TDK InvenSense

ICP-20100

High Accuracy, Low Power, Barometric Pressure and Temperature Sensor IC

GENERAL INFORMATION

The ICP-20100 pressure sensor provides a high-accuracy, low power, barometric pressure and temperature sensor solution, that integrates a capacitive pressure sensor for monitoring pressure changes in the range of 30 to 110 kPa.

The ICP-20100 integrates a DSP module for on-chip calibration with an Analog-to-Digital converter (ADC), digital filtering, a FIFO and has I²C, I3C℠, and SPI interfaces available. The solution can be configured to achieve ultra-low noise or ultra-low power performance and is flexible to perform anywhere in-between. Additionally, the filters can be enabled to allow even lower noise performance or activate features such as filtering of pressure glitches (e.g. opening/closing a window).

The ICP-20100 is available in a closed package with a vent hole.

DEVICE INFORMATION

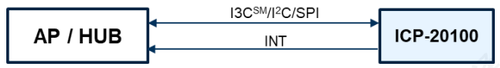
PART NUMBER	PACKAGE	LID OPENING	MSL**
ICP-20100*	2x2x0.8mm LGA-10L	1-Hole	1

* Denotes RoHS and Green-Compliant Package
** Moisture Sensitivity Level of the package

FEATURES

- Digital-output pressure and temperature sensors, with programmable output: all-pressure, all-temperature or pressure & temperature
- Programmable noise performance down to 0.5 Parms through programmable Oversampling Ratio (OSR)
- Digital filtering for pressure signals
  - Finite Impulse Response (FIR) filter for improved noise performance
  - Infinite Impulse Response (IIR) filter for e.g. filtering of pressure glitches
- Package dimensions 2x2x0.8 mm (10-pin LGA)
- 96-byte FIFO buffer enables the application processor to read up to 16 pressure-temperature pairs in a burst
- User-programmable Interrupt
- Host interface: 12 MHz SPI/1 MHz I²C/12.5 MHz I3C℠
- Temperature operating range: -40°C to 85°C
- Main Supply voltage: 1.8V ±10% or 3.3V ±10%
- I/O supply voltage externally applied (1.2V ±10%, 1.8V ±10% or 3.3V* ±10%) *available only when main supply voltage equals 3.3V ±10%
- RoHS and Green compliant

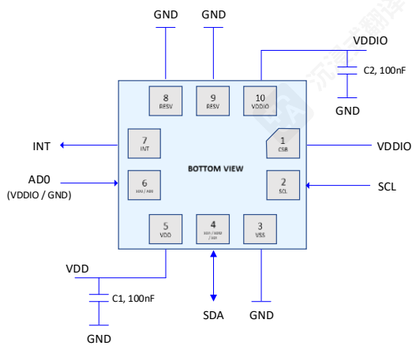
BLOCK DIAGRAM



APPLICATIONS

- Smartphones and Tablets
- Wearable Sensors
- Home and Building Automation
- Weather Stations

TYPICAL OPERATING CIRCUIT



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TDK InvenSense

ICP-20100

高精度，低功耗，气压和温度传感器IC

基本信息

ICP-20100 压力传感器提供高精度、低功耗的气压和温度传感器解决方案，集成了电容式压力传感器，用于监测 30 至 110 kPa 范围内的压力变化。

ICP-20100 集成了一个 DSP 模块用于片上使用模数转换器（ADC）进行校准、数字滤波、具有 FIFO，并提供I2C、I3C℠和SPI接口。该解决方案可配置以实现超低噪声或超低功耗性能，并灵活地在两者之间进行设置。此外，滤波器可以启用以实现更低的噪声性能，或激活诸如压力尖峰滤波等功能（例如）

打开/关闭窗口）。

ICP-20100 采用封闭包装，带有排气孔。

设备信息

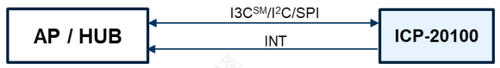
PART 编号	包装	LID 开启	MSL**
ICP-20100*	2x2x0.8mm LGA-10L	1-Hole	1

* 表示符合 RoHS 和绿色环保包装
**包装的湿度敏感度等级

特性

- 数字输出压力和温度传感器，具有可编程输出：全压力、全温度或压力 & 温度
- 通过可编程过采样比 (OSR) 实现可编程噪声性能低至 0.5 Parms
- 压力信号的数字滤波
  - 有限脉冲响应 (FIR) 滤波器用于提升噪声性能
  - 无限脉冲响应（IIR）滤波器，例如压力毛刺的滤波
- 封装尺寸 2x2x0.8 毫米（10 引脚 LGA）
- 96 字节 FIFO 缓冲区使应用处理器能够突发读取最多 16 个压力-温度对
- 用户可编程中断
- 主机接口：12 MHz SPI/1 MHz I²C/12.5 MHz I3C℠
- 温度工作范围：-40°C 至 85°C
- 主电源电压：1.8V ±10% 或 3.3V ±10%
- I/O 电源电压外部施加（1.2V ±10%，1.8V ±10% 或 3.3V* ±10%）* 仅当主电源电压等于 3.3V ±10% 时可用
- 符合 RoHS 和绿色标准

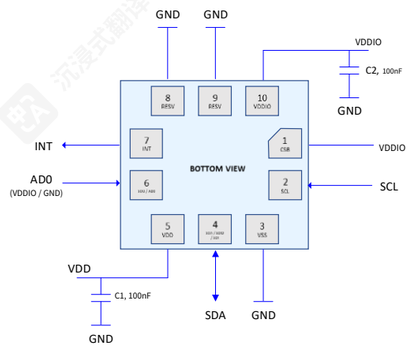
框图



应用

- 智能手机和平板电脑
- 可穿戴传感器
- 家居和楼宇自动化
- 气象站

典型操作电路



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1 INTRODUCTION

1.1 PURPOSE AND SCOPE

This document is a preliminary product specification, providing a description, specifications, and design related information for the ICP-20100 Pressure Sensor.

Specifications are subject to change without notice. Final specifications will be updated based upon characterization of production silicon.

1.2 PRODUCT OVERVIEW

The ICP-20100 is a high accuracy, low power, barometric pressure and temperature sensor solution that integrates a capacitive pressure sensor for monitoring pressure changes in the range of 30 to 110kPa.

The ICP-20100 pressure and temperature sensor device combines TDK InvenSense 2nd generation (20k-series) capacitive pressure sensors.

Other industry-leading features include up to 20-bits output data, programmable digital filters, an embedded temperature sensor, calibration, FIFO, and programmable interrupts. The device features I^2C, $I3C^{SM}$, and SPI serial interfaces, a VDD operating range of 1.8V ±10% or 3.3V ±10%, and an externally applied VDDIO operating range of 1.2V ±10%, 1.8V ±10% or 3.3V* ±10% (*available only when VDD voltage equals 3.3V ±10%).

The host interface can be configured to support SPI slave or I^2C/ $I3C^{SM}$ slave modes. The SPI interface supports speeds up to 12 MHz, the I^2C interface supports speeds up to 1 MHz, and the $I3C^{SM}$ interface supports speeds up to 12.5 MHz.

The MEMS sensor consists of a capacitive pressure sensor whose capacitance changes according to the pressure applied. An integrated temperature sensor on the same MEMS sensor allows for accurate temperature measurements.

1 简介

1.1 目的和范围

本文档是一个初步的产品规范，提供描述、规范和设计相关
ICP-20100 压力传感器的信息。

规格如有变更恕不另行通知。最终规格将根据生产硅的表征结果进行更新。

1.2 产品概述

ICP-20100 是一款高精度、低功耗的气压和温度传感器解决方案，集成了电容式压力传感器，用于监测 30 至 110kPa 范围内的压力变化。

ICP-20100 压力和温度传感器设备结合了 TDK InvenSense 2nd 代（20k 系列）电容式压力传感器。

其他行业领先的特性包括高达 20 位输出数据、可编程数字滤波器、嵌入式温度传感器、校准、FIFO 和可编程中断。该设备具有 I^2C、$I3C^{SM}$ 和 SPI 串行接口，VDD 工作范围为 1.8V ±10% 或 3.3V ±10%，外部施加的 VDDIO 工作范围为 1.2V ±10%、1.8V ±10% 或 3.3V* ±10% (* 仅当 VDD 电压等于 3.3V ±10% 时可用)。

主机接口可以配置为支持 SPI 从设备或 I^2C/ $I3C^{SM}$ 从设备模式。SPI 接口支持最高 12 MHz 的速度，I^2C 接口支持最高 1 MHz 的速度，而 $I3C^{SM}$ 接口支持最高 12.5 MHz 的速度。

MEMS传感器由一个电容式压力传感器组成，其电容会根据施加的压力变化。同一块MEMS传感器上集成的温度传感器可以精确测量温度。

2 PRESSURE AND TEMPERATURE SENSOR SPECIFICATIONS

2.1 OPERATION RANGES

PARAMETER	VALUE	UNITS
Functional Pressure Range	30 to 110	kPa
Operating Temperature Range	-40 to 85	°C

Table 1. Operation Ranges

2.2 OPERATION MODES

The sensor can be operated in the following measurement modes to satisfy different requirements for power consumption vs. noise, accuracy, and measurement frequency.

Operation mode can be selected using register field MEAS_CONFIG in register MODE_SELECT. Modes 0 to 3 are pre-defined while Mode 4 is user configurable. Please refer to “AN-000238: ICP-20100 and ICP-20132 User Configurable Operation Mode and IIR Filter” for details on how to configure MODE4.

PARAMETER	BW (HZ)	ODR (HZ)	PRESSURE NOISE (PARMS)	CURRENT CONSUMPTION (µA)	IIR FILTER ENABLED	FIR FILTER ENABLED
			TYP	TYP		
MODE0	6.25	25	0.5	211	No	Yes
MODE1	30	120	1	222	No	Yes
MODE2	10	40	2.5	49	No	Yes
MODE3	0.5	2	0.5	23	No	Yes
MODE4*	12.5	25	0.3	250	No	No

Table 2. Operation Modes

Note: MODE4 is user configurable as explained in the application note “AN-000238: ICP-20100 and ICP-20132 User Configurable Operation Mode and IIR Filter”. MODE4 functionality shown is default device calibration, user can modify MODE4 configuration as explained in AN-000238.

2.3 PRESSURE SENSOR SPECIFICATIONS

Pressure sensor specifications are given in Table 3. Default conditions of 25 °C, VDD = 1.8V and VDDIO = 1.8V apply, unless otherwise stated.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
Functional pressure range		30	70	110	kPa	
Absolute Accuracy	Valid from -20°C to 65°C		±20		Pa	1
Relative Accuracy	Any step ≤ 1 kPa at 25°C		±1		Pa	1
Temperature Coefficient of Offset (TCO)	P = 100 kPa 25°C … 45°C		±0.4		Pa/°C	1
Long-Term Drift (during 1 year)			±10		Pa	2
Solder Drift	Board-level specification		±0.4		hPa	3, 4
Resolution			20		bits	

Table 3. Pressure Sensor Specifications

Notes:

1. Parameter specifications shown are component-level. They may be different at the board-level and may depend on PCB characteristics including but not limited to PCB material, number of layers, PCB thickness. They may also depend on usage conditions.
2. Determined based on HTOL data.
3. Derived from validation or characterization of parts, not tested in production.
4. Board-level spec values depend on specific board design. For design information of boards used for device characterization, that forms the basis of the spec values reported here, please contact your local TDK InvenSense FAE.

2 压力和温度传感器规格

2.1 工作范围

参数	VALUE	UNITS
功能压力范围	30 至 110	kPa
工作温度范围	-40 至 85	°C

表1. 操作范围

2.2 操作模式

该传感器可以在以下测量模式下工作，以满足不同对功耗与噪声、精度和测量频率的要求。

操作模式可以通过MODE_SELECT寄存器中的MEAS_CONFIG字段进行选择。模式0到3是预定义的，而模式4是用户可配置的。有关如何配置MODE4的详细信息，请参阅“AN-000238：ICP-20100和ICP-20132用户可配置操作模式和IIR滤波器”。

参数	BW (HZ)	ODR (HZ)	压力噪声（参数）	当前消耗 (µA)	IIR 滤波器启用	FIR 滤波器
			TYP	TYP		
模式0	6.25	25	0.5	211	No	Yes
MODE1	30	120	1	222	No	Yes
MODE2	10	40	2.5	49	No	Yes
MODE3	0.5	2	0.5	23	No	Yes
MODE4*	12.5	25	0.3	250	No	No

表 2. 操作模式

注意：MODE4 可根据应用笔记“AN-000238：ICP-20100 和 ICP-20132 用户可配置操作模式和 IIR 滤波器”中的说明进行用户配置。显示的 MODE4 功能是默认设备校准，用户可以根据 AN-000238 中的说明修改 MODE4 配置。

2.3 压力传感器规格

压力传感器规格见表3。默认条件为25 °C、VDD = 1.8V 和 VDDIO = 1.8V，除非另有说明。

参数	条件	MIN	TYP	MAX	单位	备注
功能压力范围		30	70	110	kPa	
绝对精度	有效范围 -20°C 至 65°C		±20		Pa	1
相对精度	25°C 时任意步长 ≤ 1 kPa		±1		Pa	1
温度偏移系数 (TCO)	P = 100 kPa 25°C … 45°C		±0.4		Pa/°C	1
长期漂移（1年内）			±10		Pa	2
焊料漂移	板级规范		±0.4		hPa	3, 4
分辨率			20		bits	

表 3. 压力传感器规格

注意：

1. 参数规格显示的是组件级。它们在板级上可能不同，并可能取决于 PCB 特性，包括但不限于 PCB 材料、层数、PCB 厚度。它们也可能取决于使用条件。
2. 基于 HTOL 数据确定。
3. 源自零件的验证或表征，未在生产中测试。
4. Board 用于设备特性化的电路板的设计信息，该信息构成了此处报告的规格值的基础，请联系您当地的TDK InvenSense FAE。

2.4 TEMPERATURE SENSOR SPECIFICATIONS

Specifications of the temperature sensor are shown in Table 4.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
Temperature accuracy			±0.5		°C	
Output Data rate			ODR		Hz	1

Table 4. Temperature Sensor Specifications

Notes:

1. Temperature ODR = Pressure ODR for selected mode

2.4 温度传感器规格

温度传感器的规格在表4中显示。

参数	条件	MIN	TYP	MAX	单位	备注
温度精度			±0.5		°C	
输出数据速率			ODR		Hz	1

表4. 温度传感器规格

备注：

1. 温度 ODR = 压力 ODR for selected mode

3 ELECTRICAL SPECIFICATIONS

3.1 ELECTRICAL CHARACTERISTICS

Default conditions of 25 °C, VDD = 1.8V and VDDIO = 1.8V apply to values in Table 5 and Table 6, unless otherwise stated.

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	COMMENTS
Main Supply Voltage	V_{DD}		1.62	1.8	1.98	V	
			2.97	3.3	3.63	V	
I/O Supply Voltage	V_{DDIO}		1.08	1.2	1.32	V	Externally supplied
			1.62	1.8	1.98	V	
			2.97	3.3	3.63	V	
Supply current	I_{DD}	standby	-	2.65	-	µA	

Table 5. Electrical Supplies

3 电气规格

3.1 电气特性

除非另有说明，表5和表6中的值适用于25°C、VDD = 1.8V 和 VDDIO = 1.8V 的默认条件。

参数	符号	条件	MIN	TYP	MAX	单位	备注
主电源电压	V_{DD}		1.62	1.8	1.98	V	
			2.97	3.3	3.63	V	
I/O 供电电压	V_{DDIO}		1.08	1.2	1.32	V	外部供电
			1.62	1.8	1.98	V	
			2.97	3.3	3.63	V	
供电电流	I_{DD}	待机	-	2.65	-	µA	

表 5. 电气电源

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
SUPPLIES						
Supply Ramp Time	Monotonic ramp. Ramp rate is 10% to 90% of the final value	0.01		10	ms	2
Power Supply Noise				50	mV peak-peak	2
TEMPERATURE SENSOR						
Operating Range	Ambient	-20		65	°C	2
ADC Resolution		15			bits	1
ODR				800	Hz	1
I2C ADDRESS						
I2C ADDRESS	AD0 = 0 AD0 = 1		0x63 0x64			
DIGITAL INPUTS						
VIH, High Level Input Voltage		0.7*VDDIO			V	2
VIL, Low Level Input Voltage				0.3*VDDIO	V	
DIGITAL OUTPUTS						
VOH, High Level Output Voltage		0.75*VDDIO			V	2
VOL, Low-Level Output Voltage				0.25*VDDIO	V	
Drive strength for VDDIO = 1.2V		0.5 2 3 4	2 4 6 8	4 6 9 12	mA	
Drive strength for VDDIO = 1.8V/3.3V		1 2 4 8	2 4 8 12	4 8 12 16	mA	
INTERNAL CLOCK SOURCE						
Clock Frequency Initial Tolerance	Low clock frequency 8kHz	-2		+2	%	2
	Main clock frequency 1.9MHz	-3.125		+3.125	%	2

Table 6. Electrical Specifications

Notes:

1. Guaranteed by design.
2. Derived from validation or characterization of parts, not guaranteed in production

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS	备注
物料						
物料斜坡时间	单调斜坡。斜坡速率是最终值的 10% 到 90% 最终值	0.01		10	ms	2
电源噪声				50	mV 峰值-峰值	2
TEMPERATURE SENSOR						
工作范围	环境	-20		65	°C	2
ADC 分辨率		15			bits	1
ODR				800	Hz	1
I2C ADDRESS						
I2C 地址	AD0 = 0 AD0 = 1		0x63 0x64			
数字输入						
VIH, 高电平输入电压		0.7*VDDIO			V	2
VIL, 低电平输入电压				0.3*VDDIO	V	
DIGITAL OUTPUTS						
VOH, 高电平输出电压		0.75*VDDIO			V	2
VOL, 低电平输出电压				0.25*VDDIO	V	
VDDIO 的驱动强度 = 1.2V		0.5 2 3 4	2 4 6 8	4 6 9 12	mA	
VDDIO 的驱动强度 = 1.8V/3.3V		1 2 4 8	2 4 8 12	4 8 12 16	mA	
内部时钟源						
时钟频率初始容差	低时钟频率 8kHz	-2		+2	%	2
	主时钟频率 1.9MHz	-3.125		+3.125	%	2

表 6. 电气规格

备注：

1. 设计保证。
2. 源自零件的验证或表征，生产中不保证

3.2 ABSOLUTE MAXIMUM RATINGS

Stress levels beyond those listed in Table 7 may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these conditions cannot be guaranteed. Exposure to the absolute maximum rating conditions for extended periods may affect the reliability of the device.

PARAMETER	RATING
Supply voltage, VDD	-0.3V to +4.0V
Supply Voltage, SCL & SDA	-0.3V to VDDIO+0.3V
Operating temperature range	-40°C to +85°C
Storage temperature range	-40°C to +85°C
ESD HBM	1.5 kV
ESD CDM	500V
Radiated EMI immunity	4kV/m
Conducted EMI immunity	2Vrms

Table 7. Absolute Maximum Ratings

3.3 SENSOR SYSTEM TIMING

Default conditions of 25 °C, VDD = 1.8V and VDDIO = 1.8V apply to TYP values listed in Table 8, unless otherwise stated. MAX values apply over the specified operating range of VDD and over the operating temperature range.

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	COMMENTS
Power-up time	t_{PU}		-	2	-	ms	Time between V_{DD} reaching V_{PU} and sensor entering idle state; V_{PU} is the power-up voltage, the minimum V_{DD} at which start-up time is guaranteed, it has a value of 1.56V.

Table 8. System Timing Specifications

3.2 绝对最大额定值

超过表7中列出的应力水平可能会对设备造成永久性损坏。这些只是应力额定值，不能保证设备在这些条件下能正常工作。长时间暴露在绝对最大额定条件下可能会影响设备的可靠性。

参数	额定值
供电电压，VDD	-0.3V 至 +4.0V
供电电压，SCL & SDA	-0.3V 至 VDDIO+0.3V
工作温度范围	-40°C 至 +85°C
存储温度范围	-40°C 至 +85°C
ESD HBM	1.5 kV
ESD CDM	500V
辐射电磁干扰抗扰度	4kV/m
传导EMI抗扰度	2Vrms

表7.绝对最大额定值

3.3 传感器系统时序

默认条件为 25 °C、VDD = 1.8V 和 VDDIO = 1.8V，适用于表 8 中列出的 TYP 值，除非另有说明。MAX 值适用于指定的 VDD 工作范围和操作温度范围。

参数	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	COMMENTS
启动时间	t_{PU}		-	2	-	ms	V_{DD} 从达到V_{PU} 到传感器进入空闲状态之间的时间；V_{PU} 是启动电压，保证启动时间的最小V_{DD}，其值为1.56V。

表8. 系统时序规范

3.4 I²C TIMING CHARACTERIZATION

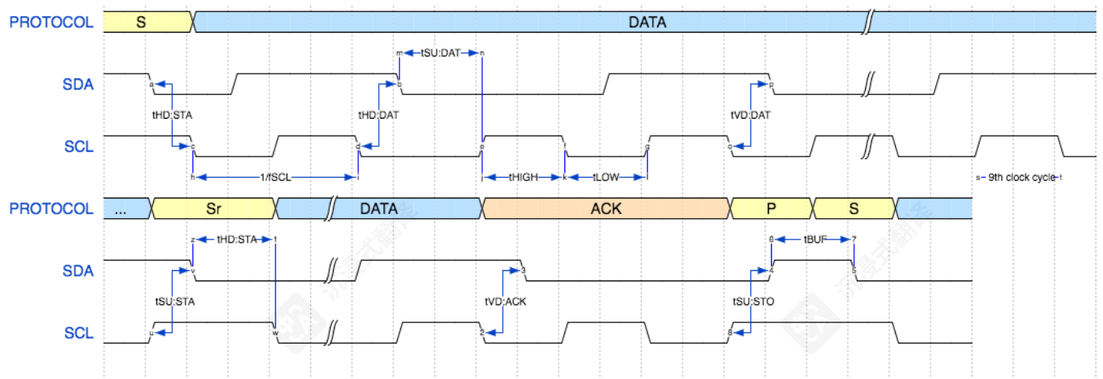
Default conditions of 25 °C, VDD = 1.8V and VDDIO = 1.8V apply to values in Table 9, unless otherwise stated.

