MA730

DESCRIPTION

1. 数据处理速度: 0~60000 RPM
2. 片上有非易失性存储可以用设置0角度为,ABZ编码器,磁场检测阈值

FEATURES

1. 14位绝对角度编码器
2. 使用SPI接口进行数据读出和芯片配置
3. 12位ABZ增量求积接口,每圈1-1024 可编程脉冲
4. PWM 14位输出
5. 可编程磁场检测强度
6. 电源:3.3V 500mA

GENERAL CHARACTERISTICS

- power-up time max: 260 ms
- latency max: 10 us
- accuracy 0.7 deg
- ABZ update rate 16 MHz
- resolution 4096

PIN FUNCITONS

PIN FUNCTIONS

Package Pin #	Name	Description
1	SSD	**Data out (SSI).**
2	A	**Incremental output.**
3	Z	**Incremental output.**
4	MOSI	**Data in (SPI).** MOSI has an internal pull-down resistor.
5	CS	**Chip select (SPI).** CS has an internal pull-up resistor.
6	B	**Incremental output.**
7	MISO	**Data out (SPI).** MISO has an internal pull-down resistor that is enabled at a high impedance state.
8	GND	**Supply ground.**
9	PWM	**PWM output.**
10	TEST	**Factory use only.** Connect TEST to ground.
11	MGL	**Digital output indicating field strength below MGLT level.**
12	SCLK	**Clock (SPI).** Internal pull-down.
13	VDD	**3.3V supply.**
14	NC	**No connection.** Leave NC unconnected.
15	SSCK	**Clock (SSI).** Internal pull-down.
16	MGH	**Digital output indicating field strength above MGHT level.**

