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AS5050 / AS5055

Programmable Magnetic Rotary Encoder

AS5050-AB-v1.1

Adapterboard

OPERATION MANUAL

1 VDD General Description

The AS5050/AS5055 is a single-chip magnetic rotary encoder IC with low voltage and low power features. It includes 4 integrated Hall elements, a high resolution ADC and a smart power management controller. The angle position, alarm bits and magnetic field information are transmitted over a standard 3-wire or 4-wire SPI interface to the host processor.

The absolute angle measurement provides instant indication of the magnet's angular position with a resolution of:

- AS5050: $0.35^\circ = 1024$ positions per revolution
- AS5055: $0.09^\circ = 4096$ positions per revolution

The AS5055 is available in a small QFN 16-pin 4x4x0.85mm package and specified over an operating temperature of -20 to +85°C.

2 The AS5050/AS5055 Adapter board

2.1 Board description

The AS5050/AS5055 adapter board is a simple circuit allowing test and evaluation of the AS5050/AS5055 rotary encoder quickly without building a test fixture or PCB.

The PCB can be attached to a microcontroller or to the AS5050/AS5055-DB Demoboard as external device.

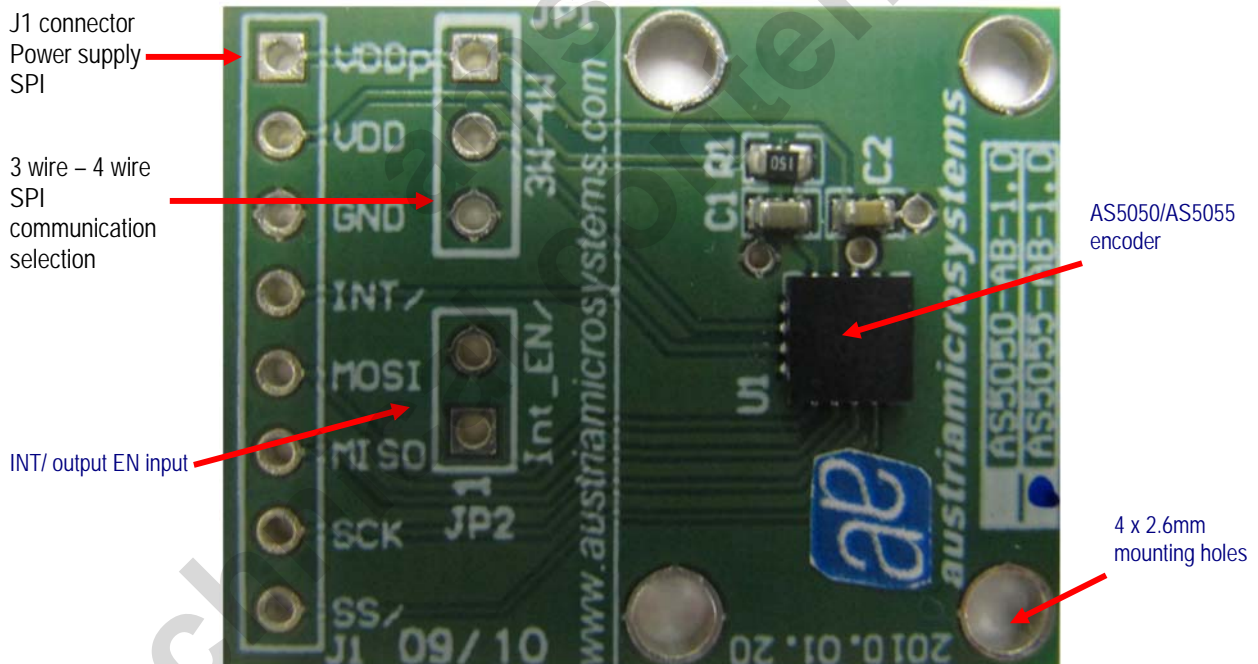


Figure 1: AS5050 Adapterboard

2.2 Mounting the AS5050 adapter board

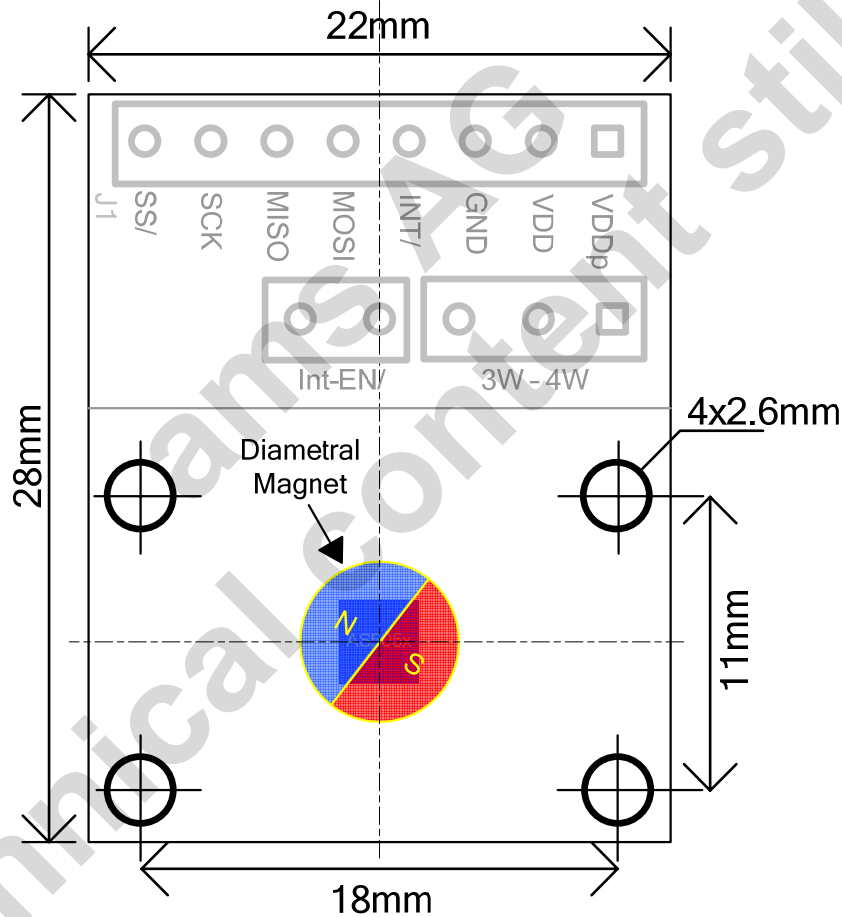
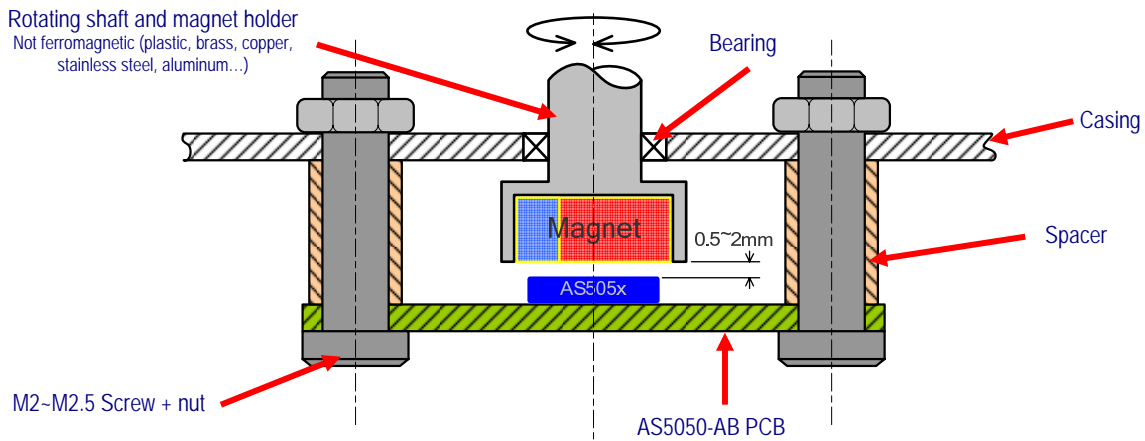


Figure 2: AS5050 adapter board mounting and dimension

A diametral magnet must be placed over on under the AS5050/AS5055 encoder, 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.