PARAMETERS	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
I²C TIMING	**I²C FAST-MODE PLUS**					
f_{SCL}, SCL Clock Frequency				1	MHz	1
$t_{HD.STA}$, (Repeated) START Condition Hold Time		260			ns	1
t_{LOW}, SCL Low Period		500			ns	1
t_{HIGH}, SCL High Period		260			ns	1
$t_{SU.STA}$, Repeated START Condition Setup Time		260			ns	1
$t_{HD.DAT}$, SDA Data Hold Time		5			ns	1
$t_{SU.DAT}$, SDA Data Setup Time		55			ns	1
t_r, SDA and SCL Rise Time [2]	C_b bus cap. From 10 to 400 pF	20*(VDD/5.5V)		120	ns	1
t_f, SDA and SCL Fall Time [2]	C_b bus cap. From 10 to 400 pF	20*(VDD/5.5V)		120	ns	1
$t_{SU.STO}$, STOP Condition Setup Time		260			ns	1
t_{BUF}, Bus Free Time Between STOP and START Condition		500			ns	1
C_b, Capacitive Load for each Bus Line				550	pF	1
$t_{VD.DAT}$, Data Valid Time				450	ns	1
$t_{VD.ACK}$, Data Valid Acknowledge Time				450	ns	1

Table 9. I²C Parameters Specification

Notes:

1. Based on characterization of 5 parts over temperature and voltage as mounted on evaluation board or in sockets.



S:Start - **Sr**:Repeated Start - **P**:Stop

Figure 1. I²C Bus Timing Diagram

3.4 I²C 时序特性

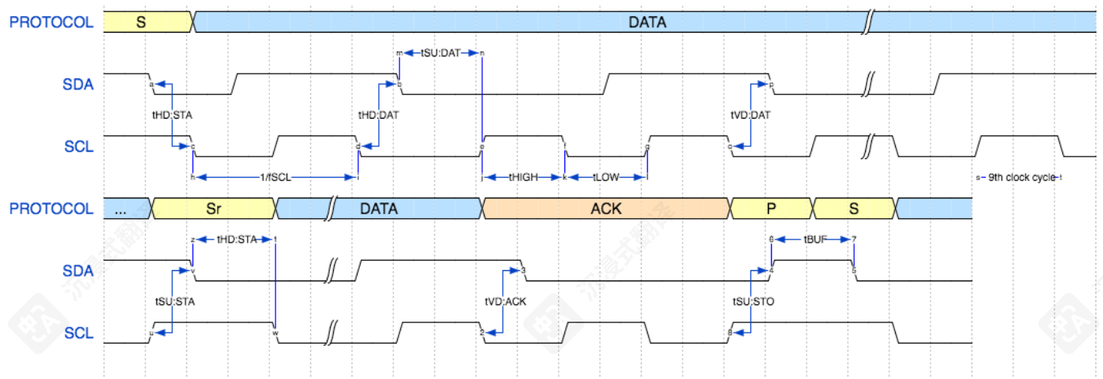
默认条件为 25 °C、VDD = 1.8V 和 VDDIO = 1.8V，适用于表 9 中的值，除非另有说明。

参数	条件	MIN	TYP	MAX	单位	备注
I²C 时序	**I²C 快速模式增强**					
f_{SCL}, SCL 时钟频率				1	MHz	1
$t_{HD.STA}$, (重复) 启动条件保持时间		260			ns	1
t_{LOW}，SCL低周期		500			ns	1
t_{HIGH}，SCL高周期		260			ns	1
$t_{SU.STA}$，重复启动条件设置时间		260			ns	1
$t_{HD.DAT}$，SDA数据保持时间		5			ns	1
$t_{SU.DAT}$，SDA数据设置时间		55			ns	1
t_r，SDA和SCL上升时间[2]	C_b 总线电容。从 10 到 400 pF	20*(VDD/5.5V)		120	ns	1
t_f, SDA 和 SCL 下降时间 [2]	C_b 总线电容。从 10 到 400 pF	20*(VDD/5.5V)		120	ns	1
$t_{SU.STO}$, 停止条件建立时间		260			ns	1
t_{BUF}, 在STOP和START之间的公交免费时间条件		500			ns	1
C_b，每条公交线的容性负载				550	pF	1
$t_{VD.DAT}$，数据有效时间				450	ns	1
$t_{VD.ACK}$，数据有效确认时间				450	ns	1

表9。I²C参数规范

备注：

1. 基于5个部件在评估板或插座上安装的温度和电压特性。



S:Start - **Sr**:Repeated Start - **P**:Stop

图1。I²C总线时序图

3.5 I3C^{SM} TIMING CHARACTERIZATION

Default conditions of 25 °C, VDD = 1.8V and VDDIO = 1.8V apply to values in Table 10, unless otherwise stated.

PARAMETERS	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
I3C^{SM} TIMING	**I3C^{SM} SDR mode**					
f_{SCL}, SCL Clock Frequency			12.5	12.9	MHz	
t_{LOW}, SCL Low Period	From 30% to 30%	24			ns	
t_{DIG_L}, SCL Low Period (to high transition)	From 30% to 70%	32			ns	
t_{HIGH_MIXED}, SCL High Period for Mixed Bus	From 70% to 70%	24			ns	
$t_{DIG\_H\_MIXED}$, SCL High Period for Mixed Bus	From 70% to 30%	32		45	ns	
t_{HIGH}, SCL High Period	From 70% to 70%	24			ns	
t_{DIG_H}, SCL High Period	From 70% to 30%	32			ns	
t_{SCO}, Clock in to Data Out for Slave				12	ns	
t_{CR}, SCL Rise Time	Capped at 60			12	ns	
t_{CF}, SCL Fall Time	Capped at 60			12	ns	
t_{HD_PP}, SDA Signal Data Hold in Push-Pull mode	Slave	0			ns	
t_{SU_PP}, SDA Signal Data Setup in Push-Pull mode		3			ns	
C_b, Capavitive Load per Bus Line	SDA/SCL			50	pF	

Table 10. I3C^{SM} Parameters Specification

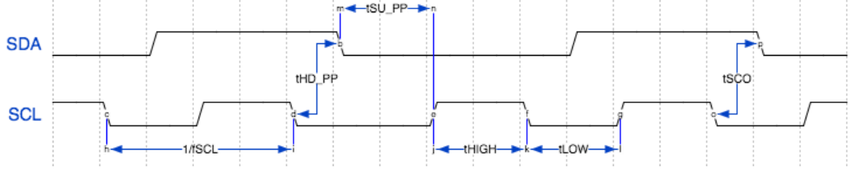


Figure 2. I3C^{SM} Bus Timing Diagrams

3.5 I3C^{SM} 时序特性

默认条件为25 °C、VDD = 1.8V和VDDIO = 1.8V，适用于表10中的值，除非另有说明。

参数	条件	MIN	TYP	MAX	单位	备注
I3C^{SM} 时序	**I3C^{SM} SDR模式**					
f_{SCL}, SCL时钟频率			12.5	12.9	MHz	
t_{LOW}, SCL低电平周期	从30%到30%	24			ns	
t_{DIG_L}, SCL低周期（到高转换）	从30%到70%	32			ns	
t_{HIGH_MIXED}, 混合总线SCL高周期	从70%到70%	24			ns	
$t_{DIG\_H\_MIXED}$, 混合总线SCL高周期	从70%到30%	32		45	ns	
t_{HIGH}, SCL高周期	从70%到70%	24			ns	
t_{DIG_H}, SCL高周期	从70%到30%	32			ns	
t_{SCO}, 从从属时钟输入到数据输出				12	ns	
t_{CR}, SCL 上升时间	限制在 60			12	ns	
t_{CF}, SCL 下降时间	限制在 60			12	ns	
t_{HD_PP}, SDA 在推挽模式下信号数据保持	从机	0			ns	
t_{SU_PP}, SDA 信号数据设置在推挽模式下		3			ns	
C_b, 每条总线线路的电容负载	SDA/SCL			50	pF	

表 10. I3C^{SM} 参数规范

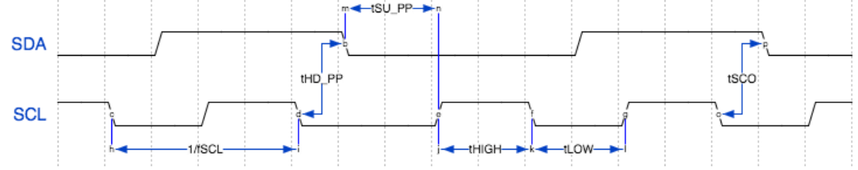


图 2. I3C^{SM} 总线时序图

3.6 SPI 4-WIRE MODE TIMING CHARACTERIZATION

Default conditions of 25°C and 1.8V supply voltage apply to values in Table 11, unless otherwise stated.

PARAMETERS	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
SPI TIMING						
f_{SPC}, SCL Clock Frequency				12	MHz	1
t_{LOW}, SCL Low Period		40			ns	1
t_{HIGH}, SCL High Period		40			ns	1
$t_{SU.CS}$, CS Setup Time		20			ns	1
$t_{HD.CS}$, CS Hold Time		20			ns	1
$t_{SU.SDI}$, SDI Setup Time		5			ns	1
$t_{HD.SDI}$, SDI Hold Time		20			ns	1
$t_{VD.SDO}$, SDO Valid Time	C_{load} = 50 pF			32	ns	1
$t_{HD.SDO}$, SDO Hold Time	C_{load} = 50 pF	5			ns	1
$t_{DIS.SDO}$, SDO Output Disable Time				25	ns	1
t_{Fall}, SCLK Fall Time				5	ns	2
t_{Rise}, SCLK Rise Time				5	ns	2

Table 11. SPI 4-Wire Mode Parameters Specification

Notes:

1. Based on characterization of 5 parts over temperature and voltage as mounted on evaluation board or in sockets
2. Based on other parameter values

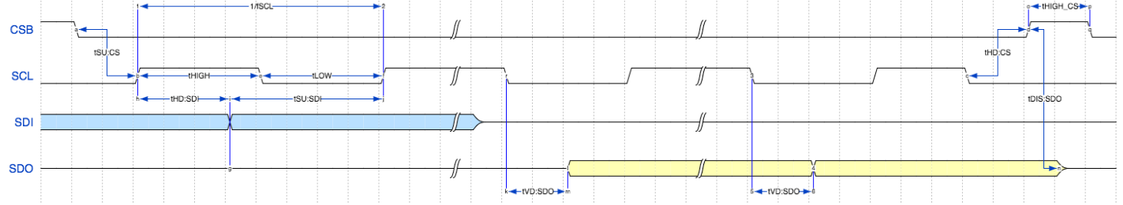


Figure 3. SPI 4-Wire Mode Bus Timing Diagram

3.6 SPI 4线模式时序特性

除非另有说明，表11中的值均适用于25°C和1.8V电源电压的默认条件。

参数	条件	MIN	TYP	MAX	单位	备注
SPI 时序						
f_{SPC}, SCL 时钟频率				12	MHz	1
t_{LOW}, SCL 低电平周期		40			ns	1
t_{HIGH}, SCL 高周期		40			ns	1
$t_{SU.CS}$, CS 设置时间		20			ns	1
$t_{HD.CS}$, CS 保持时间		20			ns	1
$t_{SU.SDI}$, SDI 设置时间		5			ns	1
$t_{HD.SDI}$, SDI 保持时间		20			ns	1
$t_{VD.SDO}$, SDO 有效时间	C_{load} = 50 pF			32	ns	1
$t_{HD.SDO}$, SDO 持续时间	C_{load} = 50 pF	5			ns	1
$t_{DIS.SDO}$, SDO 输出禁用时间				25	ns	1
t_{Fall}, SCLK 下降时间				5	ns	2
t_{Rise}, SCLK 上升时间				5	ns	2

表 11. SPI 4 线模式参数规范

注释：

1. 基于在评估板或插座上安装的 5 个部件的温度和电压特性
2. 基于其他参数值

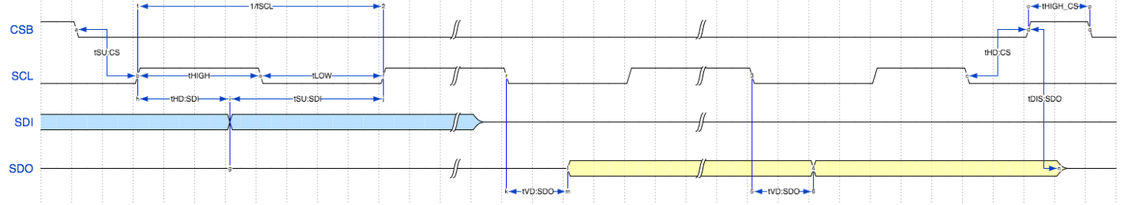


图 3. SPI 4 线模式总线时序图

3.7 SPI 3-WIRE MODE TIMING CHARACTERIZATION

Default conditions of 25°C and 1.8V supply voltage apply to values in Table 12, unless otherwise stated.

PARAMETERS	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
SPI TIMING						
f_{SPC}, SCL Clock Frequency				12	MHz	1
t_{LOW}, SCL Low Period		40			ns	1
t_{HIGH}, SCL High Period		40			ns	1
$t_{SU.CS}$, CS Setup Time		20			ns	1
$t_{HD.CS}$, CS Hold Time		20			ns	1
$t_{SU.SDI}$, SDI Setup Time		5			ns	1, 3
$t_{HD.SDI}$, SDI Hold Time		20			ns	1, 3
$t_{VD.SDO}$, SDO Valid Time	C_{load} = 50 pF			32	ns	1, 3
$t_{HD.SDO}$, SDO Hold Time	C_{load} = 50 pF	5			ns	1, 3
$t_{DIS.SDO}$, SDO Output Disable Time				25	ns	1, 3
t_{Fall}, SCLK Fall Time				5	ns	2
t_{Rise}, SCLK Rise Time				5	ns	2

Table 12. SPI 3-Wire Mode Parameters Specification

Notes:

1. Based on characterization of 5 parts over temperature and voltage as mounted on evaluation board or in sockets
2. Based on other parameter values
3. Separate SDI and SDO times are provided to account for input and output transactions on the SDIO interface for 3-wire SPI mode

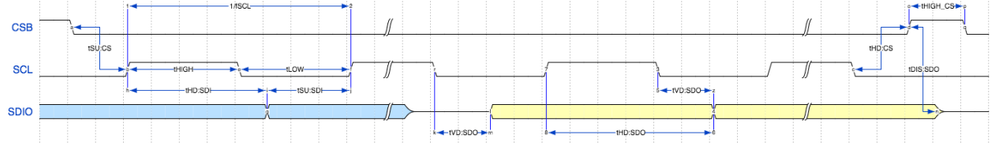


Figure 4. SPI 3-Wire Mode Bus Timing Diagram

3.7 SPI 3-WIRE 模式时序特性

默认条件为 25°C 和 1.8V 电源电压，适用于表 12 中的值，除非另有说明。

参数	条件	MIN	TYP	MAX	单位	备注
SPI 时序						
f_{SPC}, SCL 时钟频率				12	MHz	1
t_{LOW}, SCL 低电平周期		40			ns	1
t_{HIGH}, SCL 高周期		40			ns	1
$t_{SU.CS}$, CS 设置时间		20			ns	1
$t_{HD.CS}$, CS 保持时间		20			ns	1
$t_{SU.SDI}$, SDI 设置时间		5			ns	1, 3
$t_{HD.SDI}$, SDI 保持时间		20			ns	1, 3
$t_{VD.SDO}$, SDO 有效时间	C_{load} = 50 pF			32	ns	1, 3
$t_{HD.SDO}$, SDO 持续时间	C_{load} = 50 pF	5			ns	1, 3
$t_{DIS.SDO}$, SDO 输出禁用时间				25	ns	1, 3
t_{Fall}, SCLK 下降时间				5	ns	2
t_{Rise}, SCLK 上升时间				5	ns	2

表 12. SPI 3 线模式参数规范

备注：

1. 基于在评估板或插座上安装的 5 个部件的温度和电压特性
2. 基于其他参数值
3. 为 3 线 SPI 模式提供独立的 SDI 和 SDO 时间，以处理 SDIO 接口上的输入和输出事务

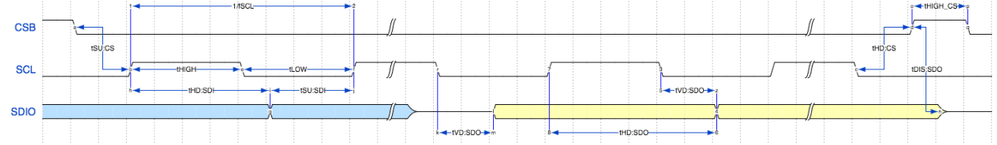


图 4. SPI 3 线模式总线时序图

4 INTERFACE SPECIFICATIONS

The ICP-20100 supports I3C^{SM}, I^{2}C, SPI host-interface options. The ICP-20100 always operates as a slave when connected to the host. Selection between SPI and I3C^{SM}/I^{2}C is done with the CSB pin. If the pin is pulled low, the SPI interface is active and I3C^{SM}/I^{2}C are disabled. If CSB is high, I3C^{SM}/I^{2}C is selected.

4.1 I3C^{SM} / I^{2}C INTERFACE

The I3C^{SM}/I^{2}C interface can operate in I^{2}C legacy mode or I3C^{SM} SDR mode (SCL clock frequency up to 12.5 MHz).

After reset, the device requires a minimum of 10 clock cycles to initialize the I3C^{SM}/I^{2}C interface. Before doing this, no communication is possible through I3C^{SM}/I^{2}C. This initialization can be done through a dummy write transaction to address 0xEE.

4.1.1 I^{2}C Interface

The ICP-20100 I^{2}C slave interface can operate in following modes:

- Standard mode (SCL clock frequency up to 100 kHz)
- Fast mode (SCL clock frequency up to 400 kHz)
- Fast mode plus (SCL clock frequency up to 1 MHz)

4.1.2 I3C^{SM} Interface

I3C^{SM} is a new 2-wire digital interface comprised of the signals serial data (SDA) and serial clock (SCLK). I3C^{SM} is intended to improve upon the I^{2}C interface, while preserving backward compatibility.

I3C^{SM} carries the advantages of I^{2}C in simplicity, low pin count, easy board design, and multi-drop (vs. point to point), but provides the higher data rates, simpler pads, and lower power of SPI. I3C^{SM} adds higher throughput for a given frequency, dynamic addressing.

The I3C^{SM} interface complies with “MIPI I3C Specification -- public edition”, version 1.0, 23 December 2016.

By default, the I^{2}C protocol is used. Only when the device detects that it is connected to an I3C^{SM} bus, will it permanently switch to the I3C^{SM} protocol and the glitch filter will be disabled.

The I3C^{SM} interface supports:

- SDR data rate up to 12.5 MHz
- Dynamic Addressing
- Error detection (Parity)
- Common Command Codes described in Table 13.

4 接口规范

ICP-20100 支持 I3C^{SM}、I^{2}C、SPI 主机接口选项。ICP-20100 在连接到主机时始终作为从设备运行。SPI 与 I3C^{SM}/I^{2}C 之间的选择通过 CSB 引脚完成。如果引脚被拉低，SPI 接口处于活动状态，I3C^{SM}/I^{2}C 被禁用。如果 CSB 为高电平，则选择 I3C^{SM}/I^{2}C。

4.1 I3C^{SM} / I^{2}C 接口

I3C^{SM}/I^{2}C 接口可以在 I^{2}C 传统模式或 I3C^{SM} SDR 模式下运行（SCL 时钟频率最高可达 12.5 MHz）。

重置后，设备需要至少 10 个时钟周期来初始化 I3C^{SM}/I^{2}C 接口。在进行此操作之前，无法通过 I3C^{SM}/I^{2}C 进行通信。此初始化可以通过向地址 0xEE 发送一个虚拟写事务来完成。

4.1.1 I^{2}C 接口

ICP-20100 I^{2}C 从接口可以在以下模式下运行：

- 标准模式（SCL 时钟频率高达 100 kHz）
- 快速模式（SCL 时钟频率高达 400 kHz）
- 快速模式加（SCL 时钟频率高达 1 MHz）

4.1.2 I3C^{SM} 接口

I3C^{SM} 是一种新的2线数字接口，由串行数据（SDA）和串行时钟（SCLK）信号组成。I3C^{SM} 旨在改进I^{2}C接口，同时保持向后兼容性。

I3C^{SM} 具有I2C在简单性、引脚数量少、易于板设计和多路复用（与点对点相比）的优点，但提供了SPI的高数据速率、更简单的引脚和更低的功耗。I3C^{SM} 增加了给定频率下的更高吞吐量和动态寻址。

I3C^{SM} 接口符合“MIPI I3C规范——公开版本”，版本1.0，2016年12月23日。

默认情况下，使用I^{2}C协议。只有当设备检测到它连接到I3C^{SM} 总线时，才会永久切换到I3C^{SM} 协议，并且故障滤波器将被禁用。

I3C^{SM} 接口支持：

- SDR 数据速率高达 12.5 MHz
- 动态寻址
- 错误检测（奇偶校验）
- 表 13 中描述的常用命令码

4.1.3 I²C Data Protocol

A transfer is always started by addressing the device with an I²C write header followed by the targeted 8-bit register address.

For write accesses, the master continues sending the 8-bit data word.

For read accesses, the master must change the transfer direction from write to read by sending an I²C read header with the correct address. The device then transmits the data word (if available). An address increment feature enables reading multiple data bytes in a row.

All commands and memory locations are mapped to an 8-bit register space which can be accessed via the I²C interface. Data is always transferred as 8-bit words. Figure 5 illustrates the different transfer types.

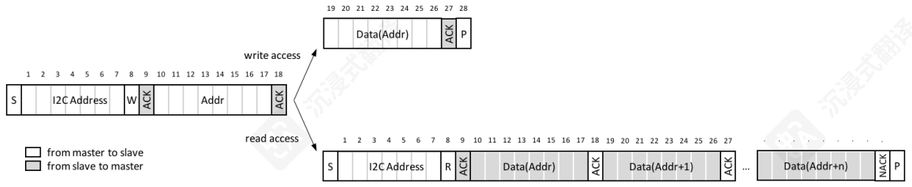


Figure 5. I²C Data Protocol

The I²C interface has access to all registers needed for functional operation.

Every byte transmitted from the I²C master to the slave device must be acknowledged.

In read direction, the master indicates with the acknowledge if an address increment read needs to be initiated. An ACK from the master indicates a request for an address increment read. A NACK from the master indicates the end of the read transfer and needs to be followed by a STOP condition.

Every last I2C bus transaction to ICP-20100 should end with read to address 0x00. At least once in every 255 I2C read or burst read transactions (Burst read accesses treated as one read transaction independent of burst size) on the bus to other I2C devices, the host should perform a read to ICP-20100 address 0x00.

One possible implementation of the requirement above would be to add a dummy read from ICP-20100 address 0x00 after any I2C transactions.

Another possible implementation is to perform a dummy read from ICP-20100 address 0x00 after each last I2C bus transaction to ICP-20100 and add a dummy read from ICP-20100 address 0x00 at a constant rate of 110Hz.

