

Product Document



User Manual – AS5048-AB-v1.1

AS5048

**14-bit Rotary Position Sensor with Digital Angle
(Interface) and PWM Output**



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Revision History

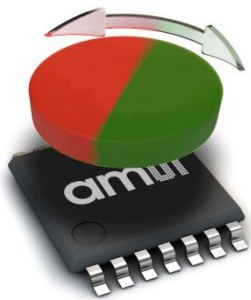
Revision	Date	Owner	Description
1.0	01.10.2009		Initial revision
1.1	18.10.2013	azen	Updated to new template
1.2	14.1.2013	rph	Minor corrections in section 4.1



1 General Description

The AS5048 is an easy to use 360° angle position sensor with a 14-bit high resolution output. To measure the angle, only a simple two-pole magnet, rotating over the center of the chip, is required. The magnet may be placed above or below the IC. This is shown in Figure 1.

Figure 1:
Magnetic Position Sensor AS5048 + Magnet



2 The AS5048 adapter board

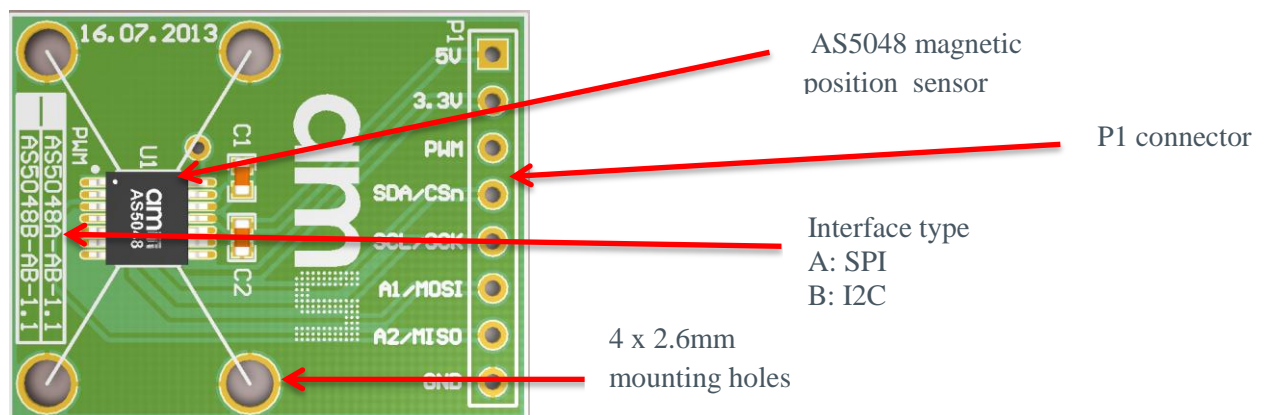
The AS5048 adapter board is a simple circuit allowing test and evaluation of the AS5048 magnetic position sensor quickly without building a test fixture or PCB.

2.1 Board description

The AS5048 Adapterboard is a simple circuit allowing test and evaluation of the AS5048 rotary encoder quickly without building a test fixture or PCB.

The PCB can be attached to a microcontroller or to the AS5048- Demoboard as external device.