3 AS5050/AS5055 and adapter board pinout

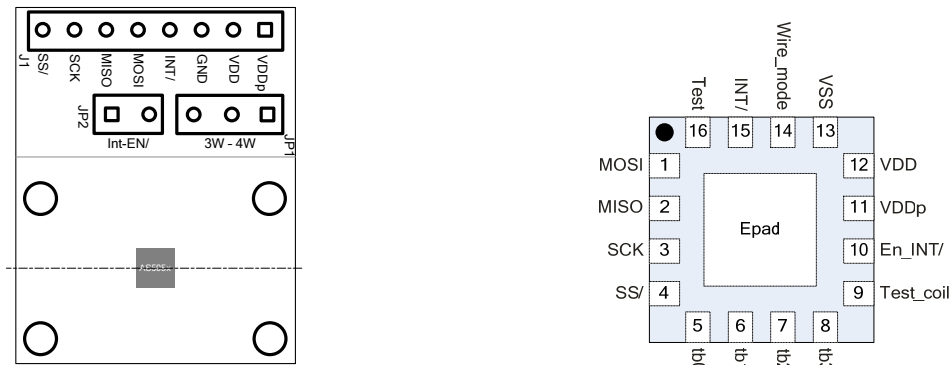


Figure 3: AS5050/AS5055 adapter board connectors and encoder pinout

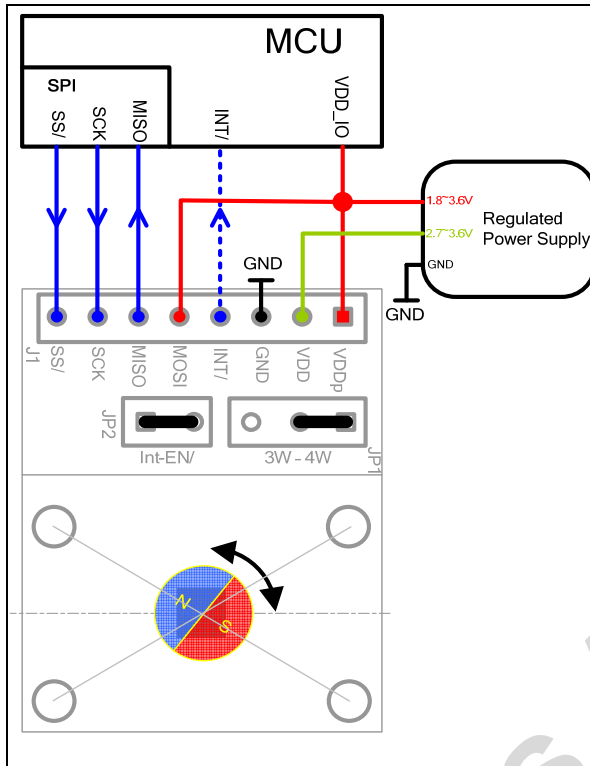
Pin# Board	Pin# AS5050/ AS5055	Symbol Board	Type	Description
J1 - 1	7	VDDp	S	Peripheral power supply, 1.8V - VDD
J1 - 2	9	VDD	S	Analog and digital power supply, 3.0 - 3.6V
J1 - 3	10	GND	S	Supply ground
J1 - 4	11	INT/	DIO	Interrupt output. Active LOW, when conversion is finished
J1 - 5	15	MOSI	DI	SPI bus data input
J1 - 6	16	MISO	DO	SPI bus data output
J1 - 7	8	SCK	DI_PD	SPI Clock Schmitt trigger
J1 - 8	8	SS/	DI_PD	SPI Slave Select, active LOW
JP1	7	Wire_Mode	S	3 wire mode or 4 wire mode SPI communication
JP2	1	INT_EN/	DO_OD	Close: enable INT/ output Pin 1 is the AS505x En_INT/ input. Can be used for interrupt daisy chain (see chapter 4.3)

Table 1: Pin description

Pin types:	DO_OD	digital output open drain	S	supply pin
	DO	digital output	DI	digital input
	DI_PD	digital input pull-down	DO_T	digital output / tri-state
	DI_PU	digital input pull-up	ST	Schmitt-Trigger input