BLOCK DIAGRAM

BLOCK DIAGRAM

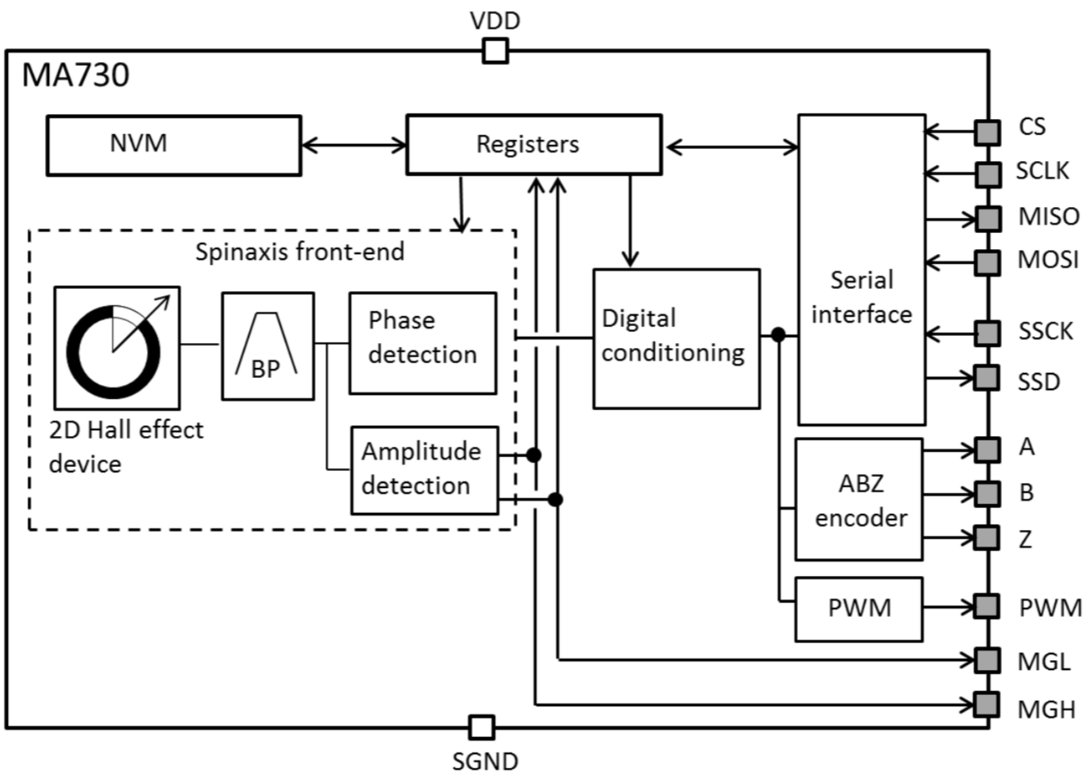


Figure 1: Functional Block Diagram

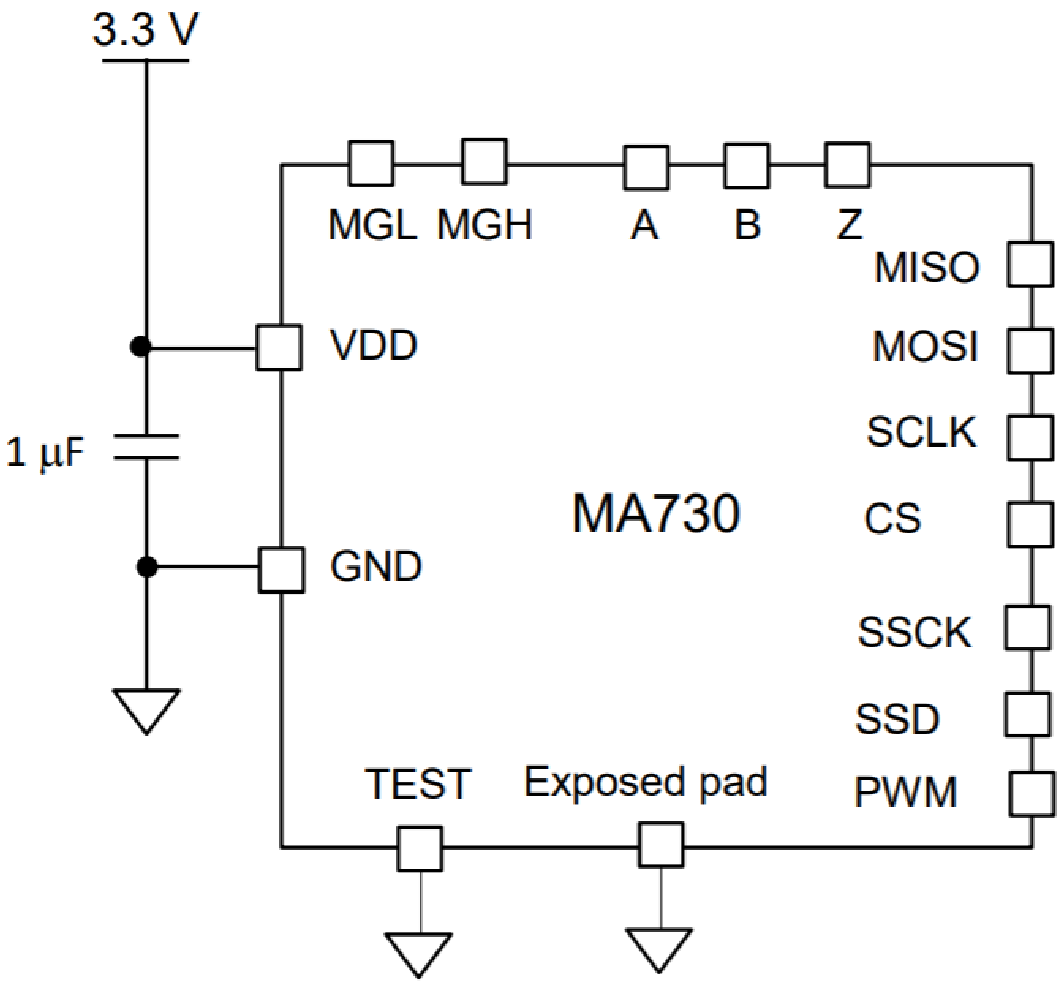


Figure 6: Connection for Supply Decoupling

SPI

- SPI最大时钟频率 25MHz
- 所有发送给MA730的命令由MOSI pin传输, 且必须为16位
- 芯片1us传输一次角度到输出buffer, 主设备通过拉低CS引脚来触发读取,当检测到触发事件时,数据会保留在buffer中直到CS信号失效

