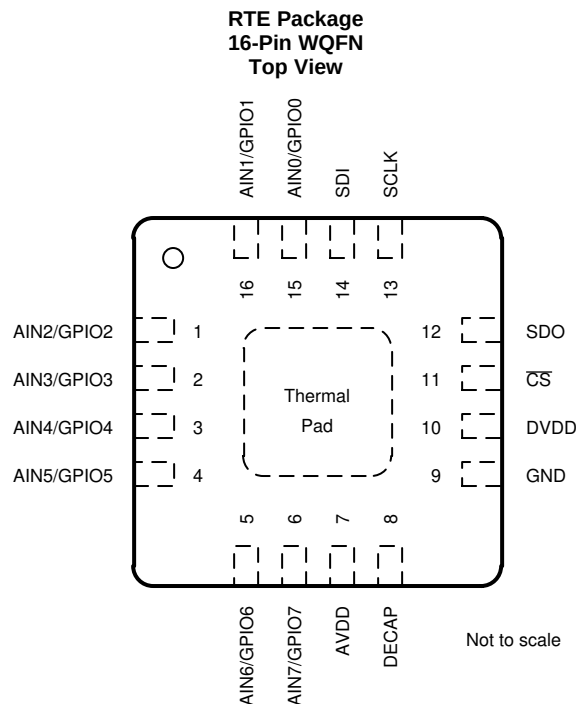
1	特性	1	7.4	Device Functional Modes	19
2	应用	1	7.5	TLA2518 Registers	22
3	说明	1	8	Application and Implementation	29
4	修订历史记录	2	8.1	Application Information	29
5	Pin Configuration and Functions	3	8.2	Typical Applications	29
6	Specifications	4	9	Power Supply Recommendations	32
6.1	Absolute Maximum Ratings	4	9.1	AVDD and DVDD Supply Recommendations	32
6.2	ESD Ratings	4	10	Layout	33
6.3	Recommended Operating Conditions	4	10.1	Layout Guidelines	33
6.4	Thermal Information	4	10.2	Layout Example	33
6.5	Electrical Characteristics	5	11	器件和文档支持	34
6.6	Timing Requirements	5	11.1	接收文档更新通知	34
6.7	Switching Characteristics	6	11.2	社区资源	34
6.8	Typical Characteristics	8	11.3	商标	34
7	Detailed Description	12	11.4	静电放电警告	34
7.1	Overview	12	11.5	Glossary	34
7.2	Functional Block Diagram	12	12	机械、封装和可订购信息	34
7.3	Feature Description	13			

4 修订历史记录

注：之前版本的页码可能与当前版本有所不同。

Changes from Original (June 2019) to Revision A	Page
• 已更改 将器件状态从“预告信息”更改为“生产数据”	1

5 Pin Configuration and Functions



Pin Functions

PIN		FUNCTION ⁽¹⁾	DESCRIPTION
NAME	NO.		
AIN0/GPIO0	15	AI, DI, DO	Channel 0; can be configured as either an analog input (default), digital input, or digital output.
AIN1/GPIO1	16	AI, DI, DO	Channel 1; can be configured as either an analog input (default), digital input, or digital output.
AIN2/GPIO2	1	AI, DI, DO	Channel 2; can be configured as either an analog input (default), digital input, or digital output.
AIN3/GPIO3	2	AI, DI, DO	Channel 3; can be configured as either an analog input (default), digital input, or digital output.
AIN4/GPIO4	3	AI, DI, DO	Channel 4; can be configured as either an analog input (default), digital input, or digital output.
AIN5/GPIO5	4	AI, DI, DO	Channel 5; can be configured as either an analog input (default), digital input, or digital output.
AIN6/GPIO6	5	AI, DI, DO	Channel 6; can be configured as either an analog input (default), digital input, or digital output.
AIN7/GPIO7	6	AI, DI, DO	Channel 7; can be configured as either an analog input (default), digital input, or digital output.
AVDD	7	Supply	Analog supply input, also used as the reference voltage to the ADC; connect a 1-μF decoupling capacitor to GND.
$\overline{\text{CS}}$	11	DI	Chip-select input pin; active low. The device takes control of the data bus when $\overline{\text{CS}}$ is low. The device starts converting the active input channel on the rising edge of $\overline{\text{CS}}$. SDO goes hi-Z when $\overline{\text{CS}}$ is high.
DECAP	8	Supply	Connect a decoupling capacitor to this pin for the internal power supply.
DVDD	10	Supply	Digital I/O supply voltage; connect a 1-μF decoupling capacitor to GND.
GND	9	Supply	Ground for the power supply; all analog and digital signals are referred to this pin voltage.
SCLK	13	DI	Serial clock for the SPI interface.
SDI	14	DI	Serial data in for the device.
SDO	12	DO	Serial data out for the device.
Thermal pad	—	Supply	Exposed thermal pad; connect to GND.

(1) AI = analog input, DI = digital input, and DO = digital output.

6 Specifications

6.1 Absolute Maximum Ratings

over operating ambient temperature range (unless otherwise noted)⁽¹⁾

	MIN	MAX	UNIT
DVDD to GND	−0.3	5.5	V
AVDD to GND	−0.3	5.5	V
AINx / GPIOx ⁽²⁾ to GND	GND − 0.3	AVDD + 0.3	V
Digital input to GND	GND − 0.3	5.5	V
Current through any pin except supply pins ⁽³⁾	−10	10	mA
Junction temperature, T _J	−40	125	°C
Storage temperature, T _{stg}	−60	150	°C

- (1) Stresses beyond those listed under *Absolute Maximum Rating* 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 Condition*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) AINx / GPIOx refers to pins 1, 2, 3, 4, 5, 6, 15, and 16.
- (3) Pin current must be limited to 10mA or less.

6.2 ESD Ratings

			VALUE	UNIT
V _(ESD)	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins ⁽¹⁾	±2000	V
		Charged device model (CDM), per JEDEC specification JESD22-C101, all pins ⁽²⁾	±500	

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

6.3 Recommended Operating Conditions

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

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
POWER SUPPLY						
AVDD	Analog supply voltage		2.35	3.3	5.5	V
DVDD	Digital supply voltage		1.65	3.3	5.5	V
ANALOG INPUTS						
FSR	Full-scale input range	AIN _x - GND	0		AVDD	V
V _{IN}	Absolute input voltage	AIN _x - GND	−0.1		AVDD + 0.1	V
TEMPERATURE RANGE						
T _A	Ambient temperature		−40	25	85	°C

- (1) AINx refers to AIN0, AIN1, AIN2, AIN3, AIN4, AIN5, AIN6, and AIN7.

6.4 Thermal Information

THERMAL METRIC ⁽¹⁾		TLA2518	UNIT
		RTE (WQFN)	
		16 PINS	
R _{θJA}	Junction-to-ambient thermal resistance	49.7	°C/W
R _{θJC(top)}	Junction-to-case (top) thermal resistance	53.4	°C/W
R _{θJB}	Junction-to-board thermal resistance	24.7	°C/W
Ψ _{JT}	Junction-to-top characterization parameter	1.3	°C/W
Ψ _{JB}	Junction-to-board characterization parameter	24.7	°C/W
R _{θJC(bot)}	Junction-to-case (bottom) thermal resistance	9.3	°C/W

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

6.5 Electrical Characteristics

at AVDD = 5 V, DVDD = 1.65 V to 5.5 V, and maximum throughput (unless otherwise noted); minimum and maximum values at T_A = –40°C to +85°C; typical values at T_A = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
ANALOG INPUTS						
C _{SH}	Sampling capacitance		12			pF
DC PERFORMANCE						
	Resolution	No missing codes	12			bits
DNL	Differential nonlinearity		±0.3			LSB
INL	Integral nonlinearity		±0.5			LSB
V _(OS)	Input offset error	Post offset calibration	±0.5			LSB
	Input offset thermal drift	Post offset calibration	±5			ppm/°C
G _E	Gain error		±0.05			%FSR
	Gain error thermal drift		±5			ppm/°C
AC PERFORMANCE						
SINAD	Signal-to-noise + distortion ratio	AVDD = 5 V, f _{IN} = 2 kHz	71.5			dB
		AVDD = 3 V, f _{IN} = 2 kHz	70.5			dB
DECAP Pin						
	Decoupling capacitor on DECAP pin		0.1	1		μF
SPI INTERFACE ($\overline{\text{CS}}$, SCLK, SDI, SDO)						
V _{IH}	Input high logic level		0.7 x DVDD	5.5		V
V _{IL}	Input low logic level		−0.3	0.3 x DVDD		V
V _{OH}	Output high logic level	Source current = 2 mA, DVDD > 2 V	0.8 x DVDD	DVDD		V
		Source current = 2 mA, DVDD ≤ 2 V	0.7 x DVDD	DVDD		
V _{OL}	Output low logic level	Sink current = 2 mA, DVDD > 2 V	0	0.4		V
		Sink current = 2 mA, DVDD ≤ 2 V	0	0.2 x DVDD		
GPIOs						
V _{IH}	Input high logic level		0.7 x AVDD	AVDD + 0.3		V
V _{IL}	Input low logic level		−0.3	0.3 x AVDD		V
V _{OH}	Output high logic level	GPO_DRIVE_CFG = push-pull, I _{SOURCE} = 2 mA	0.8 x AVDD	AVDD		V
V _{OL}	Output low logic level	I _{SINK} = 2 mA	0	0.2 x AVDD		V
I _{OH}	Output high source current	V _{OH} > 0.7 x AVDD	5			mA
I _{OL}	Output low sink current	V _{OL} < 0.3 x AVDD	5			mA
POWER-SUPPLY CURRENTS						
I _{AVDD}	Analog supply current	Full throughput, AVDD = 5 V	470		600	μA
		Full throughput, AVDD = 3 V	440		550	
		No conversion, AVDD = 5 V	10		25	

6.6 Timing Requirements

at AVDD = 5 V, DVDD = 1.65 V to 5.5 V, and maximum throughput (unless otherwise noted); minimum and maximum values at T_A = –40°C to +85°C; typical values at T_A = 25°C

		MIN	MAX	UNIT
CONVERSION CYCLE				
f _{CYCLE}	Sampling frequency		1000	kSPS
t _{CYCLE}	ADC cycle-time period	1 / f _{CYCLE}		s
t _{ACQ}	Acquisition time	300		ns
t _{QT_ACQ}	Quiet acquisition time	10		ns

Timing Requirements (continued)

at AVDD = 5 V, DVDD = 1.65 V to 5.5 V, and maximum throughput (unless otherwise noted); minimum and maximum values at T_A = –40°C to +85°C; typical values at T_A = 25°C

		MIN	MAX	UNIT
t _{D_CNVCAP}	Quiet conversion time	10		ns
t _{WH_CSZ}	Pulse duration: $\overline{CS}$ high	10		ns
t _{WL_CSZ}	Pulse duration: $\overline{CS}$ low	10		ns
SPI INTERFACE TIMINGS				
f _{CLK}	Maximum SCLK frequency		60	MHz
t _{CLK}	Minimum SCLK time period	16.67		ns
t _{PH_CK}	SCLK high time	0.45	0.55	t _{CLK}
t _{PL_CK}	SCLK low time	0.45	0.55	t _{CLK}
t _{SU_CSCK}	Setup time: $\overline{CS}$ falling to the first SCLK capture edge	3.5		ns
t _{SU_CKDI}	Setup time: SDI data valid to the SCLK capture edge	1.5		ns
t _{HT_CKDI}	Hold time: SCLK capture edge to data valid on SDI	2		ns
t _{D_CKCS}	Delay time: last SCLK falling to $\overline{CS}$ rising	6		ns

6.7 Switching Characteristics

at AVDD = 5 V, DVDD = 1.65 V to 5.5 V, and maximum throughput (unless otherwise noted); minimum and maximum values at T_A = –40°C to +85°C; typical values at T_A = 25°C

PARAMETER	Test Conditions	MIN	MAX	UNIT
CONVERSION CYCLE				
t _{CONV}	ADC conversion time		600	ns
t _{ACQ}	Acquisition time	400		ns
RESET				
t _{PU}	Power-up time for device	AVDD ≥ 2.35 V, C _{DECAP} = 1 μF	5	ms
t _{RST}	Delay time: RST bit = 1b to device reset complete ⁽¹⁾		5	ms
SPI INTERFACE TIMINGS				
t _{DEN_CSDO}	Delay time: $\overline{CS}$ falling to data enable		15	ns
t _{DZ_CSDO}	Delay time: $\overline{CS}$ rising to SDO going Hi-Z		15	ns
t _{D_CKDO}	Delay time: SCLK launch edge to (next) data valid on SDO		16	ns

(1) RST bit is automatically reset to 0b after t_{RST}.