4 Operation use cases

4.1 One device SPI mode, unidirectional – 3 wire



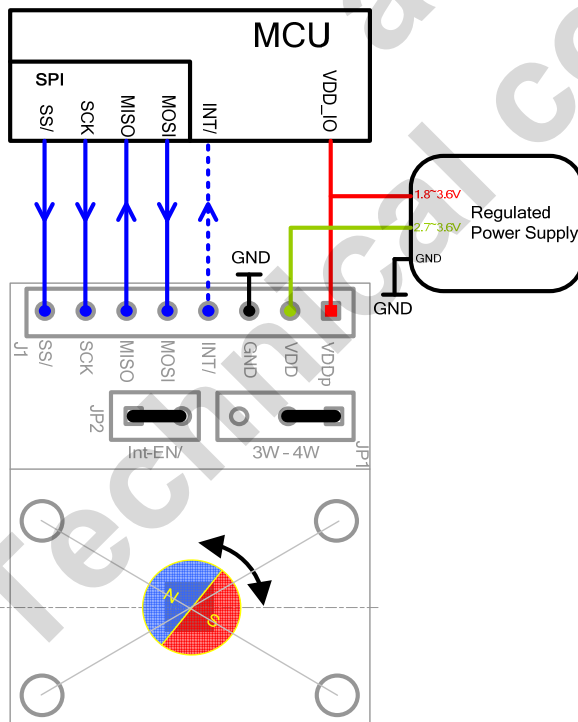
The AS5050-AB can be directly connected to an industry standard SPI port of a microcontroller. The minimum connection requirement for unidirectional communication (angle + alarm values reading) between the microcontroller and the AS5050/AS5055 are MISO, SCK, SS/.

The angle will be read at each 16-bit SPI transfer. See AS5050/AS5055 datasheet register table, register 3FFFh.

This value must be read with a period of 600µs or more in order to get a new angle position.

The INT/ signal can be attached to the microcontroller to indicate that a new angle position has been calculated.

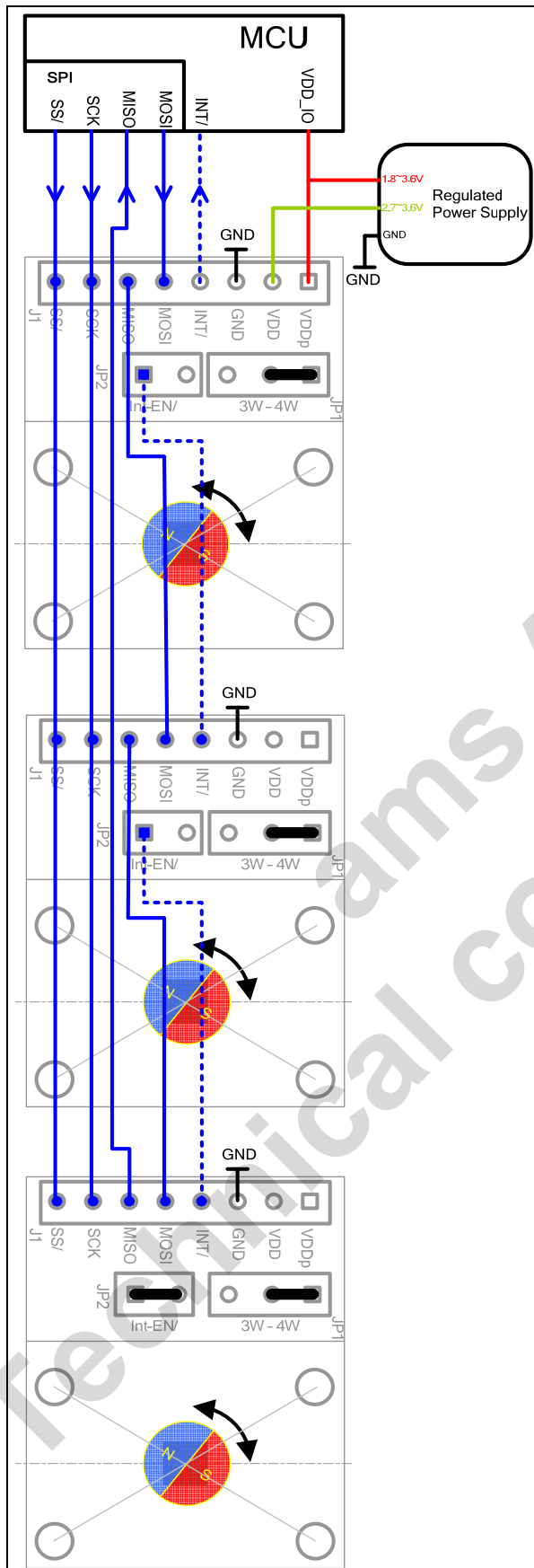
4.2 One device SPI mode, bidirectional – 4 wire



If other registers than only angle value have to be read, or in order to write registers into the AS5050/AS5055, the signal MOSI is necessary.