Table 4: Sensor Data Timing

Event	Action
CS falling edge	Start reading and freeze output buffer
CS rising edge	Release of the output buffer

- 如果传输的角度数据少于16bit,且主设备仍然发送了16次时钟脉冲,则低位补0;

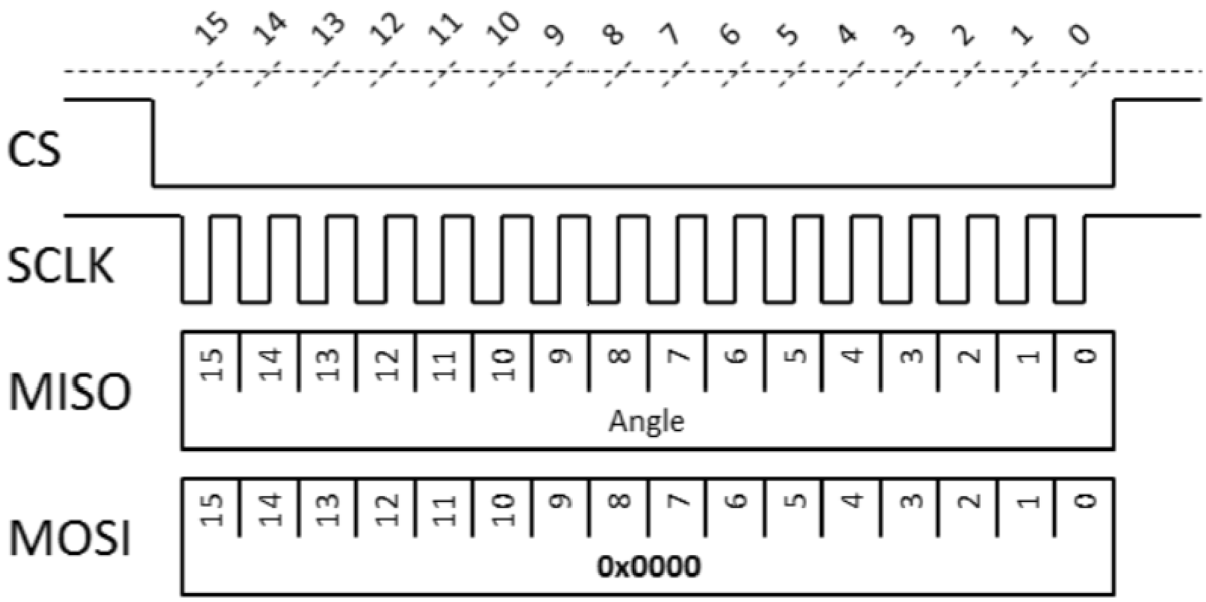


Figure 9: Diagram of a Full 16-Bit SPI Angle Reading

- SPI读寄存器
  读取操作由两个16bit帧构成

```
第一次:
  从设备->主设备:     angle(16bit)
  主设备->从设备:     010(3bit)reg.address(5bit).zero(8bit)
第二次:
  从设备->主设备:     response(8bit)zero(8bit)
  主设备->从设备:     zero(16bit)
```