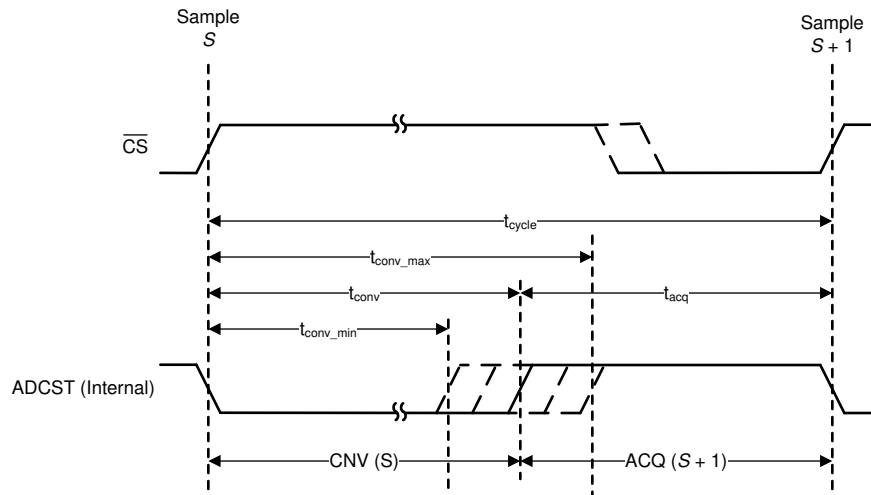
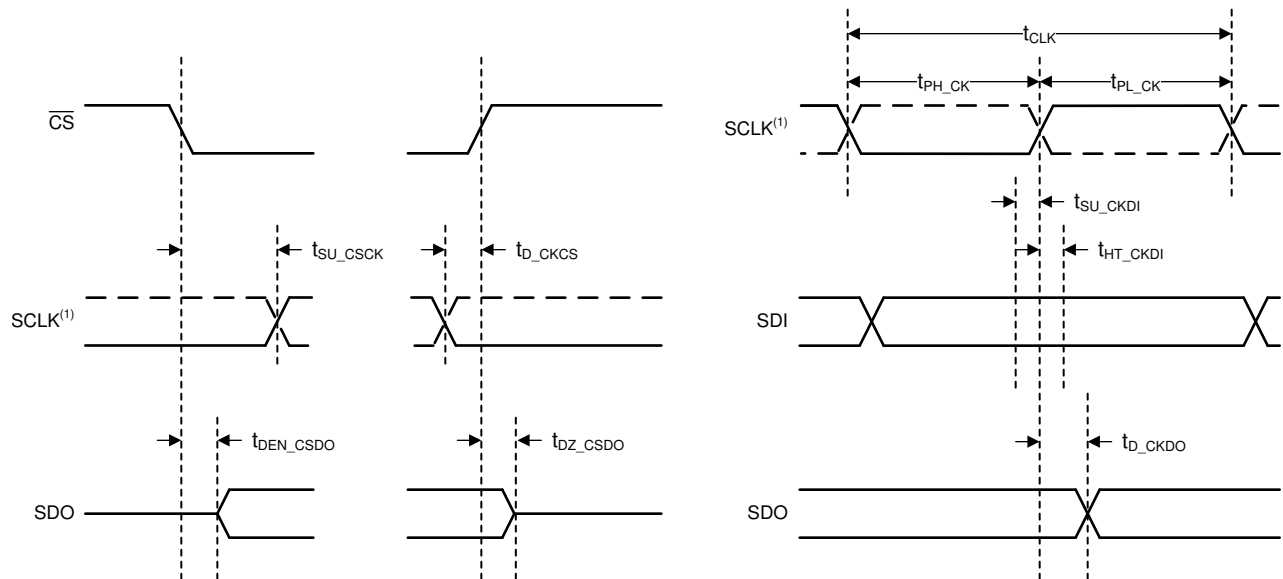


图 1. Conversion Cycle Timing

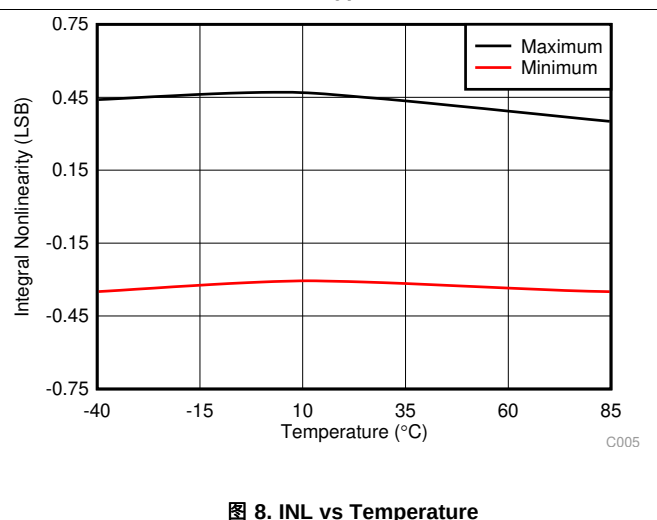
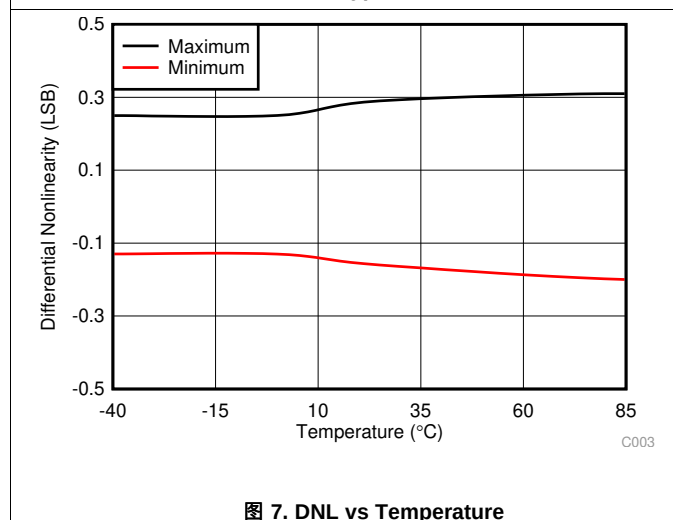
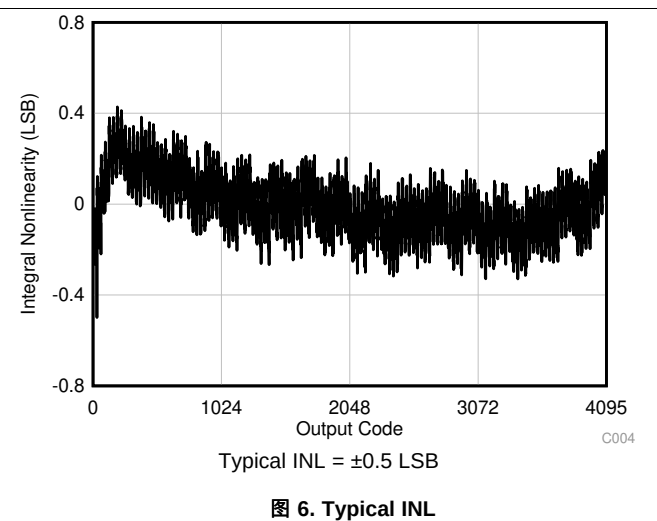
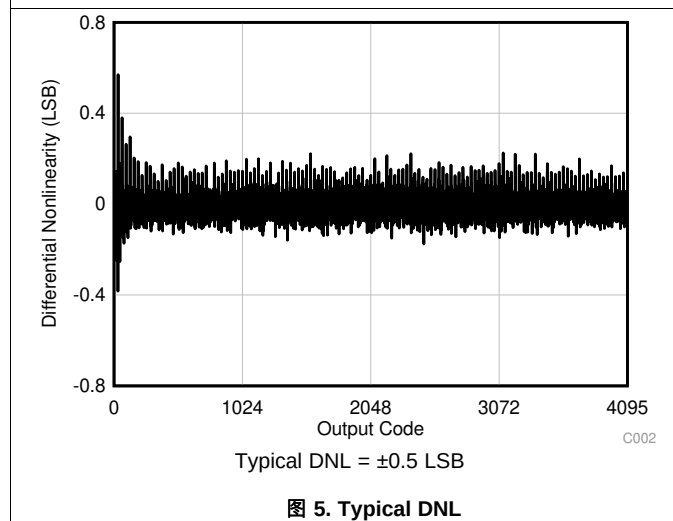
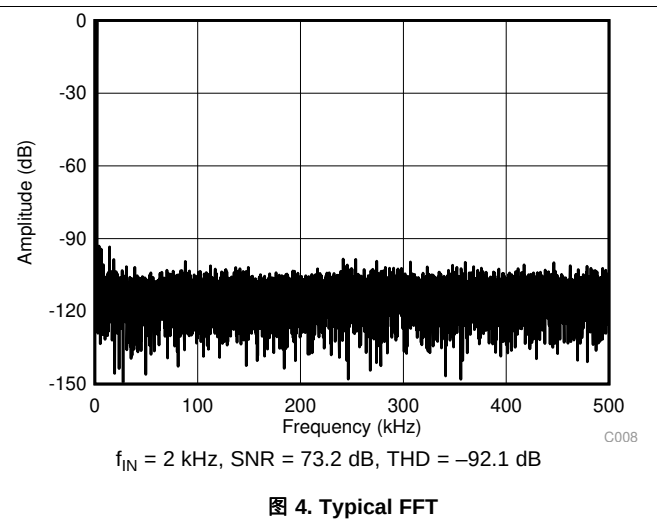
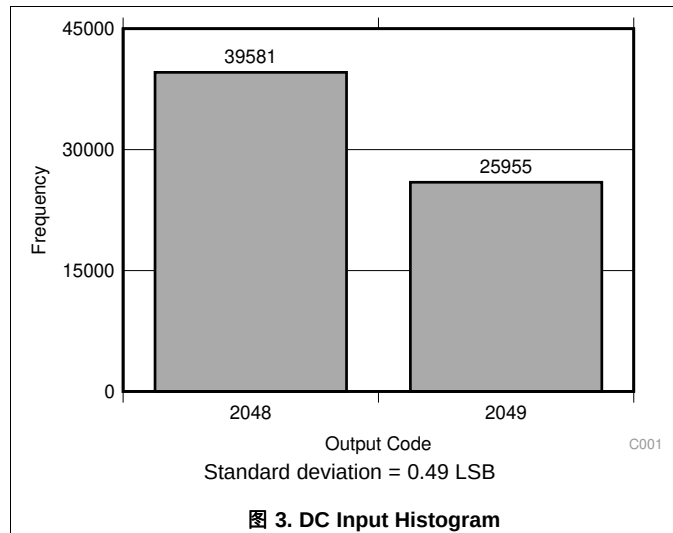


(1) The SCLK polarity, launch edge, and capture edge depend on the SPI protocol selected.

图 2. SPI-Compatible Serial Interface Timing

6.8 Typical Characteristics

at $T_A = 25^\circ\text{C}$, $AVDD = 5\text{ V}$, $DVDD = 1.8\text{ V}$, and $f_{\text{SAMPLE}} = 1\text{ MSPS}$ (unless otherwise noted)



Typical Characteristics (接下页)

at $T_A = 25^\circ\text{C}$, $AV_{DD} = 5\text{ V}$, $DV_{DD} = 1.8\text{ V}$, and $f_{\text{SAMPLE}} = 1\text{ MSPS}$ (unless otherwise noted)

