关键元器件的选用

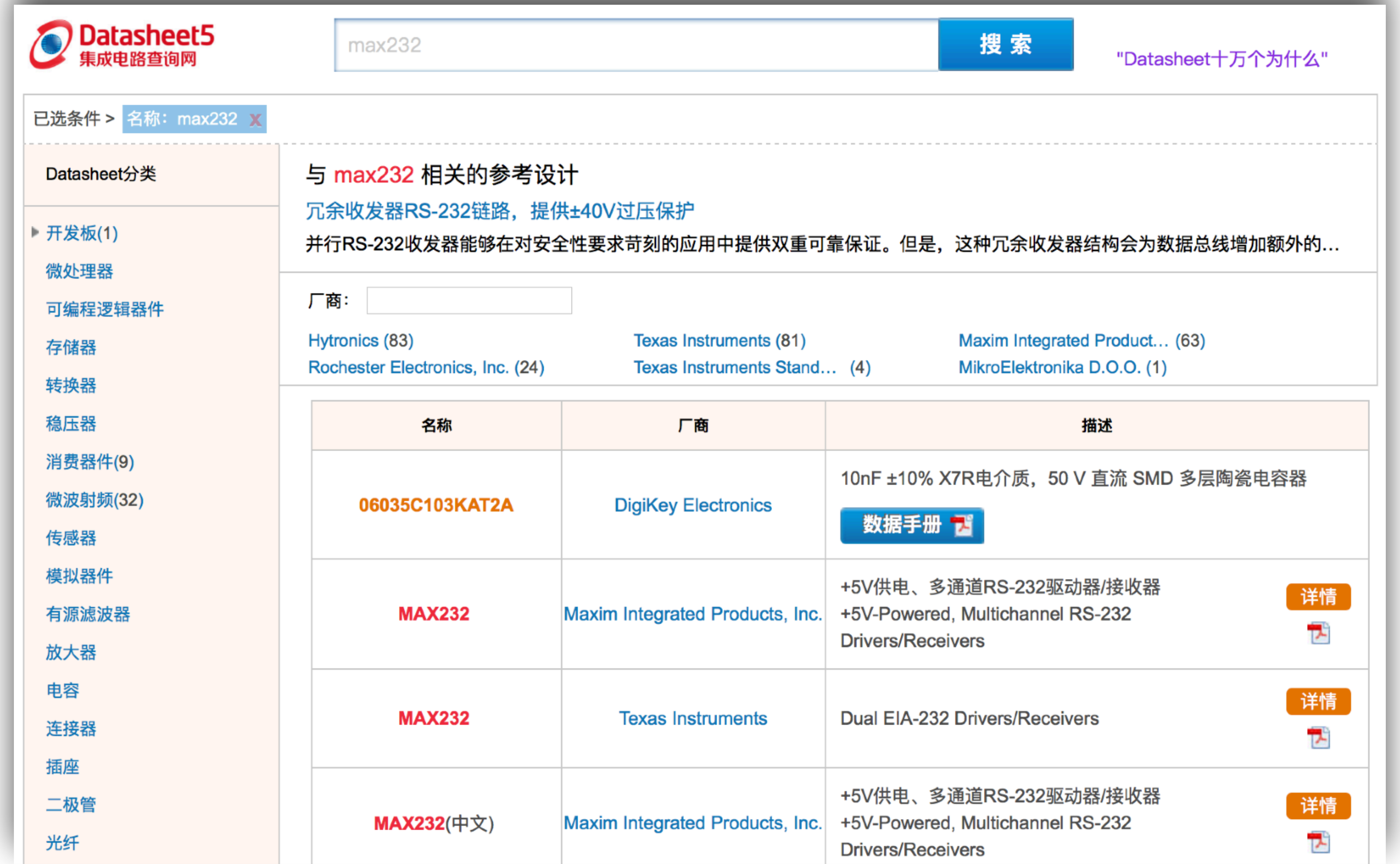
电阻、电容、电感、开关、集成电路....