Figure 2:
AS5048 Adapterboard



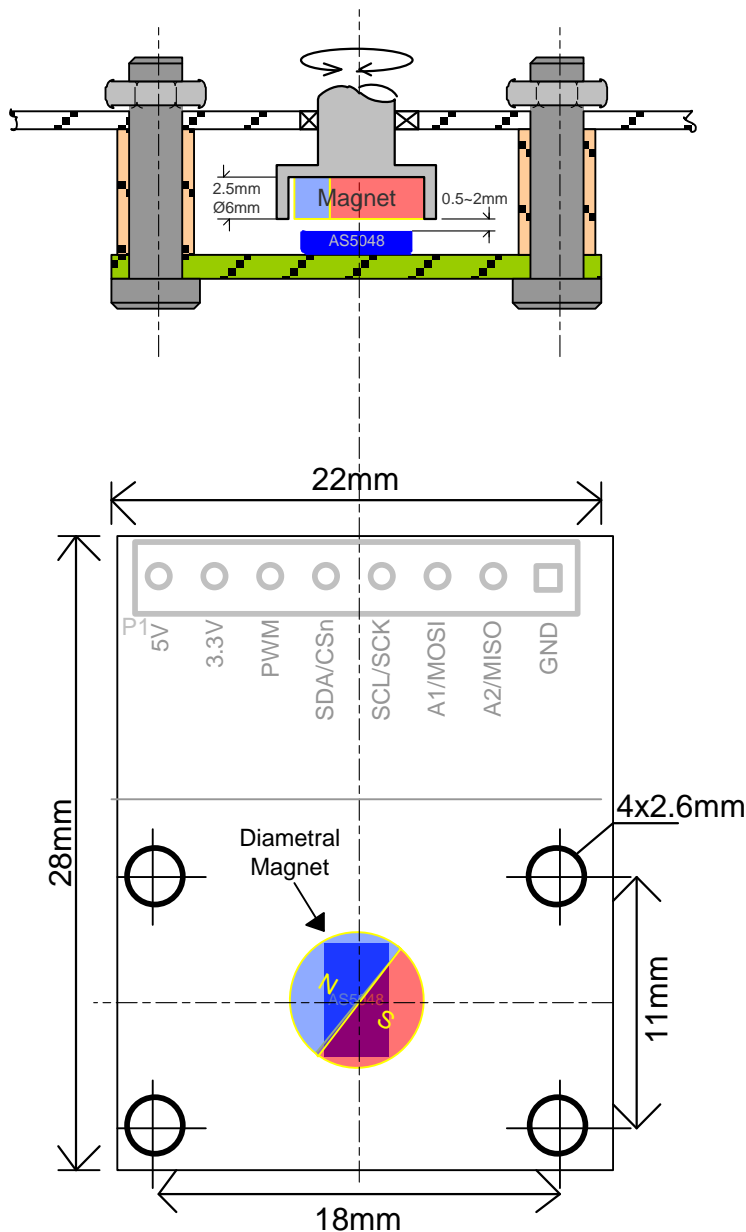
2.2 Mounting the AS5048 adapter board

A diametric magnet must be placed over on under the AS5048 position sensor, and should be centered on the middle of the package with a tolerance of 0.5mm.

The airgap between the magnet and the encoder casing should be maintained in the range 0.5mm~2mm. The magnet holder must not be ferromagnetic. Materials as brass, copper, aluminum, stainless steel are the best choices to make this part.

Figure 3:

AS5048 – AB - mounting and dimension



3 AS5048 adapter board and pinout

Figure 4:
AS5048 adapter board connectors and encoder pinout

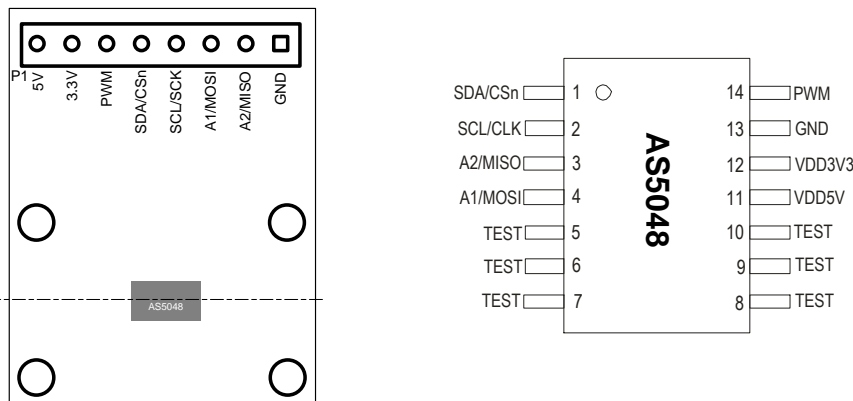


Table 1:
Pin description

Pin# Board	Pin# AS5048	Symbol Board	Description
P1 - 1	13	GND	Supply ground
P1 - 2	3	A2/MISO	SPI master in/slave out; shared with I2C address selection pin 2
P1 - 3	4	A1/MOSI	SPI master out/slave in; shared with I2C address selection pin 1
P1 - 4	2	SCL/SCK	SPI clock input; shared with I2C clock input
P1 - 5	1	SDA/CSn	SPI chip select-active low; shared with I2C data pin
P1 - 6	14	PWM	Pulse width modulation output
P1 - 7	12	3.3V	3V-Regulator output; internally regulated from VDD. Connect to VDD for 3V supply voltage
P1 - 8	11	5V	Supply voltage

4 Operation cases

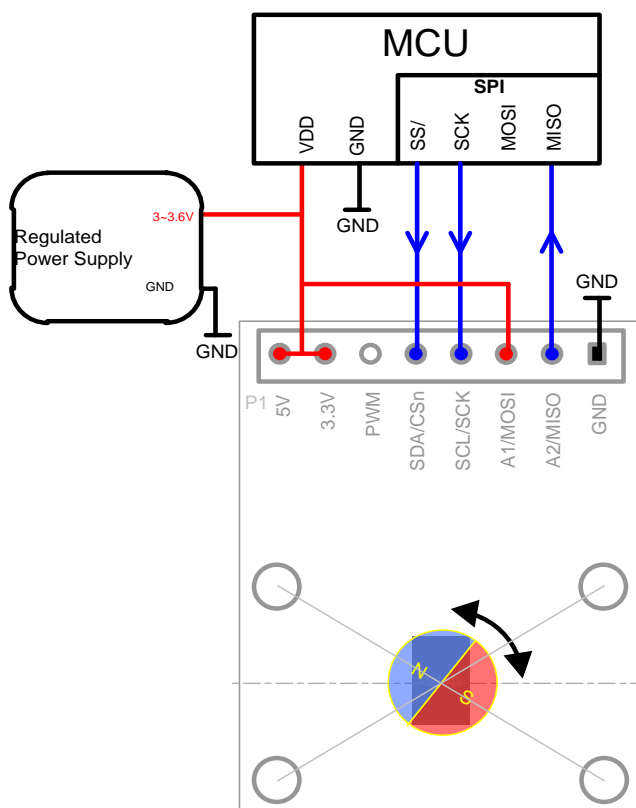
The most complete and accurate solution for a MCU to read the angle of a magnet is the SPI interface.

4.1 One Device SPI mode, unidirectional – 3 wire

The AS5048-AB can be directly connected to an industry standard SPI port of a microcontroller. The minimum connection requirement for unidirectional communication (angle + alarm values reading) between the microcontroller and the AS5048 are MISO, SCK, SS/.

The angle will be read at each 16-bit SPI transfer. See AS5048 datasheet register table, register 3FFFh.