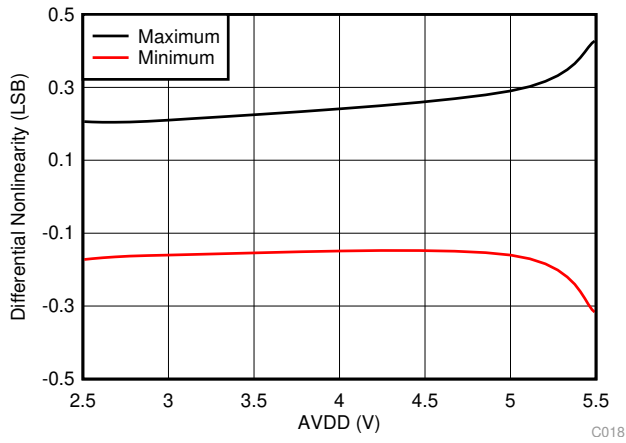


图 9. DNL vs AVDD

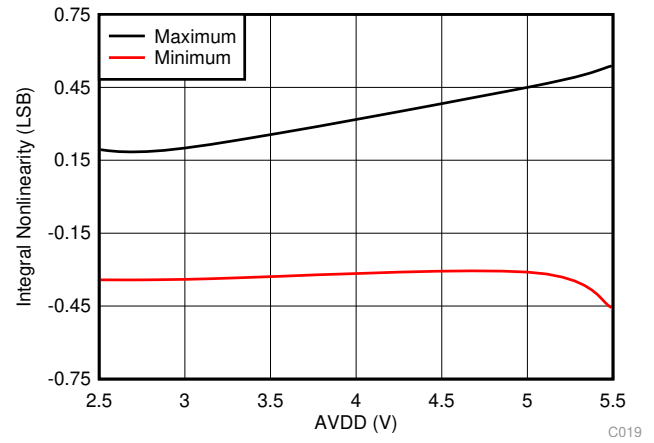


图 10. INL vs AVDD

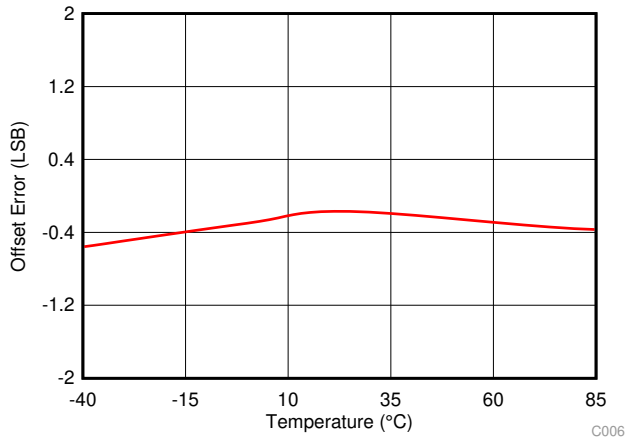


图 11. Offset Error vs Temperature

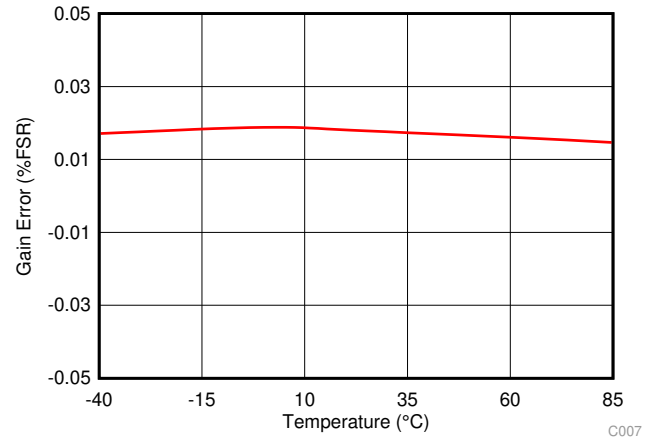


图 12. Gain Error vs Temperature

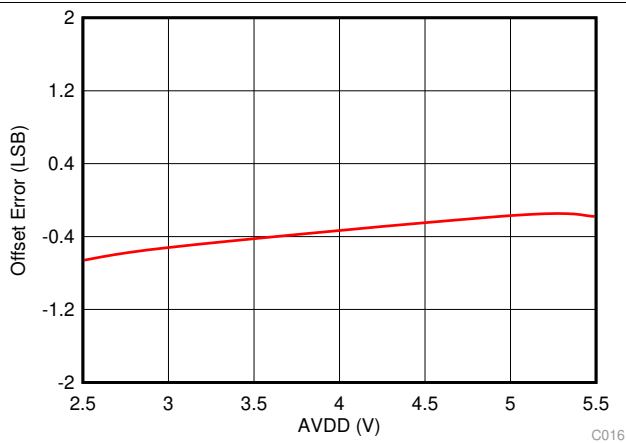


图 13. Offset Error vs AVDD

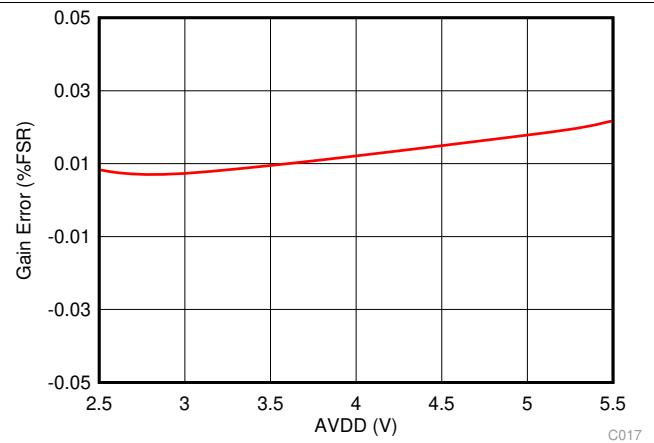
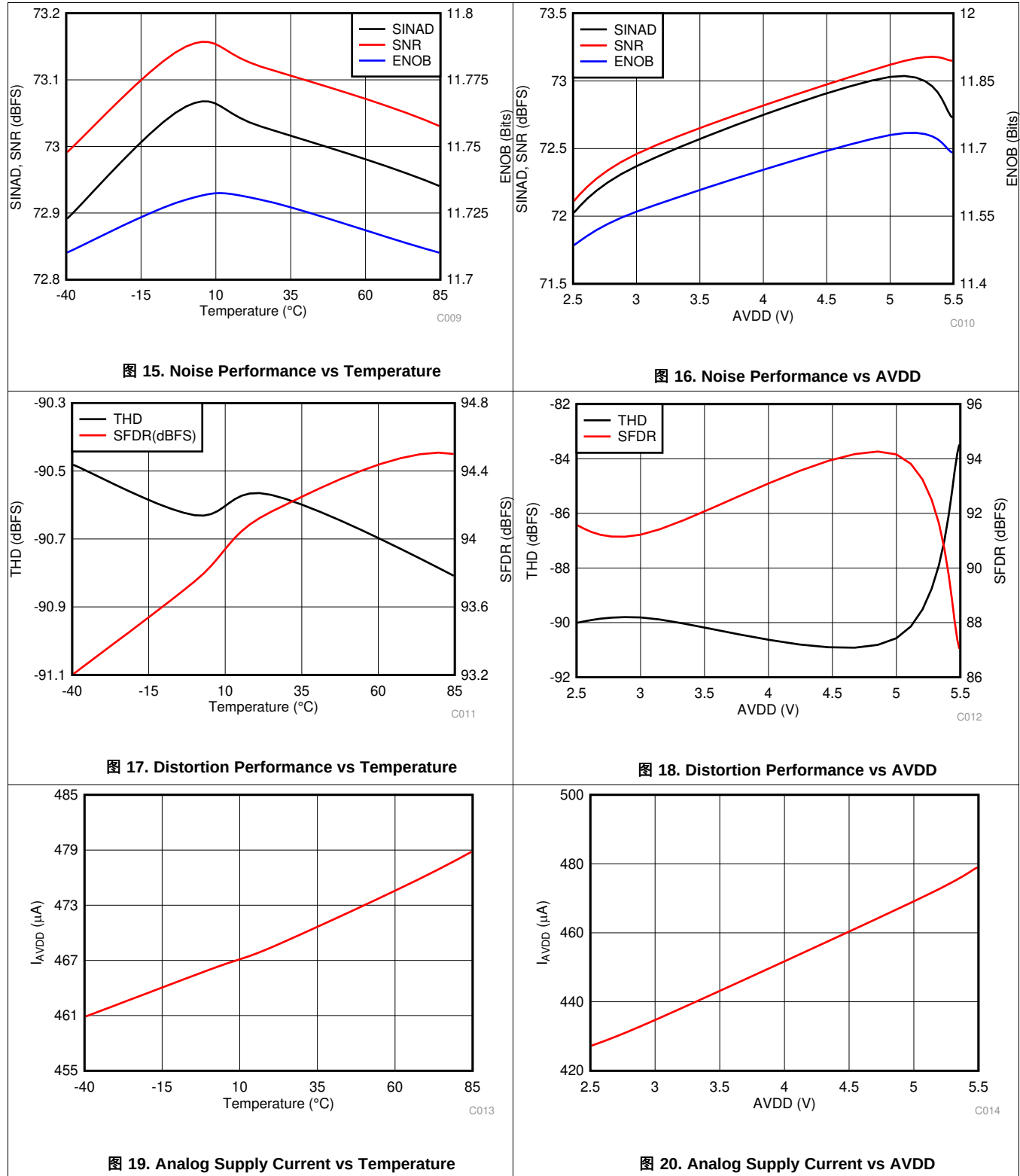


图 14. Gain Error vs AVDD

Typical Characteristics (接下页)

at $T_A = 25^\circ\text{C}$, $AVDD = 5\text{ V}$, $DVDD = 1.8\text{ V}$, and $f_{\text{SAMPLE}} = 1\text{ MSPS}$ (unless otherwise noted)



Typical Characteristics (接下页)

at $T_A = 25^\circ\text{C}$, $AVDD = 5\text{ V}$, $DVDD = 1.8\text{ V}$, and $f_{\text{SAMPLE}} = 1\text{ MSPS}$ (unless otherwise noted)

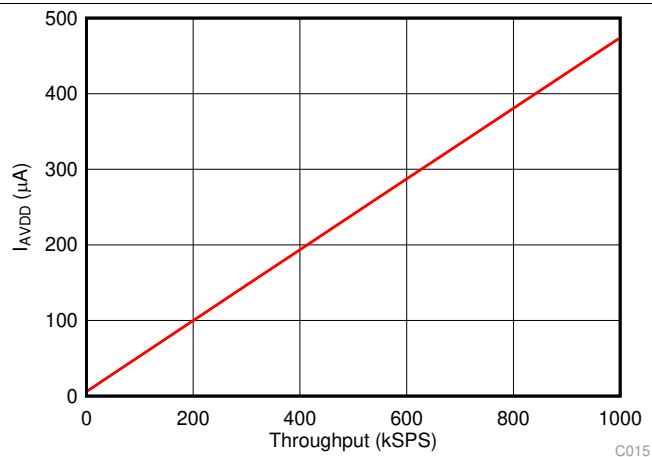


图 21. Analog Supply Current vs Throughput

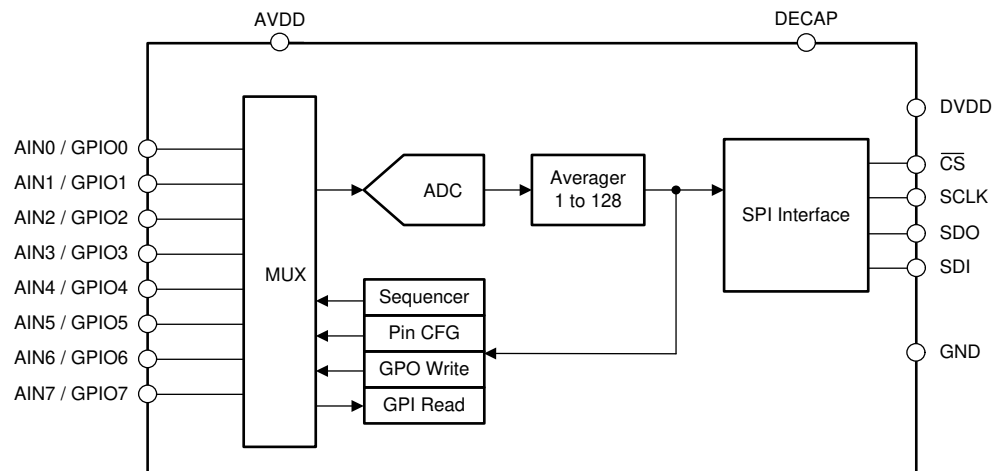
7 Detailed Description

7.1 Overview

The TLA2518 is a small, eight-channel, multiplexed, 12-bit, 1-MSPS, analog-to-digital converter (ADC) with an enhanced-SPI serial interface. The eight channels of the TLA2518 can be individually configured as either analog inputs, digital inputs, or digital outputs. The device uses an internal oscillator for conversion. The analog input channel selection can be auto-sequenced to simplify the digital interface with the host.

The device features a programmable averaging filter that outputs a 16-bit result for enhanced resolution.

7.2 Functional Block Diagram



7.3 Feature Description

7.3.1 Multiplexer and ADC

The eight channels of the multiplexer can be independently configured as ADC inputs or general-purpose inputs/outputs (GPIOs). 图 22 shows that each input pin has ESD protection diodes to AVDD and GND. On power-up or after device reset, all eight multiplexer channels are configured as analog inputs.

图 22 shows an equivalent circuit for pins configured as analog inputs. The ADC sampling switch is represented by ideal switch (SW) in series with the resistor R_{SW} (typically 150 Ω) and the sampling capacitor, C_{SH} (typically 12 pF).

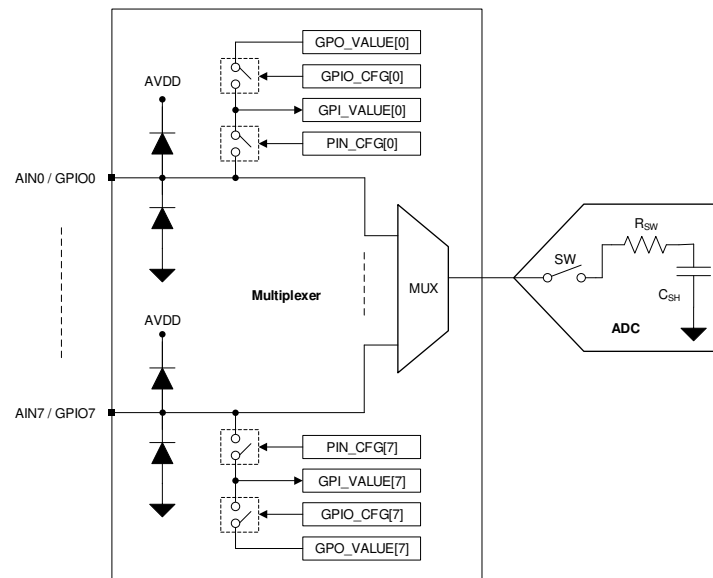


图 22. Analog Inputs, GPIOs, and ADC Connections

During acquisition, the SW switch is closed to allow the signal on the selected analog input channel to charge the internal sampling capacitor. During conversion, the SW switch is opened to disconnect the analog input channel from the sampling capacitor.

The multiplexer channels can be configured as GPIOs in the PIN_CFG register. The direction of a GPIO (either as an input or an output) can be set in the GPIO_CFG register. The logic level on the channels configured as digital inputs can be read from the GPI_VALUE register. The digital outputs can be accessed by writing to the GPO_VALUE register. The digital outputs can be configured as either open-drain or push-pull in the GPO_DRIVE_CFG register.

7.3.2 Reference

The device uses the analog supply voltage (AVDD) as a reference for the analog-to-digital conversion process. TI recommends connecting a 1- μ F, low-equivalent series resistance (ESR) ceramic decoupling capacitor between the AVDD and GND pins.

7.3.3 ADC Transfer Function

The ADC output is in straight binary format. 公式 1 computes the ADC resolution:

$$1 \text{ LSB} = V_{REF} / 2^N$$

where:

- $V_{REF} = AVDD$
- $N = 12$

(1)

Feature Description (接下页)

图 23 和 表 1 detail the transfer characteristics for the device.

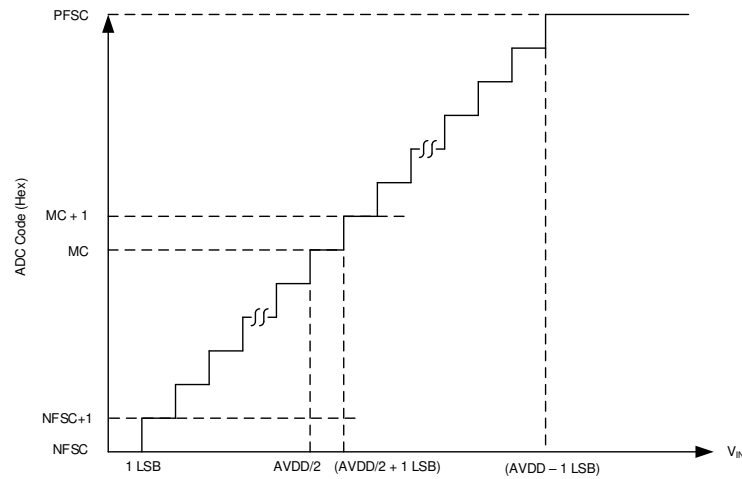


图 23. Ideal Transfer Characteristics

表 1. Transfer Characteristics

INPUT VOLTAGE FOR SINGLE-ENDED INPUT	CODE	DESCRIPTION	IDEAL OUTPUT CODE
≤ 1 LSB	NFSC	Negative full-scale code	000
1 LSB to 2 LSBs	NFSC + 1	—	001
$(AVDD / 2)$ to $(AVDD / 2) + 1$ LSB	MC	Mid code	800
$(AVDD / 2) + 1$ LSB to $(AVDD / 2) + 2$ LSB	MC + 1	—	801
$\geq AVDD - 1$ LSB	PFSC	Positive full-scale code	FFF

7.3.4 ADC Offset Calibration

The variation in ADC offset error resulting from changes in temperature or AVDD can be calibrated by setting the CAL bit in the GENERAL_CFG register. The CAL bit is reset to 0 after calibration. The host can poll the CAL bit to check the ADC offset calibration completion status.