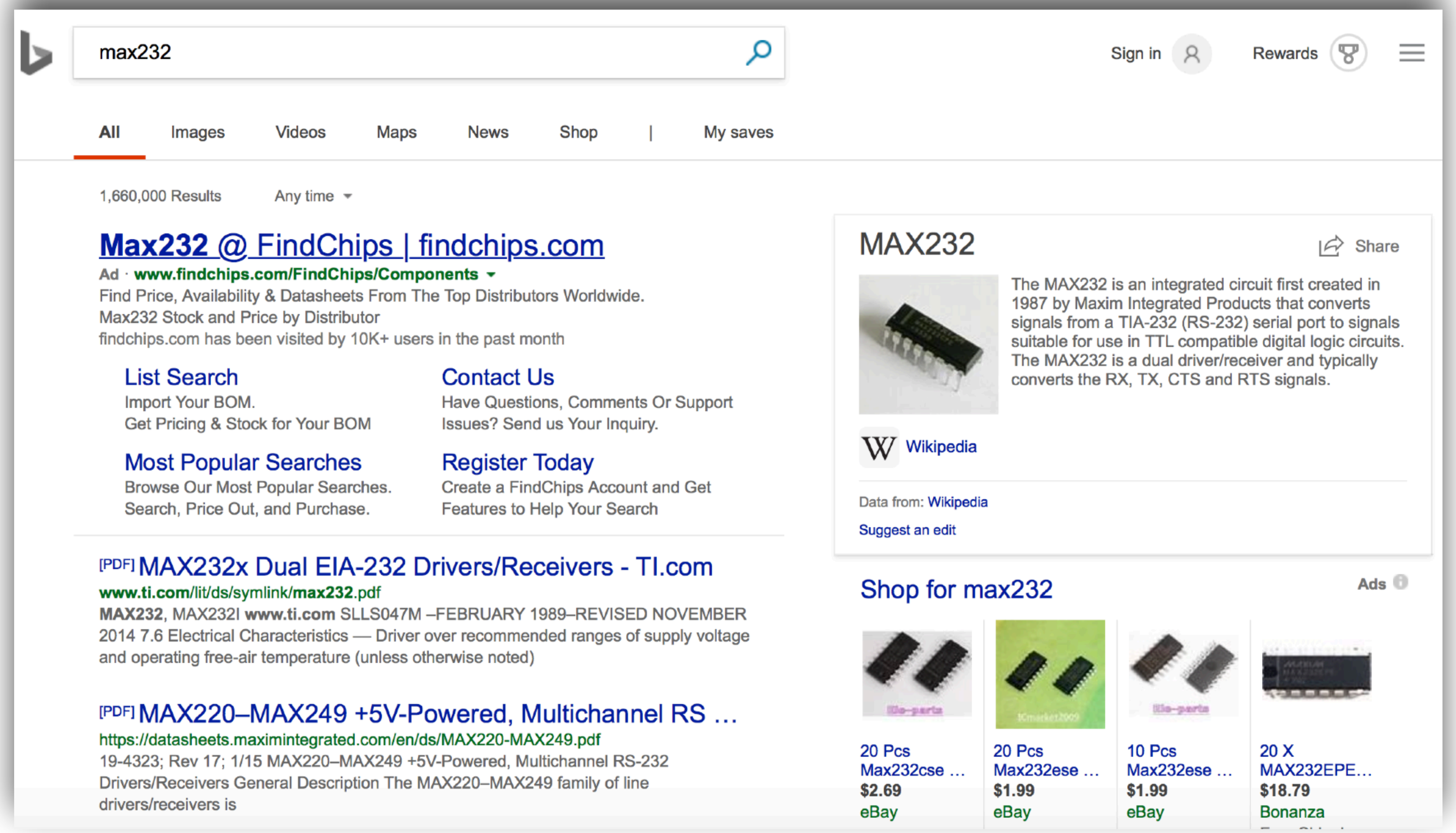
元器件选用的原则

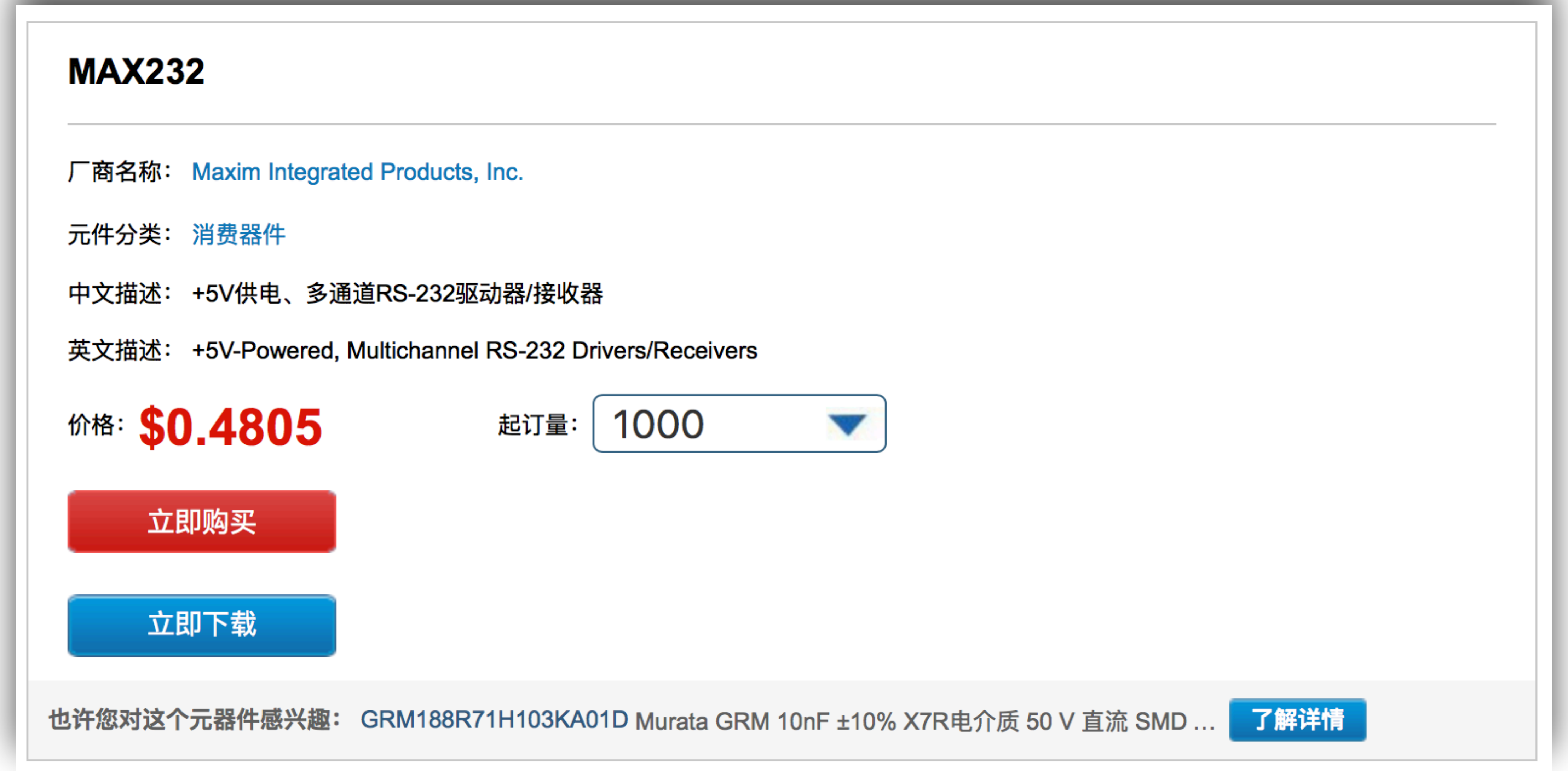
- 功能需要 - 1个或多个关键器件
- 性能满足设计要求
- 比较价格 - 同行业常用器件，系统整体成本（包括配套外围器件、加工成本）
- 供货渠道、交期、风险系数
- 封装 - 根据成本、板卡物理尺寸、功耗、接口、加工可行性
- 使用难度 - 成熟度、焊接调试、技术支持、资料、配套环境

选用渠道1 - 搜索网站

- 根据型号或关键词进行搜索
- 行业搜索网站：
  - www.datasheet5.com
  - www.alldatasheet.com
- 通用搜索引擎 - 来自多个渠道的综合信息：
  - www.bing.com
  - 翻墙访问： www.google.com





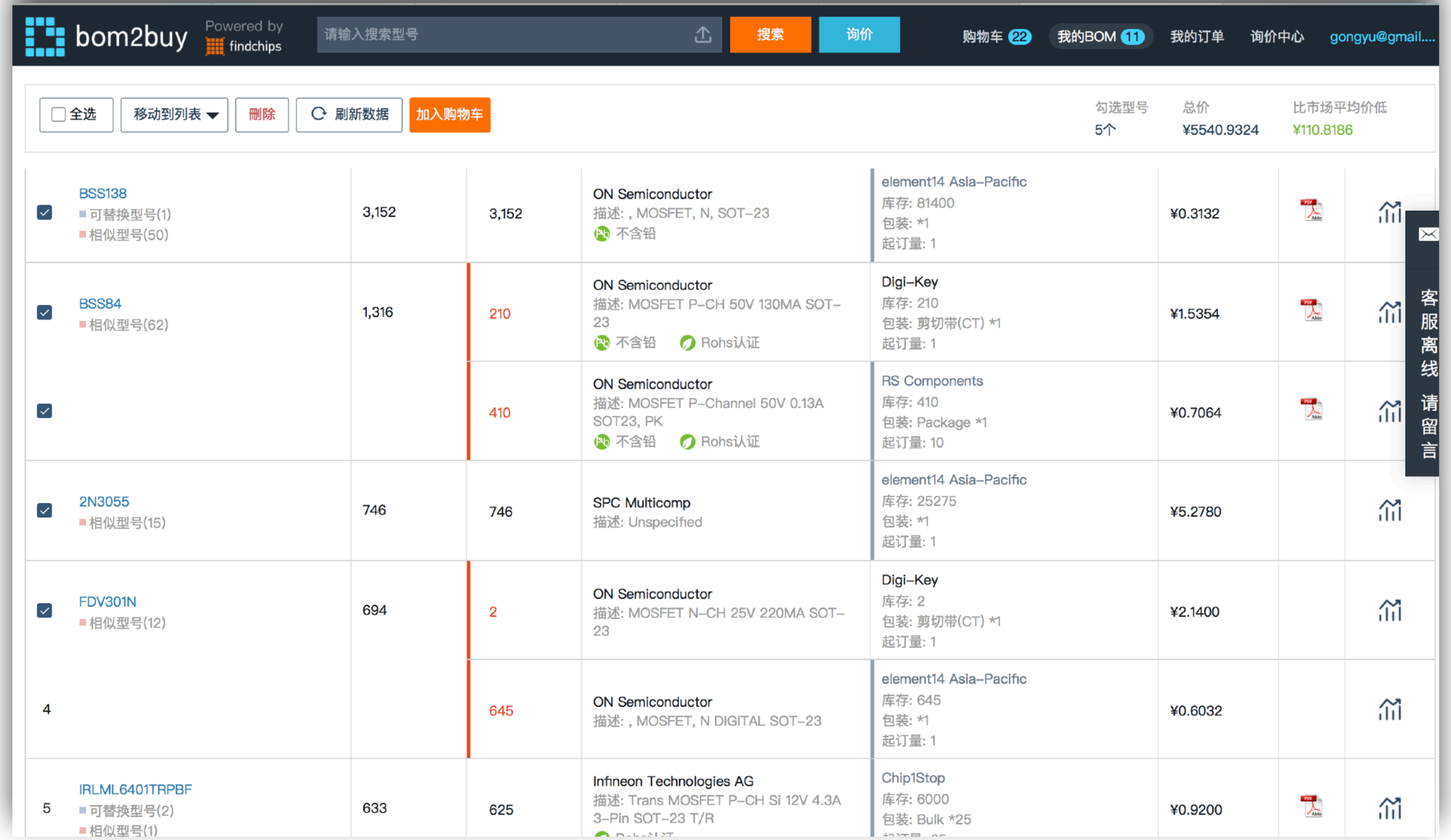


选用渠道2 - 分销商网站

- 根据型号查询
- 根据器件类别查询、根据参数过滤
- 每个分销商货品不同、价格也不同
- 现货价格、库存、参数、数据手册
- 主要分销商：
  - www.digikey.com
  - www.mouser.com
  - www.element14.com
  - www.rs-components.com
  - www.arrow.com