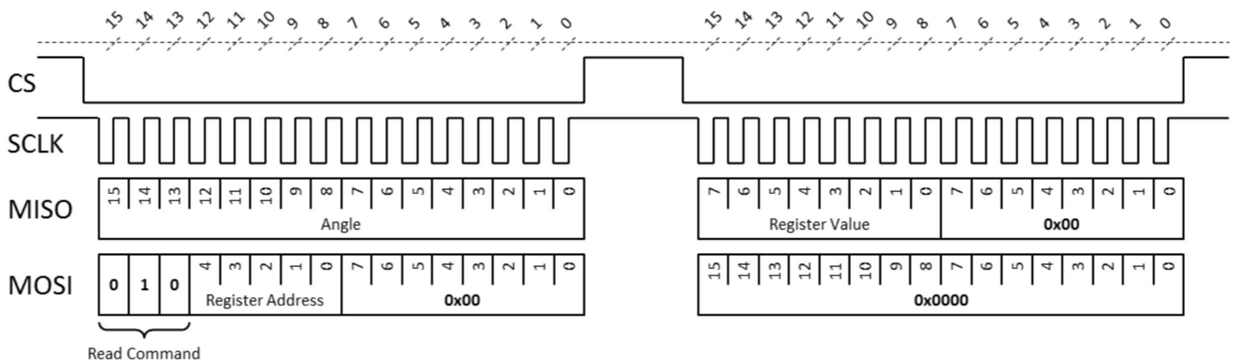


Figure 11: Two 16-Bit Frames Read Register Operation

- SPI写寄存器

REGISTER MAP

Table 7: Register Map

No	Hex	Bin	Bit 7 MSB	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0 LSB
0	0x0	00000	Z(7:0)							
1	0x1	00001	Z(15:8)							
2	0x2	00010	BCT(7:0)							
3	0x3	00011	-	-	-	-	-	-	ETY	ETX
4	0x4	00100	PPT(1:0)		ILIP(3:0)				-	-
5	0x5	00101	PPT(9:2)							
6	0x6	00110	MGLT(2:0)			MGHT(2:0)			-	-
9	0x9	01001	RD	-	-	-	-	-	-	-
27	0x1B	11011	MGH	MGL	-	-	-	-	-	-

Table 8: Factory Default Values

No	Hex	Bin	Bit 7 MSB	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0 LSB
0	0x0	00000	0	0	0	0	0	0	0	0
1	0x1	00001	0	0	0	0	0	0	0	0
2	0x2	00010	0	0	0	0	0	0	0	0
3	0x3	00011	0	0	0	0	0	0	0	0
4	0x4	00100	1	1	0	0	0	0	0	0
5	0x5	00101	1	1	1	1	1	1	1	1
6	0x6	00110	0	0	0	1	1	1	0	0
9	0x9	01001	0	0	0	0	0	0	0	0

1. 上图所示寄存器可写,数据保存在片上的非易失性存储中, 芯片上电时自动重新加载
2. 片上存储可写1000次
3. 写操作由两个16bit帧构成

```
第一次:
  从设备->主设备:    angle(16bit)
  主设备->从设备:    100(3bit)reg.address(5bit)reg.value(8bit)
第二次:
  从设备->主设备:    readbackreg.value(8bit)zero(8bit)
  主设备->从设备:    zero(16bit)
```

4. 第一帧和第二帧之间必须要25ms的间隔(读角度和读寄存器不需要此时间间隔)