7.3.5 Programmable Averaging Filter

The TLA2518 features a built-in oversampling (OSR) function that can be used to average several samples. The averaging filter can be enabled by programming the OSR[2:0] bits in the OSR_CFG register. The averaging filter configuration is common to all analog input channels. 图 24 shows that the averaging filter module output is 16 bits long. In manual conversion mode and auto-sequence mode, only the first conversion for the selected analog input channel must be initiated by the host; see the [Manual Mode](#) and [Auto-Sequence Mode](#) sections. As shown in 图 24, any remaining conversions for the selected averaging factor are generated internally. The time required to complete the averaging operation is determined by the sampling speed and number of samples to be averaged. As shown in 图 24, the 16-bit result can be read out after the averaging operation completes.

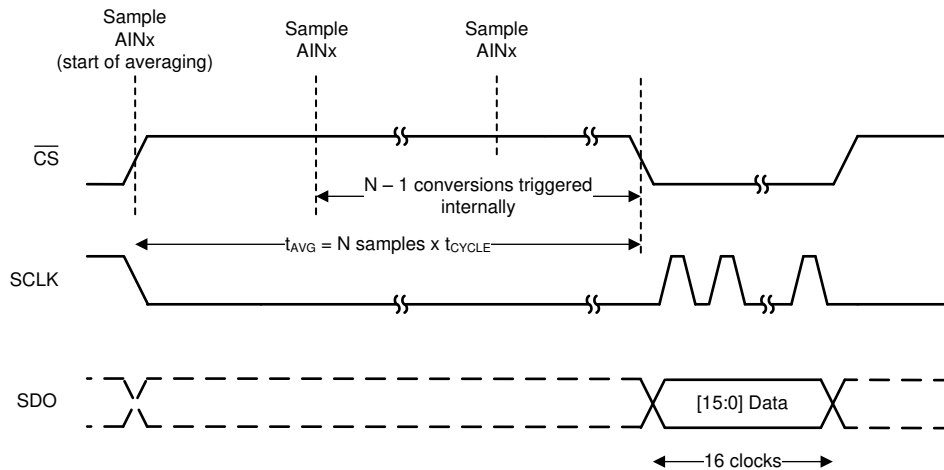


图 24. Averaging Example

公式 2 provides the LSB value of the 16-bit average result.

$$1 \text{ LSB} = \frac{AVDD}{2^{16}} \quad (2)$$

7.3.6 General-Purpose I/Os

The eight channels of the TLA2518 can be independently configured as analog inputs, digital inputs, or digital outputs. 表 2 shows how the PIN_CFG and GPIO_CFG registers can be used to configure the device channels.

表 2. Configuring Channels as Analog Inputs or GPIOs

PIN_CFG[7:0]	GPIO_CFG[7:0]	GPO_DRIVE_CFG[7:0]	CHANNEL CONFIGURATION
0	x	x	Analog input (default)
1	0	x	Digital input
1	1	0	Digital output; open-drain driver
1	1	1	Digital output; push-pull driver

Digital outputs can be configured to logic 1 or 0 by writing to the GPO_VALUE register. Reading the GPI_VALUE register returns the logic level for all channels configured as digital inputs or digital outputs. The GPI_VALUE register can be read to detect a failure in external components, such as a floating pullup resistor or a low-impedance pulldown resistor, that prevents digital outputs being set to the desired logic level.

7.3.7 Oscillator and Timing Control

The device uses an internal oscillator for conversion. When using the averaging module, the host initiates the first conversion and subsequent conversions are generated internally by the device. Also, in autonomous mode of operation, the start of the conversion signal is generated by the device. 表 3 describes how the sampling rate can be controlled by the OSC_SEL and CLK_DIV[3:0] register fields when the device generates the start of the conversion.

表 3. Configuring Sampling Rate for Internal Conversion Start Control

CLK_DIV[3:0]	OSC_SEL = 0		OSC_SEL = 1	
	SAMPLING FREQUENCY, f_{CYCLE} (kSPS)	CYCLE TIME, t_{CYCLE} (μs)	SAMPLING FREQUENCY, f_{CYCLE} (kSPS)	CYCLE TIME, t_{CYCLE} (μs)
0000b	1000	1	31.25	32
0001b	666.7	1.5	20.83	48
0010b	500	2	15.63	64
0011b	333.3	3	10.42	96
0100b	250	4	7.81	128
0101b	166.7	6	5.21	192
0110b	125	8	3.91	256
0111b	83	12	2.60	384
1000b	62.5	16	1.95	512
1001b	41.7	24	1.3	768
1010b	31.3	32	0.98	1024
1011b	20.8	48	0.65	1536
1100b	15.6	64	0.49	2048
1101b	10.4	96	0.33	3072
1110b	7.8	128	0.24	4096
1111b	5.2	192	0.16	6144

The conversion time of the device, given by t_{CONV} in the [Switching Characteristics](#) table, is independent of the OSC_SEL and CLK_DIV[3:0] configuration.

7.3.8 Output Data Format

图 25 shows various SPI frames for reading data. The data output is MSB aligned. If averaging is enabled the output data from the ADC are 16 bits long, otherwise the output data are 12 bits long. Optionally, a 4-bit channel ID can be appended at the end of the output data by configuring the APPEND_STATUS[1:0] field.

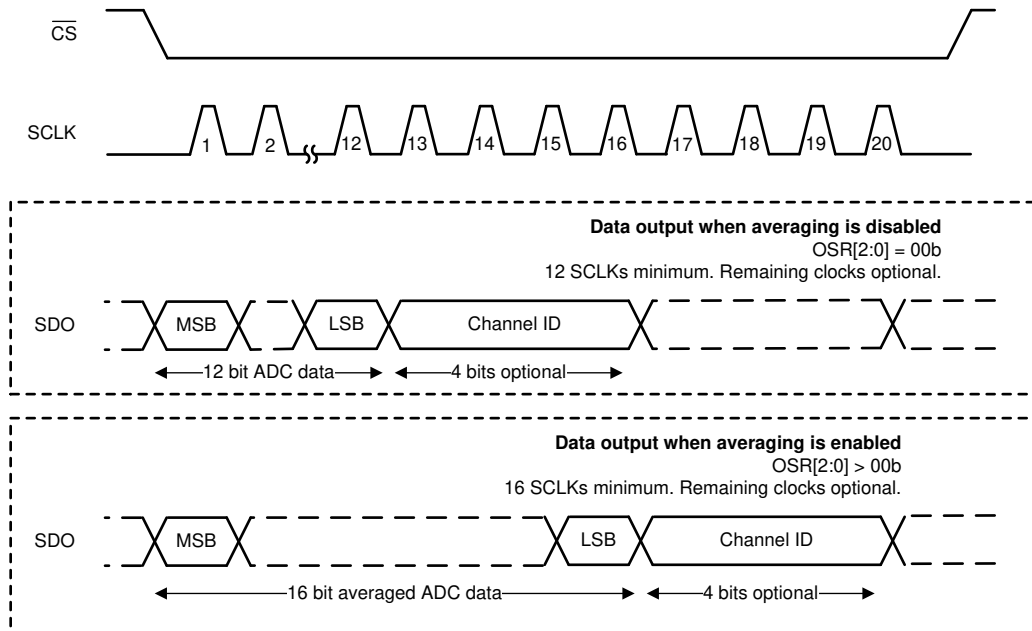


图 25. SPI Frames for Reading Data

7.3.9 Device Programming

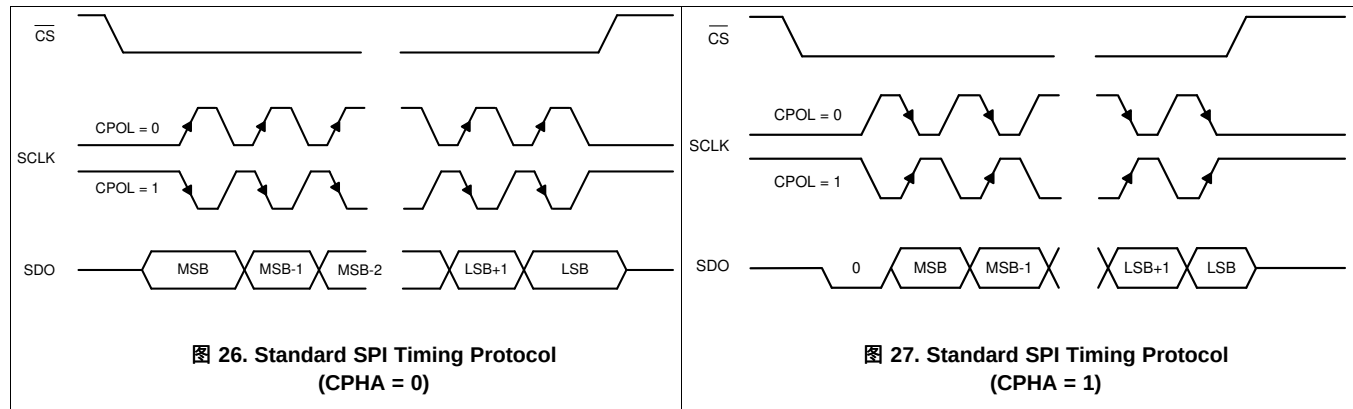
7.3.9.1 Enhanced-SPI Interface

The device features an enhanced-SPI interface that allows the host controller to operate at slower SCLK speeds and still achieve full throughput. As described in 表 4, the host controller can use any of the four SPI-compatible protocols (SPI-00, SPI-01, SPI-10, or SPI-11) to access the device.

表 4. SPI Protocols for Configuring the Device

PROTOCOL	SCLK POLARITY (At the $\overline{CS}$ Falling Edge)	SCLK PHASE (Capture Edge)	CPOL_CPHA[1:0]	DIAGRAM
SPI-00	Low	Rising	00b	图 26
SPI-01	Low	Falling	01b	图 27
SPI-10	High	Falling	10b	图 26
SPI-11	High	Rising	11b	图 27

On power-up or after coming out of any asynchronous reset, the device supports the SPI-00 protocol for data read and data write operations. To select a different SPI-compatible protocol, program the CPOL_CPHA[1:0] field. This first write operation must adhere to the SPI-00 protocol. Any subsequent data transfer frames must adhere to the newly-selected protocol.



7.3.9.2 Register Read/Write Operation

The device supports the commands listed in 表 5 to access the internal configuration registers.

表 5. Opcodes for Commands

OPCODE	COMMAND DESCRIPTION
0000 0000b	No operation
0001 0000b	Single register read
0000 1000b	Single register write
0001 1000b	Set bit
0010 0000b	Clear bit

7.3.9.2.1 Register Write

A 24-bit SPI frame is required for writing data to configuration registers. The 24-bit data on SDI, as shown in 图 28, consists of an 8-bit write command (0000 1000b), an 8-bit register address, and 8-bit data. The write command is decoded on the $\overline{\text{CS}}$ rising edge and the specified register is updated with the 8-bit data specified during the register write operation.

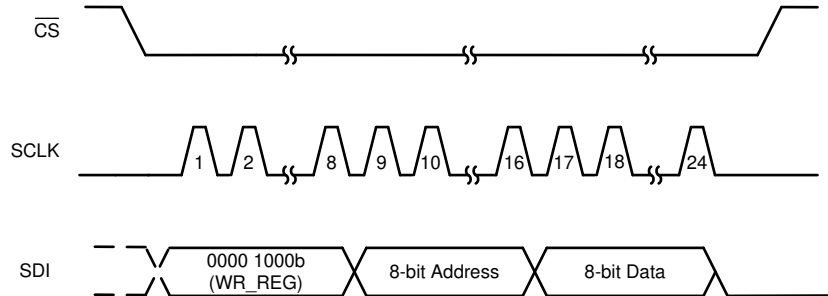


图 28. Register Write Operation

7.3.9.2.2 Register Read

Register read operation consists of two SPI frames: the first SPI frame initiates a register read and the second SPI frame reads data from the register address provided in the first frame. As shown in 图 29, the 8-bit register address and the 8-bit dummy data are sent over the SDI pin during the first 24-bit frame with the read command (0001 0000b). On the rising edge of $\overline{\text{CS}}$, the read command is decoded and the requested register data are available for reading during the next frame. During the second frame, the first eight bits on SDO correspond to the requested register read. During the second frame, SDI can be used to initiate another operation or can be set to 0.