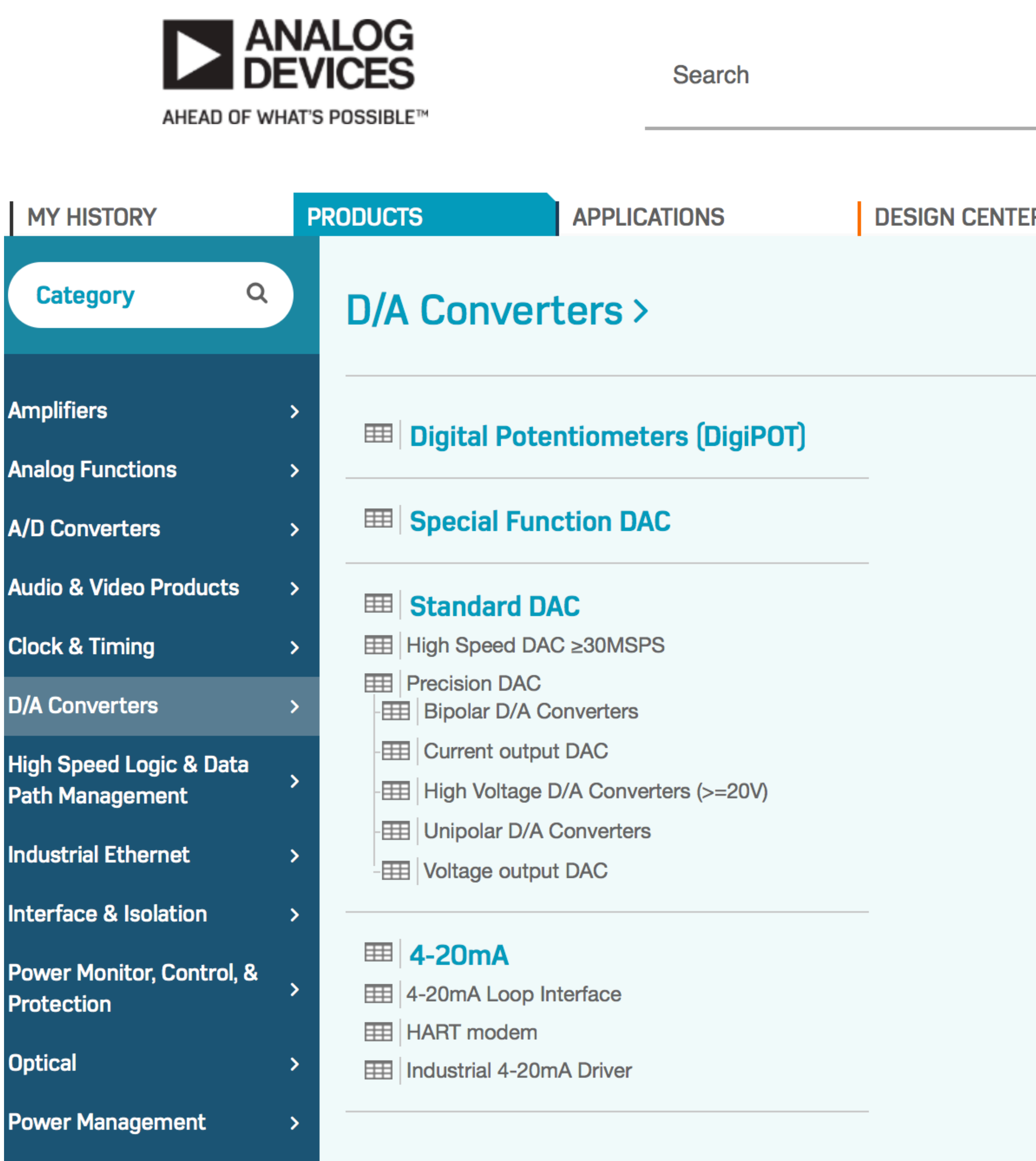
www.bom2buy.com

- **Findchips**的中文版本，支持一站式交易
- 汇聚了主流现货分销商的实时库存和价格信息
- 批量器件上传，给出最佳组合购买渠道推荐
- 价格、库存、技术资料、风险系数、替代型号



选用渠道3 - 原厂官网

- 按照原厂的产品分类逐级检索
- 按照原厂的产品应用检索
- 按照器件型号进行搜索
- 好处：
  - 丰富详尽的技术资料、使用指南
  - 常用型号可以申请免费小批量的样品
  - 信息最准确



选用渠道4 - 媒体NPI

- 适用于原厂新推出来的产品
- 配套的板卡、市场活动、论坛
- 主要来源：
  - 专业媒体的新闻报导 - www.eefocus.com
  - 开发板及电子产品评测 - www.eeboard.com
  - 工程师设计分享网站 - www.cirmall.com
  - 在线技术培训网站 - www.moore8.com

其它渠道

- 前期项目和团队选用的器件 - 风险最小，但会偏于保守
- 其它产品的参考、借鉴
- 原厂或分销商市场/FAE推荐 - 活动介绍或线下拜访，新产品替代有风险
- 技术论坛交流、QQ群、微信群

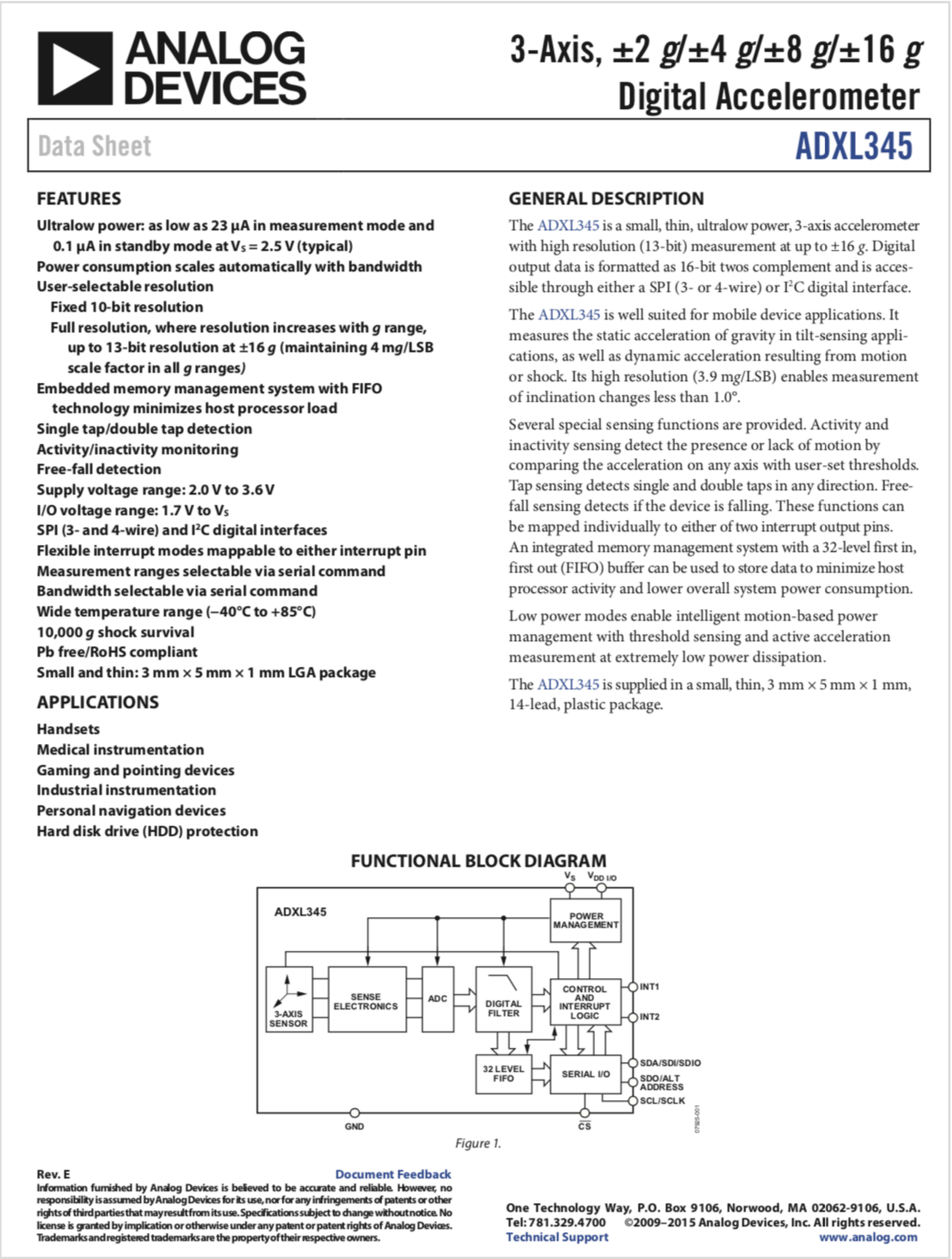
技术资料的阅读及关键信息获取

元器件数据手册的利用

- 认真阅读元器件相应的数据手册
- 确定是最终的官方版本的数据手册（www.datasheet5.com）
- 参考原厂提供的参考设计的原理图库、连接方式
- 严格按照数据手册中提供的封装信息进行PCB封装库的构建，一个器件一般会有多个不同的封装，元器件型号（Part number）要对应于器件的正确封装信息
- 尤其注意电源、时钟管脚、差分信号等的连接需求

基本信息汇总 - 第一页

- 型号、基本描述
- 功能、特性
- 应用
- 功能框图
- 封装信息



ANALOG DEVICES

3-Axis, ±2 *g*/±4 *g*/±8 *g*/±16 *g* Digital Accelerometer

Data Sheet **ADXL345**

FEATURES

Ultralow power: as low as 23 µA in measurement mode and 0.1 µA in standby mode at V_S = 2.5 V (typical)
Power consumption scales automatically with bandwidth
User-selectable resolution
Fixed 10-bit resolution
Full resolution, where resolution increases with *g* range, up to 13-bit resolution at ±16 *g* (maintaining 4 mg/LSB scale factor in all *g* ranges)
Embedded memory management system with FIFO technology minimizes host processor load
Single tap/double tap detection
Activity/inactivity monitoring
Free-fall detection
Supply voltage range: 2.0 V to 3.6 V
I/O voltage range: 1.7 V to V_S
SPI (3- and 4-wire) and I²C digital interfaces
Flexible interrupt modes mappable to either interrupt pin
Measurement ranges selectable via serial command
Bandwidth selectable via serial command
Wide temperature range (−40°C to +85°C)
10,000 *g* shock survival
Pb free/RoHS compliant
Small and thin: 3 mm × 5 mm × 1 mm LGA package

APPLICATIONS

Handsets
Medical instrumentation
Gaming and pointing devices
Industrial instrumentation
Personal navigation devices
Hard disk drive (HDD) protection

GENERAL DESCRIPTION

The ADXL345 is a small, thin, ultralow power, 3-axis accelerometer with high resolution (13-bit) measurement at up to ±16 *g*. Digital output data is formatted as 16-bit twos complement and is accessible through either a SPI (3- or 4-wire) or I²C digital interface.