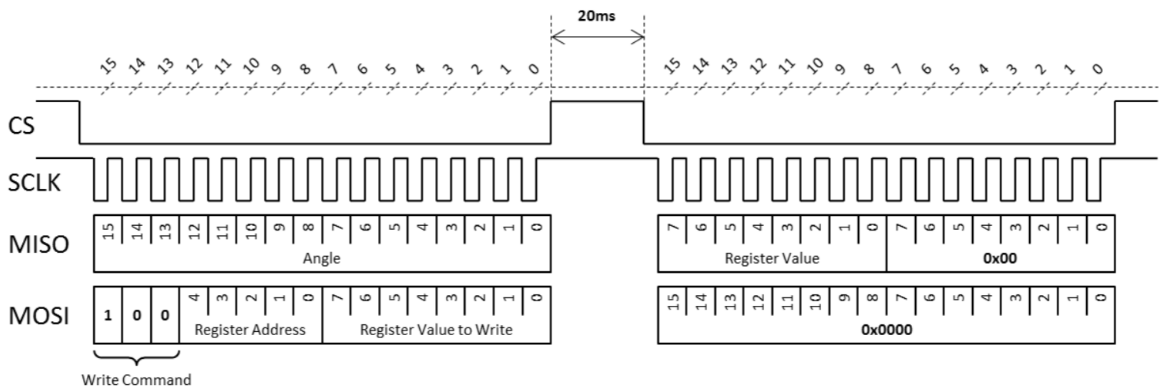


Figure 13: Overview of Two 16-Bit Frames Write Register Operation

Table 9: Programming Parameters

Parameters	Symbol	Number of Bits	Description	See Table
Zero setting	Z	16	Set the zero position	10
Bias current trimming	BCT	8	For side-shaft configuration: reduce the bias current of the X or Y Hall device	13
Enable trimming X	ETX	1	Biased current trimmed in the X direction Hall device	14
Enable trimming Y	ETY	1	Biased current trimmed in the Y direction Hall device	14
Pulses per turn	PPT	10	Number of pulses per turn of the ABZ output	17
Index length / index position	ILIP	4	Parametrization of the ABZ index pulse	Fig 26
Magnetic field high threshold	MGHT	3	Sets the field strength high threshold	16
Magnetic field low threshold	MGLT	3	Sets the field strength low threshold	16
Rotation direction	RD	1	Determines the sensor positive direction	12

REGISTER SETTINGS

- zero settings

  ma730 输出的角度a_{out}

  $a_{out} = a_{raw} - a_0$

  a_{raw}由MA前端提供的未经处理的角度

  $a_0 = 2^{16} - Z(15:0)$

  Table 10: Zero Setting Parameter

Z(15:0)	Zero pos. a_0 16-bit (dec)	Zero pos. a_0 (deg)
0	65536	360.000
1	65535	359.995
2	65534	359.989
...	...	...
65534	2	0.011
65535	1	0.005

- rotation direction

  默认情况下, 从上方观察, 磁场顺时针旋转时角度增加

  配置RD寄存器可以修改

tips

1. 编码器的分类

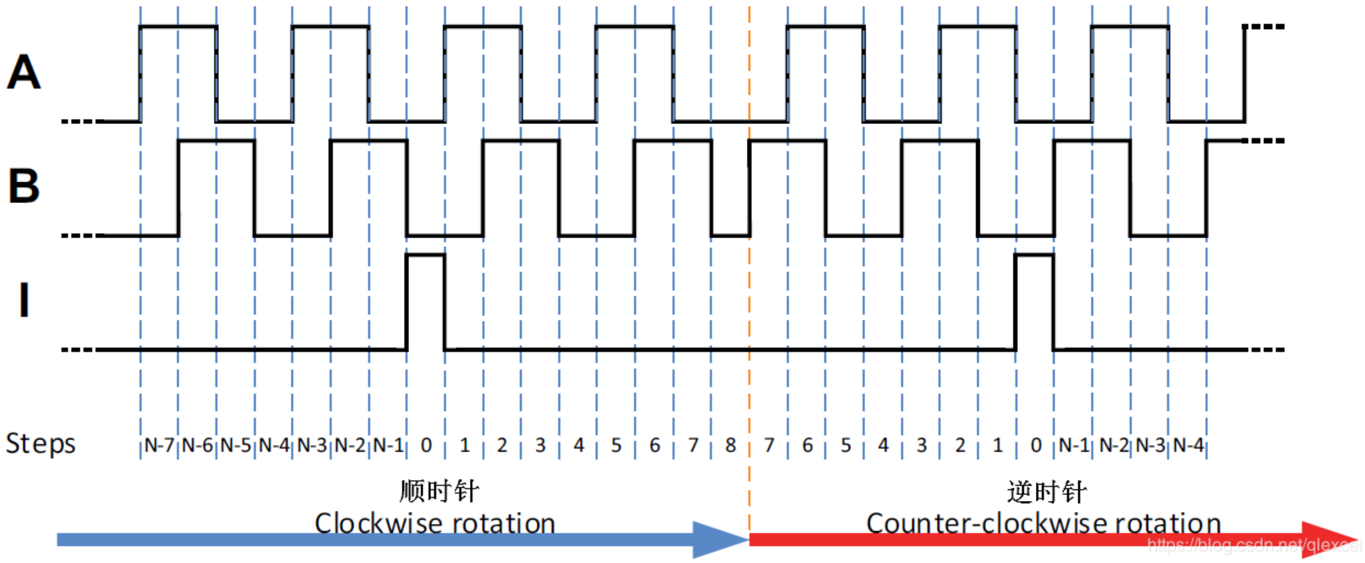
   根据检测原理,编码器可分为光学式、磁式、感应式和电容式,根据其刻度方法及信号输出形式,可分为增量式、绝对式以及混合式三种.