The INT/ signal can be attached to the microcontroller to indicate that a new angle position has been calculated.

4.3 Multi devices SPI Daisy chain mode



The AS5050/AS5055 can be daisy chained, using 4 wires only for SPI communication.

In this configuration with n x encoders, the sequence will be processed as follow:

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

At that point all the n x encoders have received the READ command FFFFh.

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

At that point the n x 16-bit received on MISO are the n x angle values.

If an interrupt is needed, the signal INT/ can be daisy chained as shown on the diagram on the left. The final INT/ signal connected to the MCU will go LOW only if all the n x encoders INT/ = 0. The n x 16-bit angle readout can be performed here.

5 Firmware coding

The following source code fits the 4-Wire application (chapter 4.2).

The function `void spiReadData()` reads/writes 3 values from the AS5050/AS5055

- Send command READ AGC / Receive value unknown
- Send command READ Angle / Receive value AGC
- 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 (T-1)

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 0x8000 /*!< flag indicating read attempt when using SPI interface */
#define SPI_REG_DATA 0x7ffe /*!< data register when using SPI */
#define SPI_REG_AGC 0x7ff0 /*!< agc register when using SPI */
#define SPI_REG_CLRERR 0x6700 /*!< clear error register when using SPI */

void spiReadData()
{
    u16 dat; // 16-bit data buffer for SPI communication
    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);
    spiTransfer((u8*)&dat, sizeof(u16));

    /* Send READ ANGLE command. Received data is the AGC value, from the precedent command */
    dat = SPI_CMD_READ | SPI_REG_DATA;
    dat |= spiCalcEvenParity(dat);
    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 >> 1) & 0x1) || ((agcreg >> 1) & 0x1))
{
    /* error flag set - need to reset it */
    dat = SPI_CMD_READ | SPI_REG_CLRERR;
    dat |= spiCalcEvenParity(dat);
    spiTransfer((u8*)&dat, sizeof(u16));
}
else
{
    agc = (agcreg >> 2) & 0x3f; // AGC value (0..63)
    value = (dat >> 2) & 0x3fff; // Angle value (0..4095 for AS5055)
    angle = (value * 360) / 4095; // Angle value in degree (0..359.9°)
    alarmLo = (dat >> 14) & 0x1;
    alarmHi = (dat >> 15) & 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 AS5050 adapter board hardware