The ADXL345 is well suited for mobile device applications. It measures the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion or shock. Its high resolution (3.9 mg/LSB) enables measurement of inclination changes less than 1.0°.

Several special sensing functions are provided. Activity and inactivity sensing detect the presence or lack of motion by comparing the acceleration on any axis with user-set thresholds. Tap sensing detects single and double taps in any direction. Free-fall sensing detects if the device is falling. These functions can be mapped individually to either of two interrupt output pins. An integrated memory management system with a 32-level first in, first out (FIFO) buffer can be used to store data to minimize host processor activity and lower overall system power consumption.

Low power modes enable intelligent motion-based power management with threshold sensing and active acceleration measurement at extremely low power dissipation.

The ADXL345 is supplied in a small, thin, 3 mm × 5 mm × 1 mm, 14-lead, plastic package.

FUNCTIONAL BLOCK DIAGRAM

Figure 1.

Rev. E Document Feedback

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Tel: 781.329.4700
Technical Support www.analog.com

管脚定义

- 管脚编号
- 每个管脚的功能
- 物理上的排列方式
- 注意不同的封装其定义不同
- 管脚1的位置
- 散热/接地管脚
- Vcc、Vdd、Vs、CLK、CLR、NC
- 低电平有效

Data Sheet ADXL345

PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

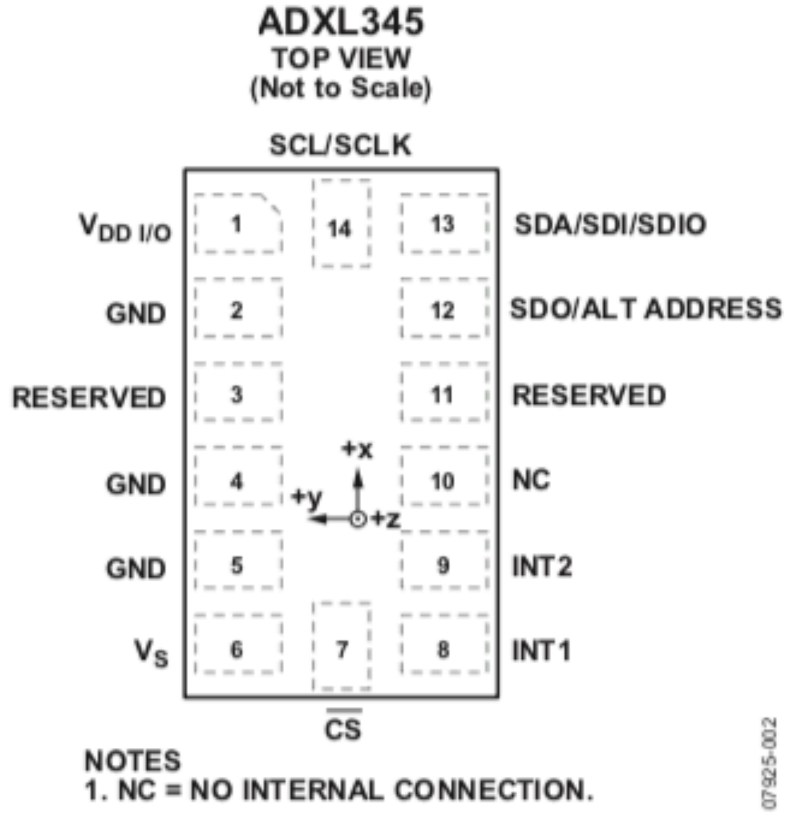


Figure 3. Pin Configuration (Top View)

Table 5. Pin Function Descriptions

Pin No.	Mnemonic	Description
1	$V_{DD\ I/O}$	Digital Interface Supply Voltage.
2	GND	This pin must be connected to ground.
3	RESERVED	Reserved. This pin must be connected to V_S or left open.
4	GND	This pin must be connected to ground.
5	GND	This pin must be connected to ground.
6	V_S	Supply Voltage.
7	$\overline{CS}$	Chip Select.
8	INT1	Interrupt 1 Output.
9	INT2	Interrupt 2 Output.
10	NC	Not Internally Connected.
11	RESERVED	Reserved. This pin must be connected to ground or left open.
12	SDO/ALT ADDRESS	Serial Data Output (SPI 4-Wire)/Alternate I^2C Address Select (I^2C).
13	SDA/SDI/SDIO	Serial Data (I^2C)/Serial Data Input (SPI 4-Wire)/Serial Data Input and Output (SPI 3-Wire).
14	SCL/SCLK	Serial Communications Clock. SCL is the clock for I^2C, and SCLK is the clock for SPI.

极限工作和推荐工作条件

ABSOLUTE MAXIMUM RATINGS

Table 2.

Parameter	Rating
Acceleration	
Any Axis, Unpowered	10,000 *g*
Any Axis, Powered	10,000 *g*
V_S	−0.3 V to +3.9 V
$V_{DD\,I/O}$	−0.3 V to +3.9 V
Digital Pins	−0.3 V to $V_{DD\,I/O}$ + 0.3 V or 3.9 V, whichever is less
All Other Pins	−0.3 V to +3.9 V
Output Short-Circuit Duration (Any Pin to Ground)	Indefinite
Temperature Range	
Powered	−40°C to +105°C
Storage	−40°C to +105°C

Stresses at or above those listed under Absolute Maximum Ratings may cause permanent damage to the product. This is a stress rating only; functional operation of the product at these or any other conditions above those indicated in the operational section of this specification is not implied. Operation beyond the maximum operating conditions for extended periods may affect product reliability.

SPECIFICATIONS

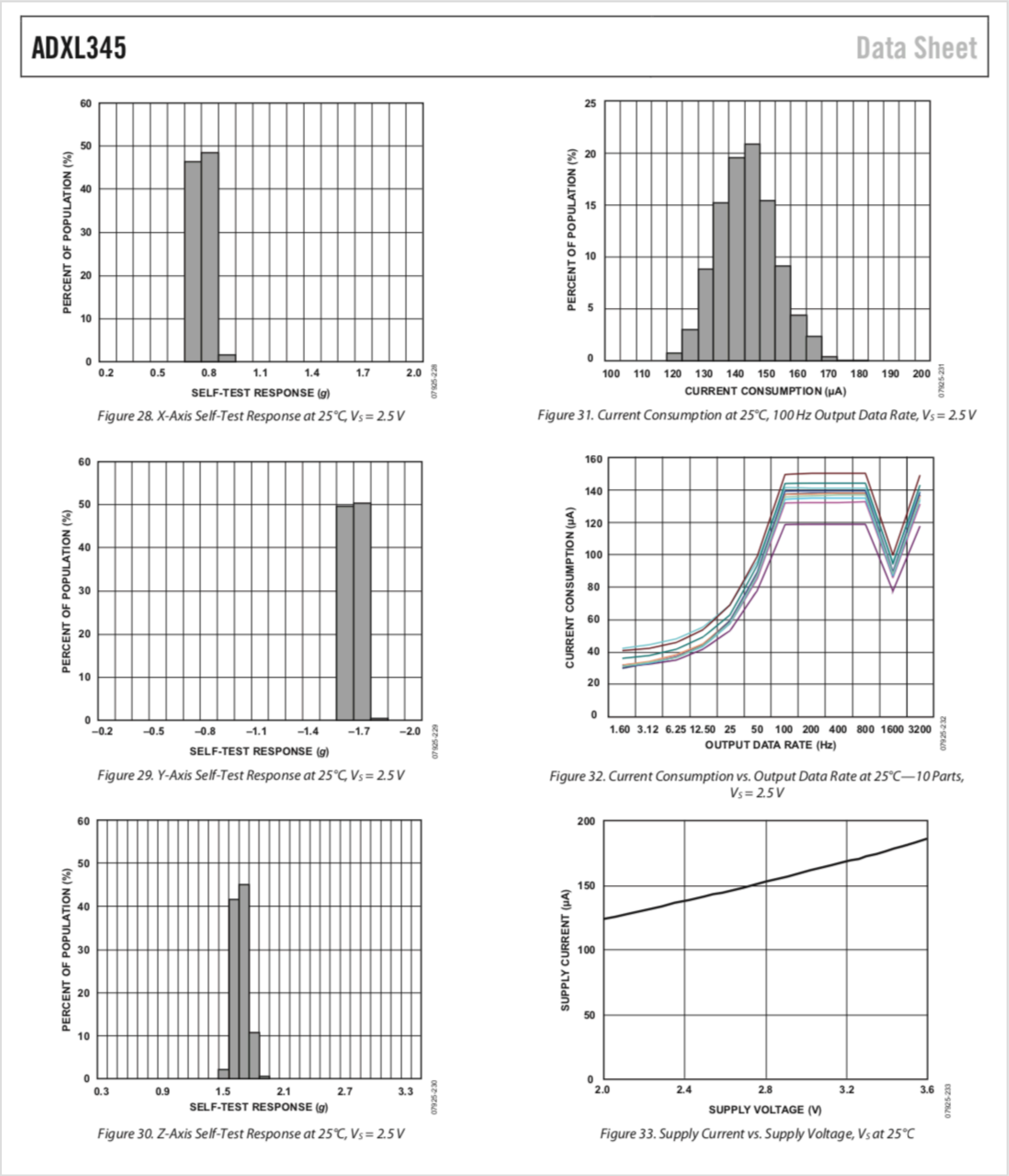
T_A = 25°C, V_S = 2.5 V, $V_{DD\,I/O}$ = 1.8 V, acceleration = 0 *g*, C_S = 10 μF tantalum, $C_{I/O}$ = 0.1 μF, output data rate (ODR) = 800 Hz, unless otherwise noted. All minimum and maximum specifications are guaranteed. Typical specifications are not guaranteed.