4.1.4 I3C^{SM} Data Protocol

The device is switched to I3C^{SM} mode by sending the reserved byte 7'h7E.

While in I3C^{SM} mode, the device is addressed with an I3C^{SM} write header containing the dynamic device address, followed by the targeted 8-bit register address.

For write accesses, the master continues sending the 8-bit data word.

For read accesses, the master must change the transfer direction from write to read by sending an I3C^{SM} read header containing the dynamic device address. The device then transmits the data word. An address increment feature allows to read out multiple data bytes in a row.

All commands and memory locations are mapped to an 8-bit register space which can be accessed via the I3C^{SM} interface. Data is always transferred as 8-bit words. Figure 6 illustrates the different transfer types.

4.1.3 I²C 数据协议

每次传输都是由使用I²C写头寻址设备，然后是目标8位寄存器地址开始的。

对于写访问，主设备继续发送8位数据字。

对于读访问，主设备必须通过发送带有正确地址的I²C读头改变传输方向从写变为读。设备随后传输数据字（如果可用）。地址增量功能允许连续读取多个数据字节。

所有命令和内存位置都映射到 8 位寄存器空间，可以通过 I²C 接口访问。数据始终以 8 位字的形式传输。图 5 说明了不同的传输类型。

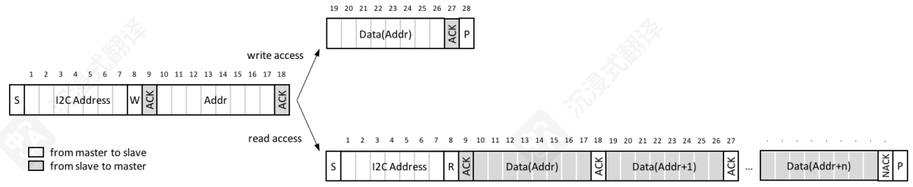


图 5。I²C 数据协议

I²C 接口可以访问所有功能操作所需的寄存器。

从 I²C 主机传输到从设备的所有字节都必须被确认。

在读取方向上，主机通过确认信号指示是否需要启动地址递增读取。主机的确认信号表示请求地址递增读取。主机的非确认信号表示
读取传输的结束，并且需要随后发送一个停止条件。

每一个到最后一个I2C总线事务到ICP-20100都应该以读取地址0x00结束。在每255个I2C读取或突发读取事务（突发读取访问视为一个独立的读取事务，与突发大小无关）中，主机应该在
总线到其他I2C设备上执行读取到ICP-20100地址0x00的操作。

上述要求的一种可能实现方式是在任何I2C事务之后添加从ICP-20100地址0x00的虚拟读取。

另一种可能的实现方式是在每个到最后一个I2C总线事务到ICP-20100之后执行从ICP-20100地址0x00的虚拟读取，并在110Hz的恒定速率下添加从ICP-20100地址0x00的虚拟读取。

4.1.4 I3C^{SM} 数据协议

通过发送保留字节7' h7E将设备切换到I3C^{SM} 模式。

在 I3C^{SM} 模式下，设备通过包含动态设备地址的 I3C^{SM} 写入头进行寻址，随后是目标 8 位寄存器地址。

对于写入访问，主设备继续发送 8 位数据字。

对于读取访问，主设备必须通过发送包含动态设备地址的 I3C^{SM} 读取头来改变传输方向从写入变为读取。设备随后传输数据字。地址增量功能允许连续读取多个数据字节。

所有命令和内存位置都映射到 8 位寄存器空间，可以通过 I3C^{SM}接口访问。数据始终以 8 位字的形式传输。图 6 说明了不同的传输类型。

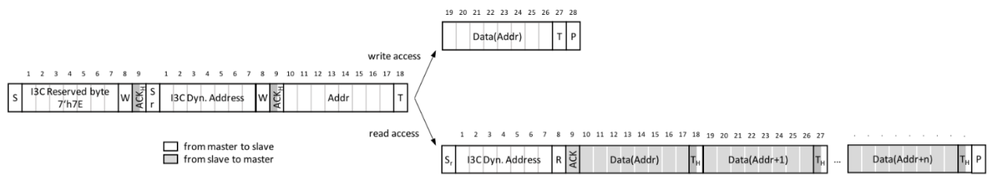


Figure 6. I3C^{SM} Data Protocol

The I3C^{SM} interface has access to all registers needed for functional operation.

Every last I3C bus transaction to ICP-20100 should end with read to address 0x00. At least once in every 255 I3C read or burst read transactions (Burst read accesses treated as one read transaction independent of burst size) on the bus to other I3C devices, the host should perform a read to ICP-20100 address 0x00.

One possible implementation of the requirement above would be to add a dummy read from ICP-20100 address 0x00 after any I3C transactions.

Another possible implementation is to perform a dummy read from ICP-20100 address 0x00 after each last I3C bus transaction to ICP-20100 and add a dummy read from ICP-20100 address 0x00 at a constant rate of 110Hz.

4.1.5 Supported I3C^{SM} Common Command Codes (CCC)

I3C^{SM} features CCCs that allow the master to manage the bus and its connected slaves, either directly or through a broadcast.

The I3C^{SM} master should not use any unsupported CCCs.

CODE	CCC TYPE	MNEMONIC	DESCRIPTION
0x06	broadcast	RSTDAA	Reset Dynamic Address Assignment
0x07	broadcast	ENTDAA	Enter Dynamic Address Assignment
0x86	direct	RSTDAA	Reset Dynamic Address Assignment (p2p)
0x87	direct	SETDASA	Set Dynamic Address from Static Address
0x88	direct	SETNEWDA	Set New Dynamic Address
0x8D	direct	GETPID	Get Provisional ID
0x8E	direct	GETBCR	Get Bus Characteristics Register
0x8F	direct	GETDCR	Get Device Characteristics Register
0x90	direct	GETSTATUS	Get Device Status

Table 13. Supported I3C^{SM} CCCs

4.1.6 I3C^{SM} Provisional Identifier

The Provision Identifier (PID) is hardwired as:

BIT	NAME	FIXED VALUE	NOTE
47:33	MIPI Manufacturer ID	15'h0235	TDK Manufacturer ID
32	PID Type Selector	0	0 = PID fixed value
31:16	Part ID	0	
15:12	Instance ID	0	
11:0	Vendor defined	0	

Table 14. I3C^{SM} Provisional Identifier

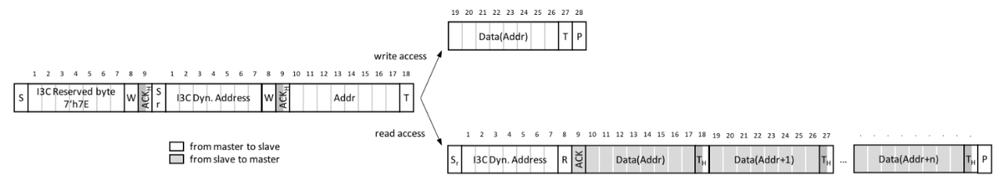


图6. I3C^{SM} 数据协议

I3C^{SM} 接口可以访问所有功能操作所需的寄存器。

每个I3C总线事务都应该以读取地址0x00结束。在每255次I3C读取或突发读取事务（突发读取访问视为一次独立的读取事务，与突发大小无关）中，主机应该执行一次读取ICP-20100地址0x00的操作。

上述要求的一种可能实现方式是在任何 I3C 交易之后从 ICP-20100 地址 0x00 添加一个虚拟读取。

另一种可能的实现方式是在每次最后对 ICP-20100 的 I3C 总线交易之后从 ICP-20100 地址 0x00 执行一个虚拟读取，并在 110Hz 的恒定速率下从 ICP-20100 地址 0x00 添加一个虚拟读取。

4.1.5 支持的 I3C^{SM} 通用命令代码 (CCC)

I3C^{SM} 提供 CCC，允许主设备直接或通过广播管理总线及其连接的从设备。

I3C^{SM} 主控不应使用任何不支持的CCC。

CODE	CCC 类型	助记符	描述
0x06	广播	RSTDAA	重置动态地址分配
0x07	广播	ENTDAA	输入动态地址分配
0x86	direct	RSTDAA	重置动态地址分配 (p2p)
0x87	direct	SETDASA	从静态地址设置动态地址
0x88	direct	SETNEWDA	设置新的动态地址
0x8D	direct	GETPID	获取临时ID
0x8E	direct	GETBCR	获取总线特性寄存器
0x8F	direct	GETDCR	获取设备特性寄存器
0x90	直接	GETSTATUS	获取设备状态

表13. 支持的I3C^{SM} CCCs

4.1.6 I3C^{SM} 临时标识符

提供标识符（PID）是硬接线的：

BIT	NAME	固	NOTE
47:33	MIPI制造商ID	15'h0235	TDK制造商ID
32	PID 类型选择器	0	0 = PID 固定值
31:16	部件 ID	0	
15:12	实例 ID	0	
11:0	供应商定义	0	

表14. I3C^{SM} 临时标识符

4.1.7 I3C^{SM} Bus Characteristics Register

The Bus Characteristics Register (BCR) is hardwired as:

BIT	NAME	FIXED VALUE	NOTE
7	Device Role [1]	0	fixed (slave role)
6	Device Role [0]	0	fixed (slave role)
5	Data Rate support	0	fixed (SDR only)
4	Bridge Identifier	0	fixed (no bridge)
3	Offline Capable	0	fixed (not offline capable)
2	IBI Payload	0	fixed (IBI not supported)
1	IBI Request Capable	0	fixed (IBI not supported)
0	Max Data Speed Limit	0	fixed (no speed limit, GETMXDS not supported)

Table 15. I3C^{SM} Bus Characteristics Register

4.1.8 I3C^{SM} Device Characteristics Register

The Device Characteristics Register (DCR) byte [7:0] is hardwired to the fixed value 0x62, which corresponds to the "Environment Pressure Sensor" as defined by MIPI. (see https://www.mipi.org/MIPI_I3C_device_characteristics_register)

4.1.9 Fixed I^{2}C slave address and address increment

The value assigned on AD0 allows to adapt the I^{2}C address as follows:

- AD0 = 0 : I^{2}C address = 0x63
- AD0 = 1 : I^{2}C address = 0x64

4.1.10 I3C^{SM} Slave Address

I3C^{SM} supports dynamic addressing feature which allows master and slaves to do dynamic address arbitration on the I3C^{SM} bus.

The concatenation of {PID[15:0],BCR[7:0],DCR[7:0]} is used to determine the priority for dynamic addressing by the Master.

Since there is already a static address present for I^{2}C, this can be used via the SETDASA command if known by the Master up front. When applicable, the address increment is applied as well.

4.2 SPI INTERFACE

The ICP-20100 SPI slave interface can operate in the following modes:

- 3-wire mode using pins CSB, SDIO and SCL
- 4-wire mode using pins CSB, SDI, SDO and SCL

The SPI interface has access to all registers needed for functional operation.

4.1.7 I3C^{SM} 总线特性寄存器

总线特性寄存器（BCR）是硬接线的：

BIT	NAME	固	NOTE
7	设备角色 [1]	0	固定（从属角色）
6	设备角色 [0]	0	固定（从属角色）
5	数据速率支持	0	固定（仅 SDR）
4	桥接标识符	0	固定（无桥接）
3	支持离线	0	固定（不支持离线）
2	IBI有效载荷	0	固定（不支持IBI）
1	支持IBI请求	0	固定 (不支持 IBI)
0	最大数据速度限制	0	固定 (无速度限制，不支持 GETMXDS)

表 15. I3C^{SM} 总线特性寄存器

4.1.8 I3C^{SM} 设备特性寄存器

设备特性寄存器 (DCR) 字节 [7:0] 固定设置为 0x62，对应 MIPI 定义的“环境压力传感器”。（参见

https://www.mipi.org/MIPI_I3C_device_特性_寄存器)

4.1.9 固定I^{2}C从设备地址和地址增量

在AD0上分配的值允许按如下方式调整I^{2}C地址：

- AD0 = 0 : I^{2}C地址 = 0x63
- AD0 = 1 : I^{2}C地址 = 0x64

4.1.10 I3C^{SM} 从设备地址

I3C^{SM} 支持动态寻址功能，该功能允许主设备和从设备在I3C^{SM} 总线上进行动态地址仲裁。

将{PID[15:0],BCR[7:0],DCR[7:0]}的连接字符串用于由主设备确定动态寻址的优先级。

由于I^{2}C已经存在静态地址，如果主设备事先知道，可以通过SETDASA命令使用该地址。当适用时，也会应用地址增量。

4.2 SPI 接口

ICP-20100 SPI 从设备接口可以在以下模式下运行：

- 使用引脚CSB、SDIO和SCL的3线模式
- 4线模式使用引脚CSB、SDI、SDO和SCL

SPI接口可以访问所有功能操作所需的寄存器。

4.2.1 SPI Protocol

The SPI frame format is as follows:

1. SPI master pulls CSB low
2. SPI master sends 1 command byte
3. SPI master sends 1 address byte
4. For write frames, SPI master sends a master data byte
5. For read frames, IFPS replies with a number of slave data bytes
6. SPI master releases CSB

This is pictured in the Figure 7 and Figure 8 respectively for 4-wire SPI and 3-wire SPI.

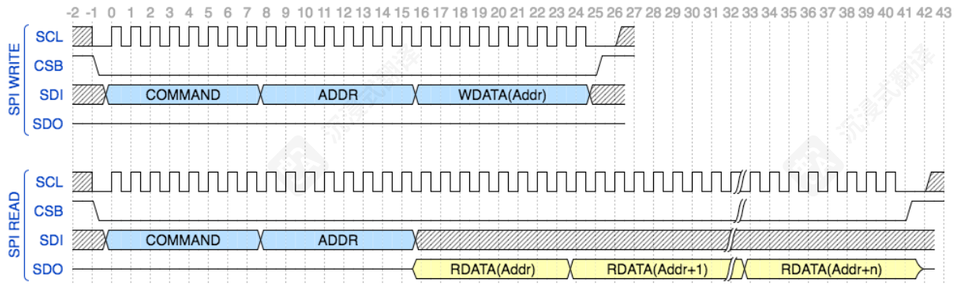


Figure 7. 4-Wire SPI Transaction Overview

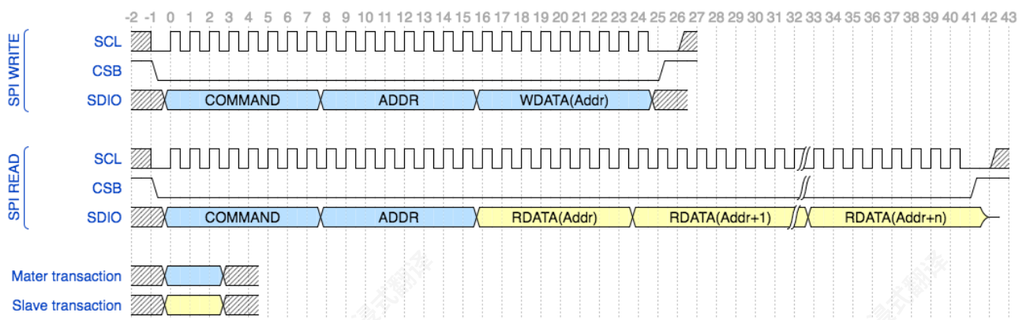


Figure 8. 3-Wire SPI Transaction Overview

A transmitter conceptually produces data bits at the falling edge of the SPI clock SCL, and a receiver samples the data bits at the rising edge of the SPI clock.

Bytes are transmitted in the order MSB to LSB.

The slave keeps SDO in high-Z unless a reply is expected from the command (read request).

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNIT	COMMENTS
spi_speed	Data rate of the SPI protocol	DC		12	Mbps	

Table 16. SPI Data Rate Specifications

4.2.1 SPI 协议

SPI帧格式如下：

1. SPI 主机拉低CSB
2. SPI 主机发送1个命令字节
3. SPI 主机发送 1 个地址字节
4. 对于写帧，SPI 主机发送一个主数据字节
5. 对于读帧，IFPS 以多个从数据字节进行回复
6. SPI 主机释放 CSB

这分别如图 7 和图 8 所示，适用于 4 线 SPI 和 3 线 SPI。

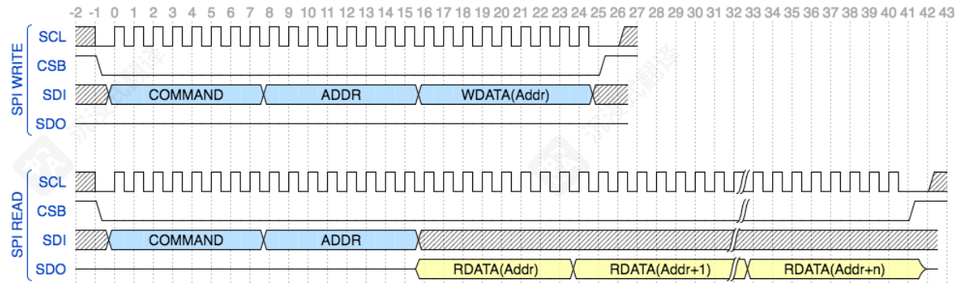


图 7. 4 线 SPI 事务概述

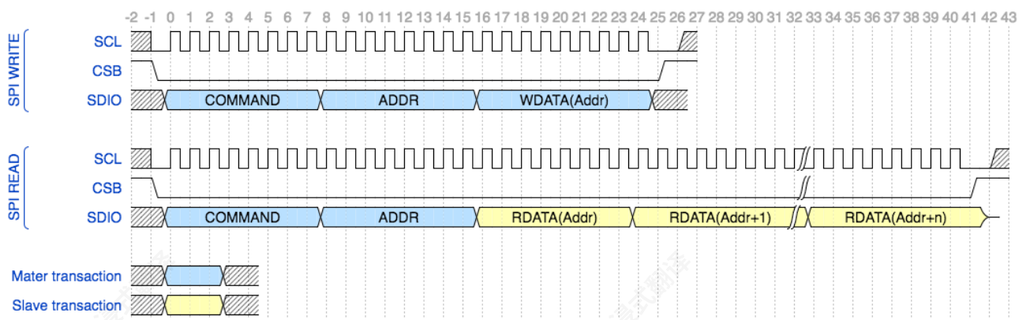


图8. 三线SPI事务概述

发射器在SPI时钟SCL的下降沿概念性地产生数据位，接收器在SPI时钟的上升沿采样数据位。

字节按MSB到LSB的顺序传输。

从机在未收到命令（读取请求）的回复时，将SDO保持在高阻态。

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNIT	COMMENTS
spi_速度	SPI 协议的数据速率	DC		12	Mbps	

表 16. SPI 数据速率规范

4.2.2 SPI Modes

The ICP-20100 supports SPI MODE0 and MODE3.

When the SPI interface is idle, SCL is low. Data is propagated on the clock's falling edge and captured on the clock's rising edge.

4.2.3 SPI Frame Abort

The SPI master can abort an SPI frame by de-asserting CSB.

4.2.4 Supported Commands

Table 17 shows the supported commands via the SPI interface.

COMMAND CODE	COMMAND	DESCRIPTION
0x3C	CMD_READ_REG	Read from register
0x33	CMD_WRITE_REG	Write to register

Table 17. SPI Supported Commands

4.2.2 SPI 模式

ICP-20100支持SPI MODE0和MODE3。

当 SPI 接口空闲时，SCL 为低电平。数据在时钟下降沿传播，并在时钟上升沿捕获。

4.2.3 SPI 帧中止

SPI 主机可以通过撤销 CSB 来中止 SPI 帧。

4.2.4 支持的命令

表 17 显示了通过 SPI 接口支持的命令。

命令代码	命令	描述
0x3C	CMD 读取 REG_ _	从寄存器读取
0x33	CMD 写寄存器_ _	写入寄存器

表 17. SPI 支持的命令

4.3 DRIVE STRENGTH CONFIGURATION

The device starts up with drive strength 2 mA in 1.8V IO supply mode. If the application requires high speed communication (>1 MHz) or uses VDDIO=1.2V, the drive strength settings need to be adapted. This is done by reconfiguring register IO_DRIVE_STRENGTH (section 13.5 in this datasheet).