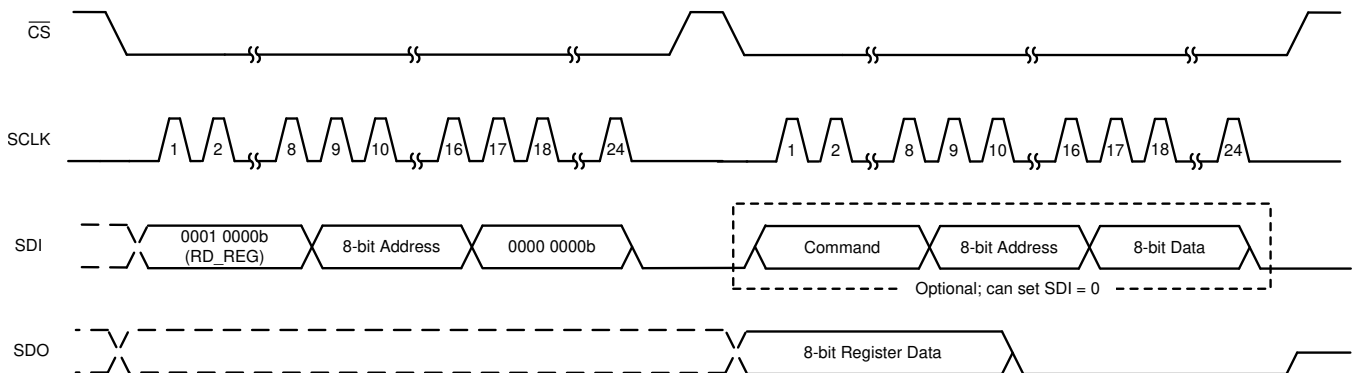


图 29. Register Read Operation

7.4 Device Functional Modes

表 6 lists the functional modes supported by the TLA2518.

表 6. Functional Modes

FUNCTIONAL MODE	CONVERSION CONTROL	MUX CONTROL	SEQ_MODE[1:0]
Manual	$\overline{CS}$ rising edge	Register write to MANUAL_CHID	00b
On-the-fly	$\overline{CS}$ rising edge	First 5 bits after the $\overline{CS}$ falling edge	10b
Auto-sequence	$\overline{CS}$ rising edge	Channel sequencer	01b

The device powers up in manual mode and can be configured into either of these modes by writing the configuration registers for the desired mode.

7.4.1 Device Power-Up and Reset

On power-up, the BOR bit is set indicating a power-cycle or reset event. The device can be reset by setting the RST bit or by recycling the power on the AVDD pin.

7.4.2 Manual Mode

Manual mode allows the external host processor to directly select the analog input channel. 图 30 shows the steps for operating the device in manual mode.

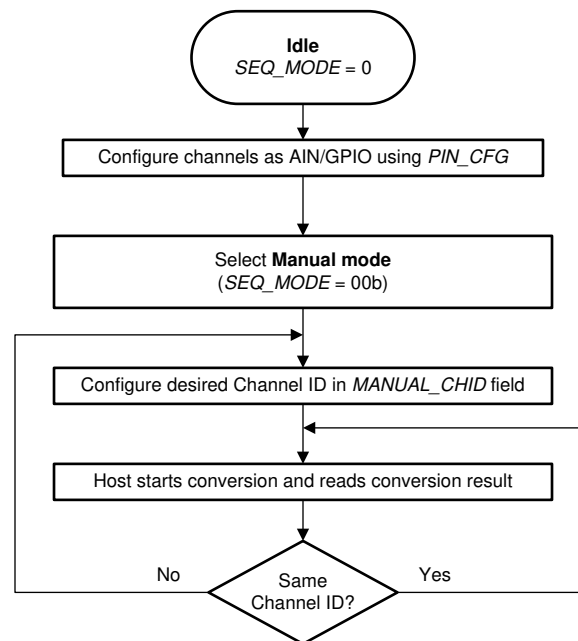


图 30. Device Operation in Manual Mode

In manual mode, the command to switch to a new channel (indicated by cycle N in 图 31) is decoded by the device on the $\overline{CS}$ rising edge. The $\overline{CS}$ rising edge is also the start of the conversion signal, and therefore the device samples the previously selected MUX channel in cycle N+1. The newly selected analog input channel data are available in cycle N+2. For switching the analog input channel, a register write to the $MANUAL_CHID$ field requires 24 clocks; see the [Register Write](#) section for more details. After a channel is selected, the number of clocks required for reading the output data depends on the device output data frame size; see the [Output Data Format](#) section for more details.

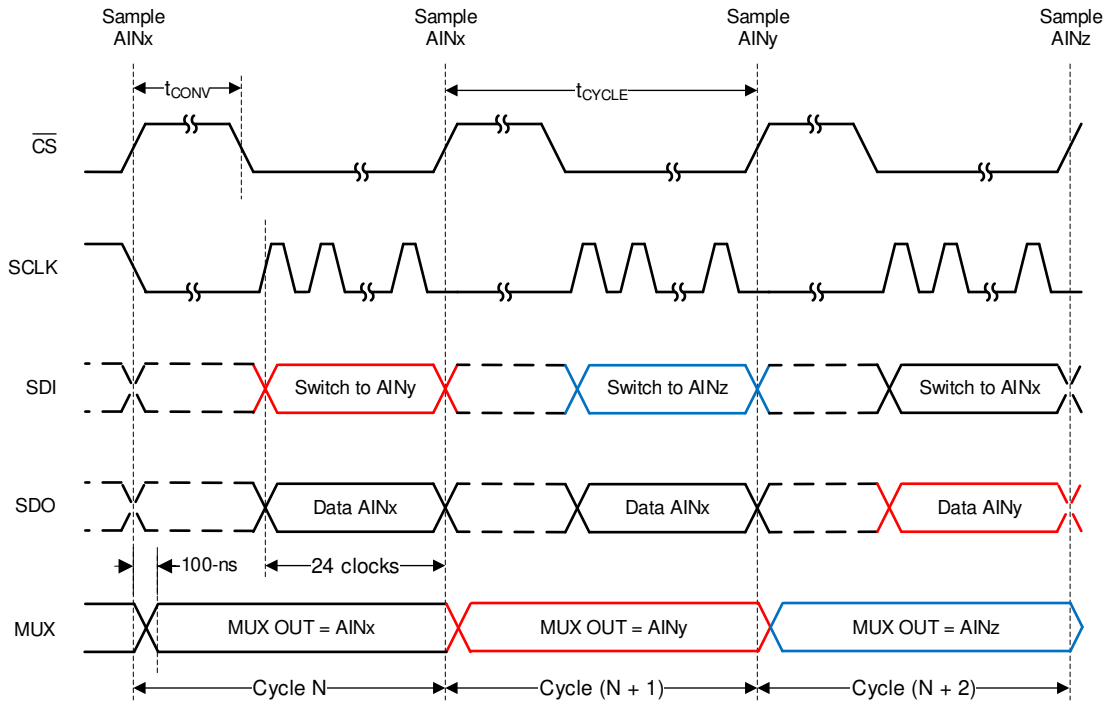


图 31. Starting Conversions and Reading Data in Manual Mode

7.4.3 On-the-Fly Mode

In the on-the-fly mode of operation, the analog input channel is selected, as shown in 图 32, using the first five bits on SDI without waiting for the $\overline{CS}$ rising edge. Thus, the ADC samples the newly selected channel on the $\overline{CS}$ edge and there is no latency between the channel selection and the ADC output data.

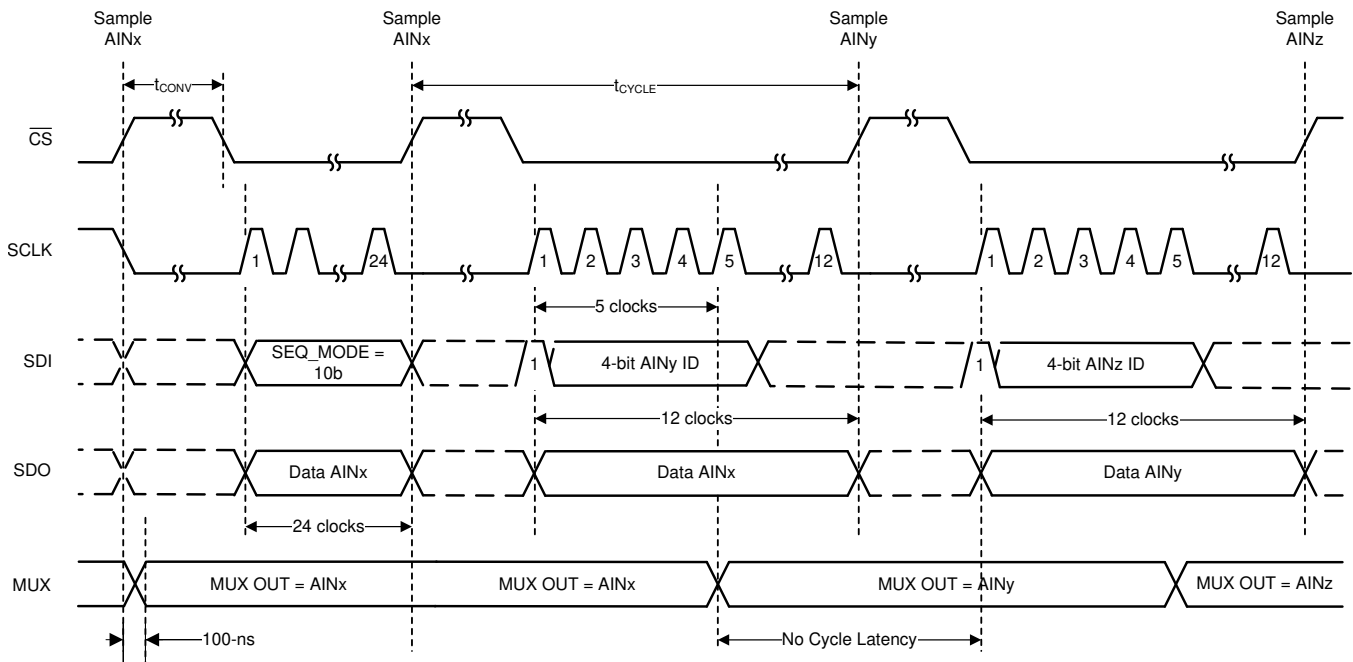


图 32. Starting Conversions and Reading Data in On-the-Fly Mode

The number of clocks required for reading the output data depends on the device output data frame size; see the [Output Data Format](#) section for more details.

7.4.4 Auto-Sequence Mode

In auto-sequence mode, the internal channel sequencer switches the multiplexer to the next analog input channel after every conversion. The desired analog input channels can be configured for sequencing in the AUTO_SEQ_CHSEL register. To enable the channel sequencer, set SEQ_START = 1b. After every conversion, the channel sequencer switches the multiplexer to the next analog input in ascending order. To stop the channel sequencer from selecting channels, set SEQ_START = 0b.

In the example shown in [图 33](#), AIN2 and AIN6 are enabled for sequencing in AUTO_SEQ_CHSEL. The channel sequencer loops through AIN2 and AIN6 and repeats until SEQ_START is set to 0b. The number of clocks required for reading the output data depends on the device output data frame size; see the [Output Data Format](#) section for more details.

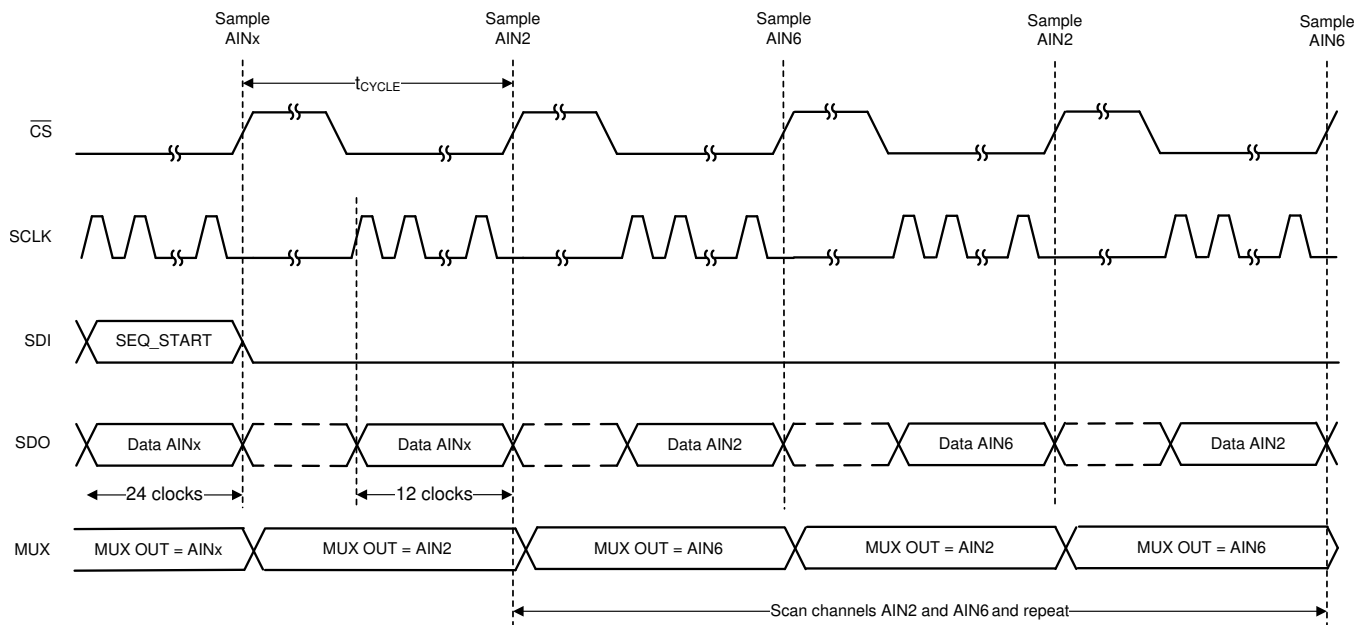


图 33. Starting Conversions and Reading Data in Auto-Sequence Mode

7.5 TLA2518 Registers

Table 7 lists the TLA2518 registers. All register offset addresses not listed in Table 7 should be considered as reserved locations and the register contents should not be modified.