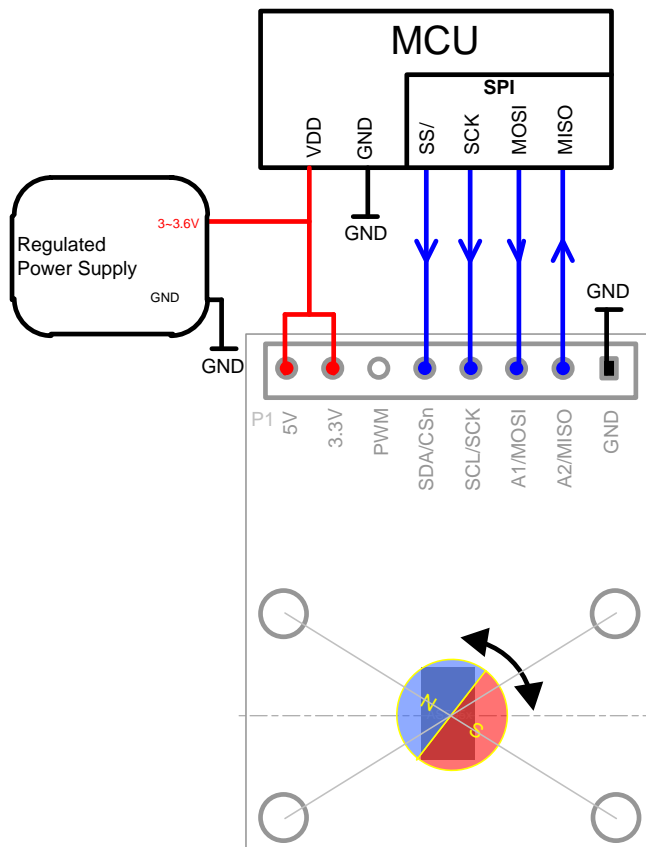
Figure 5:
Using the SPI Interface unidirectional with a microcontroller



4.2 One device SPI mode, bidirectional – 4 wire

If other registers than only angle values have to be read, or in order to write registers into the AS5048, the signal MOSI is necessary.

Figure 6:
Using the SPI Interface bidirectional with a microcontroller



4.3 Multi devices SPI Daisy chain mode

The AS5048 can be daisy chained, using 4 wires only for SPI communication.

In this configuration with $n \times$ encoders, the sequence will be processed as follow:

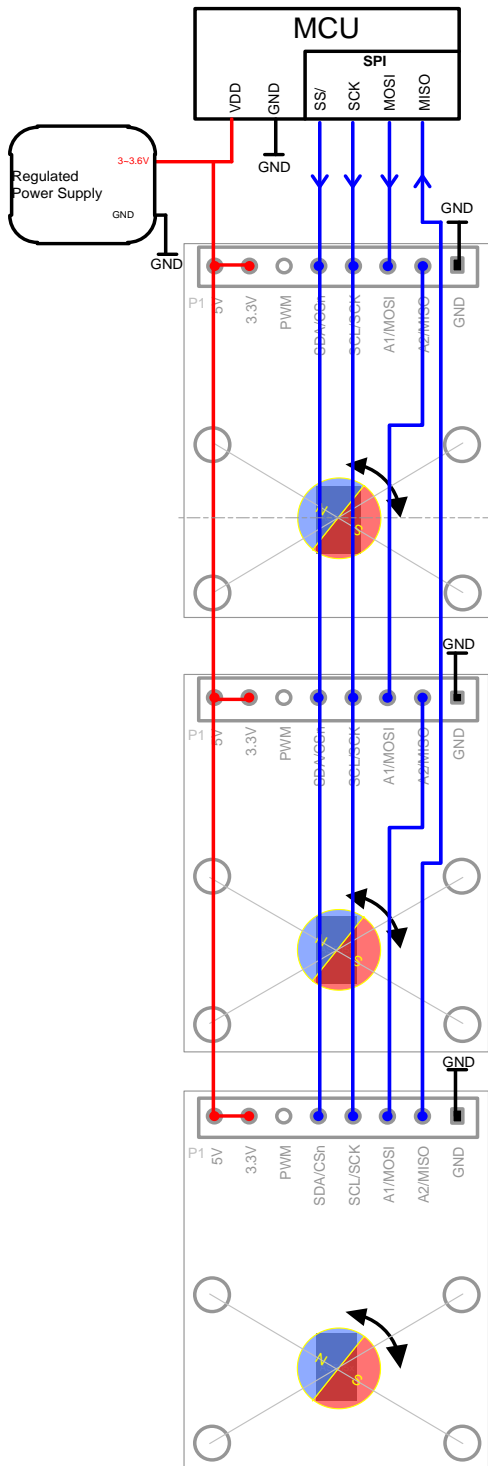
- MCU sets SS/ = 0
- MCU shifts $n \times$ 16-bit (e.g. READ command FFFFh) through the chain
- MCU sets SS/=1

At that point all the $n \times$ encoders have received the READ command FFFFh.