This section provides MATLAB sample code on how to do this. The following terminology is used in this code for register map references:

regMap.Register_Name.Register_Field_Name.Write(Value)

where

- "Register_Name" is the register name;
- "Register_Field_Name" is the name of the register field in the register;
- "Write" is a write operation for the specified register field;
- "Value" is the value being written to the specified register field

Please refer to sections 12 and 13 for information about the registers/register fields shown in the sample code.

```
function PowerMode(self)
    %% PowerMode: function to move into power mode
    global regMap

    %% Move to power mode if not already inside
    if (regMap.MODE_SELECT.POWER_MODE.read==0)
        fprintf('Moving into power mode...\n')
        regMap.MODE_SELECT.POWER_MODE.write(1);
        pause(0.001);
    end
end

function Configure_drive_strength(self)
    %% Configure_drive_strength: sample code on how to configure the drive strength
    %  after a reset of the device

    global regMap

    self.PowerMode;

    %% Configure the drive strength mirror registers
    %  This example configures a drive strength of 12mA for 1.8V IO supply
    regMap.IO_DRIVE_STRENGTH.IO_DS.write('0x3');
end
```


4.3 驱动强度配置

设备在 1.8V IO 电源模式下以 2 mA 的驱动强度启动。如果应用程序需要高速通信 (>1 MHz) 或使用 VDDIO=1.2V，则需要调整驱动强度设置。这是通过重新配置本数据表第 13.5 节中的寄存器 IO_DRIVE_STRENGTH 实现的。

本节提供了如何执行此操作的 MATLAB 示例代码。此代码中用于寄存器映射引用的术语如下：

regMap.Register_Name.Register_Field_Name.Write(Value)

哪里

- "Register_Name" 是寄存器名称；
- "Register_Field_Name" 是寄存器中的寄存器字段名称；
- "Write" 是对指定寄存器字段进行的写操作；
- "Value" 是写入指定寄存器字段的值

请参考第 12 节和第 13 节，了解示例代码中显示的寄存器/寄存器字段的信息。

```
function PowerMode(self)
    %% PowerMode: function to move into power mode
    global regMap

    %% Move to power mode if not already inside
    if (regMap.MODE_SELECT.POWER_MODE.read==0)
        fprintf('Moving into power mode...\n')
        regMap.MODE_SELECT.POWER_MODE.write(1);
        pause(0.001);
    end
end

function Configure_drive_strength(self)
    %% Configure_drive_strength: sample code on how to configure the drive strength
    %  after a reset of the device

    全局 regMap

    self.PowerMode;

    %% Configure the drive strength mirror registers
    %  This example configures a drive strength of 12mA for 1.8V IO supply
    regMap.IO_DRIVE_STRENGTH.IO_DS.write('0x3');
end
```

5 APPLICATIONS INFORMATION

5.1 ICP-20100 PIN OUT DIAGRAM AND SIGNAL DESCRIPTION

PIN NUMBER	PIN NAME	DESCRIPTION
1	CSB	SPI Chip Select
2	SCL	I3C℠ / I²C / SPI Serial Clock
3	VSS	Power Supply Ground
4	SDA / SDIO / SDI	SDA: I3C℠ / I²C serial data; SDIO: SPI serial data I/O (3-wire mode); SDI: SPI serial data input (4-wire mode)
5	VDD	Power Supply Voltage
6	SDO / AD0	SDO: SPI serial data output (4-wire mode); AD0: I3C℠ / I²C slave address LSB
7	INT	Interrupt Output
8	RESV	Connect to Ground
9	RESV	Connect to Ground
10	VDDIO	IO Power Supply

Table 18. ICP-20100 Signal Descriptions

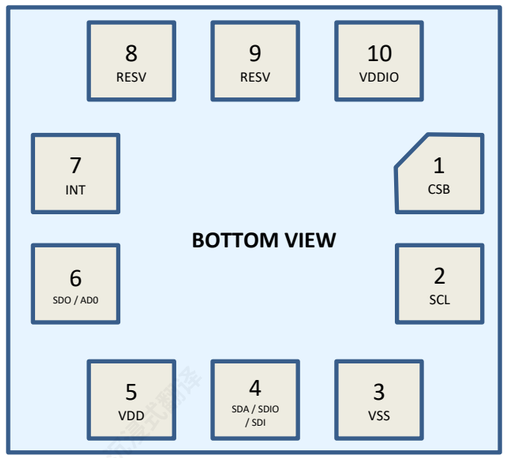


Figure 9. Pin Out Diagram for ICP-20100, 2mm x 2mm x 0.8mm LGA

5 应用信息

5.1 ICP-20100 引脚排列图和信号描述

引脚编号	PIN NAME	描述
1	CSB	SPI 片选
2	SCL	I3C℠ / I²C / SPI 串行时钟
3	VSS	电源地
4	SDA / SDIO / SDI	SDA: I3C℠ / I²C 串行数据； SDIO: SPI 串行数据 I/O (3-wire 模式)； SDI: SPI 串行数据输入 (4-wire 模式)
5	VDD	电源电压
6	SDO / AD0	SDO: SPI 串行数据输出 (4-wire 模式)； AD0: I3C℠ / I²C 从机地址 LSB
7	INT	中断输出
8	RESV	连接到地
9	RESV	连接到地
10	VDDIO	IO 电源

表 18. ICP-20100 信号描述

图9. ICP-20100 2mm x 2mm x 0.8mm LGA引脚排列图

5.2 TYPICAL OPERATING CIRCUITS

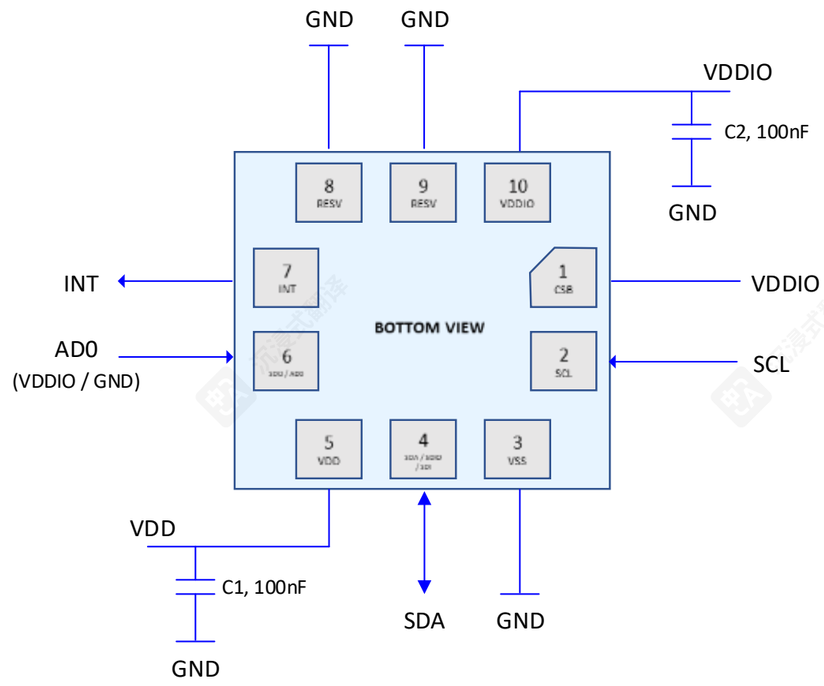


Figure 10. ICP-20100 Application Schematic (I3C^{SM} / I²C Interface to Host)

Note: I²C lines are open drain and pull-up resistors (e.g. 5kΩ) are required.

5.2 典型工作电路

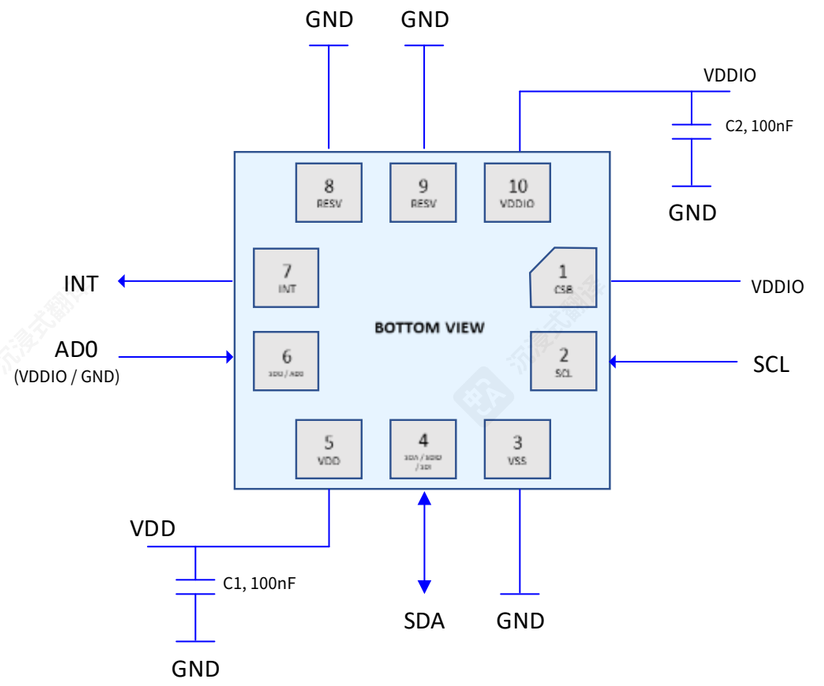


图10. ICP-20100应用原理图 (I3C^{SM} / I²C接口到主机)

注意：I²C线路为开漏输出，需要上拉电阻（例如5kΩ）。

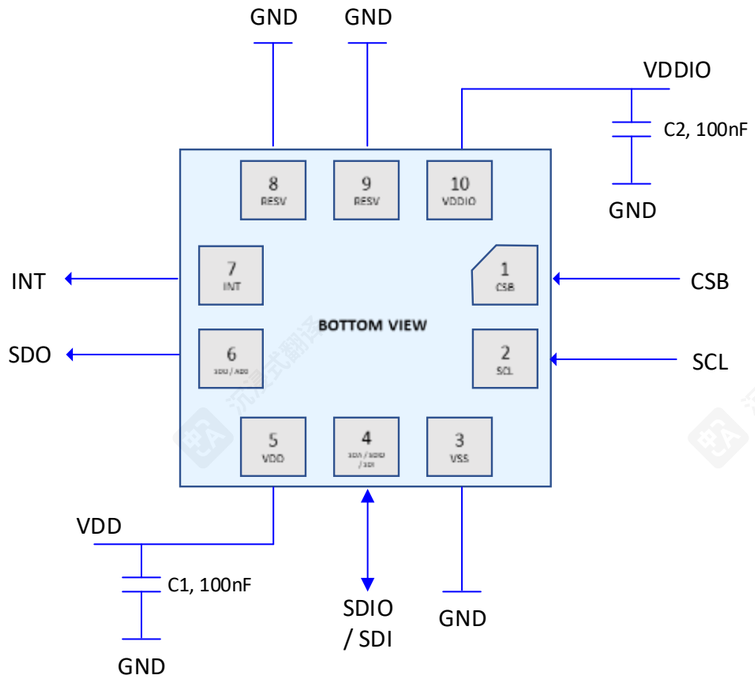


Figure 11. ICP-20100 Application Schematic (SPI Interface to Host)

5.3 BILL OF MATERIALS FOR EXTERNAL COMPONENTS

COMPONENT	LABEL	SPECIFICATION	QUANTITY
VDD Bypass Capacitor	C1	X7R, 100nF ±10%	1
VDDIO Bypass Capacitor	C2	X7R, 100nF ±10%	1

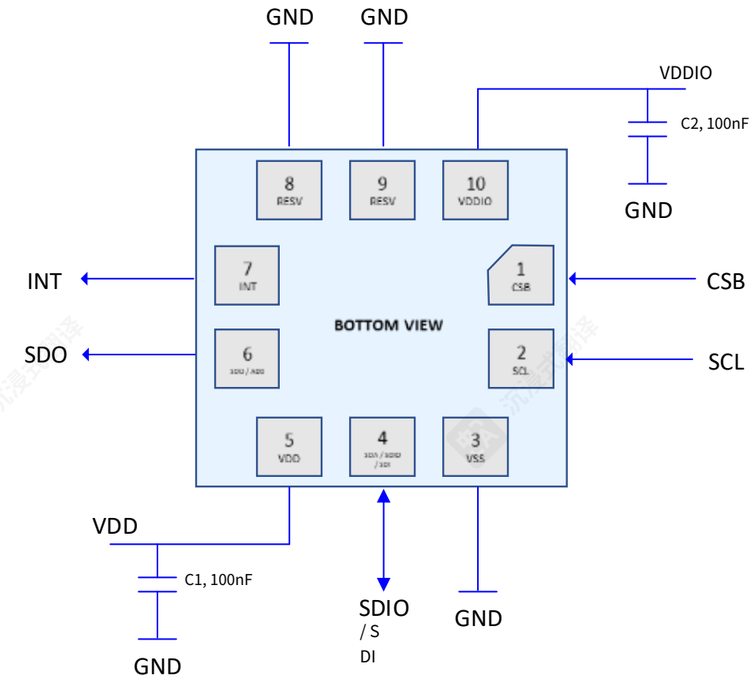


图11. ICP-20100应用原理图（SPI接口到主机）

5.3 外部组件物料清单

组件	标签	规格	数量
VDD 旁路电容	C1	X7R，100nF ±10%	1
VDDIO 旁路电容	C2	X7R，100nF ±10%	1

5.4 ASIC IDENTIFICATION

For identifying this device, please use following procedure:

1) Power-on the ASIC
2) Initialize the I²C interface by toggling the clock line a few times. The easiest way to do that is by inserting a dummy I²C write transaction. You can, for example, execute the first transaction (write to lock register) twice.
3) Check that the value from register regMap.device_id equals 0x63
4) Check the value from register regMap.version:
   - 0x00 indicates a device version A
   - 0xB2 indicates a device version B

5.4 ASIC 识别

为识别此设备，请使用以下步骤：

1) 开启 ASIC
2) 通过切换时钟线几次来初始化 I²C 接口。最简单的方法是
   插入一个虚拟 I²C 写事务。例如，您可以执行第一次事务（写入锁定寄存器）两次。
3) 检查寄存器 regMap.device_id 的值是否等于 0x63
4) 检查寄存器 regMap.version：的值
   - 0x00 表示设备版本 A
   - 0xB2 表示设备版本 B

6 PRESSURE AND TEMPERATURE MEASUREMENT

The ICP-20100 uses a 2nd order ∑Δ ADC with time-multiplexed pressure and temperature measurements. Integration time for measurement, or over-sampling ratio (OSR) can be configured independently for pressure and temperature.

6.1 PRESSURE AND TEMPERATURE MEASUREMENT ACCURACY

Increasing the pressure OSR improves the noise on the pressure measurement but also results in more current consumption due to a delayed return to STANDBY mode.

Increasing the temperature OSR improves the noise on the temperature measurement and on the pressure measurement due to the non-linear pressure compensation as a function of the temperature but also results in more current consumption due to a delayed return to STANDBY.

The pressure and temperature OSR values are limited by the Output Data Rate (ODR) selection. For details of the relationship between these parameters, refer to section 6.2.

For given OSR and ODR settings, the noise can further be optimized by using an IIR filter. Refer to section 0 for details of the IIR filter.

6.2 PRESSURE AND TEMPERATURE MEASUREMENT SEQUENCING

Pressure and temperature measurements are time-multiplexed, with pressure measurement performed first and followed by temperature measurement.

A measurement can be started either automatically (duty cycled operation) or manually (triggered operation).

6.2.1 Duty Cycled Operation

In duty cycled operation Pressure/Temperature measurements are automatically started.

The time between 2 measurements is defined by the ODR (Output Data Rate) setting and is timed based on the low power clock.

In Figure 12 and Figure 13, T_{OSR_P} is the pressure sensor OSR and T_{OSR_T} is the temperature sensor OSR.

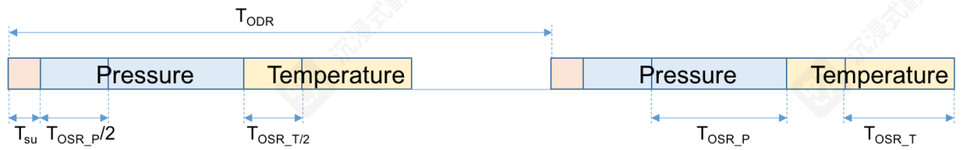


Figure 12. Duty Cycled Measurement

If the configured ODR period is smaller than the conversion time for pressure and temperature, the actual ODR is adapted to match the conversion time.

6 压力和温度测量

ICP-20100 使用一个 2nd 顺序 ∑Δ ADC 进行时间复用压力和温度测量。测量积分时间或过采样率 (OSR) 可独立配置给压力和温度。

6.1 压力和温度测量精度

增加压力 OSR 会提高压力测量的噪声，但由于返回 STANDBY 模式延迟，也会导致电流消耗增加。

增加温度 OSR 会提高温度测量的噪声，并由于温度作为非线形压力补偿函数导致压力测量的噪声增加，但由于返回 STANDBY 延迟，也会导致电流消耗增加。

压力和温度 OSR 值受输出数据速率 (ODR) 选择限制。有关这些参数之间关系的详细信息，请参阅第 6.2 节。

对于给定的 OSR 和 ODR 设置，可以通过使用 IIR 滤波器进一步优化噪声。有关 IIR 滤波器的详细信息，请参阅第 0 节。

6.2 压力和温度测量顺序

压力和温度测量是时间复用的，首先执行压力测量，然后执行温度测量。

测量可以自动启动（周期性运行）或手动启动（触发运行）。

6.2.1 周期性运行

在周期性运行中，压力/温度测量会自动启动。

两次测量之间的时间由ODR（输出数据速率）设置定义，并基于低功耗时钟计时。

在图12和图13中，T_{OSR_P} 是压力传感器OSR，T_{OSR_T} 是温度传感器OSR。

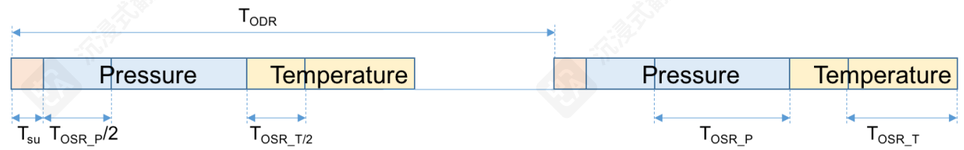


图12。周期性测量

如果配置的ODR周期小于压力和温度的转换时间，实际ODR会调整以匹配转换时间。

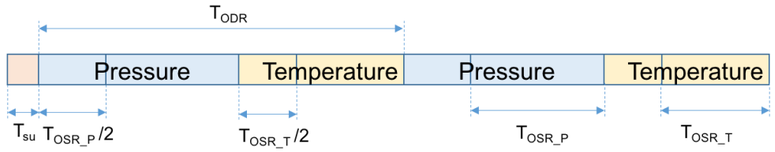


Figure 13. Duty Cycled Measurement Without Wait

By disabling the pressure or temperature measurement through setting its respective OSR configuration register (refer to the application note "*AN-000238: ICP-20100 and ICP-20132 User Configurable Operation Mode and IIR Filter*") to value 0, a temperature-only or pressure-only measurement can be configured.

If a pressure-only setting is combined with an ODR period setting that is smaller than the conversion time, a maximal conversion rate can be established in which no settling is needed for each individual sample and a higher ODR can be reached. The same principle applies for temperature-only setting.

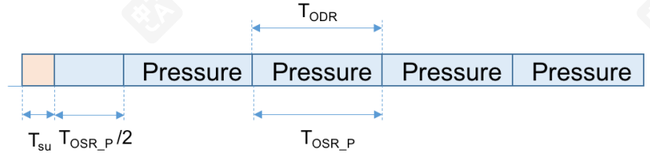


Figure 14. Pressure-Only Mode

The maximum ODR can be calculated based on the pressure and temperature OSR by the following formula:

$ODR_{MAX}(Hz) = 10^6/(168+2.1*1.5*(OSR_{PRESS}+OSR_{TEMP}))$

with OSR_{PRESS}, OSR_{TEMP} the pressure and temperature Over Sampling Ratio.

where $OSR_{PRESS} = \left(OSR\_PRESS_{register} + 1\right) * 2^5$ and $OSR_{TEMP} = \left(OSR\_TEMP_{register} + 1\right) * 2^5$

6.2.2 Triggered operation

Triggered operation (also called forced measurement mode) performs a single Pressure, Temperature, or Pressure/Temperature pair measurement. After the measurement, the device returns to standby mode.

Triggered operation is only supported for MODE4.

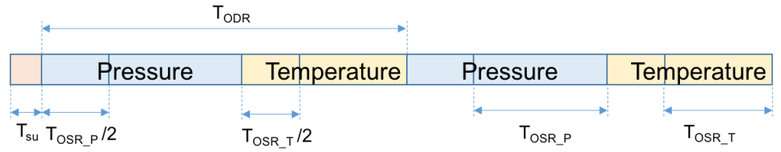


图13. 无等待周期测量

通过将压力或温度测量的相应OSR配置寄存器设置为0（参考应用笔记“AN-000238：ICP-20100和ICP-20132用户可配置操作模式和IIR滤波器”），可以配置仅温度或仅压力的测量。

如果压力设置与小于转换时间的ODR周期设置相结合，可以建立最大转换率，其中每个单个样本无需稳定即可达到更高的ODR。温度设置同样适用此原理。

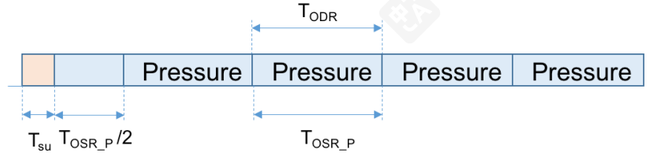


图14. 仅压力模式

最大ODR可以根据压力和温度OSR通过以下公式计算：

$ODR_{MAX}(Hz) = 10^6/(168+2.1*1.5*(OSR_{PRESS}+OSR_{TEMP}))$

其中OSR_{PRESS}, OSR_{TEMP} 表示压力和温度过采样率。

where $OSR_{PRESS} = \left(OSR\_PRESS_{register} + 1\right) * 2^5$ and $OSR_{TEMP} = \left(OSR\_TEMP_{register} + 1\right) * 2^5$

6.2.2 触发操作

触发操作（也称为强制测量模式）执行一次压力、温度或压力/温度组合测量。测量完成后，设备返回待机模式。触发操作仅支持MODE4。

6.3 FIR FILTER

The ICP-20100 includes a FIR filter in the signal path.
The FIR filter is a low pass filter, filtering off the remaining noise above ODR/4.

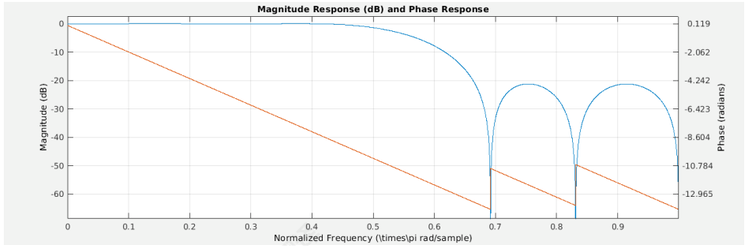


Figure 15. FIR Filter

In case the FIR filter is enabled first 14 samples should be ignored after mode change. This can be done by configuring ICP-20100 in required mode and poll for FIFO count to be 14 and flushing FIFO or by using FIFO watermark interrupt. The following sequence will explain ignoring first 14 samples using FIFO watermark interrupt:

1) Power-on the ASIC
2) Only for I^2C: initialize the I^2C interface by toggling the clock line a few times. The easiest way to do that is by inserting a dummy I^2C write transaction.
3) Configure the FIFO watermark high to 14 samples
   - regMap.FIFO_CONFIG = 0xE0
4) Unmask the watermark high interrupt
   - regMap.INTERRUPT_MASK = 0xFB
5) Start a measurement
   - regMap.MODE_SELECT.MEAS_CONFIG = M (M is the selected mode)
   - regMap.MODE_SELECT.MEAS_MODE = 1
   - regMap.MODE_SELECT.POWER_MODE = 0
6) Wait for the interrupt
7) Stop the measurement
   - regMap.MODE_SELECT = 0x00
   - wait 10us;
8) Flush the FIFO
   - regMap.FIFO_FILL = 0x80;
9) Reconfigure the interrupt settings if required for the application and detection of measurement data
10) Start a measurement
    - regMap.MODE_SELECT.MEAS_CONFIG = M (M is the selected mode)
    - regMap.MODE_SELECT.MEAS_MODE = 1
    - regMap.MODE_SELECT.POWER_MODE = 0

6.3 FIR 滤波器

ICP-20100在信号路径中包含一个FIR滤波器。
FIR 滤波器是一种低通滤波器，滤除 ODR/4 以上的剩余噪声。

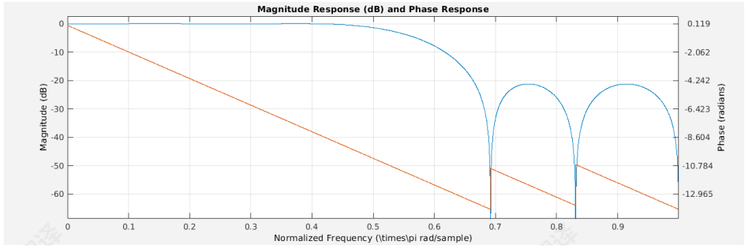


图 15. FIR 滤波器

如果 FIR 滤波器首先启用，则模式更改后应忽略前 14 个样本。这可以通过配置 ICP-20100 到所需模式并轮询 FIFO 计数达到 14 并清除 FIFO，或使用 FIFO 水位中断来完成。以下序列将解释如何使用 FIFO 水位中断忽略前 14 个样本：

1) 开启ASIC
2) 仅适用于I^2C：通过切换时钟线几次来初始化I^2C接口。最简单的方法是插入一个虚拟I^2C写事务。
3) 将FIFO水位线高配置为14个样本
   - regMap.FIFO_CONFIG = 0xE0
4) 解除水位线高中断的屏蔽
   - regMap.INTERRUPT_MASK = 0xFB
5) 开始测量
   - regMap.MODE_SELECT.MEAS_CONFIG = M (M是选择的模式)
   - regMap.MODE_SELECT.MEAS_MODE = 1
   - regMap.MODE_SELECT.POWER_MODE = 0
6) 等待中断
7) 停止测量
   - regMap.MODE_SELECT = 0x00
   - 等待 10us;
8) 刷新 FIFO
   - regMap.FIFO_FILL = 0x80;
9) 如果需要，重新配置中断设置以用于应用程序和测量数据检测
10) 开始测量
    - regMap.MODE_SELECT.MEAS_CONFIG = M (M是选择的模式)
    - regMap.MODE_SELECT.MEAS_MODE = 1
    - regMap.MODE_SELECT.POWER_MODE = 0

11) Wait for the interrupt or use another mechanism (polling, fixed wait) to detect if measurement data is available
12) Read the data from FIFO registers
    - Press[7:0] = regMap.PRESS_DATA_0
    - Press[15:8] = regMap.PRESS_DATA_1
    - Press[19:16] = regMap.PRESS_DATA_2
    - Temp[7:0] = regMap.TEMP_DATA_0
    - Temp[15:8] = regMap.TEMP_DATA_1
    - Temp[19:16] = regMap.TEMP_DATA_2
13) Repeat step 12 until the FIFO is empty

In case FIR filter is disabled (for operation mode 4) the first sample after mode change need to be ignored.