Table 1.

Parameter	Test Conditions	Min	Typ[1]	Max	Unit
SENSOR INPUT	Each axis				
Measurement Range	User selectable		±2, ±4, ±8, ±16		*g*
Nonlinearity	Percentage of full scale		±0.5		%
Inter-Axis Alignment Error			±0.1		Degrees
Cross-Axis Sensitivity[2]			±1		%
OUTPUT RESOLUTION	Each axis				
All *g* Ranges	10-bit resolution		10		Bits
±2 *g* Range	Full resolution		10		Bits
±4 *g* Range	Full resolution		11		Bits
±8 *g* Range	Full resolution		12		Bits
±16 *g* Range	Full resolution		13		Bits
SENSITIVITY	Each axis				
Sensitivity at X_{OUT}, Y_{OUT}, Z_{OUT}	All *g*-ranges, full resolution	230	256	282	LSB/*g*
	±2 *g*, 10-bit resolution	230	256	282	LSB/*g*
	±4 *g*, 10-bit resolution	115	128	141	LSB/*g*
	±8 *g*, 10-bit resolution	57	64	71	LSB/*g*
	±16 *g*, 10-bit resolution	29	32	35	LSB/*g*
Sensitivity Deviation from Ideal	All *g*-ranges		±1.0		%
Scale Factor at X_{OUT}, Y_{OUT}, Z_{OUT}	All *g*-ranges, full resolution	3.5	3.9	4.3	m*g*/LSB
	±2 *g*, 10-bit resolution	3.5	3.9	4.3	m*g*/LSB
	±4 *g*, 10-bit resolution	7.1	7.8	8.7	m*g*/LSB
	±8 *g*, 10-bit resolution	14.1	15.6	17.5	m*g*/LSB
	±16 *g*, 10-bit resolution	28.6	31.2	34.5	m*g*/LSB
Sensitivity Change Due to Temperature			±0.01		%/°C
0 *g* OFFSET	Each axis				
0 *g* Output for X_{OUT}, Y_{OUT}		−150	0	+150	m*g*
0 *g* Output for Z_{OUT}		−250	0	+250	m*g*
0 *g* Output Deviation from Ideal, X_{OUT}, Y_{OUT}			±35		m*g*
0 *g* Output Deviation from Ideal, Z_{OUT}			±40		m*g*
0 *g* Offset vs. Temperature for X-, Y-Axes			±0.4		m*g*/°C
0 *g* Offset vs. Temperature for Z-Axis			±1.2		m*g*/°C
NOISE					
X-, Y-Axes	ODR = 100 Hz for ±2 *g*, 10-bit resolution or all *g*-ranges, full resolution		0.75		LSB rms
Z-Axis	ODR = 100 Hz for ±2 *g*, 10-bit resolution or all *g*-ranges, full resolution		1.1		LSB rms
OUTPUT DATA RATE AND BANDWIDTH	User selectable				
Output Data Rate (ODR)[3,4,5]		0.1		3200	Hz
SELF-TEST[6]					
Output Change in X-Axis		0.20		2.10	*g*
Output Change in Y-Axis		−2.10		−0.20	*g*
Output Change in Z-Axis		0.30		3.40	*g*
POWER SUPPLY					
Operating Voltage Range (V_S)		2.0	2.5	3.6	V
Interface Voltage Range ($V_{DD\,I/O}$)		1.7	1.8	V_S	V
Supply Current	ODR ≥ 100 Hz		140		μA
	ODR < 10 Hz		30		μA
Standby Mode Leakage Current			0.1		μA
Turn-On and Wake-Up Time[7]	ODR = 3200 Hz		1.4		ms

关键性能和各参数之间的曲线

- 参数变量之间的关系
- 电流 vs 电压
- 灵敏度 vs 温度
- 要让器件工作在“安全区”



应用中要特别注意的地方

- 供电
- 接地
- 时钟
- 物理连接

APPLICATIONS INFORMATION

POWER SUPPLY DECOUPLING

A 1 μF tantalum capacitor (C_S) at V_S and a 0.1 μF ceramic capacitor ($C_{I/O}$) at $V_{DD\ I/O}$ placed close to the ADXL345 supply pins is recommended to adequately decouple the accelerometer from noise on the power supply. If additional decoupling is necessary, a resistor or ferrite bead, no larger than 100 Ω, in series with V_S may be helpful. Additionally, increasing the bypass capacitance on V_S to a 10 μF tantalum capacitor in parallel with a 0.1 μF ceramic capacitor may also improve noise.

Care should be taken to ensure that the connection from the ADXL345 ground to the power supply ground has low impedance because noise transmitted through ground has an effect similar to noise transmitted through V_S. It is recommended that V_S and $V_{DD\ I/O}$ be separate supplies to minimize digital clocking noise on the V_S supply. If this is not possible, additional filtering of the supplies, as previously mentioned, may be necessary.

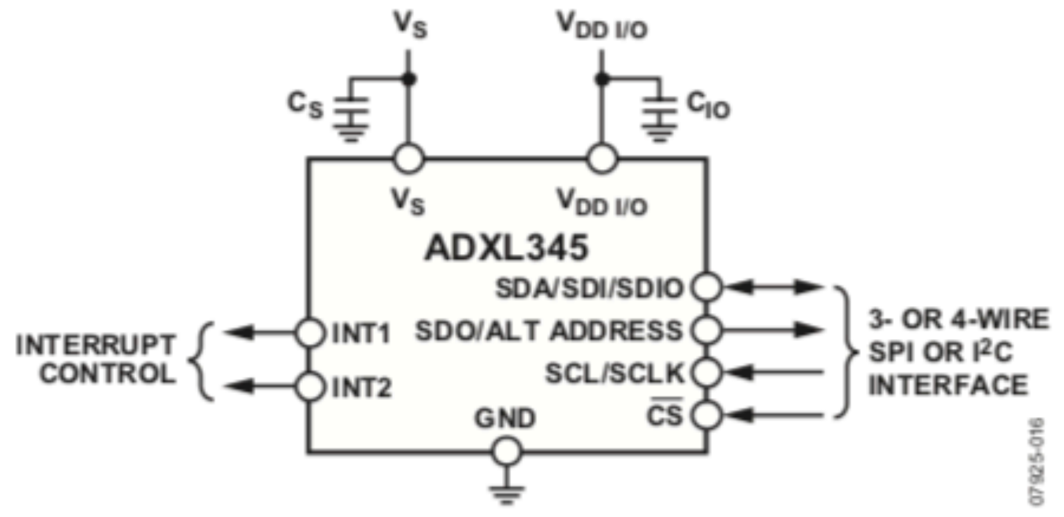


Figure 44. Application Diagram

MECHANICAL CONSIDERATIONS FOR MOUNTING

The ADXL345 should be mounted on the PCB in a location close to a hard mounting point of the PCB to the case. Mounting the ADXL345 at an unsupported PCB location, as shown in Figure 45, may result in large, apparent measurement errors due to undampened PCB vibration. Locating the accelerometer near a hard mounting point ensures that any PCB vibration at the accelerometer is above the accelerometer's mechanical sensor resonant frequency and, therefore, effectively invisible to the accelerometer. Multiple mounting points, close to the sensor, and/or a thicker PCB also help to reduce the effect of system resonance on the performance of the sensor.