2. 增量式编码器

增量式编码器是直接利用光电转换原理输出三组方波脉冲A、B和Z相,A、B两组脉冲相位差90,从而可方便的判断出旋转方向,而Z相为每转一个脉冲,用于基准点定位.

它的优点是原理构造简单,机械平均寿命可在几万小时以上,抗干扰能力强,可靠性高,适合于长距离传输.

其缺点是无法输出轴转动的绝对位置信息.



编码器输出三组方波脉冲A、B和I相.

A、B两组脉冲相位差90度,根据谁先出现可以方便的判断旋转方向.而Z相为每转一圈输出一个脉冲,用于基准点定位.

3. 绝对式编码器

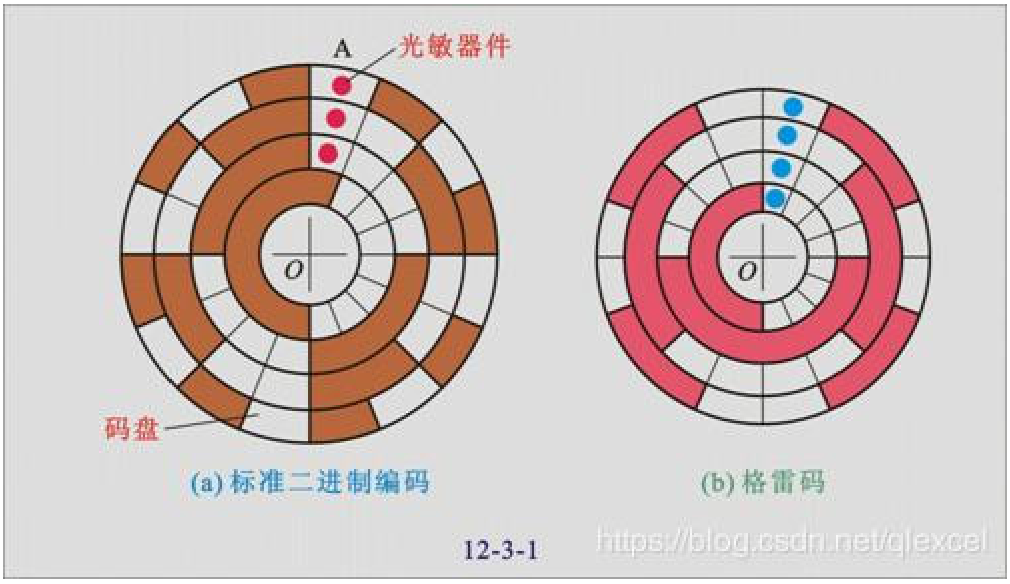
绝对式编码器是直接输出数字的传感器.

在它的圆形码盘上沿径向有若干同心码盘,每条道上有透光和不透光的扇形区相间组成,相邻码道的扇区数目是双倍关系,码盘上的码道数是它的二进制数码的位数.