- MCU sets SS/=0
- MCU shifts $n \times$ 16-bit (e.g. NOP command 0000h)
- MCU sets SS/=1

At that point the $n \times$ 16-bit received on MISO are the $n \times$ angle values.

Figure 7:
Multi Devices in Daisy chain mode





5 Firmware coding

The following source code fits the 4-Wire application

The function `void spiReadData()` reads/writes 4 values from the AS5048

- Send command READ AGC / Receive value unknown
- Send command READ MAG / Receive value AGC
- Send command READ Angle / Receive value MAG
- Send command NOP (no operation) / Receive value ANGLE

If a READ ANGLE only is necessary in a loop, the procedure can be reduced to one line:

- Send command READ Angle / Receive value Angle

The function `static u8 spiCalcEvenParity(ushort value)` is optional, it calculates the parity bit of the 16-bit SPI stream.

```

/*!
*****
* Reads out chip data via SPI interface
*
* This function is used to read out cordic value from chips supporting SPI
* interface.
*****
*/
#define SPI_CMD_READ 0x4000 /*!< flag indicating read attempt when using SPI interface */
#define SPI_REG_AGC 0x3ffd /*!< agc register when using SPI */
#define SPI_REG_MAG 0x3ffe /*!< magnitude register when using SPI */
#define SPI_REG_DATA 0x3fff /*!< data register when using SPI */
#define SPI_REG_CLRERR 0x1 /*!< clear error register when using SPI */

void spiReadData()
{
    u16 dat; // 16-bit data buffer for SPI communication
    u16 magreg;
    ushort angle, agcreg;
    ubyte agc;
    ushort value;
    bit alarmHi, alarmLo;

    /* Send READ AGC command. Received data is thrown away: this data comes from the precedent
    command (unknown)*/
    dat = SPI_CMD_READ | SPI_REG_AGC;
    dat |= spiCalcEvenParity(dat) << 15;
    spiTransfer((u8*)&dat, sizeof(u16));

    /* Send READ MAG command. Received data is the AGC value: this data comes from the
    precedent command (unknown)*/
    dat = SPI_CMD_READ | SPI_REG_MAG;
    dat |= spiCalcEvenParity(dat) << 15;
    spiTransfer((u8*)&dat, sizeof(u16));
    magreg = dat;

    /* Send READ ANGLE command. Received data is the MAG value, from the precedent command */
    dat = SPI_CMD_READ | SPI_REG_DATA;
    dat |= spiCalcEvenParity(dat) << 15;
    spiTransfer((u8*)&dat, sizeof(u16));
    agcreg = dat;

    /* Send NOP command. Received data is the ANGLE value, from the precedent command */
    dat = 0x0000; // NOP command.
    spiTransfer((u8*)&dat, sizeof(u16));
    angle = dat >> 2;

}

if ((dat & 0x4000) || (agcreg & 0x4000) || (magreg & 0x4000))
{
    /* error flag set - need to reset it */
}