6.4 IIR FILTER

The ICP-20100 includes an IIR filter in the signal path, to filter out pressure glitches due to sudden pressure changes caused by events such as slamming door, or wind blowing on the sensor. The IIR filter is a 1st order filter with programmable cut-off frequency.

For details on how to program and use the IIR filter, refer to the application note "*AN-000238: ICP-20100 and ICP-20132 User Configurable Operation Mode and IIR Filter*."

6.5 BOOT SEQUENCE

Before starting any measurement, the device needs to be configured. This section lists the different steps to be taken before being able to conduct a measurement.

The following terminology is used in this code for register map references:

regMap.Register_Name.Register_Field_Name = Value

where

- "Register_Name" is the register name
- "Register_Field_Name" is the name of the register field in the register
- "Value" is the value being written to the specified register field

1) Power-on the ASIC
2) Initialize the I²C interface by toggling the clock line a few times. The easiest way to do that is by inserting a dummy I²C write transaction. You can for example execute the first transaction (write to lock register) twice.
3) Check the value from register regMap.version:
    - If 0x00 (version A), continue to step 4.
    - If 0xB2 (version B), no further initialization is required.
4) Check the value from register regMap. OTP_STATUS2. BOOT_UP_STATUS

11) 等待中断或使用其他机制（轮询、固定等待）来检测是否测量数据可用
12) 从FIFO寄存器读取数据
    - 按[7:0] = regMap.PRESS_DATA_0
    - 按[15:8] = regMap.PRESS_DATA_1
    - 按[19:16] = regMap.PRESS_DATA_2
    - Temp[7:0] = regMap.TEMP_DATA_0
    - Temp[15:8] = regMap.TEMP_DATA_1
    - Temp[19:16] = regMap.TEMP_DATA_2
13) 重复步骤12，直到FIFO为空

如果 FIR 滤波器被禁用（对于操作模式 4），在模式切换后的第一个样本需要被忽略。

6.4 IIR 滤波器

ICP-20100 在信号路径中包含一个 IIR 滤波器，用于过滤由于突然的压力变化（例如猛关门或风吹传感器）引起的压力毛刺。IIR 滤波器是一个 1st 阶滤波器，具有可编程的截止频率。

有关如何编程和使用 IIR 滤波器的详细信息，请参阅应用笔记"AN-000238: ICP-20100 和 ICP- 20132 用户可配置操作模式和 IIR 滤波器。"

6.5 启动序列

在进行任何测量之前，设备需要被配置。本节列出了在进行测量之前需要采取的不同步骤。

以下术语用于此代码中的寄存器映射引用：

regMap.Register_Name.Register_Field_Name = Value

where

- "Register_Name" 是寄存器名称
- "Register_Field_Name" 是寄存器中的寄存器字段名称
- "Value" 是写入指定寄存器字段的值

1) ASIC 上电
2) 通过几次切换时钟线来初始化 I²C 接口。最简单的方法是插入一个虚拟 I²C 写事务。例如，您可以执行第一次事务（写入锁寄存器）两次。

3) 检查寄存器 regMap.version 的值：
    - 如果为 0x00（版本 A），继续执行步骤 4。
    - 如果为 0xB2（版本 B），则无需进一步初始化。
4) 检查寄存器 regMap.OTP_STATUS2 和 BOOT_UP_STATUS 的值。

- If 1, ICP-20100 didn't go through power cycle after previous boot up sequence. No further initialization is required.
- If 0, boot up config is not done after ICP-20100 power on. Continue to step 5

5) Bring the ASIC in power mode to activate the OTP power domain and get access to the main registers
   - regMap.MODE_SELECT.POWER_MODE = 1
   - Wait 4ms;
6) Unlock the main registers
   - regMap.MASTER_LOCK.LOCK = 0x1f
7) Enable the OTP and the write switch
   - regMap.OTP_CONFIG1.OTP_ENABLE = 1;
   - regMap.OTP_CONFIG1.OTP_WRITE_SWITCH = 1;
   - wait 10µs;
8) Toggle the OTP reset pin
   - regMap.OTP_DBG2.RESET = 1
   - wait 10us
   - regMap.OTP_DBG2.RESET = 0
   - wait 10us
9) Program redundant read
   - regMap.OTP_MRA_LSB = 0x04
   - regMap.OTP_MRA_MSB = 0x04
   - regMap.OTP_MRB_LSB = 0x21
   - regMap.OTP_MRB_MSB = 0x20
   - regMap.OTP_MR_LSB = 0x10
   - regMap.OTP_MR_MSB = 0x80
10) Write the address content and read command
   - regMap.OTP_ADDRESS.ADDRESS = 8'hF8 // for offset
   - regMap.OTP_COMMAND.ADDRESS = 4'h0
   - regMap.OTP_COMMAND.COMMAND = 1 // read action
11) Wait for the OTP read to finish
   - Monitor regMap.OTP_STATUS.BUSY to be 0
12) Read the data from register
   - Offset = regMap.OTP_RDATA.VALUE
13) Write the next address content and read command
   - regMap.OTP_ADDRESS.ADDRESS = 8'hF9 // for gain
   - regMap.OTP_COMMAND.ADDRESS = 4'h0

- 如果为1，ICP-20100在之前的启动序列后没有经过电源循环。无需进一步初始化。
- 如果为0，ICP-20100上电后没有完成启动配置。继续执行步骤5

5) 将ASIC置于电源模式以激活OTP电源域并访问主寄存器
   - regMap.MODE_SELECT.POWER_MODE = 1
   - 等待4ms;
6) 解锁主寄存器
   - regMap.MASTER_LOCK.LOCK = 0x1f
7) 启用OTP和写入开关
   - regMap.OTP_CONFIG1.OTP_ENABLE = 1;
   - regMap.OTP_CONFIG1.OTP_WRITE_SWITCH = 1;
   - wait 10µs;
8) 切换OTP重置引脚
   - regMap.OTP_DBG2.RESET = 1
   - wait 10us
   - regMap.OTP_DBG2.RESET = 0
   - 等待 10 微秒
9) 冗余读取程序
   - regMap.OTP_MRA_LSB = 0x04
   - regMap.OTP_MRA_MSB = 0x04
   - regMap.OTP_MRB_LSB = 0x21
   - regMap.OTP_MRB_MSB = 0x20
   - regMap.OTP_MR_LSB = 0x10
   - regMap.OTP_MR_MSB = 0x80
10) 写入地址内容并读取命令
   - regMap.OTP_ADDRESS.ADDRESS = 8'hF8 // 用于偏移
   - regMap.OTP_COMMAND.ADDRESS = 4'h0
   - regMap.OTP_COMMAND.COMMAND = 1 // read action
11) 等待OTP读取完成
   - 监控regMap.OTP_STATUS.BUSY为0
12) 从寄存器读取数据
   - 偏移量 = regMap.OTP_RDATA.VALUE
13) 写入下一个地址内容并读取命令
   - regMap.OTP_ADDRESS.ADDRESS = 8'hF9 // for gain
   - regMap.OTP_COMMAND.ADDRESS = 4'h0

- regMap.OTP_COMMAND.COMMAND = 1 // read action

14) Wait for the OTP read to finish
    - Monitor regMap.OTP_STATUS.BUSY to be 0
15) Read the data from register
    - Gain = regMap.OTP_RDATA.VALUE
16) Write the next address content and read command
    - regMap.OTP_ADDRESS.ADDRESS = 8'hFA // for HFosc
    - regMap.OTP_COMMAND.ADDRESS = 4'h0
    - regMap.OTP_COMMAND.COMMAND = 1 // read action
17) Wait for the OTP read to finish
    - Monitor regMap.OTP_STATUS.BUSY to be 0
18) Read the data from register
    - HFosc = regMap.OTP_RDATA.VALUE
19) Disable OTP and write switch
    - regMap.OTP_CONFIG1.OTP_ENABLE = 0;
    - regMap.OTP_CONFIG1.OTP_WRITE_SWITCH = 0;
    - wait 10µs;
20) Write the Offset to the main registers
    - regMap.TRIM1_MSB.PEFE_OFFSET_TRIM = Offset[5:0]
21) Write the Gain to the main registers without touching the parameter BG_PTAT_TRIM
    - Rdata = regMap.TRIM2_MSB
    - Rdata[6:4] = Gain[2:0]
    - regMap.TRIM2_MSB = Rdata
22) Write the HFosc trim value to the main registers
    - regMap.TRIM2_LSB = HFosc
23) Lock the main registers
    - regMap.MASTER_LOCK.LOCK = 0x00
24) Move to standby
    - regMap.MODE_SELECT.POWER_MODE = 0
25) Write bootup config status to 1 to avoid re initialization with out power cycle.
    regMap. OTP_STATUS2. BOOT_UP_STATUS = 1

Note: The bootup sequence should be run only once for every powerup. Running the boot sequence multiple times could create issues.

- regMap.OTP_COMMAND.COMMAND = 1 // read action

14) 等待OTP读取完成
    - 监控regMap.OTP_STATUS.BUSY为0
15) 从寄存器读取数据
    - 获取 = regMap.OTP_RDATA.VALUE
16) 写入下一个地址内容并读取命令
    - regMap.OTP_ADDRESS.ADDRESS = 8'hFA // for HFosc
    - regMap.OTP_COMMAND.ADDRESS = 4'h0
    - regMap.OTP_COMMAND.COMMAND = 1 // read action
17) 等待 OTP 读取完成
    - 监控 regMap.OTP_STATUS.BUSY 为 0
18) 从寄存器读取数据
    - HFosc = regMap.OTP_RDATA.VALUE
19) 禁用 OTP 并写入开关
    - regMap.OTP_CONFIG1.OTP_ENABLE = 0;
    - regMap.OTP_CONFIG1.OTP_WRITE_SWITCH = 0;
    - 等待 10µ 秒;
20) 将偏移量写入主寄存器
    - regMap.TRIM1_MSB.PEFE_OFFSET_TRIM = Offset[5:0]
21) 将增益写入主寄存器，同时不触碰参数 BG_PTAT_TRIM
    - Rdata = regMap.TRIM2_MSB
    - Rdata[6:4] = Gain[2:0]
    - regMap.TRIM2_MSB = Rdata
22) 将HFosc微调值写入主寄存器
    - regMap.TRIM2_LSB = HFosc
23) 锁定主寄存器
    - regMap.MASTER_LOCK.LOCK = 0x00
24) 移至待机状态
    - regMap.MODE_SELECT.POWER_MODE = 0
25) 将启动配置状态写入1以避免在不进行电源循环的情况下重新初始化。
    regMap. OTP_状态2. 启动_状态_ = 1

注意：每次通电时，启动序列应只运行一次。多次运行启动序列可能会导致问题。

6.6 MODE SWITCHING/SELECTION

Mode switching/selection is done by

- Making sure the previous mode is selected by reading the register field MODE_SYNC_STATUS of register DEVICE_STATUS until it is set to '1'.
- Starting the new mode by selecting it in the register field MEAS_CONFIG of register MODE_SELECT.

6.7 PRESSURE/TEMPERATURE READ-OUT

Pressure and temperature are read out by

- Waiting until the FIFO contains data (either by polling the FIFO_LEVEL register field in register FIFO_FILL or though configuration of the FIFO watermark high interrupt).
- Read out registers PRESS_DATA_0, PRESS_DATA_1, PRESS_DATA_2, TEMP_DATA_0 , TEMP_DATA_1, and TEMP_DATA_2 using the address increment burst feature of the SPI, I^2C or $I3C^{SM}$ interface. The FIFO read pointer will automatically increment on reading the last register TEMP_DATA_2. The read address will automatically wrap to address PRESS_DATA_0 (in case of Pressure first mode refer to section 7). This means that multiple FIFO locations can be read out by continuously using the interface address increment function until the FIFO is empty.

6.7.1 Pressure conversion formula

The 20-bit output pressure value represents a two's complement integer from -2^{19} till $2^{19}-1$

To convert this value into pressure, use the formula

$P = (P_{OUT}/2^{17})*40kPa + 70kPa$

- P: pressure in kPa
- P_{OUT}: two's complement representation of the pressure output code

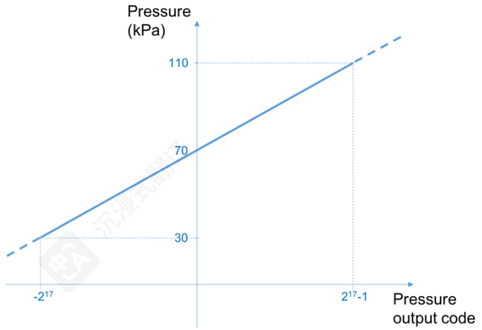


Figure 16. Pressure Output Code

6.6 模式切换/选择

模式切换/选择是由

- 确保通过读取寄存器字段 DEVICE STATUS 的 MODE_SYNC_STATUS，直到其设置为 '1' 来选择上一个模式._
- 通过在寄存器字段 MODE_SELECT 的 MEAS_CONFIG 中选择它来启动新模式。

6.7 压力/温度读出

压力和温度由

- 等待FIFO包含数据（通过轮询FIFO_LEVEL寄存器字段在寄存器FIFO_FILL或通过配置FIFO水位高中断）。
- 使用SPI、I^2C或$I3C^{SM}$ 接口的地址增量突发功能，读出寄存器PRESS_DATA_0、PRESS_DATA_1、PRESS_DATA_2、TEMP_DATA_0 、TEMP_DATA_1和TEMP_DATA_2 。在读取最后一个寄存器TEMP_DATA_2时，FIFO读指针将自动递增。读地址将自动回绕到地址PRESS_DATA_0 （在压力优先模式下，请参考第7节）。这意味着可以通过连续使用接口地址增量功能，直到FIFO为空，读出多个FIFO位置。

6.7.1 压力转换公式

20位输出压力值表示一个从-2^{19} 到$2^{19}-1$的二进制补码整数

将此值转换为压力，使用公式

$P = (P_{OUT}/2^{17})*40kPa + 70kPa$ -

P: 压力，单位为kPa

- P_{OUT}: 压力输出代码的二进制补码表示

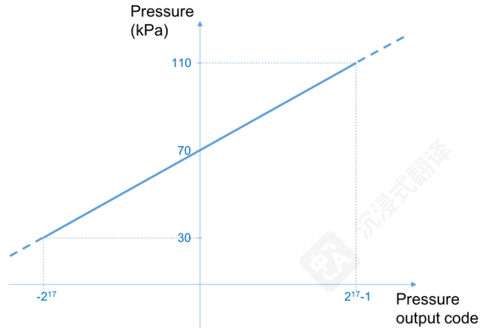


图16. 压力输出代码

6.7.2 Temperature conversion formula

The 20-bit output temperature value represents a two's complement integer from -2^{19} till $2^{19}-1$

To convert this value into temperature, use the formula

$T = (T_{OUT}/2^{18})*65C + 25C$

- T: temperature in degrees Celsius
- T_{OUT}: two's complement representation of the temperature output code

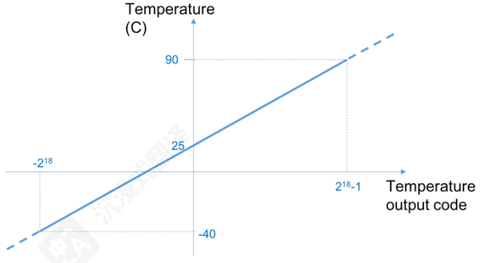


Figure 17. Temperature Output Code

6.7.2 温度转换公式

20位的输出温度值表示一个从-2^{19} 到 $2^{19}-1$ 的二进制补码整数

将此值转换为温度，请使用公式

$T = (T_{OUT}/2^{18})*65C + 25C$

- T：摄氏温度
- T_{OUT}：二进制补码表示的温度输出代码

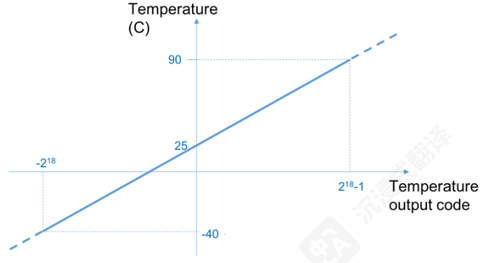


图17. 温度输出代码

7 FIFO

A 96-bytes FIFO allows to buffer up to 16 pressure and temperature measurement pairs before reading them out through I²C, I3C^SM or SPI.

Four modes are supported when reading out the FIFO with address increment:

- Pressure first: The address wraps to the start address of the Pressure value
- Temperature only: The address wraps to the start address of the Temperature value
- Temperature first: Temperature and pressure locations are switched, the address wraps to the start address of the Temperature value
- Pressure only: Temperature and pressure locations are switched, the address wraps to the start address of the Pressure value

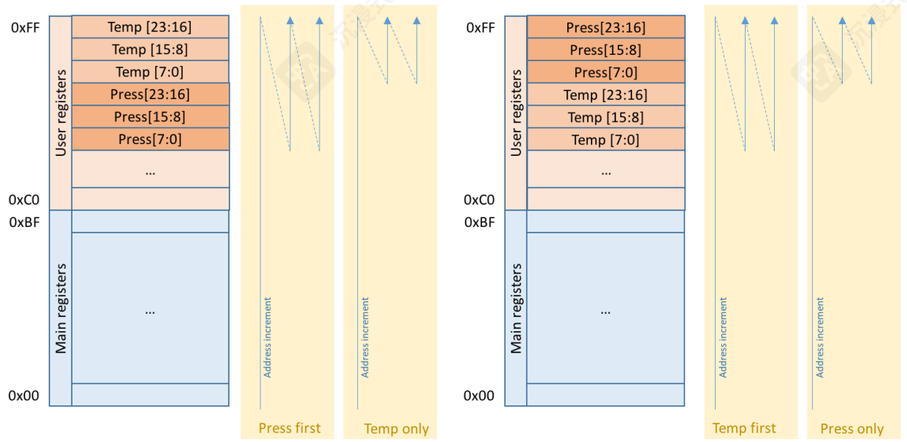


Figure 18. FIFO Read Out Modes

7.1 FIFO ACCESSIBILITY

The Measurement FIFO registers are accessible from the I²C/I3C^SM/SPI interface in all operating modes, including Standby mode.

The Measurement FIFO registers need to be read out in burst mode for I²C/I3C^SM. The data that is read out is not guaranteed to be consistent if every byte is addressed separately.

7 FIFO

一个 96 字节的 FIFO 允许在通过 I²C、I3C^SM 或 SPI 读取之前缓冲多达 16 个压力和温度测量对

在以地址递增方式读取FIFO时，支持四种模式：

- 压力优先：地址回绕到压力值的起始地址
- 仅温度：地址绕到温度值的起始地址
- 温度优先：温度和压力位置被交换，地址绕到温度值的起始地址
- 仅压力：温度和压力位置被交换，地址绕到压力值的起始地址

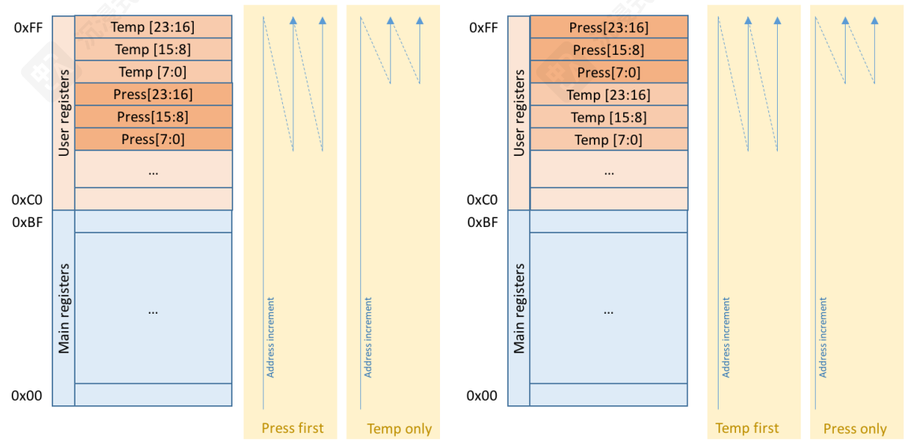


图18。FIFO读出模式

7.1 FIFO可访问性

测量FIFO寄存器可在所有工作模式（包括待机模式）中通过I²C/I3C^SM/SPI接口访问。

测量 FIFO 寄存器需要以突发模式读取 I²C/I3C^SM。如果单独寻址每个字节，读取出的数据可能无法保证一致性。

7.2 FIFO FULL/EMPTY

A FIFO full flag is raised when the FIFO level reaches the FIFO size.