Table 7. TLA2518 Registers

Address	Acronym	Register Name	Section
0x0	SYSTEM_STATUS	SYSTEM_STATUS Register (Address = 0x0) [reset = 0x81]	
0x1	GENERAL_CFG	GENERAL_CFG Register (Address = 0x1) [reset = 0x0]	
0x2	DATA_CFG	DATA_CFG Register (Address = 0x2) [reset = 0x0]	
0x3	OSR_CFG	OSR_CFG Register (Address = 0x3) [reset = 0x0]	
0x4	OPMODE_CFG	OPMODE_CFG Register (Address = 0x4) [reset = 0x0]	
0x5	PIN_CFG	PIN_CFG Register (Address = 0x5) [reset = 0x0]	
0x7	GPIO_CFG	GPIO_CFG Register (Address = 0x7) [reset = 0x0]	
0x9	GPO_DRIVE_CFG	GPO_DRIVE_CFG Register (Address = 0x9) [reset = 0x0]	
0xB	GPO_VALUE	GPO_VALUE Register (Address = 0xB) [reset = 0x0]	
0xD	GPI_VALUE	GPI_VALUE Register (Address = 0xD) [reset = 0x0]	
0x10	SEQUENCE_CFG	SEQUENCE_CFG Register (Address = 0x10) [reset = 0x0]	
0x11	CHANNEL_SEL	CHANNEL_SEL Register (Address = 0x11) [reset = 0x0]	
0x12	AUTO_SEQ_CH_SEL	AUTO_SEQ_CH_SEL Register (Address = 0x12) [reset = 0x0]	

Complex bit access types are encoded to fit into small table cells. Table 8 shows the codes that are used for access types in this section.

Table 8. TLA2518 Access Type Codes

Access Type	Code	Description
Read Type		
R	R	Read
Write Type		
W	W	Write
Reset or Default Value		
-n		Value after reset or the default value
Register Array Variables		
i,j,k,l,m,n		When these variables are used in a register name, an offset, or an address, they refer to the value of a register array where the register is part of a group of repeating registers. The register groups form a hierarchical structure and the array is represented with a formula.
y		When this variable is used in a register name, an offset, or an address it refers to the value of a register array.

7.5.1 SYSTEM_STATUS Register (Address = 0x0) [reset = 0x81]

SYSTEM_STATUS is shown in Figure 34 and described in Table 9.

Return to the [Summary Table](#).

Figure 34. SYSTEM_STATUS Register

7	6	5	4	3	2	1	0
RSVD	SEQ_STATUS	RESERVED		OSR_DONE	CRCERR_FUSE	RESERVED	BOR
R-1b	R-0b	R-0b		R/W-0b	R-0b	R-0b	R/W-1b

Table 9. SYSTEM_STATUS Register Field Descriptions

Bit	Field	Type	Reset	Description
7	RSVD	R	1b	Reads return 1b.
6	SEQ_STATUS	R	0b	Status of the channel sequencer. 0b = Sequence stopped 1b = Sequence in progress
5-4	RESERVED	R	0b	Reserved. Reads return 0b.
3	OSR_DONE	R/W	0b	Averaging status. Clear this bit by writing 1b to this bit. 0b = Averaging in progress or not started; average result is not ready. 1b = Averaging complete; average result is ready.
2	CRCERR_FUSE	R	0b	Device power-up configuration CRC check status. To re-evaluate this bit, software reset the device or power cycle AVDD. 0b = No problems detected in power-up configuration. 1b = Device configuration not loaded correctly.
1	RESERVED	R	0b	Reserved. Reads return 0b.
0	BOR	R/W	1b	Brown out reset indicator. This bit is set if brown out condition occurs or device is power cycled. Write 1b to this bit to clear the flag. 0b = No brown out from the last time this bit was cleared. 1b = Brown out condition detected or device power cycled.

7.5.2 GENERAL_CFG Register (Address = 0x1) [reset = 0x0]

GENERAL_CFG is shown in [Figure 35](#) and described in [Table 10](#).

Return to the [Summary Table](#).

Figure 35. GENERAL_CFG Register

7	6	5	4	3	2	1	0
RESERVED					CH_RST	CAL	RST
R-0b					R/W-0b	R/W-0b	W-0b

Table 10. GENERAL_CFG Register Field Descriptions

Bit	Field	Type	Reset	Description
7-3	RESERVED	R	0b	Reserved. Reads return 0b.
2	CH_RST	R/W	0b	Force all channels to be analog inputs. 0b = Normal operation. 1b = All channels are set as analog inputs irrespective of configuration in other registers.
1	CAL	R/W	0b	Calibrate ADC offset. 0b = Normal operation. 1b = ADC offset is calibrated. After calibration is complete, this bit is set to 0b.
0	RST	W	0b	Software reset all registers to default values. 0b = Normal operation. 1b = Device is reset. After reset is complete, this bit is set to 0b and BOR bit is set to 1b.

7.5.3 DATA_CFG Register (Address = 0x2) [reset = 0x0]

DATA_CFG is shown in Figure 36 and described in Table 11.

Return to the [Summary Table](#).

Figure 36. DATA_CFG Register

7	6	5	4	3	2	1	0
FIX_PAT	RESERVED	APPEND_STATUS[1:0]	RESERVED	RESERVED	RESERVED	CPOL_CPHA[1:0]	
R/W-0b	R-0b	R/W-0b	R-0b	R-0b	R-0b	R/W-0b	

Table 11. DATA_CFG Register Field Descriptions

Bit	Field	Type	Reset	Description
7	FIX_PAT	R/W	0b	Device outputs fixed data bits which can be helpful for debugging communication with the device. 0b = Normal operation. 1b = Device outputs fixed code 0xA5A repeatedly when reading ADC data.
6	RESERVED	R	0b	Reserved. Reads return 0b.
5-4	APPEND_STATUS[1:0]	R/W	0b	Append 4-bit channel ID or status flags to output data. 0b = Channel ID is not appended to ADC data. 1b = 4-bit channel ID is appended to ADC data. 10b = Reserved. 11b = Reserved.
3-2	RESERVED	R	0b	Reserved. Reads return 0b.
1-0	CPOL_CPHA[1:0]	R/W	0b	This field sets the polarity and phase of SPI communication. 0b = CPOL = 0, CPHA = 0. 1b = CPOL = 0, CPHA = 1. 10b = CPOL = 1, CPHA = 0. 11b = CPOL = 1, CPHA = 1.

7.5.4 OSR_CFG Register (Address = 0x3) [reset = 0x0]

OSR_CFG is shown in Figure 37 and described in Table 12.

Return to the [Summary Table](#).

Figure 37. OSR_CFG Register

7	6	5	4	3	2	1	0
RESERVED					OSR[2:0]		
R-0b					R/W-0b		

Table 12. OSR_CFG Register Field Descriptions

Bit	Field	Type	Reset	Description
7-3	RESERVED	R	0b	Reserved. Reads return 0b.
2-0	OSR[2:0]	R/W	0b	Selects the oversampling ratio for ADC conversion result. 0b = No averaging 1b = 2 samples 10b = 4 samples 11b = 8 samples 100b = 16 samples 101b = 32 samples 110b = 64 samples 111b = 128 samples

7.5.5 OPMODE_CFG Register (Address = 0x4) [reset = 0x0]

OPMODE_CFG is shown in [Figure 38](#) and described in [Table 13](#).

Return to the [Summary Table](#).

Figure 38. OPMODE_CFG Register

7	6	5	4	3	2	1	0
RESERVED			OSC_SEL	CLK_DIV[3:0]			
R-0b			R/W-0b	R/W-0b			

Table 13. OPMODE_CFG Register Field Descriptions

Bit	Field	Type	Reset	Description
7-5	RESERVED	R	0b	Reserved. Reads return 0b.
4	OSC_SEL	R/W	0b	Selects the oscillator for internal timing generation. 0b = High-speed oscillator. 1b = Low-power oscillator.
3-0	CLK_DIV[3:0]	R/W	0b	Refer to section on oscillator and timing control for details.

7.5.6 PIN_CFG Register (Address = 0x5) [reset = 0x0]

PIN_CFG is shown in [Figure 39](#) and described in [Table 14](#).

Return to the [Summary Table](#).

Figure 39. PIN_CFG Register

7	6	5	4	3	2	1	0
PIN_CFG[7:0]							
R/W-0b							

Table 14. PIN_CFG Register Field Descriptions

Bit	Field	Type	Reset	Description
7-0	PIN_CFG[7:0]	R/W	0b	Configure device channels AIN / GPIO [7:0] as analog inputs or GPIOs. 0b = Channel is configured as analog input. 1b = Channel is configured as GPIO.

7.5.7 GPIO_CFG Register (Address = 0x7) [reset = 0x0]

GPIO_CFG is shown in [Figure 40](#) and described in [Table 15](#).

Return to the [Summary Table](#).

Figure 40. GPIO_CFG Register

7	6	5	4	3	2	1	0
GPIO_CFG[7:0]							
R/W-0b							

Table 15. GPIO_CFG Register Field Descriptions

Bit	Field	Type	Reset	Description
7-0	GPIO_CFG[7:0]	R/W	0b	Configure GPIO[7:0] as either digital inputs or digital outputs. 0b = GPIO is configured as digital input. 1b = GPIO is configured as digital output.

7.5.8 GPO_DRIVE_CFG Register (Address = 0x9) [reset = 0x0]

GPO_DRIVE_CFG is shown in [Figure 41](#) and described in [Table 16](#).

Return to the [Summary Table](#).

Figure 41. GPO_DRIVE_CFG Register

7	6	5	4	3	2	1	0
GPO_DRIVE_CFG[7:0]							
R/W-0b							

Table 16. GPO_DRIVE_CFG Register Field Descriptions

Bit	Field	Type	Reset	Description
7-0	GPO_DRIVE_CFG[7:0]	R/W	0b	Configure digital outputs GPO[7:0] as open-drain or push-pull outputs. 0b = Digital output is open-drain; connect external pullup resistor. 1b = Push-pull driver is used for digital output.

7.5.9 GPO_VALUE Register (Address = 0xB) [reset = 0x0]

GPO_VALUE is shown in [Figure 42](#) and described in [Table 17](#).

Return to the [Summary Table](#).

Figure 42. GPO_VALUE Register

7	6	5	4	3	2	1	0
GPO_VALUE[7:0]							
R/W-0b							

Table 17. GPO_VALUE Register Field Descriptions

Bit	Field	Type	Reset	Description
7-0	GPO_VALUE[7:0]	R/W	0b	Logic level to be set on digital outputs GPO[7:0]. 0b = Digital output set to logic 0. 1b = Digital output set to logic 1.

7.5.10 GPI_VALUE Register (Address = 0xD) [reset = 0x0]

GPI_VALUE is shown in [Figure 43](#) and described in [Table 18](#).

Return to the [Summary Table](#).

Figure 43. GPI_VALUE Register

7	6	5	4	3	2	1	0
GPI_VALUE[7:0]							
R-0b							

Table 18. GPI_VALUE Register Field Descriptions

Bit	Field	Type	Reset	Description
7-0	GPI_VALUE[7:0]	R	0b	Readback the logic level on channels configured digital inputs. 0b = Digital input is at logic 0. 1b = Digital input is at logic 1.

7.5.11 SEQUENCE_CFG Register (Address = 0x10) [reset = 0x0]

SEQUENCE_CFG is shown in [Figure 44](#) and described in [Table 19](#).

Return to the [Summary Table](#).

Figure 44. SEQUENCE_CFG Register

7	6	5	4	3	2	1	0
RESERVED			SEQ_START	RESERVED		SEQ_MODE[1:0]	
R-0b			R/W-0b	R-0b		R/W-0b	

Table 19. SEQUENCE_CFG Register Field Descriptions

Bit	Field	Type	Reset	Description
7-5	RESERVED	R	0b	Reserved. Reads return 0b.
4	SEQ_START	R/W	0b	Control for start of channel sequence when using auto sequence mode (SEQ_MODE = 01b). 0b = Stop channel sequencing. 1b = Start channel sequencing in ascending order for channels enabled in AUTO_SEQ_CH_SEL register.
3-2	RESERVED	R	0b	Reserved. Reads return 0b.
1-0	SEQ_MODE[1:0]	R/W	0b	Selects the mode of scanning of analog input channels. 0b = Manual sequence mode; channel selected by MANUAL_CHID field. 1b = Auto sequence mode; channel selected by AUTO_SEQ_CH_SEL. 10b = On-the-fly sequence mode. 11b = Reserved.

7.5.12 CHANNEL_SEL Register (Address = 0x11) [reset = 0x0]

CHANNEL_SEL is shown in [Figure 45](#) and described in [Table 20](#).

Return to the [Summary Table](#).

Figure 45. CHANNEL_SEL Register

7	6	5	4	3	2	1	0
RESERVED				MANUAL_CHID[3:0]			
R-0b				R/W-0b			

Table 20. CHANNEL_SEL Register Field Descriptions

Bit	Field	Type	Reset	Description
7-4	RESERVED	R	0b	Reserved. Reads return 0b.
3-0	MANUAL_CHID[3:0]	R/W	0b	In manual mode (SEQ_MODE = 00b), this field contains the 4-bit channel ID of the analog input channel for next ADC conversion. For valid ADC data, the selected channel must not be configured as GPIO in PIN_CFG register. 1xxx = Reserved. 0b = AIN0 1b = AIN1 10b = AIN2 11b = AIN3 100b = AIN4 101b = AIN5 110b = AIN6 111b = AIN7

7.5.13 AUTO_SEQ_CH_SEL Register (Address = 0x12) [reset = 0x0]

AUTO_SEQ_CH_SEL is shown in [Figure 46](#) and described in [Table 21](#).

Return to the [Summary Table](#).

Figure 46. AUTO_SEQ_CH_SEL Register

7	6	5	4	3	2	1	0
AUTO_SEQ_CH_SEL[7:0]							
R/W-0b							

Table 21. AUTO_SEQ_CH_SEL Register Field Descriptions

Bit	Field	Type	Reset	Description
7-0	AUTO_SEQ_CH_SEL[7:0]	R/W	0b	Select analog input channels AIN[7:0] in for auto sequencing mode. 0b = Analog input channel is not enabled in scanning sequence. 1b = Analog input channel is enabled in scanning sequence.