```



```

    dat = SPI_CMD_READ | SPI_REG_CLRERR;
    dat |= spiCalcEvenParity(dat)<<15;
    spiTransfer((u8*)&dat, sizeof(u16));
}
else
{
    agc = agcreg & 0xff // AGC value (0..255)
    value = dat & (16384 - 31 - 1); // Angle value (0.. 16384 steps)
    angle = (value * 360) / 16384 // Angle value in degree
(0..359.9°)
    magnitude = magreg & (16384 - 31 - 1);
    alarmLo = (agcreg >> 10) & 0x1;
    alarmHi = (agcreg >> 11) & 0x1;
}
}
}
/*!
*****
* Calculate even parity of a 16 bit unsigned integer
*
* This function is used by the SPI interface to calculate the even parity
* of the data which will be sent via SPI to the encoder.
*
* \param[in] value : 16 bit unsigned integer whose parity shall be calculated
*
* \return : Even parity
*
*****
*/
static u8 spiCalcEvenParity(ushort value)
{
    u8 cnt = 0;
    u8 i;

    for (i = 0; i < 16; i++)
    {
        if (value & 0x1)
        {
            cnt++;
        }
        value >>= 1;
    }
    return cnt & 0x1;
}
/*!
*****
* Calculate even parity of a 16 bit unsigned integer
*
* This function is used by the SPI interface to calculate the even parity
* of the data which will be sent via SPI to the encoder.
*
* \param[in] value : 16 bit unsigned integer whose parity shall be calculated
*
* \return : Even parity
*
*****
*/
static u8 spiCalcEvenParity(ushort value)
{
    u8 cnt = 0;
    u8 i;

    for (i = 0; i < 16; i++)
    {
        if (value & 0x1)
        {
            cnt++;
        }
        value >>= 1;
    }
    return cnt & 0x1;
}
}

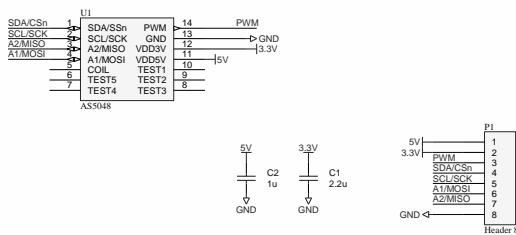
```

6 AS5048-AB-Hardware

Following the schematic and layout of the Adapterboard can be found.

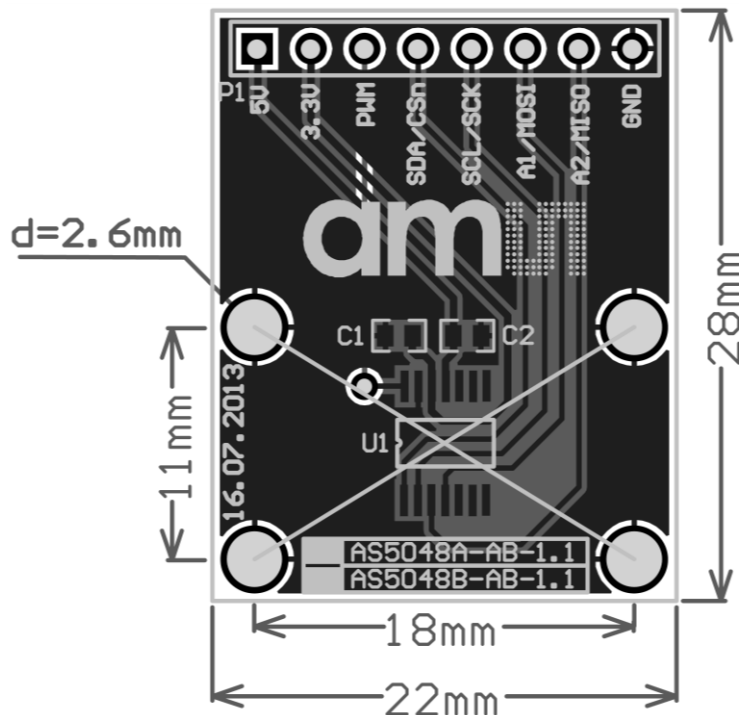
6.1 AS5048-AB-1.1 Schematics

Figure 8:
AS5048-AB-1.1 adapterboard schematics



6.2 AS5048 – AB – 1.1 PCB layout

Figure 9:
AS5048-AB-1.1 adapter board layout



7 Copyright

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