Data is not written to the FIFO if it is full. The FIFO full flag is reset when the FIFO level drops below the FIFO size by fetching a FIFO word through from the I²C/I3C^SM/SPI interface.

A FIFO empty flag is raised when the FIFO level reaches 0.

A read transaction from the FIFO returns 0x00 values if it is empty. The FIFO empty flag is reset when the FIFO level increases above 0.

7.3 FIFO OVERFLOW/UNDERFLOW

A FIFO overflow flag is raised when a new pressure/temperature pair is written to the FIFO while it is full. The written pressure/temperature pair is ignored. The FIFO overflow flag is latched and can be reset by setting it through the I²C/I3C^SM/SPI interface.

A FIFO underflow flag is raised when a pressure/temperature pair is fetched from the FIFO while it is empty. The data read from the FIFO contains 0x00 values. The FIFO underflow flag is latched and can be reset by setting it through the I²C/I3C^SM/SPI interface.

7.4 FIFO WATERMARK LOW/HIGH

Two FIFO watermark register fields, FIFO_WMK_LOW and FIFO_WMK_HIGH, can be used to manage the data flow from the sensor to the host.

The watermark high flag is set when the FIFO level reaches the high value watermark specified by FIFO_WMK_HIGH.

The watermark low flag is set when the FIFO level reaches the low value watermark specified by FIFO_WMK_LOW.

The FIFO watermark flags are latched and can be reset by setting them through the I²C/I3C^SM/SPI interface.

7.5 FIFO FLUSH

A FIFO flush command allows the user to flush the FIFO. The register field FLUSH should be set to 1 to flush the FIFO.

7.6 ABSOLUTE PRESSURE VALUE OVERRUN/UNDERRUN

An absolute pressure value overrun flag is raised when the pressure value crosses a configurable 16-bit pressure overrun/underrun value. This value is configurable in the user register map using registers PRESS_ABS_LSB and PRESS_ABS_MSB.

7.7 DELTA PRESSURE VALUE OVERRUN

A delta pressure value overrun flag is raised when the absolute difference between 2 consecutive pressure values exceeds a configurable 16-bit delta pressure overrun value. This value is configurable in the user register map, using registers PRESS_DELTA_LSB and PRESS_DELTA_MSB.

7.2 FIFO FULL/EMPTY

当FIFO水位达到FIFO大小时，会触发FIFO满标志。

如果 FIFO 满了，数据不会被写入 FIFO。当 FIFO 水平低于 FIFO 大小时，通过 I²C/I3C^SM/SPI 接口获取 FIFO 字，FIFO 满标志会被重置。

当FIFO水位达到0时，会触发FIFO空标志。

从FIFO读取事务如果为空会返回0x00值。当FIFO水位高于0时，FIFO空标志位会被重置。

7.3 FIFO溢出/下溢

当FIFO满时，写入新的压力/温度对会触发FIFO溢出标志位。写入的压力/温度对会被忽略。FIFO溢出标志位会被锁存，可以通过通过I²C/I3C^SM/SPI接口将其重置。

当FIFO空时，从FIFO读取压力/温度对会触发FIFO下溢标志位。从FIFO读取的数据包含0x00值。FIFO下溢标志位会被锁存，可以通过通过I{v1}C/I3C{v2}/SPI接口将其重置。
通过I²C/I3C^SM/SPI接口。

7.4 FIFO低水位/高水位

两个FIFO水位线寄存器字段，FIFO_WMK_LOW和FIFO_WMK_HIGH，可用于管理从传感器到主机的数据流。

当FIFO水位线达到由FIFO WMK HIGH._ _指定的水位线高值时，水位线高标志位会被设置。

当FIFO水位线达到由FIFO_WMK_LOW指定的水位线低值时，水位线低标志位会被设置。FIFO水位线标志位会被锁存，并通过I²C/I3C^SM/SPI接口进行重置。

7.5 FIFO FLUSH

一个FIFO刷新命令允许用户刷新FIFO。FLUSH寄存器字段应设置为1以刷新FIFO。

7.6 绝对压力值溢出/欠溢出

当压力值跨越一个可配置的16位压力溢出/欠量值时，会触发绝对压力值溢出标志。此值可通过用户寄存器映射中的寄存器 PRESS_ABS_LSB 和 PRESS ABS MSB._ _ 进行配置。

7.7 DELTA 压力值溢出

当两个连续的压力值之间的绝对差值超过可配置的16位Delta压力过载值时，会触发Delta压力过载标志。此值可在用户寄存器映射中配置，使用寄存器PRESS_DELTA_LSB和PRESS_DELTA_MSB。

8 INTERRUPTS

The interrupt pin is open-drain. It is pulled high by default by an internal pull-up resistor. On an interrupt event, it is driven low until the interrupt source has been cleared through the I²C/I3C^SM/SPI interface.

The interrupt can be configured to be connected to any of the following interrupt sources:

- FIFO overflow
- FIFO underflow
- FIFO watermark low
- FIFO watermark high
- Absolute pressure threshold overrun
- Absolute pressure threshold underrun
- Delta pressure threshold overrun

Each interrupt source can be individually masked.

8 中断

中断引脚是开漏的。它默认由内部上拉电阻拉高。在发生中断事件时，它会被驱动低，直到通过I²C/I3C^SM/SPI接口清除中断源。

中断可以被配置为连接到以下任意中断源：

- FIFO 溢出
- FIFO 溢出
- FIFO 水位低
- FIFO 水位高
- 绝对压力阈值超限
- 绝对压力阈值欠限
- 压差阈值超限

每个中断源都可以单独屏蔽。

9 ASSEMBLY

This section provides general guidelines for assembling TDK Micro Electro-Mechanical Systems (MEMS) pressure sensors.

9.1 IMPLEMENTATION AND USAGE RECOMMENDATIONS

9.1.1 Soldering

When soldering, use the standard soldering profile IPC/JEDEC J-STD-020 with peak temperatures of 260°C. ICP-20100 may exhibit a pressure offset after soldering, some settling time may be required depending on soldering properties, PCB properties, and ambient conditions.

ICP-20100 devices have MSL rating 1, appropriate JEDEC J-STD-020 guidelines should be followed to avoid damaging the part.

9.1.2 Chemical Exposure and Sensor Protection

The ICP-20100 is an open cavity package and should not be exposed to particulates or liquids. If any type of protective coating must be applied to the circuit board, the sensor must be protected during the coating process.

9 组件

本节提供了组装TDK微型机电系统（MEMS）压力传感器的一般指南。

9.1 实施和使用建议

9.1.1 焊接

焊接时，请使用标准的焊接温度曲线 IPC/JEDEC J-STD-020，峰值温度为 260°C。
ICP-20100 在焊接后可能会出现压力偏移，根据焊接特性、PCB 特性和环境条件，可能需要一定的稳定时间。

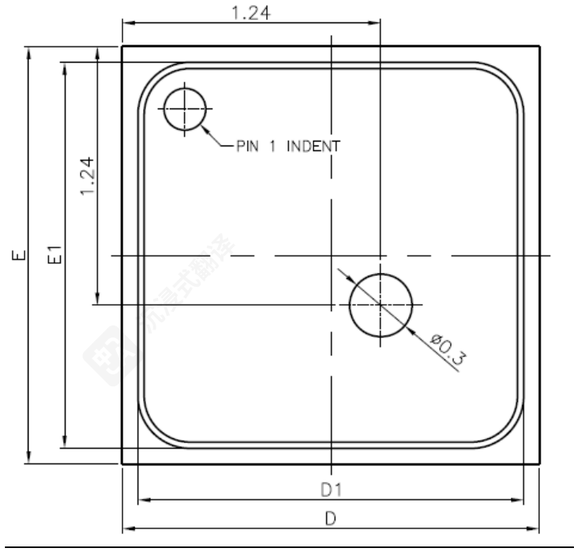
ICP-20100 器件具有 MSL 等级 1，应遵循适当的 JEDEC J-STD-020 指南，以避免损坏器件。

9.1.2 化学暴露和传感器保护

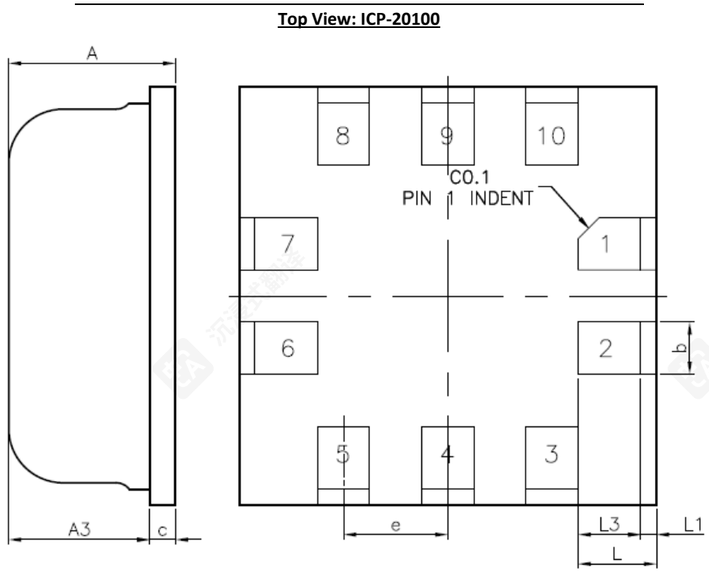
ICP-20100 是一个开腔体封装，不应暴露于颗粒物或液体中。如果必须在电路板上应用任何类型的保护涂层，传感器的封装过程必须进行保护。

10 PACKAGE DIMENSIONS

Package dimensions for the ICP-20100:



Top View: ICP-20100

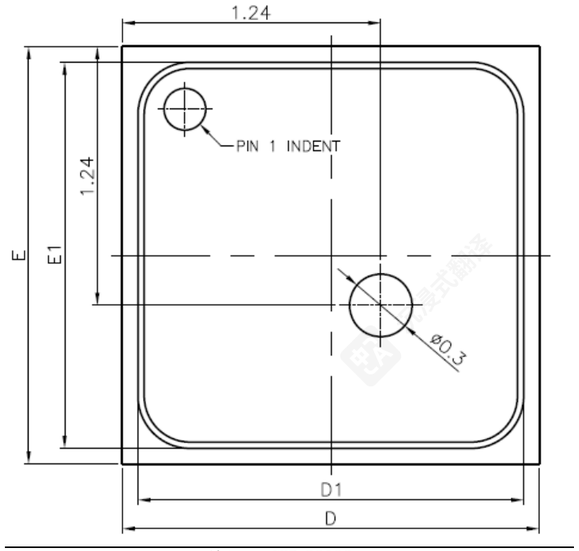


Bottom View: ICP-20100

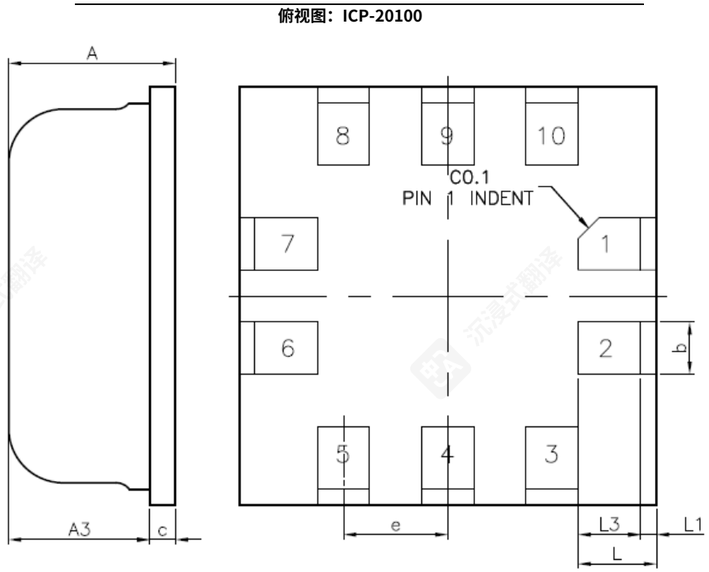
Figure 19. ICP-20100 Package Diagrams

10 包装尺寸

ICP-20100 的封装尺寸：



俯视图：ICP-20100



底视图：ICP-20100

图19. ICP-20100 封装图

SYMBOLS	DIMENSIONS IN MILLIMETERS		
	MIN.	NOM.	MAX.
A	0.750	0.800	0.850
A3	0.655	0.675	0.695
b	0.200	0.250	0.300
c	0.100	0.125	0.150
D	1.950	2.000	2.050
D1	1.820	1.850	1.880
E	1.950	2.000	2.050
E1	1.820	1.850	1.880
e	0.450	0.500	0.550
L	0.275	0.375	0.425
L1	0.025	0.075	0.100
L3	0.250	0.300	0.325

Table 19. ICP-20100 Package Dimensions

SYMBOLS	毫米单位尺寸		
	MIN.	NOM.	MAX.
A	0.750	0.800	0.850
A3	0.655	0.675	0.695
b	0.200	0.250	0.300
c	0.100	0.125	0.150
D	1.950	2.000	2.050
D1	1.820	1.850	1.880
E	1.950	2.000	2.050
E1	1.820	1.850	1.880
e	0.450	0.500	0.550
L	0.275	0.375	0.425
L1	0.025	0.075	0.100
L3	0.250	0.300	0.325

表19. ICP-20100封装尺寸

11 PART NUMBER PART MARKINGS

The part number part markings for ICP-20100 devices are summarized below:

PART NUMBER	PART MARKING
ICP-20100	S1

Table 20. Part Number Part Markings

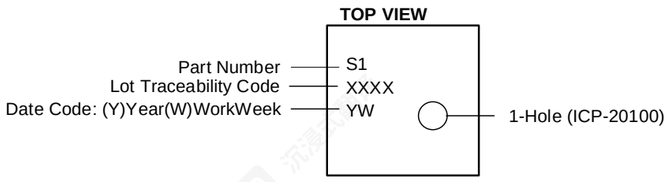


Figure 20. Part Number Part Markings for ICP-20100

11 零件编号 零件标记

ICP-20100 设备的零件编号零件标记总结如下：

零件编号	零件标记
ICP-20100	S1

表 20. 零件编号 零件标记

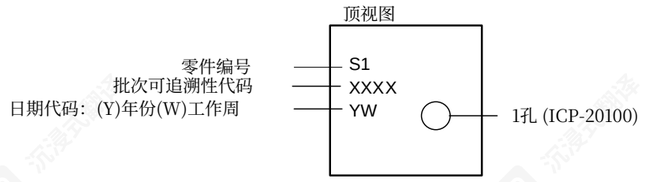


图 20. ICP-20100 的零件编号 零件标记

12 REGISTER MAP

This section lists the register map for ICP-20100.

Addr (Hex)	Addr (Dec.)	Register Name	Serial I/F	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
5	5	TRIM1_MSB	R/W	-		PEFE_OFFSET_TRIM					
6	6	TRIM2_LSB	R/W		HF_OSC_TRIM						
7	7	TRIM2_MSB	R/W	-	PEFE_GAIN_TRIM			BG_PTAT_TRIM			
C	12	DEVICE_ID	RO	VALUE							
D	13	IO_DRIVE_STRENGTH	R/W	-					IO_DS		
AC	172	OTP_CONFIG1	R/W	-						OTP_EN	OTP_WR
AD	173	OTP_MR_LSB	R/W	VALUE_LSB							
AE	174	OTP_MR_MSB	R/W	VALUE_MSB							
AF	175	OTP_MRA_LSB	R/W	VALUE_LSB							
B0	176	OTP_MRA_MSB	R/W	VALUE_MSB							
B1	177	OTP_MRB_LSB	R/W	VALUE_LSB							
B2	178	OTP_MRB_MSB	R/W	VALUE_MSB							
B5	181	OTP_ADDRESS_REG	R/W	OTP_ADDRESS_LSB							
B6	182	OTP_COMMAND_REG	R/W	-	COMMAND			OTP_ADDRESS_MSB			
B8	184	OTP_RDATA	R	VALUE							
B9	185	OTP_STATUS	R	-							BUSY
BC	188	OTP_DBG2	R/W	RESET	-						
BE	190	MASTER_LOCK	W	LOCK							
BF	191	OTP_STATUS2	R/W	-							BOOT_UP_STATUS
C0	192	MODE_SELECT	R/W	MEAS_CONFIG			FORCED_MEAS_TRIGGER	MEAS_MODE	POWER_MODE	FIFO_READOUT_MODE	
C1	193	INTERRUPT_STATUS	R/W	-	PRESS_DELTA_INT	PRESS_ABS_INT	-	FIFO_WM_LOW_INT	FIFO_WM_HIGH_INT	FIFO_UNDERFLOW_INT	FIFO_OVERFLOW_INT
C2	194	INTERRUPT_MASK	R/W	-	PRESS_DELTA_MASK	PRESS_ABS_MASK	-	FIFO_WM_LOW_MASK	FIFO_WM_HIGH_MASK	FIFO_UNDERFLOW_MASK	FIFO_OVERFLOW_MASK
C3	195	FIFO_CONFIG	R/W	FIFO_WM_HIGH				FIFO_WM_LOW			
C4	196	FIFO_FILL	R/W	FIFO_FLUSH	FIFO_EMPTY	FIFO_FULL	FIFO_LEVEL				
C5	197	SPI_MODE	R/W	-							SPI_MODE
C7	199	PRESS_ABS_LSB	R/W	PRESS_ABS_LSB							
C8	200	PRESS_ABS_MSB	R/W	PRESS_ABS_MSB							
C9	201	PRESS_DELTA_LSB	R/W	PRESS_DELTA_LSB							
CA	202	PRESS_DELTA_MSB	R/W	PRESS_DELTA_MSB							
CD	205	DEVICE_STATUS	R	-							MODE_SYNC_STATUS
CE	206	I3C_INFO	R	I3C_INFO							
D3	211	VERSION	R	MAJOR				MINOR			
FA	250	PRESS_DATA_0	R	PRESS_DATA_0							
FB	251	PRESS_DATA_1	R	PRESS_DATA_1							
FC	252	PRESS_DATA_2	R	-				PRESS_DATA_2			
FD	253	TEMP_DATA_0	R	TEMP_DATA_0							
FE	254	TEMP_DATA_1	R	TEMP_DATA_1							
FF	255	TEMP_DATA_2	R	-				TEMP_DATA_2			

Table 21. Register Map

12 寄存器映射

本节列出了 ICP-20100 的寄存器映射。

地址（十六进制）	地址（十进制）	寄存器名称	序列 I/F	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
5	5	TRIM1_MSB	R/W	-		PEFE_OFFSET_TRIM					
6	6	TRIM2_LSB	R/W		HF_OSC_TRIM						
7	7	TRIM2_MSB	R/W	-	PEFE_GAIN_TRIM			BG_PTAT_TRIM			
C	12	DEVICE_ID	RO	VALUE							
D	13	IO_DRIVE_STRENGTH	R/W	-					IO_DS		
AC	172	OTP_CONFIG1	R/W	-						OTP_EN	OTP_WR
AD	173	OTP_MR_LSB	R/W	VALUE_LSB							
AE	174	OTP_MR_MSB	R/W	VALUE_MSB							
AF	175	OTP_MRA_LSB	R/W	VALUE_LSB							
B0	176	OTP_MRA_MSB	R/W	VALUE_MSB							
B1	177	OTP_MRB_LSB	R/W	VALUE_LSB							
B2	178	OTP_MRB_MSB	R/W	VALUE_MSB							
B5	181	OTP_ADDRESS_REG	R/W	OTP_ADDRESS_LSB							
B6	182	OTP_COMMAND_REG	R/W	-	COMMAND			OTP_ADDRESS_MSB			
B8	184	OTP_RDATA	R	VALUE							
B9	185	OTP_STATUS	R	- 忙碌							
BC	188	OTP_DBG2	R/W	RESET	-						
BE	190	MASTER_LOCK	W	LOCK							
BF	191	OTP_STATUS2	R/W	-							启动_状态
C0	192	模式选择	R/W	测量配置			强制测量触发	测量模式	POWER_MODE	FIFO_READOUT_MODE	
C1	193	INTERRUPT_STATUS	R/W	-	PRESS_DELTA_INT	PRESS_ABS_INT	-	FIFO_WM_LOW_INT	FIFO_WM_HIGH_INT	FIFO_UNDERFLOW_INT	FIFO_OVERFLOW_INT
C2	194	INTERRUPT_MASK	R/W	-	PRESS_DELTA_MASK	PRESS_ABS_MASK	-	FIFO_WM_LOW_MASK	FIFO_WM_HIGH_MASK	FIFO_UNDERFLOW_MASK	FIFO_OVERFLOW_MASK
C3	195	FIFO_CONFIG	R/W	FIFO_WM_HIGH				FIFO_WM_LOW			
C4	196	FIFO_FILL	R/W	FIFO_FLUSH	FIFO_EMPTY	FIFO_FULL	FIFO_LEVEL				
C5	197	SPI_MODE	R/W	-							SPI_MODE
C7	199	PRESS_ABS_LSB	R/W	PRESS_ABS_LSB							
C8	200	PRESS_ABS_MSB	R/W	PRESS_ABS_MSB							
C9	201	PRESS_DELTA_LSB	R/W	PRESS_DELTA_LSB							
CA	202	PRESS_DELTA_MSB	R/W	PRESS_DELTA_MSB							
CD	205	DEVICE_STATUS	R	-							MODE_SYNC_STATUS
CE	206	I3C_INFO	R	I3C_INFO							
D3	211	VERSION	R	MAJOR				MINOR			
FA	250	PRESS_DATA_0	R	PRESS_DATA_0							
FB	251	PRESS_DATA_1	R	PRESS_DATA_1							
FC	252	PRESS_DATA_2	R	-				PRESS_DATA_2			
FD	253	TEMP_DATA_0	R	TEMP_DATA_0							
FE	254	TEMP_DATA_1	R	TEMP_DATA_1							
FF	255	TEMP_DATA_2	R	-				TEMP_DATA_2			

表 21. 寄存器映射

13 REGISTER MAP DESCRIPTION

This section describes the function and contents of each register.