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

The two primary circuits required to maximize the performance of a high-precision, successive approximation register analog-to-digital converter (SAR ADC) are the input driver and the reference driver circuits. This section details some general principles for designing the input driver circuit, reference driver circuit, and provides some application circuits designed for the TLA2518.

8.2 Typical Applications

8.2.1 Mixed-Channel Configuration

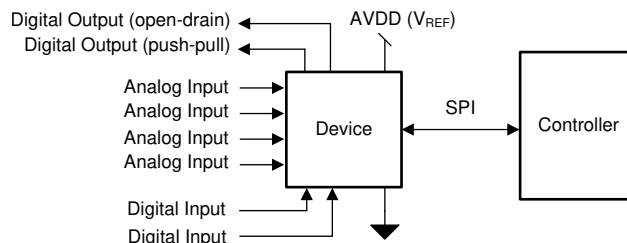


图 47. DAQ Circuit: Single-Supply DAQ

8.2.1.1 Design Requirements

The goal of this application is to configure some channels of the TLA2518 as digital inputs, open-drain digital outputs, and push-pull digital outputs.

8.2.1.2 Detailed Design Procedure

The TLA2518 can support GPIO functionality at each input pin. Any analog input pin can be independently configured as a digital input, a digital open-drain output, or a digital push-pull output through the PIN_CFG and GPIO_CFG registers; see 表 2.

8.2.1.2.1 Digital Input

The digital input functionality can be used to monitor a signal within the system. 图 48 illustrates that the state of the digital input can be read from the GPI_VALUE register.

Typical Applications (接下页)

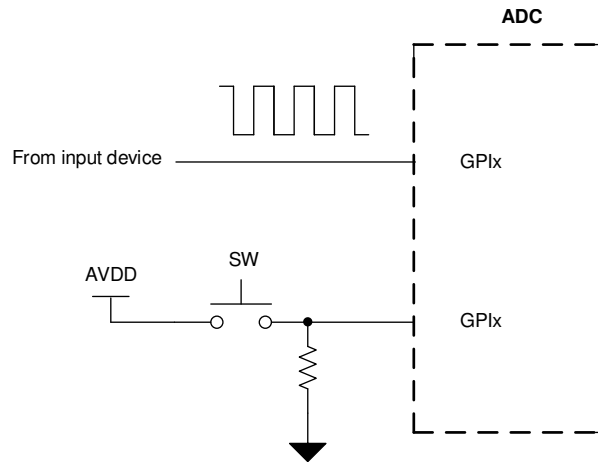


图 48. Digital Input

8.2.1.2.2 Digital Open-Drain Output

The channels of the TLA2518 can be configured as digital open-drain outputs supporting an output voltage up to 5.5 V. An open-drain output, as shown in 图 49, consists of an internal FET (Q) connected to ground. The output is idle when not driven by the device, which means Q is off and the pullup resistor, R_{PULL_UP} , connects the GPOx node to the desired output voltage. The output voltage can range anywhere up to 5.5 V, depending on the external voltage that the GPIOx is pulled up to. When the device is driving the output, Q turns on, thus connecting the pullup resistor to ground and bringing the node voltage at GPOx low.

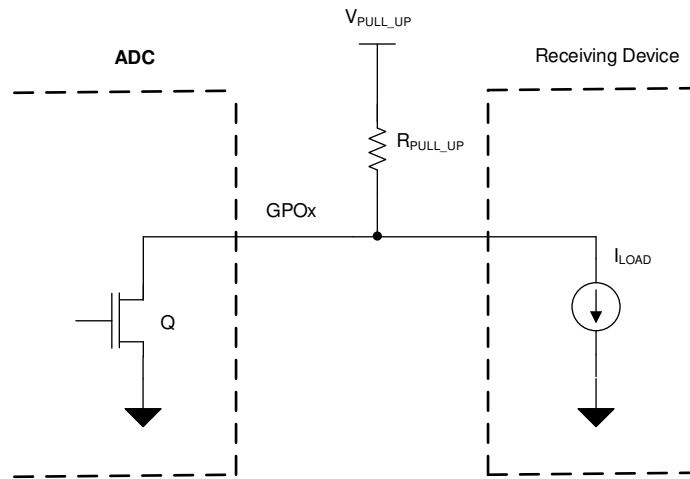


图 49. Digital Open-Drain Output

The minimum value of the pullup resistor, as calculated in 公式 3, is given by the ratio of V_{PULL_UP} and the maximum current supported by the device digital output (5 mA).

$$R_{MIN} = (V_{PULL_UP} / 5 \text{ mA}) \quad (3)$$

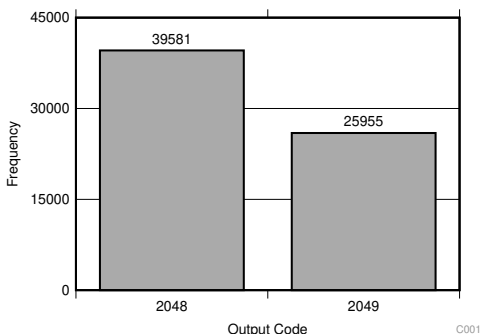
The maximum value of the pullup resistor, as calculated in 公式 4, depends on the minimum input current requirement, I_{LOAD} , of the receiving device driven by this GPIO.

$$R_{MAX} = (V_{PULL_UP} / I_{LOAD}) \quad (4)$$

Select R_{PULL_UP} such that $R_{MIN} < R_{PULL_UP} < R_{MAX}$.

Typical Applications (接下页)

8.2.1.2.3 Application Curve



Standard deviation = 0.49 LSB

图 50. DC Input Histogram

8.2.2 Digital Push-Pull Output Configuration

The channels of the TLA2518 can be configured as digital push-pull outputs supporting an output voltage up to AVDD. As shown in 图 51, a push-pull output consists of two mirrored opposite bipolar transistors, Q1 and Q2. The device can both source and sink current because only one transistor is on at a time (either Q2 is on and pulls the output low, or Q1 is on and sets the output high). A push-pull configuration always drives the line opposed to an open-drain output where the line is left floating.

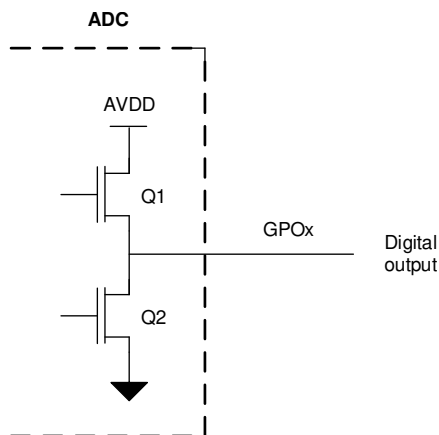


图 51. Digital Push-Pull Output

9 Power Supply Recommendations

9.1 AVDD and DVDD Supply Recommendations

The TLA2518 has two separate power supplies: AVDD and DVDD. The device operates on AVDD; DVDD is used for the interface circuits. For supplies greater than 2.35 V, AVDD and DVDD can be shorted externally if single-supply operation is desired. The AVDD supply also defines the full-scale input range of the device. Decouple the AVDD and DVDD pins individually, as illustrated in [图 52](#), with 1- μ F ceramic decoupling capacitors. The minimum capacitor value required for AVDD and DVDD is 200 nF and 20 nF, respectively. If both supplies are powered from the same source, a minimum capacitor value of 220 nF is required for decoupling.

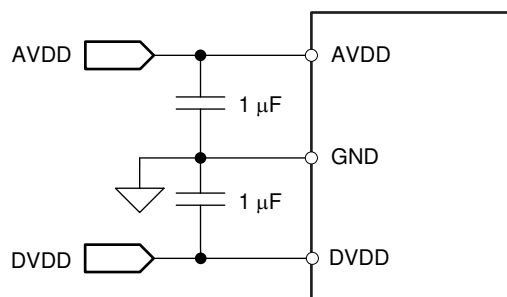


图 52. Power-Supply Decoupling

10 Layout

10.1 Layout Guidelines

图 53 shows a board layout example for the TLA2518. Avoid crossing digital lines with the analog signal path and keep the analog input signals and the AVDD supply away from noise sources.

Use 1- μ F ceramic bypass capacitors in close proximity to the analog (AVDD) and digital (DVDD) power-supply pins. Avoid placing vias between the AVDD and DVDD pins and the bypass capacitors. Connect the GND pin to the ground plane using short, low-impedance paths. The AVDD supply voltage also functions as the reference voltage for the TLA2518. Place the decoupling capacitor (C_{REF}) for AVDD close to the device AVDD and GND pins and connect C_{REF} to the device pins with thick copper tracks.

10.2 Layout Example

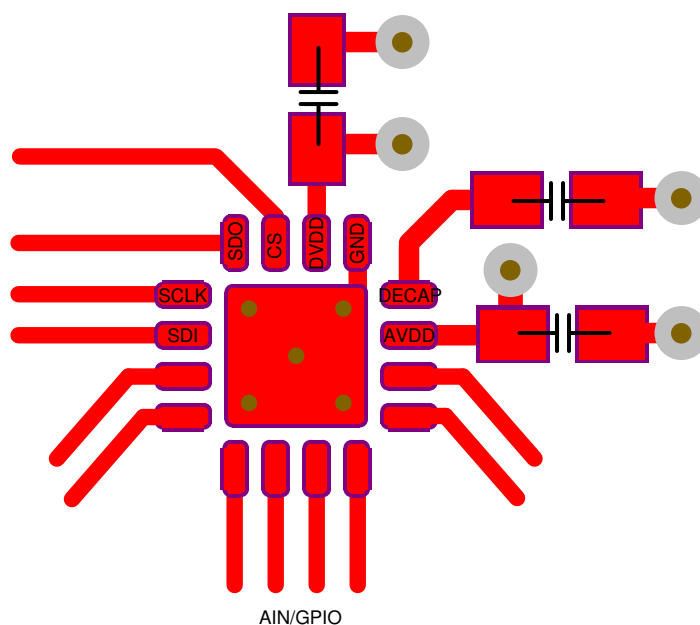


图 53. Example Layout

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

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TI E2E™ support forums are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

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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。数据如有变更，恕不另行通知，且不会对此文档进行修订。如需获取此数据表的浏览器版本，请查阅左侧的导航栏。

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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
TLA2518IRTER	ACTIVE	WQFN	RTE	16	3000	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	2518	Samples
TLA2518IRTET	ACTIVE	WQFN	RTE	16	250	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	2518	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".

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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.

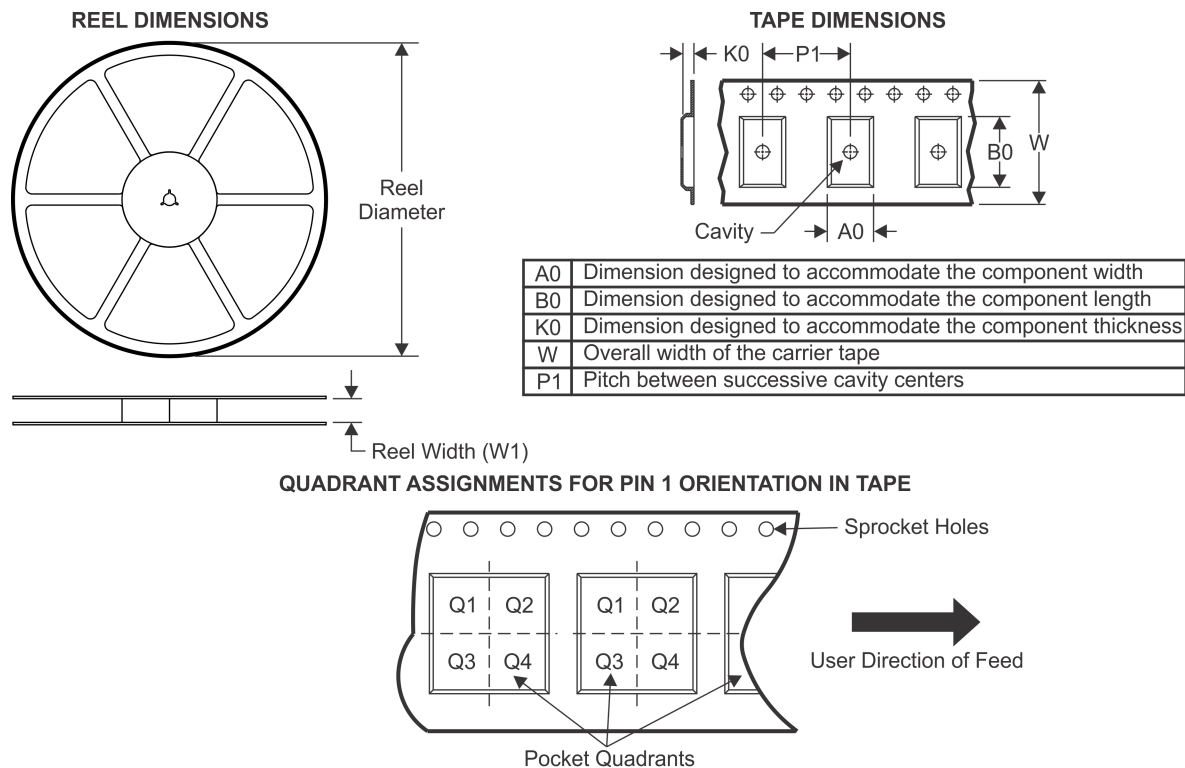
⁽⁴⁾ There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

⁽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.