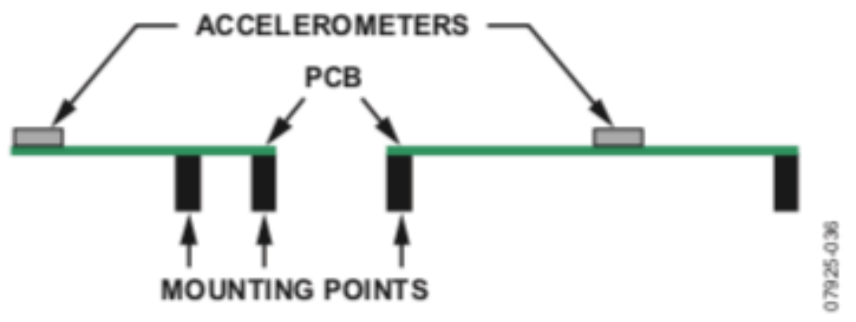


Figure 45. Incorrectly Placed Accelerometers

TAP DETECTION

The tap interrupt function is capable of detecting either single or double taps. The following parameters are shown in Figure 46 for a valid single and valid double tap event:

- The tap detection threshold is defined by the THRESH_TAP register (Address 0x1D).
- The maximum tap duration time is defined by the DUR register (Address 0x21).
- The tap latency time is defined by the latent register (Address 0x22) and is the waiting period from the end of the first tap until the start of the time window, when a second tap can be detected, which is determined by the value in the window register (Address 0x23).
- The interval after the latency time (set by the latent register) is defined by the window register. Although a second tap must begin after the latency time has expired, it need not finish before the end of the time defined by the window register.

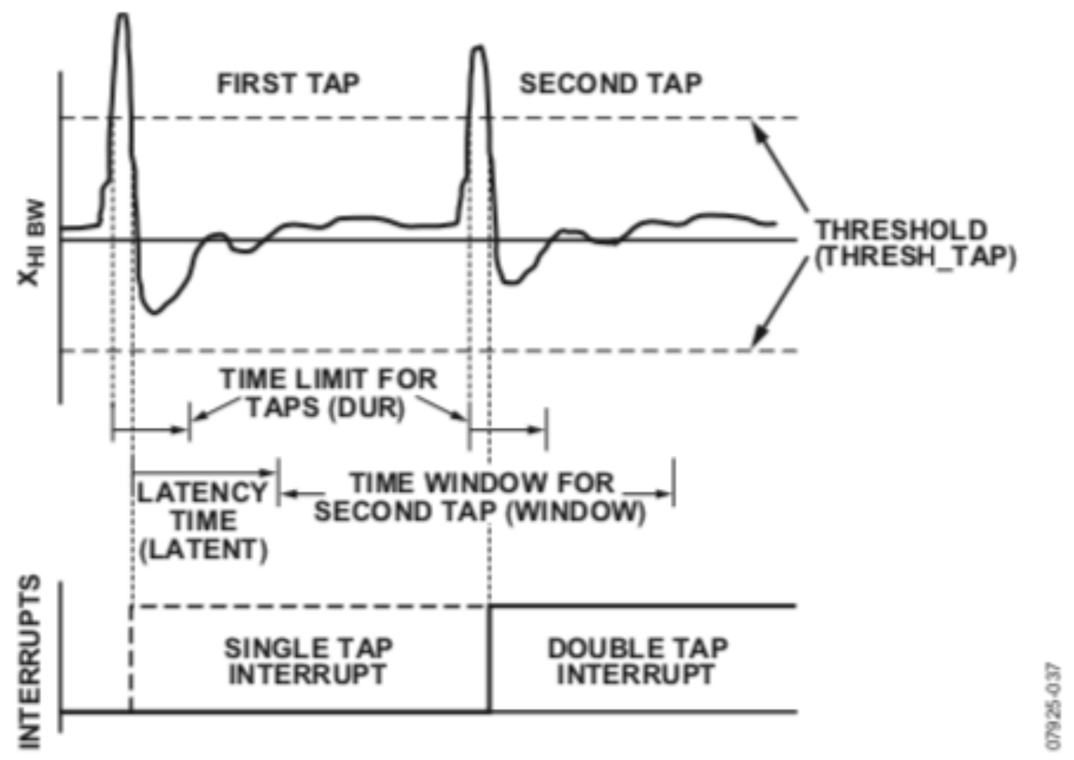


Figure 46. Tap Interrupt Function with Valid Single and Double Taps

If only the single tap function is in use, the single tap interrupt is triggered when the acceleration goes below the threshold, as long as DUR has not been exceeded. If both single and double tap functions are in use, the single tap interrupt is triggered when the double tap event has been either validated or invalidated.

封装信息

- 制作PCB封装库的重要参考
- 注意Pin1的位置
- 注意其焊盘的大小
- 一般在Datasheet的最后面
- 不同的封装对应不同的型号尾标
- 不同的温度范围/应用级别也对应不同的型号尾标

OUTLINE DIMENSIONS

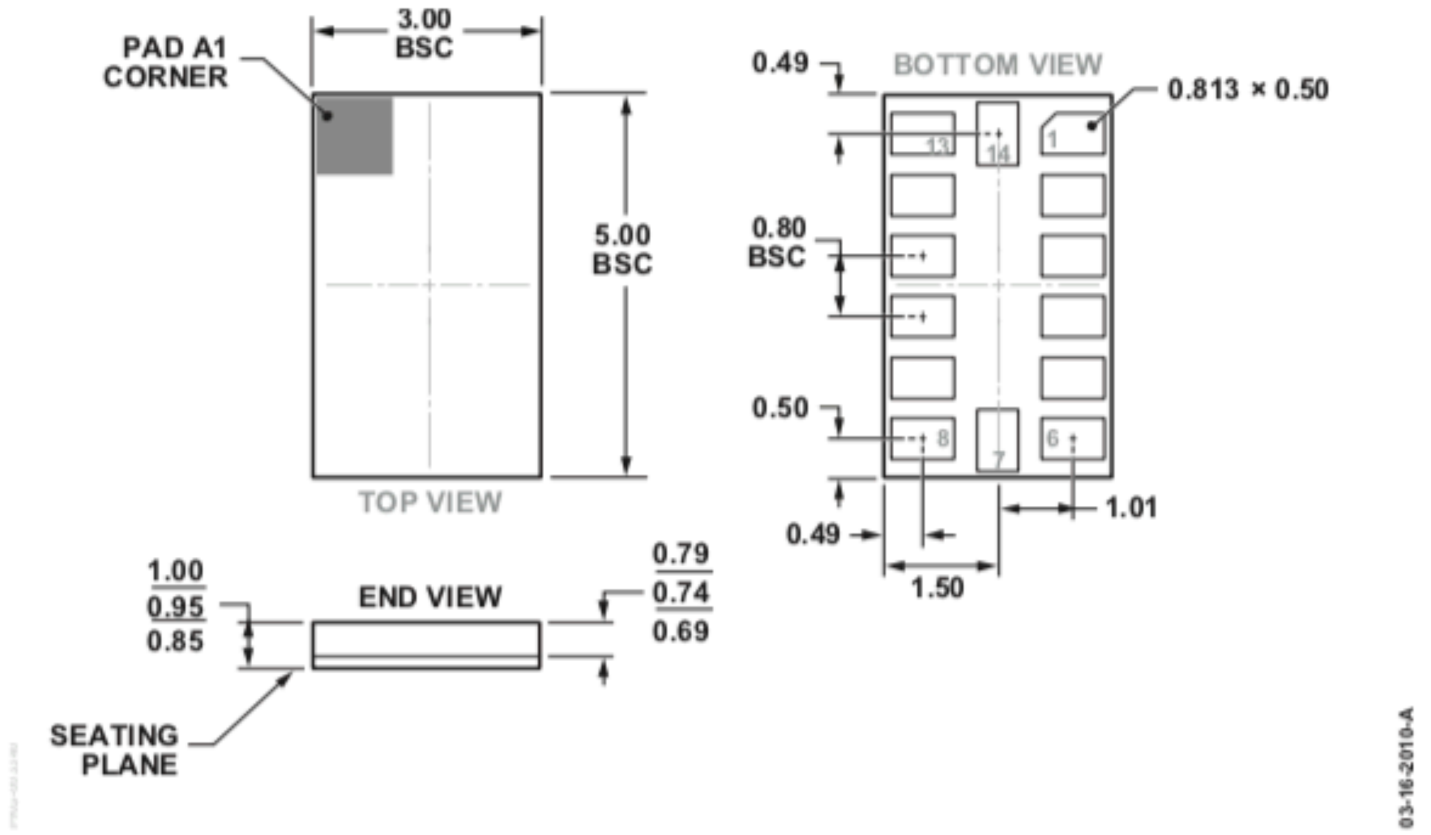


Figure 61. 14-Terminal Land Grid Array [LGA]
(CC-14-1)
Solder Terminations Finish Is Au over Ni
Dimensions shown in millimeters