13.1 TRIM1_MSB

Name: TRIM1_MSB
Address: 5 (0x05)
Serial IF: R/W
Reset value: Device dependent

BIT	NAME	FUNCTION
7:6	-	Reserved
5:0	PEFE_OFFSET_TRIM	Trim value for the pressure front-end

13.2 TRIM2_LSB

Name: TRIM2_LSB
Address: 6 (0x06)
Serial IF: R/W
Reset value: Device dependent

BIT	NAME	FUNCTION
7	-	Reserved
6:0	HFOSC_TRIM	Trim value for the high frequency oscillator

13.3 TRIM2_MSB

Name: TRIM1_MSB
Address: 7 (0x07)
Serial IF: R/W
Reset value: Device dependent

BIT	NAME	FUNCTION
7	-	Reserved
6:4	PEFE_GAIN_TRIM	Trim value for the pressure front-end
3:0	BG_PTAT_TRIM	Trim value for PTAT current

13.4 DEVICE_ID

Name: DEVICE_ID
Address: 12 (0x0C)
Serial IF: RO
Reset value: 0x63

BIT	NAME	FUNCTION
7:0	VALUE	8-bit Device ID

13 寄存器映射描述

本节描述了每个寄存器的功能和内容。

13.1 TRIM1 MSB_

名称：TRIM1 MSB_
地址：5 (0x05)
串行接口：读写
复位值：设备相关

BIT	NAME	功能
7:6	-	保留
5:0	PEFE 偏移修剪_	压力前端修剪值

13.2 修剪2 LSB_

名称：修剪2 LSB_
地址：6 (0x06)
串行接口：读写
重置值：设备相关

BIT	NAME	FUNCTION
7	-	保留
6:0	HFOSC TRIM_	高频振荡器微调值

13.3 TRIM2 MSB_

名称: TRIM1 MSB_
地址: 7 (0x07)
串行接口: R/W
复位值: 设备相关

BIT	NAME	FUNCTION
7	-	保留
6:4	PEFE GAIN TRIM_	压力前端调整值
3:0	BG PTAT TRIM	PTAT 电流调整值

13.4 设备 ID_

名称：设备 ID_
地址: 12 (0x0C)
串行接口: RO
复位值: 0x63

BIT	NAME	FUNCTION
7:0	VALUE	8位设备ID

13.5 IO_DRIVE_STRENGTH

Name: IO_DRIVE_STRENGTH
Address: 13 (0x0D)
Serial IF: R/W
Reset value: 0x03

BIT	NAME	FUNCTION
7:3	-	Reserved
2:0	IO_DS	IO drive strength value 000: 2 mA for 1.8V IO supply 001: 4 mA for 1.8V IO supply 010: 8 mA for 1.8V IO supply 011: 12 mA for 1.8V IO supply 100: 2 mA for 1.2V IO supply 101: 4 mA for 1.2V IO supply 110: 6 mA for 1.2V IO supply 111: 8 mA for 1.2V IO supply

13.6 OTP_CONFIG1

Name: OTP_CONFIG1
Address: 172 (0xAC)
Serial IF: R/W
Reset value: 0x00

BIT	NAME	FUNCTION
7:2	RESERVED	-
1	OTP_WRITE_SWITCH	Connect OTP VCC to VCORE. This is needed for OTP write. VCORE should be 3V3 in this case
0	OTP_ENABLE	Enable the OTP

13.7 OTP_MR_LSB

Name: OTP_MR_LSB
Address: 173 (0xAD)
Serial IF: R/W
Reset value: 0x00

BIT	NAME	FUNCTION
7:0	VALUE_LSB	OTP MR register bits 7:0

13.8 OTP_MR_MSB

Name: OTP_MR_MSB
Address: 174 (0xAE)
Serial IF: R/W
Reset value: 0x00

BIT	NAME	FUNCTION
7:0	VALUE_MSB	OTP MR register bits 15:8

13.5 IO 驱动强度_ _

名称：IO 驱动强度_ _
地址：13 (0x0D)
串行接口：R/W 复
位值：0x03

BIT	NAME	FUNCTION
7:3	-	保留
2:0	IO DS_	IO 驱动强度值 000: 2 mA 用于 1.8V IO 电源 001: 4 mA 用于 1.8V IO 电源 010: 8 mA 用于 1.8V IO 电源 011: 12 mA 用于 1.8V IO 电源 100: 2 mA 用于 1.2V IO 电源 101: 4 mA 用于 1.2V IO 电源 110: 6 mA 用于 1.2V IO 电源 111: 8 mA 用于 1.2V IO 电源

13.6 OTP CONFIG1_

名称：OTP 配置1_地址：172
(0xAC)
串行接口：R/W 复
位值：0x00

BIT	NAME	功能
7:2	保留	-
1	OTP 写入开关_ _	将OTP VCC连接到VCORE。这是OTP写入所需的。VCORE应为3V3
0	OTP_ENABLE	启用OTP

13.7 OTP MR LSB_ _

Name: OTP_MR_LSB
Address: 173 (0xAD)
Serial IF: R/W
重置值：0x00

BIT	NAME	FUNCTION
7:0	VALUE _LSB	OTP MR register bits 7:0

13.8 OTP MR MSB_ _

Name: OTP_MR_MSB
Address: 174 (0xAE)
(串行接口：读写
复位值：0x00)

BIT	NAME	FUNCTION
7:0	VALUE _MSB	OTP MR 寄存器位 15:8

13.9 OTP_MRA_LSB

Name: OTP_MRA_LSB
Address: 175 (0xAF)
Serial IF: R/W
Reset value: 0x00

BIT	NAME	FUNCTION
7:0	VALUE_LSB	OTP MRA register bits 7:0

13.10 OTP_MRA_MSB

Name: OTP_MRA_MSB
Address: 176 (0xB0)
Serial IF: R/W
Reset value: 0x00

BIT	NAME	FUNCTION
7:0	VALUE_MSB	OTP MRA register bits 15:8

13.11 OTP_MRB_LSB

Name: OTP_MRB_LSB
Address: 177 (0xB1)
Serial IF: R/W
Reset value: 0x00

BIT	NAME	FUNCTION
7:0	VALUE_LSB	OTP MRB register bits 7:0

13.12 OTP_MRB_MSB

Name: OTP_MRB_MSB
Address: 178 (0xB2)
Serial IF: R/W
Reset value: 0x00

BIT	NAME	FUNCTION
7:0	VALUE_MSB	OTP MRB register bits 15:8

13.13 OTP_ADDRESS

Name: OTP_ADDRESS
Address: 181 (0xB5)
Serial IF: R/W
Reset value: 0x00

BIT	NAME	FUNCTION
7:0	ADDRESS	OTP address [7:0] to read from or to write to

13.9 OTP MRA LSB_ _

名称：OTP MRA LSB
_ _地址：175
(0xAF) 串行接口：
R/W 复位值：0x00

BIT	NAME	功能
7:0	VALUE _LSB	OTP MRA 寄存器位 7:0

13.10 OTP MRA MSB_ _

名称: OTP MRA MSB
_ _地址: 176 (0xB0)
串行接口: R/W 复
位值: 0x00

BIT	NAME	功能
7:0	VALUE _MSB	OTP MRA register bits 15:8

13.11 OTP MRB LSB_ _

名称：OTP MRB LSB
_ _地址：177
(0xB1)串行接口：
R/W复位值：0x00

BIT	NAME	FUNCTION
7:0	VALUE _LSB	OTP MRB 寄存器位 7:0

13.12 OTP MRB MSB_ _

名称：OTP _MRB_MSB
地址：178 (0xB2) 串
行接口：R/W 复位值：
0x00

BIT	NAME	功能
7:0	值 _MSB	OTP MRB 寄存器位 15:8

13.13 OTP 地址_

名称: OTP 地址_地址:
181 (0xB5) 串行接口 :
R/W 复位值 : 0x00

BIT	NAME	功能
7:0	地址	OTP 地址 [7:0] 用于读取或写入

13.14 OTP_COMMAND

Name: OTP_COMMAND
Address: 182 (0xB6)
Serial IF: R/W
Reset value: 0x00

BIT	NAME	FUNCTION
7	RESERVED	-
6:4	COMMAND	OTP access command
3:0	ADDRESS	OTP address [11:8] to read from or to write to

13.15 OTP_RDATA

Name: OTP_RDATA
Address: 184 (0xB8)
Serial IF: R
Reset value: 0x00

BIT	NAME	FUNCTION
7:0	VALUE	OTP read data word

13.16 OTP_STATUS

Name: OTP_STATUS
Address: 185 (0xB9)
Serial IF: R
Reset value: 0x00

BIT	NAME	FUNCTION
7:1	RESERVED	-
0	BUSY	OTP controller BUSY flag

13.17 OTP_DBG2

Name: OTP_DBG2
Address: 188 (0xBC)
Serial IF: R/W
Reset value: 0x00

BIT	NAME	FUNCTION
7	RESET	Value of the OTP port RESET
6:0	RESERVED	-

13.18 OTP_STATUS2

Name: OTP_STATUS2
Address: 191 (0xBF)
Serial IF: R/W
Reset value: 0xF0

BIT	NAME	FUNCTION
7:1	RESERVED	-

13.14 OTP命令_

名称：OTP命令_
地址：182 (0xB6)
串行接口：读写
复位值：0x00

BIT	NAME	FUNCTION
7	RESERVED	-
6:4	COMMAND	OTP访问命令
3:0	地址	OTP地址 [11:8] 用于读取或写入

13.15 OTP RDATA_

名称: OTP RDATA_
地址: 184 (0xB8)
串行接口: R
重置值：0x00

BIT	NAME	FUNCTION
7:0	VALUE	OTP读取数据字

13.16 OTP状态_

名称：OTP状态_
地址: 185 (0xB9)
串行接口: R
复位值: 0x00

BIT	NAME	FUNCTION
7:1	RESERVED	-
0	BUSY	OTP控制器忙标志

13.17 OTP DBG2_

名称：OTP DBG2_地址：188
(0xBC)
串行接口：读写
复位值：0x00

BIT	NAME	FUNCTION
7	RESET	OTP端口的RESET值
6:0	RESERVED	-

13.18 OTP状态2_

名称：OTP状态2_地址：191
(0xBF)
串行接口：读写
复位值：0xF0

BIT	NAME	FUNCTION
7:1	RESERVED	-

0	BOOT_UP_STATUS	Boot up config status. Host can set this bit to 1 when boot up config is done and read later to know if ICP-20100 is power cycled and needs boot up config.

13.19 MASTER_LOCK

Name: MASTER_LOCK
Address: 190 (0xBE)
Serial IF: W
Reset value: 0x00

BIT	NAME	FUNCTION
7:0	LOCK	Write 8'h1F to unlock write access to all main registers Write any other value to lock write access to all main registers The OTP mirror registers are not locked by this register

13.20 MODE_SELECT

Name: MODE_SELECT
Address: 192 (0xC0)
Serial IF: R/W
Reset value: 0x00

BIT	NAME	FUNCTION
7:5	MEAS_CONFIG	Measurement Configuration (the modes listed below are described in section 2.2) 000: Mode0 001: Mode1 010: Mode2 011: Mode3 100: Mode4 101 to 111: Reserved
4	FORCED_MEAS_TRIGGER	Initiate Triggered Operation (also called Forced Measurement Mode) 0: Stay in Standby mode 1: Trigger for forced measurement (only supported for Mode4)
3	MEAS_MODE	Measurement Mode Selection 0: Standby or trigger forced measurement based on the field FORCED_MEAS_TRIGGER 1: Continuous Measurements (duty cycled): Measurements are started based on the selected mode ODR_REG
2	POWER_MODE	Power Mode Selection 0: Normal Mode: Device is in standby and goes to active mode during the execution of a measurement 1: Active Mode: Power on DVDD and enable the high frequency clock
1:0	FIFO_READOUT_MODE	FIFO Readout Mode Selection (refer to the FIFO section for further information) 00: Pressure first. When you start reading from address 0xFA with address increment, you will read out press(n), temp(n), press(n+1), temp(n+1), … 01: Temperature only. When you start reading from address 0xFD with address increment, you will read out temp(n), temp(n+1), …

0	启动状态_ _	启动配置状态。 主机在启动配置完成后可以将此位设置为1，稍后读取以了解 如果ICP-20100需要上电重启并进行启动配置。

13.19 MASTER LOCK_

名称: MASTER LOCK_
地址: 190 (0xBE)
串行接口: W
复位值: 0x00

BIT	NAME	功能
7:0	LOCK	将 8'h1F 写入以解锁所有主寄存器的写访问权限 写入任何其他值以锁定所有主寄存器的写访问权限 OTP镜像寄存器不会被此寄存器锁定

13.20 模式_选择

名称：模式选择_地
址：192 (0xC0)
串行接口：读写
复位值：0x00

BIT	NAME	FUNCTION
7:5	测量配置_	测量配置（以下模式在2.2节中描述） 000：模式0 001: 模式1 010: 模式2 011: 模式3 100: 模式4 101至111: 保留
4	强制测量触发_ _	启动触发操作（也称为强制测量模式） 0: 保持待机模式 1: 触发强制测量（仅支持模式4）
3	MEAS_MODE	测量模式选择 0: 待机或根据字段 FORCED MEAS TRIGGER_ _ 触发强制测量 1: 连续测量（周期性）：测量基于所选模式 ODR REG_ 启动
2	POWER MODE_	电源模式选择 0: 正常模式：设备处于待机状态，在执行测量时进入活动模式 1: 活动模式：打开 DVDD 并启用高频时钟
1:0	FIFO 读取模式_ _	FIFO 读取模式选择（请参阅 FIFO 部分以获取更多信息） 00: 先读取压力。 当从地址 0xFA 开始并以地址递增方式读取时，将读出 press(n)、temp(n)、press(n+1)、temp(n+1)、… 仅温度。 当以地址递增的方式从地址 0xFD 开始读取时，将会读出 temp(n)、temp(n+1)、…

		10: Temperature first. When you start reading from address 0xFA with address increment, you will read out temp(n), press(n), temp(n+1), press(n+1), … 11: Pressure only. When you start reading from address 0xFD with address increment, you will read out press(n), press(n+1), …
Notes: - Make sure DEVICE_STATUS.MODE_SYNC_STATUS bit is set before writing this register.		

13.21 INTERRUPT_STATUS

Name: INTERRUPT_STATUS
Address: 193 (0xC1)
Serial IF: R/W
Reset value: 0x00

BIT	NAME	FUNCTION
7	-	Reserved
6	PRESS_DELTA_INT	Delta pressure overrun Read 0: The difference between 2 consecutive pressure measurements after filtering didn't exceed the programmed delta pressure overrun value. The interrupt has not triggered 1: The difference between 2 consecutive pressure measurements after filtering exceeded the programmed delta pressure overrun value. The interrupt has triggered Write policy is W1C 0: the press_delta_int interrupt status bit is unchanged 1: the press_delta_int interrupt status bit is cleared
5	PRESS_ABS_INT	Pressure underrun/overrun Read 0: The pressure value didn't cross the programmed pressure underrun/overrun value. The interrupt has not triggered 1: The pressure value crossed the programmed pressure underrun/overrun value. The interrupt has triggered Write policy is W1C 0: the press_abs interrupt status bit is unchanged 1: the press_abs interrupt status bit is cleared
4	-	Reserved
3	FIFO_WMK_LOW_INT	FIFO watermark low Read 0: The FIFO fill level didn't reach in downward direction the programmed watermark low value. The interrupt has not triggered 1: The FIFO fill level reached in downward direction the programmed watermark low value. The interrupt has triggered Write policy is W1C 0: the fifo_wmk_low interrupt status bit is unchanged 1: the fifo_wmk_low interrupt status bit is cleared
2	FIFO_WMK_HIGH_INT	FIFO watermark high Read 0: The FIFO fill level didn't reach in upward direction the programmed watermark high value. The interrupt has not triggered 1: The FIFO fill level reached in upward direction the programmed watermark high value. The interrupt has triggered

		10: 先读取温度。当从地址 0xFA 开始以地址递增方式读取时，将读取出 temp(n)、press(n)、temp(n+1)、press(n+1)、… 11: 仅读取压力。当从地址 0xFD 开始以地址递增方式读取时，将读取出 press(n)、press(n+1)、…
备注： - 在写入此寄存器前，请确保 DEVICE_STATUS.MODE_SYNC_STATUS 位已设置。		

13.21 中断状态_

名称: 中断状态_地址:
193 (0xC1) 串行接口:
R/W 复位值: 0x00

BIT	NAME	功能
7	-	保留
6	按DELTA中断_ _	Delta压力溢出 Read 0: 过滤后的两次连续压力测量值之差未超过程序设定的压力超限值。中断未触发 1: 过滤后的两次连续压力测量值之差超过程序设定的压力超限值。中断已触发 写入策略是 W1C 0: 压力_delta_int中断状态位未改变 1: 压力_delta_int中断状态位被清除
5	PRESS ABS INT_ _	压力欠压/超压读取 0: 压力值未跨越程序设定的欠压/超压值。中断未触发 1: 压力值跨越了编程设定的压力下溢/上溢值。中断已触发 写策略是 W1C 0: the press_abs中断状态位未改变 1: the press_abs中断状态位已清除
4	-	Reserved
3	FIFO WMK LOW INT _ _ _	FIFO水位低 Read 0: FIFO液位未在向下方向达到编程的最低水位。中断未触发 1: FIFO液位在向下方向达到编程的最低水位。中断已触发 写入策略是W1C 0: fifo_wmk_low中断状态位未改变 1: fifo_wmk_low中断状态位被清除
2	FIFO WMK HIGH INT _ _ _	FIFO水位高读取 0: FIFO液位未在向上方向达到编程的水印高值。中断未触发 1: FIFO液位在向上方向达到编程设定的水印高值。中断已触发

		Write policy is W1C 0: the fifo_wmk_high interrupt status bit is unchanged 1: the fifo_wmk_high interrupt status bit is cleared
1	FIFO_UNDERFLOW_INT	FIFO underflow Read 0: No new pressure/temperature pair was fetched from the FIFO while it was empty. The interrupt has not triggered 1: A new pressure/temperature pair was fetched from the FIFO while it was empty. The interrupt has triggered Write policy is W1C 0: the fifo_underflow interrupt status bit is unchanged 1: the fifo_underflow interrupt status bit is cleared
0	FIFO_OVERFLOW_INT	FIFO overflow Read 0: No new pressure/temperature pair was written to the FIFO while it was full. The interrupt has not triggered 1: A new pressure/temperature pair was written to the FIFO while it was full. The interrupt has triggered Write policy is W1C 0: the fifo_overflow interrupt status bit is unchanged 1: the fifo_overflow interrupt status bit is cleared

13.22 INTERRUPT_MASK

Name: INTERRUPT_MASK
Address: 194 (0xC2)
Serial IF: R/W
Reset value: 0x00

BIT	NAME	FUNCTION
7	-	Reserved (program to 1)
6	PRESS_DELTA_MASK	0: PRESS_DELTA interrupt is not masked 1: PRESS_DELTA interrupt is masked
5	PRESS_ABS_MASK	0: PRESS_ABS interrupt is not masked 1: PRESS_ABS interrupt is masked
4	-	Reserved
3	FIFO_WMK_LOW_MASK	0: FIFO_WMK_LOW interrupt is not masked 1: FIFO_WMK_LOW interrupt is masked
2	FIFO_WMK_HIGH_MASK	0: FIFO_WMK_HIGH interrupt is not masked 1: FIFO_WMK_HIGH interrupt is masked
1	FIFO_UNDERFLOW_MASK	0: FIFO_UNDERFLOW interrupt is not masked 1: FIFO_UNDERFLOW interrupt is masked
0	FIFO_OVERFLOW_MASK	0: FIFO_OVERFLOW interrupt is not masked 1: FIFO_OVERFLOW interrupt is masked

13.23 FIFO_CONFIG

Name: FIFO_CONFIG
Address: 195 (0xC3)
Serial IF: R/W
Reset value: 0x00

		写入策略是 W1C 0：fifo_wmk_高中断状态位不变 1：fifo_wmk_ 高中断状态位被清除
1	FIFO_UNDERFLOW _INT	FIFO 下溢 Read 0: 未从FIFO中获取新的压力/温度对，此时为空。中断未触发 1: 未从FIFO中获取新的压力/温度对，此时为空。中断已触发 写入策略为W1C 0: fifo_下溢中断状态位未改变 1: fifo_下溢中断状态位被清除
0	FIFO_OVERFLOW _INT	FIFO溢出 Read 0: 在其满时，未向FIFO写入新的压力/温度对中断未触发 1: 在其满时，向FIFO写入了一个新的压力/温度对中断已触发 写入策略是W1C 0: the fifo_溢出中断状态位未改变 1: the fifo_溢出中断状态位已清除

13.22 中断 _MASK

姓名：中断掩码_地址：194
(0xC2)
串行接口：R/W复
位值：0x00

BIT	NAME	FUNCTION
7	-	保留（程序设为1）
6	按DELTA掩码_ _	0：按_DELTA中断未被屏蔽 1: PRESS_DELTA中断被屏蔽
5	PRESS ABS MASK_ _	0: PRESS_ABS中断未被屏蔽 1: PRESS_ABS中断被屏蔽
4	-	保留
3	FIFO WMK LOW MASK _ _ _	0: FIFO_WMK_LOW中断未被屏蔽 1: FIFO_WMK_LOW中断被屏蔽
2	FIFO WMK HIGH MASK _ _ _	0: FIFO_WMK_HIGH中断未被屏蔽 1: FIFO_WMK_HIGH中断被屏蔽
1	FIFO UNDERFLOW MASK _ _	0: FIFO_下溢中断未被屏蔽 1: FIFO_下溢中断被屏蔽
0	FIFO 上溢屏蔽_ _	0: FIFO _上溢中断未被屏蔽 1: FIFO_上溢中断被屏蔽

13.23 FIFO 配置_

名称：FIFO _配置
地址：195 (0xC3)
串行接口：读写
复位值：0x00

BIT	NAME	FUNCTION
7:4	FIFO_WM_HIGH	FIFO high watermark value. Interrupt is triggered when the FIFO fill level reaches this value in the upward direction. A value of 0 disables the high watermark check.
3:0	FIFO_WM_LOW	FIFO low watermark value. Interrupt is triggered when the FIFO fill level reaches this value in the downward direction.