在码盘的一侧是光源,另一侧对应每一码道有一光敏元件,当码盘处于不同位置时,各光敏元件根据受光照与否转换出相应的电平信号,形成二进制数.

这种编码器的特点是不要计数器,在转轴的任意位置都可读书一个固定的与位置相对应的数字码.

显然,码道数越多精度越大.目前国内已有16位的绝对编码器产品.



4. 磁编码器原理

   磁性旋转编码器依赖于三个主要组件: 磁盘,传感器和调节电路.

   磁盘已磁化,其圆周上有许多磁极.传感器检测磁盘旋转时磁场的变化,并将此信息转换为正弦波.

   传感器可以是感应电压变化的霍尔效应器件,也可以是感应磁场变化的磁阻器件.

   调节电路对信号进行倍增,分频或内插以产生所需的输出.

5. SPI总线介绍

Interface

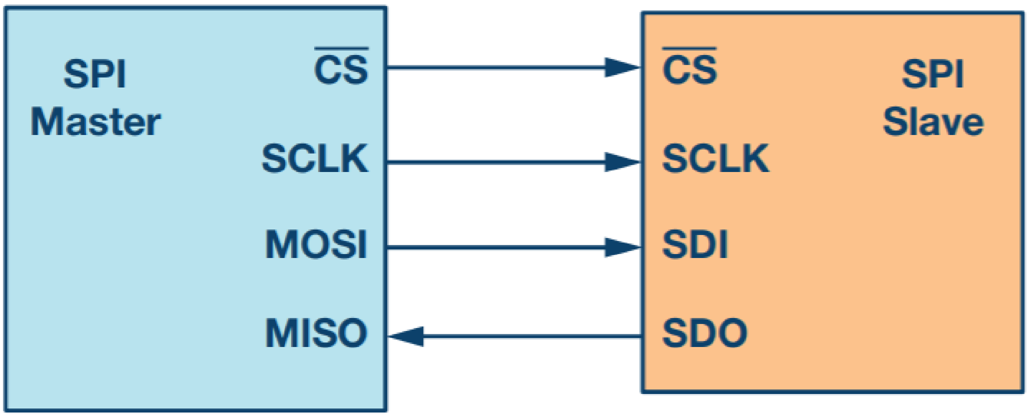


Figure 1. SPI configuration with master and a slave.

Table 1. SPI Modes with CPOL and CPHA

SPI Mode	CPOL	CPHA	Clock Polarity in Idle State	Clock Phase Used to Sample and/or Shift the Data
0	0	0	Logic low	Data sampled on rising edge and shifted out on the falling edge
1	0	1	Logic low	Data sampled on the falling edge and shifted out on the rising edge
2	1	1	Logic high	Data sampled on the falling edge and shifted out on the rising edge
3	1	0	Logic high	Data sampled on the rising edge and shifted out on the falling edge

CPOL: IDLE时CLK的极性, 0 -- 低电平, 1 -- 高电平

CPHA: 数据有效时的相位, 0 -- 第一个边沿, 1 -- 第二个边沿

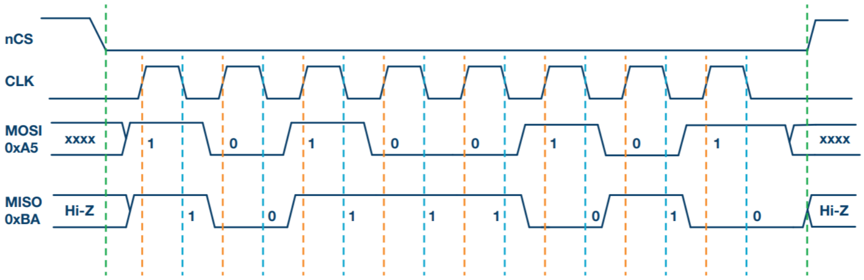


Figure 2. SPI Mode 0, CPOL = 0, CPHA = 0: CLK idle state = low, data sampled on rising edge and shifted on falling edge.