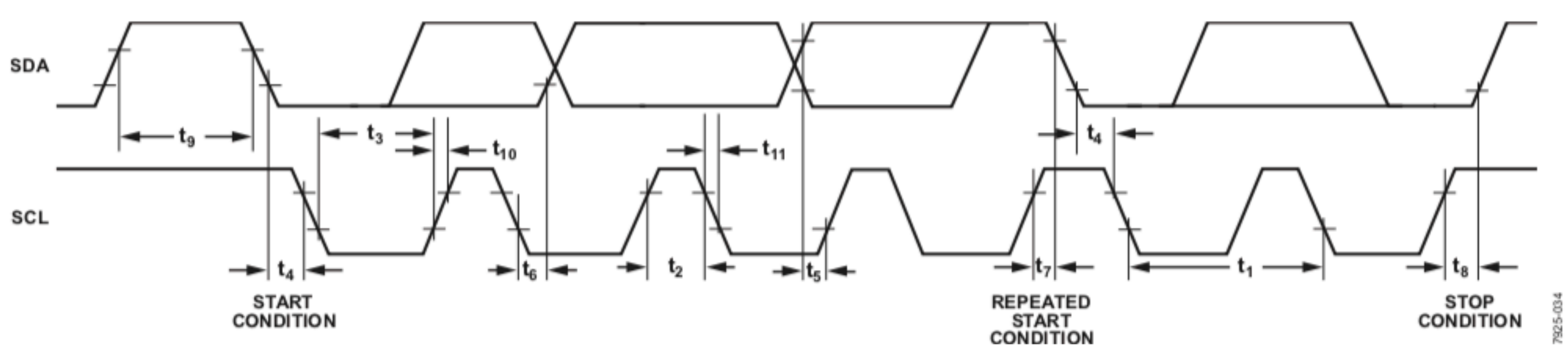
ORDERING GUIDE

Model[1]	Measurement Range (*g*)	Specified Voltage (V)	Temperature Range	Package Description	Package Option
ADXL345BCCZ	±2, ±4, ±8, ±16	2.5	−40°C to +85°C	14-Terminal Land Grid Array [LGA]	CC-14-1
ADXL345BCCZ-RL	±2, ±4, ±8, ±16	2.5	−40°C to +85°C	14-Terminal Land Grid Array [LGA]	CC-14-1
ADXL345BCCZ-RL7	±2, ±4, ±8, ±16	2.5	−40°C to +85°C	14-Terminal Land Grid Array [LGA]	CC-14-1
EVAL-ADXL345Z				Evaluation Board	
EVAL-ADXL345Z-DB				Evaluation Board	
EVAL-ADXL345Z-M				Analog Devices Inertial Sensor Evaluation System, Includes ADXL345 Satellite	
EVAL-ADXL345Z-S				ADXL345 Satellite, Standalone	

[1] Z = RoHS Compliant Part.

Parameter	Limit[1,2] Min	Max	Unit	Description
f_{SCL}		400	kHz	SCL clock frequency
t_1	2.5		µs	SCL cycle time
t_2	0.6		µs	t_{HIGH}, SCL high time
t_3	1.3		µs	t_{LOW}, SCL low time
t_4	0.6		µs	$t_{HD, STA}$, start/repeated start condition hold time
t_5	100		ns	$t_{SU, DAT}$, data setup time
t_6[3, 4, 5, 6]	0	0.9	µs	$t_{HD, DAT}$, data hold time
t_7	0.6		µs	$t_{SU, STA}$, setup time for repeated start
t_8	0.6		µs	$t_{SU, STO}$, stop condition setup time
t_9	1.3		µs	t_{BUF}, bus-free time between a stop condition and a start condition
t_{10}		300	ns	t_R, rise time of both SCL and SDA when receiving
	0		ns	t_R, rise time of both SCL and SDA when receiving or transmitting
t_{11}		300	ns	t_F, fall time of SDA when receiving
		250	ns	t_F, fall time of both SCL and SDA when transmitting
C_b		400	pF	Capacitive load for each bus line

[1] Limits based on characterization results, with f_{SCL} = 400 kHz and a 3 mA sink current; not production tested.
[2] All values referred to the V_{IH} and the V_{IL} levels given in Table 11.
[3] t_6 is the data hold time that is measured from the falling edge of SCL. It applies to data in transmission and acknowledge.
[4] A transmitting device must internally provide an output hold time of at least 300 ns for the SDA signal (with respect to $V_{IH(min)}$ of the SCL signal) to bridge the undefined region of the falling edge of SCL.
[5] The maximum t_6 value must be met only if the device does not stretch the low period (t_3) of the SCL signal.
[6] The maximum value for t_6 is a function of the clock low time (t_3), the clock rise time (t_{10}), and the minimum data setup time ($t_{5(min)}$). This value is calculated as $t_{6(max)} = t_3 - t_{10} - t_{5(min)}$.