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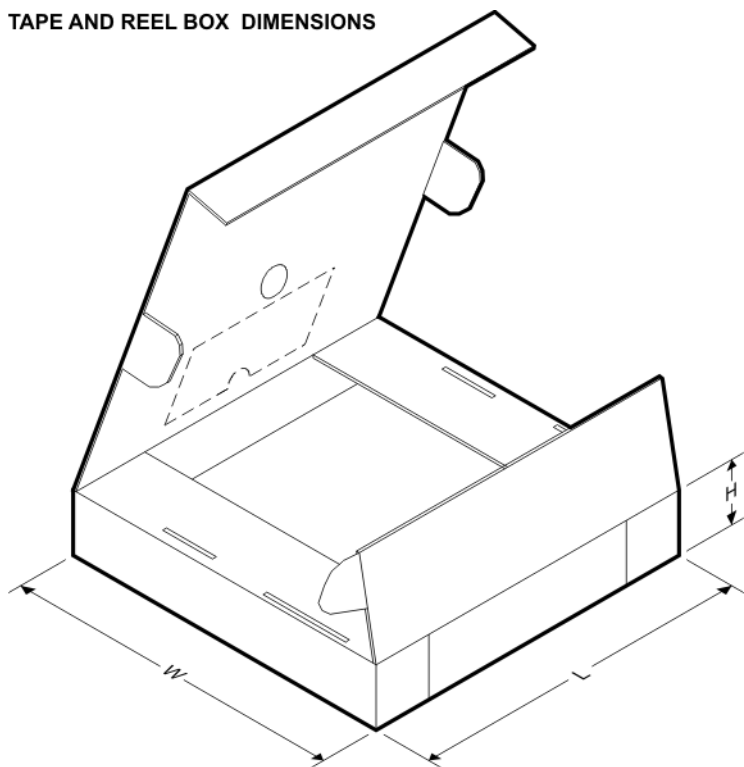
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TAPE AND REEL INFORMATION


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TLA2518IRTER	WQFN	RTE	16	3000	330.0	12.4	3.3	3.3	1.1	8.0	12.0	Q2
TLA2518IRTET	WQFN	RTE	16	250	180.0	12.4	3.3	3.3	1.1	8.0	12.0	Q2

TAPE AND REEL BOX DIMENSIONS

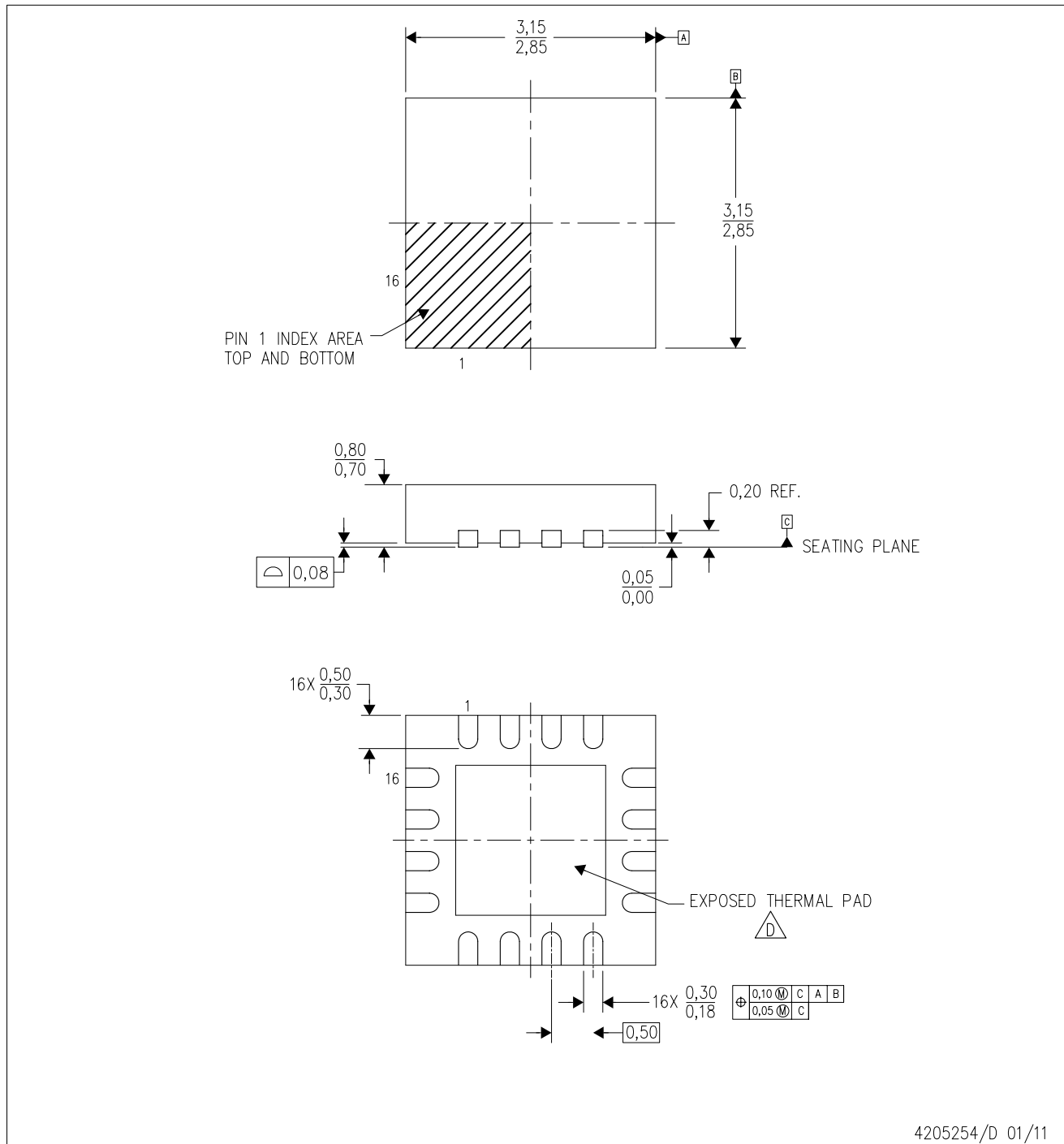


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TLA2518IRTER	WQFN	RTE	16	3000	367.0	367.0	35.0
TLA2518IRTET	WQFN	RTE	16	250	210.0	185.0	35.0

RTE (S-PWQFN-N16)

PLASTIC QUAD FLATPACK NO-LEAD



- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
 - B. This drawing is subject to change without notice.
 - C. Quad Flatpack, No-leads (QFN) package configuration.
 -  The package thermal pad must be soldered to the board for thermal and mechanical performance. See the Product Data Sheet for details regarding the exposed thermal pad dimensions.
 - E. Falls within JEDEC MO-220.

RTE (S-PWQFN-N16)

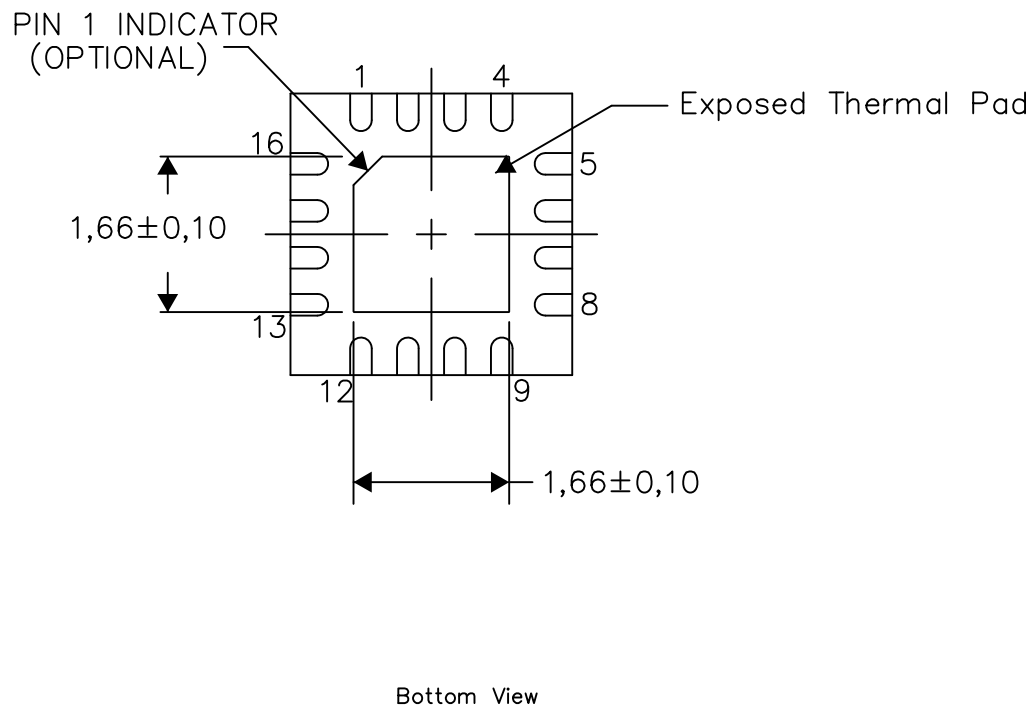
PLASTIC QUAD FLATPACK NO-LEAD

THERMAL INFORMATION

This package incorporates an exposed thermal pad that is designed to be attached directly to an external heatsink. The thermal pad must be soldered directly to the printed circuit board (PCB). After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

For information on the Quad Flatpack No-Lead (QFN) package and its advantages, refer to Application Report, QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271. This document is available at www.ti.com.

The exposed thermal pad dimensions for this package are shown in the following illustration.



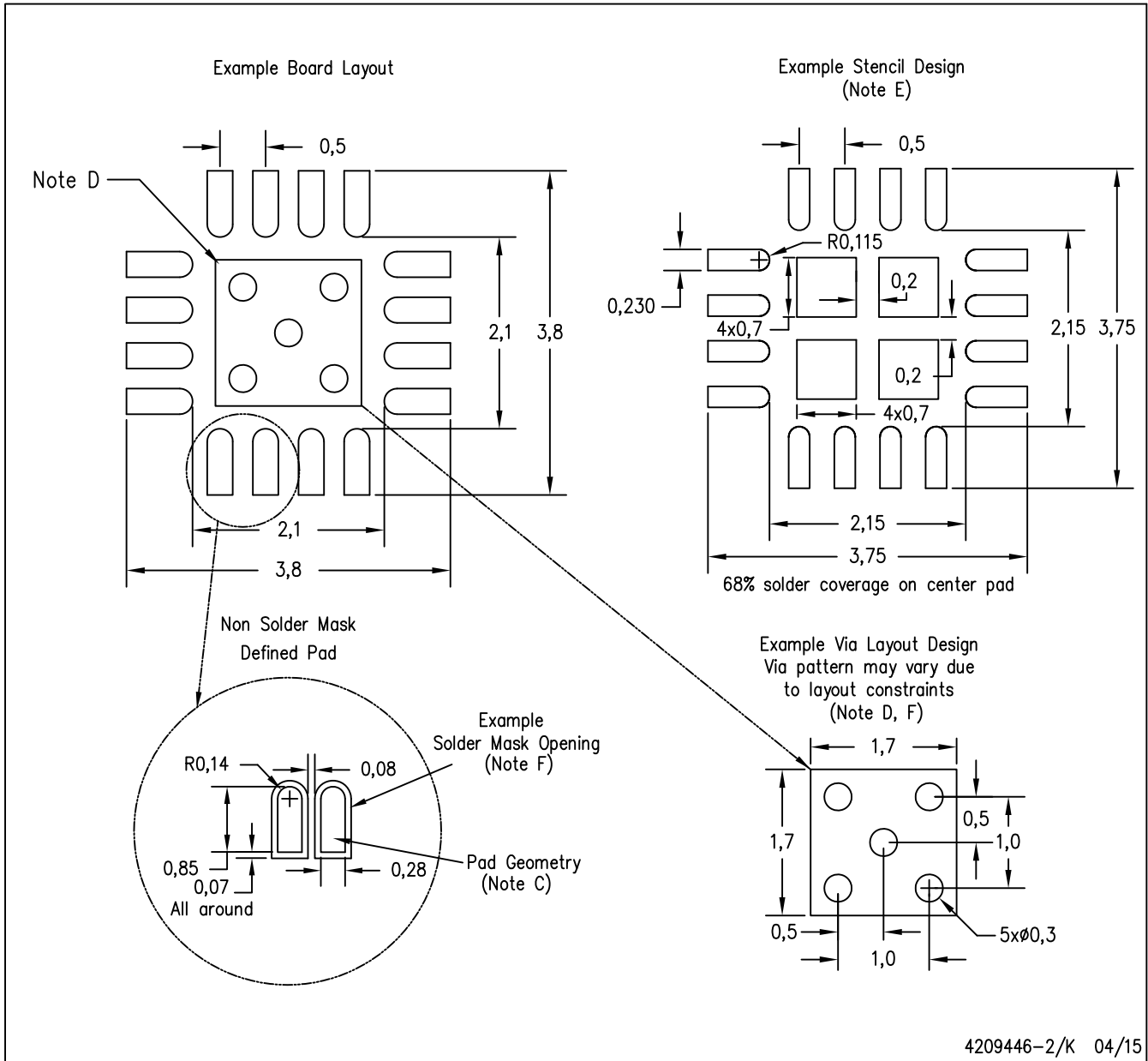
Exposed Thermal Pad Dimensions

4206446-8/U 08/15

NOTE: A. All linear dimensions are in millimeters

RTE (S-PWQFN-N16)

PLASTIC QUAD FLATPACK NO-LEAD



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Publication IPC-7351 is recommended for alternate designs.
 - D. This package is designed to be soldered to a thermal pad on the board. Refer to Application Note, Quad Flat-Pack Packages, Texas Instruments Literature No. SLUA271, and also the Product Data Sheets for specific thermal information, via requirements, and recommended board layout. These documents are available at www.ti.com <<http://www.ti.com>>.
 - E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC 7525 for stencil design considerations.
 - F. Customers should contact their board fabrication site for minimum solder mask web tolerances between signal pads.

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