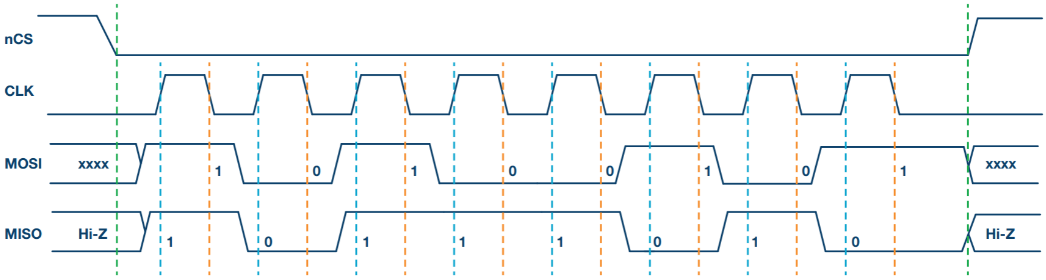


Figure 3. SPI Mode 1, CPOL = 0, CPHA = 1: CLK idle state = low, data sampled on the falling edge and shifted on the rising edge.

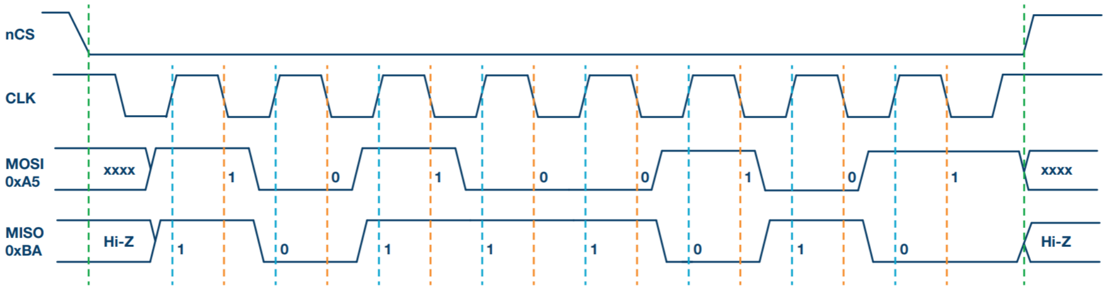


Figure 4. SPI Mode 2, CPOL = 1, CPHA = 1: CLK idle state = high, data sampled on the falling edge and shifted on the rising edge.

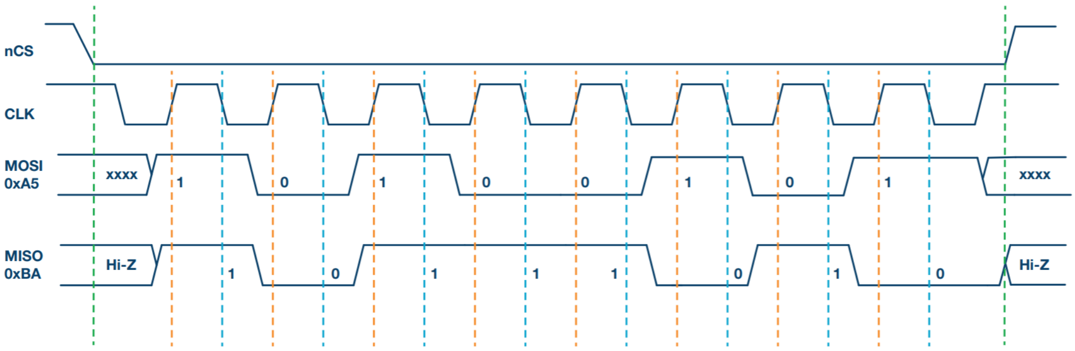


Figure 5. SPI Mode 3, CPOL = 1, CPHA = 0: CLK idle state = high, data sampled on the rising edge and shifted on the falling edge.