参考连接方式及相应的时序要求

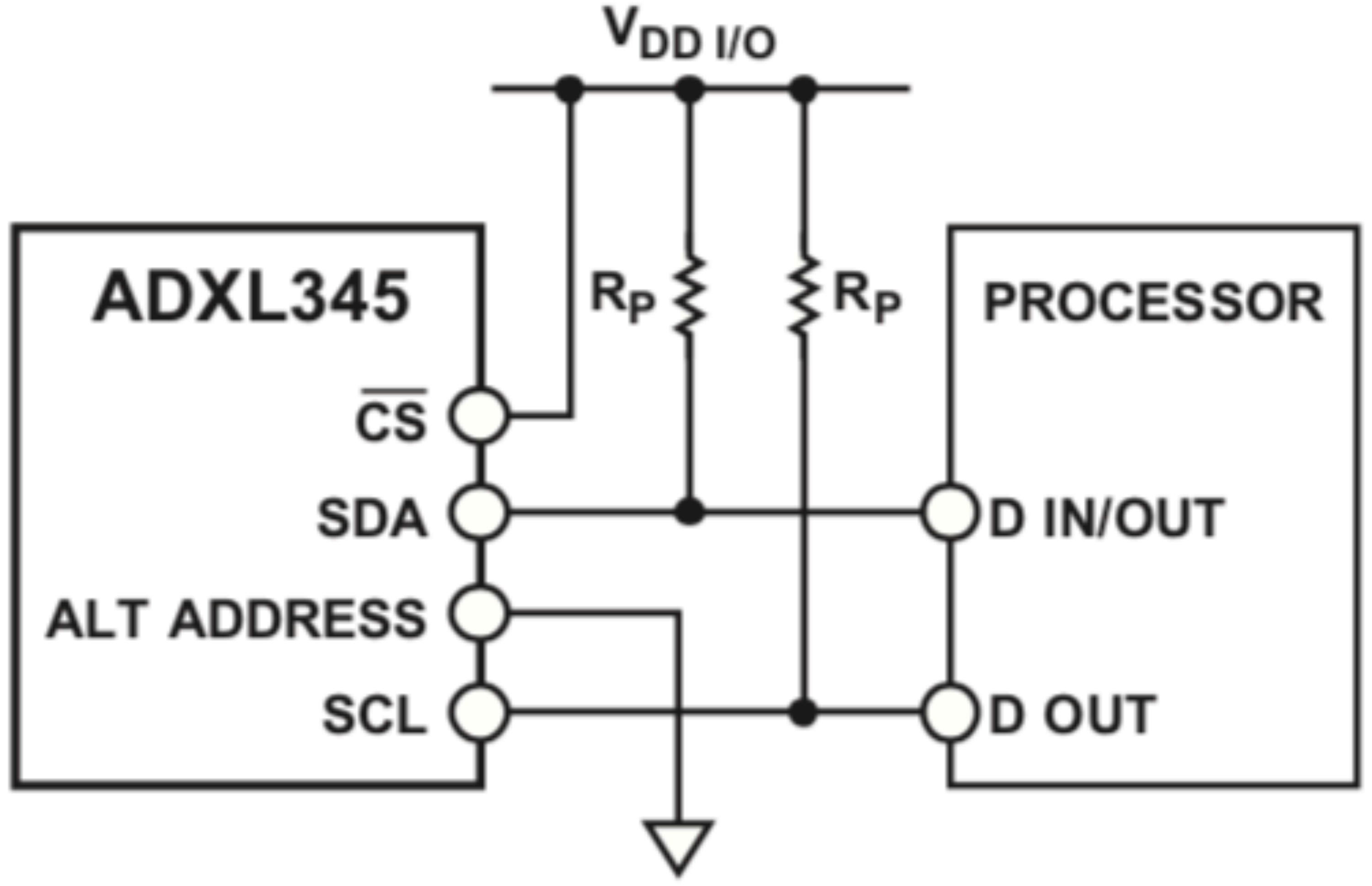


Figure 40. I²C Connection Diagram (Address 0x5

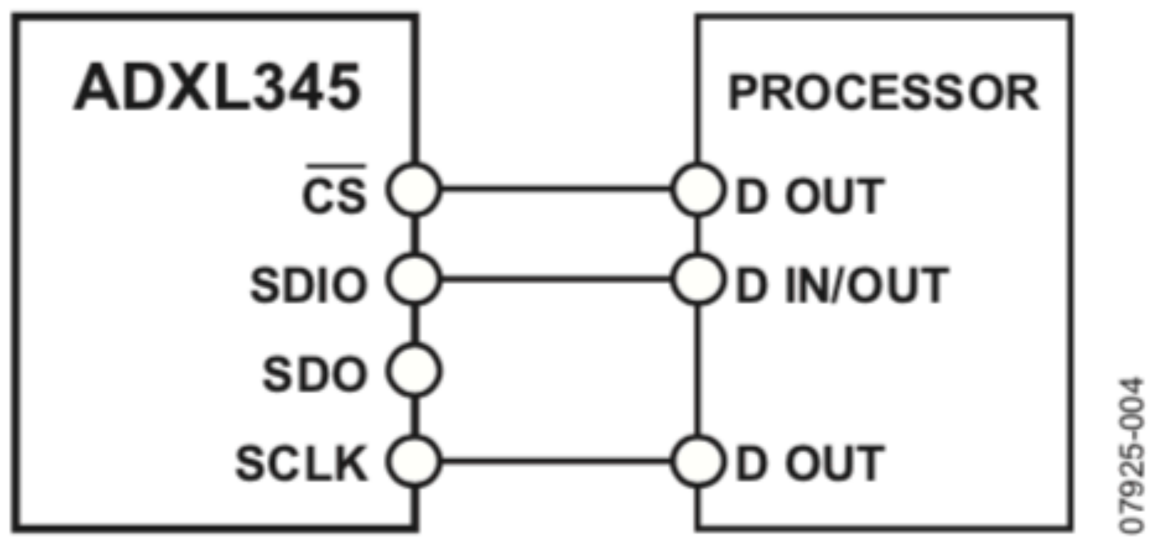


Figure 34. 3-Wire SPI Connection Diagram

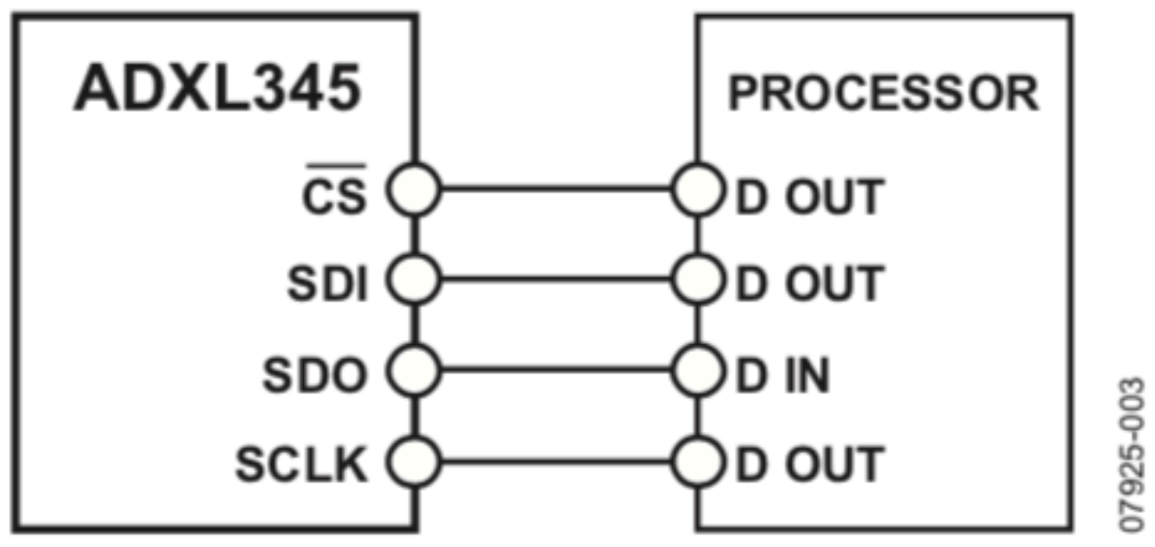


Figure 35. 4-Wire SPI Connection Diagram

BOM文件的产生及元器件备料

- 工程师和采购之间的桥梁
- 版本控制
- 正确的 Partnumber并尽可能指定采购的货源
- 关联器件采购渠道
- 估价 - 使用www.bom2buy.com
- 成本优化

Description	Designator	Comment	value	Footprint	Quantity
Electric Capacity Polarized 220uF，16V,10%	C10	220uF	220uF	TAcap-D	1
Fixed Inductors 150uH 10% Mangnetic-Core 150uH 铁氧芯电感	L1	150uH	150uH	INDC4532	1
Header 2	J3	Header 2		HDR1X2	1
Header 3	J2, J4	Header 3		HDR1X3	2
Header, 6-Pin	P1	Header 6		HDR1X6	1
Inductor 1.5uH,10%	L2	1.5uH	1.5uH	1206	1
Inverting IC LTC1983-5	U6	LTC1983-5		SOT23	1
LDO IC LTC117-3.3	U2	LTC1117-3.3		SOT223	1
LDO IC LTC117-5	U4	LTC1117-5		SOT223	1
LED Green	LED1	LED		0805-A	1
Micro USB Header	J1	Header 5		MICRO-USB	1
Multilayer Ceramic Capacitors MLCC - SMD/SMT 16volts 10uF 5%	C1, C2, C11, C13, C14	10uF	10uF	1206	5
Multilayer Ceramic Capacitors MLCC - SMD/SMT 47uF 16Volts 10%	C16	47uF	47uF	C1210	1
Multilayer Ceramic Capacitors MLCC - SMD/SMT 500PF 50V 2%	C6	500pF	500pF	0805	1
Multilayer Ceramic Capacitors MLCC - SMD/SMT 0805 0.1uF 16volts X7R 5%	C3	0.1uF	0.1uF	0805	1
Multilayer Ceramic Capacitors MLCC - SMD/SMT 0805 1uF 16volts X7R 5%	C12, C15	1uF	1uF	0805	2
NPN General Purpose Amplifier,SOT-23	Q1	NPN		SOT-23	1
Resistance 0Ohm,5%,0603	R4, R5, R8, R9	0	0	0603	4
Resistance 0.82Ohm,5%,0603	R13	0.82	0.82	0603	1
Resistance 3.9k,5%,0603	R17	3.9k	3.9k	0603	1
Resistance 10k,5%,0603	R6, R7, R18	10k	10k	0603	3
Resistance 18k,5%,0603	R15	18k	18k	0603	1
Resistance 100k,5%,0603	R10, R11	100k	100k	0603	2
Resistance 180Ohm,5%,0603	R12	180	180	0603	1
Resistance 300Ohm,5%,0603	R2	300	300	0603	1
Resistance 330,5%,0603	R3	330	330	0603	1
Resistance 510k,5%,0603	R23	510k	510k	0603	1
Resistance ,1,0603,5%	R1	1	1	0603	1
Resistance,5.1k,5%,0603	R24	5.1k	5.1k	0603	1
Resistance,10k,5%,0603	R19	10k	10k	0603	1
Resistance,150,5%,0603	R14	180	180	0603	1
Resistance,330,5%,0603	R16, R20, R22	330	330	0603	3
Resistance ,330k,5%,0603	R21	330k	330k	0603	1
Schottky Diode 1N5819	D1, D2	1N5819		SMA	2
Tantalum Capacity Polarized 10uF,16V,10%	C4, C8	10uF	10uF	TAcap-B	2
Tantalum Capacity Polarized 22uF,16V,10%	C5, C9	22uF	22uF	TAcap-B	2
Tantalum Capacity Polarized 100uF,16V,10%	C7	100uF	100uF	TAcap-B	1
Typical INFRARED GaAs LED,1.8V,10mA,Red	LED2, LED3, LED4, LED5, LED6	LED		0805-A	5
USB Power Charing & Managing IC	U1	LTC4055-1		QFN	1
Voltage Regulators - Switching Regulators 1.5-A Boost/Buck Inverting Swtch Reg	U3	MC34063A		SOIC-8	1
Voltage Regulators - Switching Regulators ICs, P	U5	BD90571EFJ-C		HTSOP	1

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