13.24 FIFO_FILL

Name: FIFO_FILL
Address: 196 (0xC4)
Serial IF: R/W
Reset value: 0x40

BIT	NAME	FUNCTION
7	FIFO_FLUSH	FIFO flush command. (This field should not be modified while doing a measurement) 0: No change 1: FIFO is flushed. Flushing the FIFO will empty it.
6	FIFO_EMPTY	FIFO empty indication. 0: The FIFO level is above 0 1: The FIFO level is at 0
5	FIFO_FULL	FIFO full indication. 0: The FIFO level is below the FIFO size 1: The FIFO level has reached the FIFO size
4:0	FIFO_LEVEL	FIFO fill level 00000: Empty 00001: 1/16 full 00010: 2/16 full 00011: 3/16 full 00100: 4/16 full 00101: 5/16 full 00110: 6/16 full 00111: 7/16 full 01000: 8/16 full 01001: 9/16 full 01010: 10/16 full 01011: 11/16 full 01100: 12/16 full 01101: 13/16 full 01110: 14/16 full 01111: 15/16 full 10000: Full 10001 to 11111: Reserved

13.25 SPI_MODE

Name: SPI_MODE
Address: 197 (0xC5)
Serial IF: R/W
Reset value: 0x00

BIT	NAME	FUNCTION
7:4	FIFO_WM HIGH_	FIFO高水位值。当FIFO填充水平 在向上方向达到此值。值为 0 会禁用高水位检查。
3:0	FIFO_ WM LOW_	FIFO 低水位值。当 FIFO 填充水平在向下方向达到此值时触发中断。

13.24 FIFO FILL_

名称：FIFO FILL_地
址：196 (0xC4)串行
接口：读写复位值：
0x40

BIT	NAME	FUNCTION
7	FIFO FLUSH_	FIFO 冲洗命令。 （在进行测量时，此字段不应被修改） 0: 无变化 1: FIFO 被冲洗。 冲洗 FIFO 将使其清空。
6	FIFO_ EMPTY	FIFO 空指示。 0: FIFO 水平高于 0 1: FIFO 水平为 0
5	FIFO FULL_	FIFO 满指示。 0: FIFO 水平低于 FIFO 大小 1: FIFO 水平已达 到 FIFO 大小
4:0	FIFO_ LEVEL	FIFO 填充水平 00000: 空闲 00001: 1/16 满 00010: 2/16 满 00011: 3/16 满 00100: 4/16 满 00101: 5/16 满 00110: 6/16 满 00111: 7/16 满 01000: 8/16 满 01001: 9/16 满 01010: 10/16 满 01011: 11/16 满 01100: 12/16 满 01101: 13/16 满 01110: 14/16 满 01111: 15/16 满 10000: 满 10001 到 11111: 保留

13.25 SPI 模式_

名称: SPI 模式_地址:
197 (0xC5) 串行接口:
R/W 复位值 : 0x00

BIT	NAME	FUNCTION
7:1	-	Reserved
0	SPI_MODE	0: SPI 4-wire mode enabled 1: SPI 3-wire mode enabled

13.26 PRESS_ABS_LSB

Name: PRESS_ABS_LSB
Address: 199 (0xC7)
Serial IF: R/W
Reset value: 0x00

BIT	NAME	FUNCTION
7:0	PRESS_ABS_LSB	LSB part of the 16bit pressure overrun/underrun value. The 16bit value represents pressure values according to the formula P_{ABS} = (P(kPa)-70kPa)/40kPa*2^{13} For example, 80 kPa threshold results in value 0x0800, 50 kPa results in value 0xF000 This register should not be modified while doing a measurement.

13.27 PRESS_ABS_MSB

Name: PRESS_ABS_MSB
Address: 200 (0xC8)
Serial IF: R/W
Reset value: 0x00

BIT	NAME	FUNCTION
7:0	PRESS_ABS_MSB	MSB part of the 16bit pressure overrun/underrun value. The 16bit value represents pressure values according to the formula P_{ABS} = (P(kPa)-70kPa)/40kPa*2^{13} For example, 80kPa threshold results in value 0x0800, 50 kPa results in value 0xF000 This register should not be modified while doing a measurement.

13.28 PRESS_DELTA_LSB

Name: PRESS_DELTA_LSB
Address: 201 (0xC9)
Serial IF: R/W
Reset value: 0x00

BIT	NAME	FUNCTION
7:0	PRESS_DELTA_LSB	LSB part of the 16bit delta pressure overrun/underrun value. The 16bit value represents pressure values according to the formula P_{DELTA} = (P(kPa)/80)* 2^{14} For example, a delta pressure of 0.5 kPa is represented by the value 0x0066 This register should not be modified while doing a measurement.

BIT	NAME	FUNCTION
7:1	-	保留
0	SPI 模式_	0: SPI 4-wire 模式启用 1: SPI 3-wire 模式启用

13.26 压力 _ABS_LSB

名称: 压力 ABS LSB
_ _地址: 199 (0xC7)
串行接口: R/W 复位值:
0x00

BIT	NAME	功能
7:0	压力 ABS LSB_ _	16位压力溢出/欠压值中的LSB部分。16位值根据公式 P_{ABS} = (P(kPa)-70kPa)/40kPa*2^{13} 表示压力值。例如，80 kPa阈值对应值0x0800，50 kPa对应值0xF000。在测量过程中不应修改此寄存器。

13.27 压力 _ABS_MSB

名称：压力绝对值MSB
_ _地址：200 (0xC8)
串行接口：读写复位值：
0x00

BIT	NAME	功能
7:0	压力绝对值MSB_ _	16位压力溢出/欠压值中的MSB部分。16位值根据公式 P_{ABS} = (P(kPa)-70kPa)/40kPa*2^{13} 表示压力值。例如，80kPa阈值对应值0x0800，50 kPa对应值0xF000。在测量过程中不应修改此寄存器。

13.28 压力 DELTA LSB_ _

名称: 压力 DELTA LSB
_ _地址: 201 (0xC9) 串
行接口: R/W 复位值: 0x00

BIT	NAME	功能
7:0	压力 DELTA LSB_ _	16位 delta 压力溢出/欠量值的 LSB 部分。 16位值根据公式表示压力值。 P_{DELTA} = (P(kPa)/80)* 2^{14}例如，0.5 kPa的压差由值0x0066表示。在测量过程中，此寄存器不应被修改。

13.29 PRESS_DELTA_MSB

Name: PRESS_DELTA_MSB
Address: 202 (0xCA)
Serial IF: R/W
Reset value: 0x00

BIT	NAME	FUNCTION
7:0	PRESS_DELTA_MSB	MSB part of the 16bit delta pressure overrun/underrun value. The 16bit value represents pressure values according to the formula $P_{DELTA} = (P(kPa)/80)* 2^{14}$ For example, a delta pressure of 0.5 kPa is represented by the value 0x0066 This register should not be modified while doing a measurement.

13.30 DEVICE_STATUS

Name: DEVICE_STATUS
Address: 205 (0xCD)
Serial IF: R
Reset value: 0x00

BIT	NAME	FUNCTION
7:6	-	Reserved
0	MODE_SYNC_STATUS	0: Synchronization of the selected mode to the internal clock domain is ongoing. MODE_SELECT register is not accessible by the user. 1: Synchronization of the selected mode to the internal clock domain is finished. MODE_SELECT register is accessible by the user.

13.31 I3C_INFO

Name: I3C_INFO
Address: 206 (0xCE)
Serial IF: R
Reset value: 0x00

BIT	NAME	FUNCTION
7:0	I3C_INFO	This register contains the I3C^{SM} dynamic slave address

13.32 VERSION

Name: VERSION
Address: 211 (0xD3)
Serial IF: R
Reset value: 0x00 (version A); 0xB2 (version B)

BIT	NAME	FUNCTION
7:4	MAJOR	Major version number
3:0	MINOR	Minor version number

13.29 压力 DELTA MSB_ _

名称：压力 DELTA MSB_ _
地址：202 (0xCA)
串行接口：读写
复位值：0x00

BIT	NAME	FUNCTION
7:0	按DELTA_ – MSB	16位delta压力过载/欠载值的高位部分。 16位值根据公式表示压力值。 $P_{DELTA} = (P(kPa)/80)* 2^{14}$ 例如，0.5 kPa的压差由值0x0066表示 在测量过程中不应修改此寄存器。

13.30 设备 _状态

名称：设备 _状态
地址: 205 (0xCD)
串行接口: R
复位值: 0x00

BIT	NAME	功能
7:6	-	保留
0	同步模式状态_ _	0: 选中模式同步到内部时钟域正在进行中。MODE_SELECT寄存器不可由用户访问。 1: 选中模式同步到内部时钟域已完成。MODE_SELECT寄存器可由用户访问。

13.31 I3C信息_

名称：I3C信息_地
址：206 (0xCE)
串行接口：R
重置值：0x00

BIT	NAME	FUNCTION
7:0	I3C_INFO	此寄存器包含I3C^{SM} 动态从机地址

13.32 版本

名称：版本
地址：211 (0xD3)
串行接口：R
复位值：0x00（版本A）；0xB2（版本B）

BIT	NAME	FUNCTION
7:4	MAJOR	主版本号
3:0	MINOR	次要版本号

13.33 PRESS_DATA_0

Name: PRESS_DATA_0
Address: 250 (0xFA)
Serial IF: R
Reset value: 0x00

BIT	NAME	FUNCTION
7:0	PRESS_DATA_0	Pressure data bits [7:0]

13.34 PRESS_DATA_1

Name: PRESS_DATA_1
Address: 251 (0xFB)
Serial IF: R
Reset value: 0x00

BIT	NAME	FUNCTION
7:0	PRESS_DATA_1	Pressure data bits [15:8]

13.35 PRESS_DATA_2

Name: PRESS_DATA_2
Address: 252 (0xFC)
Serial IF: R
Reset value: 0x00

BIT	NAME	FUNCTION
7:4	-	Reserved
3:0	PRESS_DATA_2	Pressure data bits [19:16]

13.36 TEMP_DATA_0

Name: TEMP_DATA_0
Address: 253 (0xFD)
Serial IF: R
Reset value: 0x00

BIT	NAME	FUNCTION
7:0	TEMP_DATA_0	Temperature data bits [7:0]

13.37 TEMP_DATA_1

Name: TEMP_DATA_1
Address: 254 (0xFE)
Serial IF: R
Reset value: 0x00

BIT	NAME	FUNCTION
7:0	TEMP_DATA_1	Temperature data bits [15:8]

13.33 压力数据 0_ _

名称：压力数据 0_ _
地址：250 (0xFA)
串行接口：R
重置值：0x00

BIT	NAME	FUNCTION
7:0	PRESS _DATA_0	压力数据位 [7:0]

13.34 压力数据 1_ _

Name: PRESS_DATA_1
Address: 251 (0xFB)
串行接口：R 重置
值：0x00

BIT	NAME	FUNCTION
7:0	PRESS _DATA_1	压力数据位 [15:8]

13.35 压力数据 2_ _

名称: 压力数据 2_ _地址: 252
(0xFC)
串行接口：R 复位
值：0x00

BIT	NAME	FUNCTION
7:4	-	保留
3:0	按压力据 2_ _	压力数据位 [19:16]

13.36 温度数据 0_ _

Name: TEMP_DATA_0
Address: 253 (0xFD)
Serial IF: R
重置值：0x00

BIT	NAME	FUNCTION
7:0	TEMP_DATA_0	温度数据位 [7:0]

13.37 温度数据 1_ _

Name: TEMP_DATA_1
Address: 254 (0xFE)
(串行接口：
R 重置值：0x00

BIT	NAME	FUNCTION
7:0	TEMP_DATA_1	温度数据位 [15:8]

13.38 TEMP_DATA_2

Name: TEMP_DATA_2
Address: 255 (0xFF)
Serial IF: R
Reset value: 0x00

BIT	NAME	FUNCTION
7:4	-	Reserved
3:0	TEMP_DATA_2	Temperature data bits [19:16]

13.38 临时数据 2_ _

名称：临时数据 2_ _
地址：255 (0xFF)
串行接口：R
重置值：0x00

BIT	NAME	FUNCTION
7:4	-	Reserved
3:0	临时数据2_ _	温度数据位 [19:16]

14 TAPE & REEL SPECIFICATION

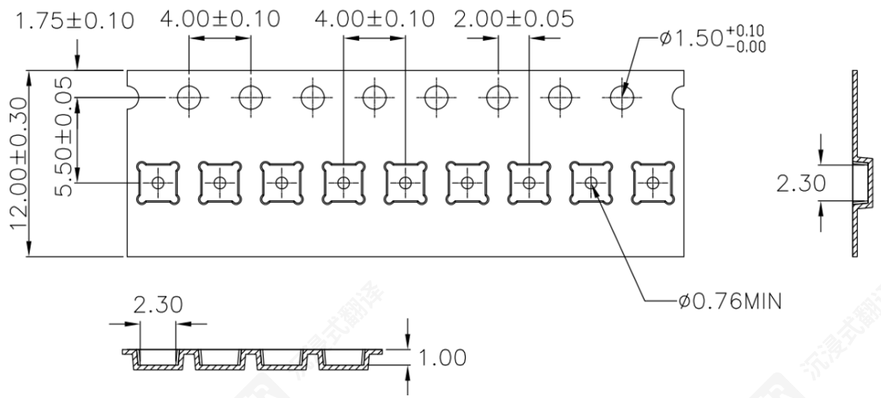
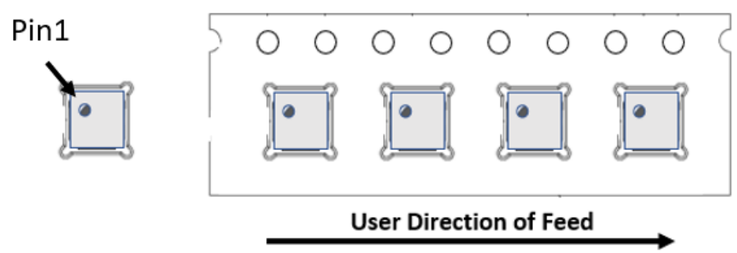


Figure 21. ICP-20100 Tape Dimensions



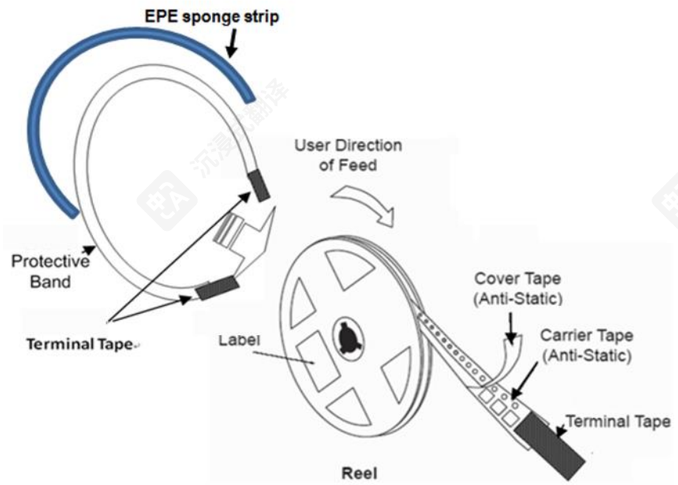


Figure 22. ICP-20100 Tape and Reel Drawing

14 磁带及卷轴规格

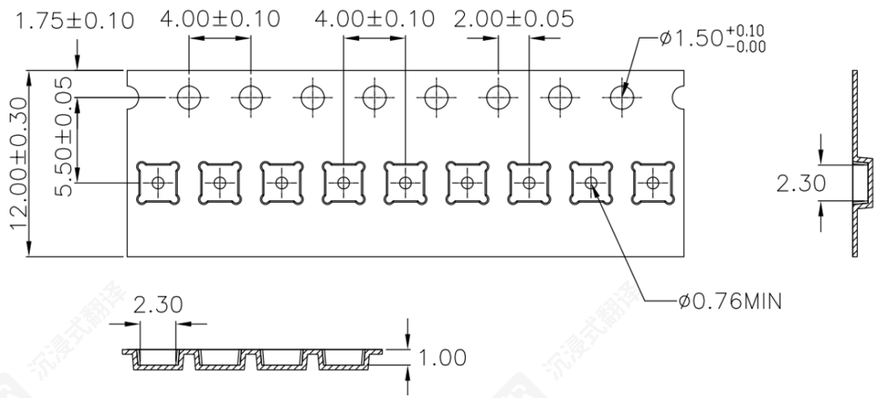
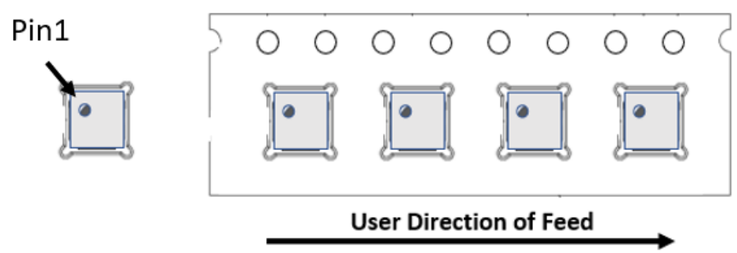


图21. ICP-20100 磁带尺寸



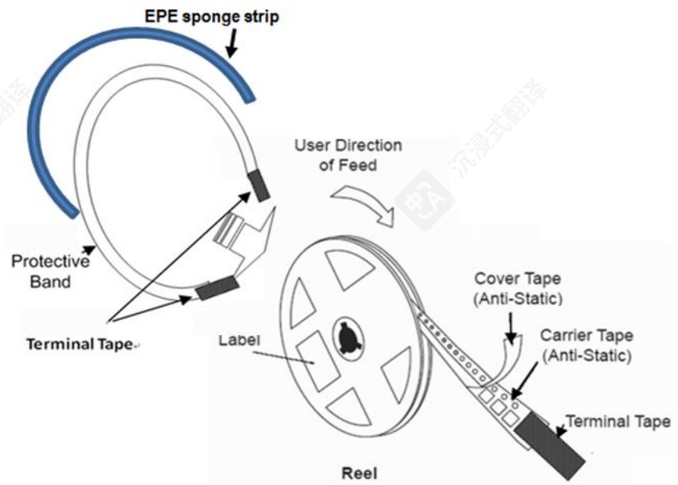


图22。ICP-20100卷带图

15 ORDERING GUIDE

PART	TEMP RANGE	PACKAGE BODY	PACKAGE LID	QUANTITY	PACKAGING
ICP-20100†	–40°C to +85°C	2x2x0.8mm LGA-10L	1-Hole	10,000	13” Tape and Reel

†Denotes RoHS and Green-Compliant Package

15 订购指南

PART	温度范围	封装体	包装盖	数量	包装
ICP-20100 †	–40°C 至 +85°C	2x2x0.8mm LGA-10L	1-孔	10,000	13” 带子和 卷轴

† 表示符合RoHS和绿色环保包装

16 REFERENCES

Please refer to “InvenSense MEMS Handling Application Note (AN-IVS-0002A-00)” and “Pressure Sensor PCB Design Guidelines (AN-000140)” for the following information:

- Manufacturing Recommendations
  - Assembly Guidelines and Recommendations
  - PCB Design Guidelines and Recommendations
  - MEMS Handling Instructions
  - ESD Considerations
  - Reflow Specification
  - Storage Specifications
  - Package Marking Specification
  - Reel & Pizza Box Label
  - Packaging
  - Representative Shipping Carton Label
- Compliance
  - Environmental Compliance
  - DRC Compliance
  - Compliance Declaration Disclaimer

16 参考资料

请参考“InvenSense MEMS处理应用笔记（AN-IVS-0002A-00）”和“压力传感器PCB设计指南（AN-000140）”获取以下信息：

- 制造建议
  - 组装指南和建议
  - PCB 设计指南和建议
  - MEMS 处理说明
  - ESD 考虑因素
  - 回流规范
  - 存储规范
  - 封装标记规范
  - 卷轴 & 披萨盒标签
  - 包装
  - 代表性运输纸箱标签
- 合规
  - 环境合规
  - DRC合规
  - 合规声明免责声明

17 REVISION HISTORY

REVISION DATE	REVISION	DESCRIPTION
10/12/2020	0.1	Initial Release
03/12/2021	0.2	Updated ASIC Identification Procedure (Section 5.4); Updated Duty Cycled Operation Description (Section 6.2.1); Updated FIFO FULL/EMPTY Description (Section 7.2); Moved sections on FIFO OVERFLOW/UNDERFLOW, FIFO WATERMARK LOW/HIGH, ABSOLUTE PRESSURE VALUE OVERRUN/UNDERRUN, DELTA PRESSURE VALUE OVERRUN from Section 7 to Section 8.
04/01/2021	0.3	Updated Pressure Sensor Specifications (Table 3); Updated ASIC Identification Procedure (Section 5.4); Updated Duty Cycled Operation Description (Section 6.2.1); Updated Interrupts (Section 8).
05/03/2021	0.4	Added MSL information (Cover Page); Added Tape & Reel Specification (Section 14).
07/09/2021	1.0	Updated Pressure Sensor Specifications (Table 3); Updated References (Section 16)
09/15/2021	1.1	Updated Table 3 Notes and Conditions; Added OSR_{PRESS} and OSR_{TEMP} Calculation (Section 6.2.1); Updated FIFO_FLUSH Register Field Description (Section 13.23)
12/08/2021	1.2	Updated Drive Strength for VDDIO = 1.2V and for VDDIO = 1.8V/3.3V (Section 3.1); Updated HBM from 2kV to 1.5kV (Section 3.2); Added new dummy reads for I2C and I3C (Section 4.1.3 and Section 4.1.4); Updated Drive Strength Configuration (Section 4.3); Updated FIR Filter section (Section 6.3); Updated drive strength (Section 13.5, 3.1); Updated boot section (Section 6.5); Updated ASIC identification section (Section 5.4, 13.31); Added register OTP_STATUS2 (Section 12, 13.18); Updated IO_DS description (Section 13.5); Added Notes (Section 13.20)
12/17/2021	1.3	Updated Boot Sequence (Section 6.5)

17 修订历史

修订日期	修订	描述
10/12/2020	0.1	初始发布
03/12/2021	0.2	更新ASIC识别程序（第5.4节）；更新循环工作描述（第6.2.1节）；更新FIFO FULL/EMPTY描述（第7.2节）； 移动了关于FIFO OVERFLOW/UNDERFLOW、FIFO WATERMARK LOW/HIGH、绝对压力值OVERRUN/UNDERRUN、Delta压力值的章节 从第7节到第8节的超限。
04/01/2021	0.3	更新的压力传感器规格（表3）；更新的ASIC识别 程序（第5.4节）；更新的循环操作描述（第6.2.1节）；更新的中断（第8节）。
05/03/2021	0.4	添加了MSL信息（封面）；添加了卷带规格（第14节）。
07/09/2021	1.0	更新压力传感器规格（表3）；更新参考文献（第16节）
09/15/2021	1.1	更新表3注释和条件；添加OSR_{PRESS}和OSR_{TEMP}计算（第6.2.1节）；更新FIFO_FLUSH寄存器字段描述（第13.23节）
12/08/2021	1.2	更新VDDIO = 1.2V的驱动强度和VDDIO = 1.8V/3.3V的驱动强度（第3.1节）；将HBM从2kV更新为1.5kV（第3.2节）；添加I2C和I3C的新占位读取（第4.1.3节和第4.1.4节）；更新驱动强度配置（第 4.3）；更新FIR滤波器部分（第6.3节）；更新驱动强度（第13.5节，3.1节）；更新启动部分（第6.5节）；更新ASIC识别部分（第5.4节，13.31节）；添加OTP_STATUS2寄存器（第12节，13.18节）；更新IO_DS描述（第13.5节）；添加注释（第13.20节）
12/17/2021	1.3	更新启动序列（第6.5节）

TDK InvenSense

TDK InvenSense