6.1 AS5050-AB-1.1 schematics

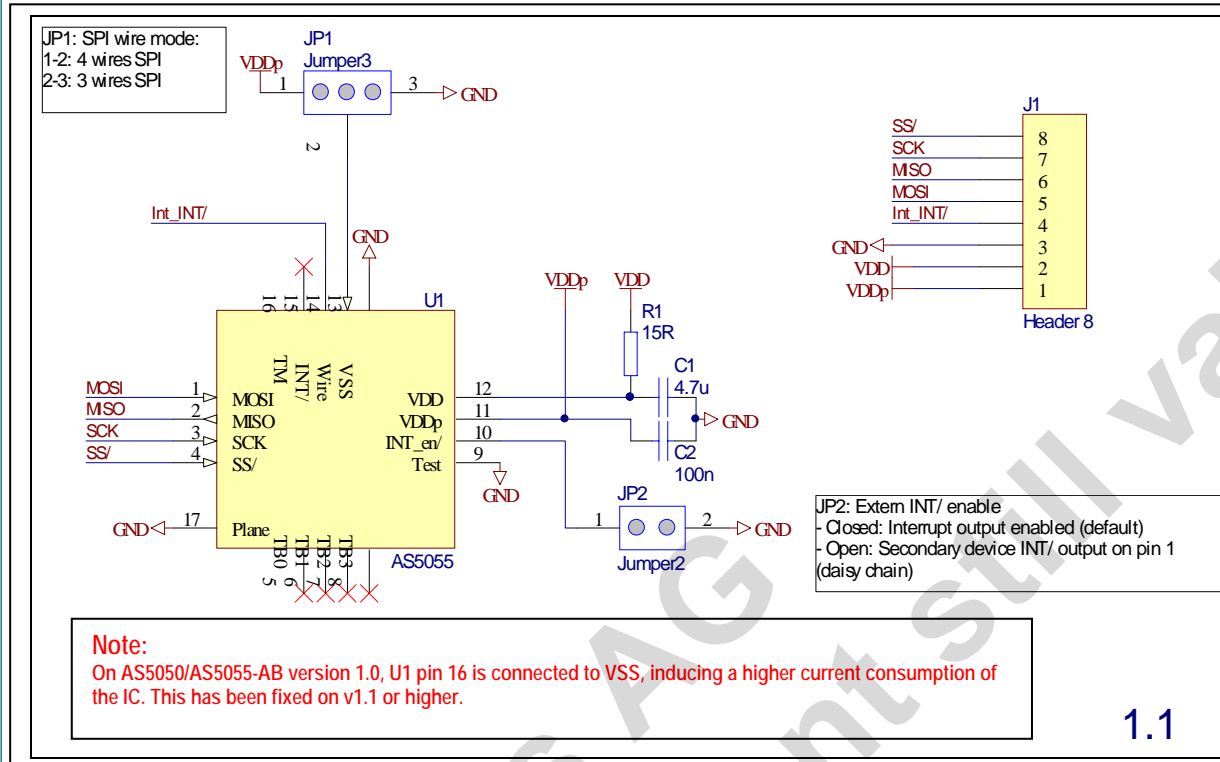


Figure 4: AS5050-AB-1.1 adapterboard schematics

6.2 AS5050-AB-1.1 PCB layout

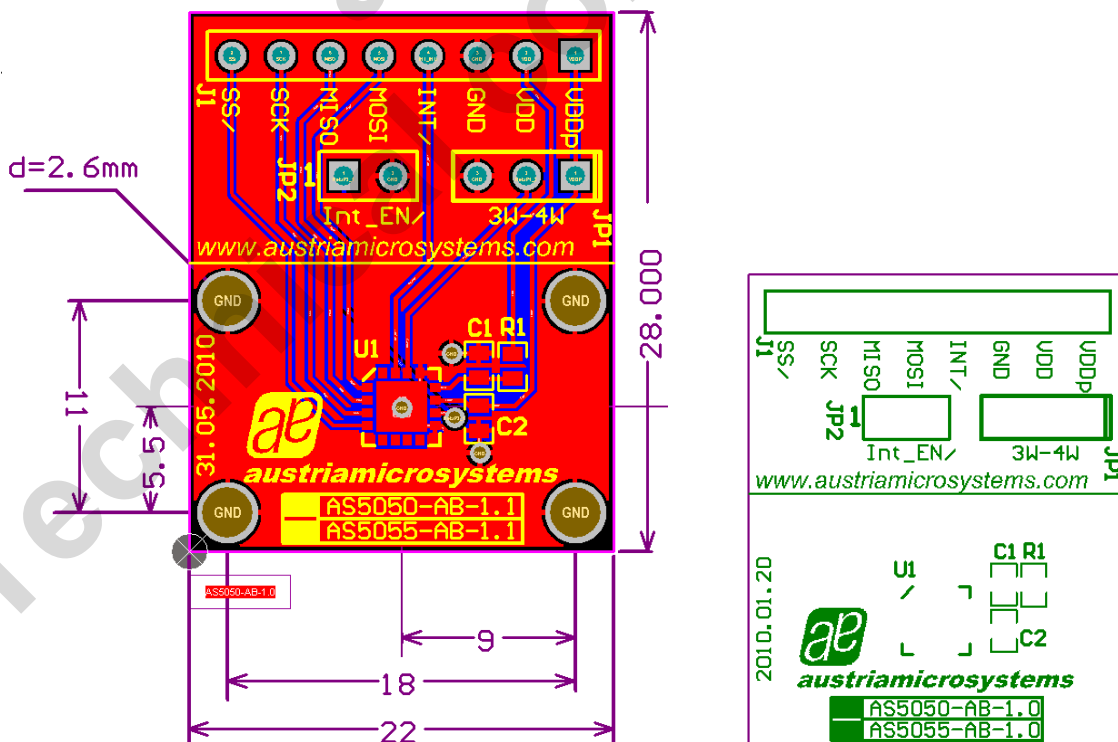


Figure 5: AS5050-AB-1.0 adapter board layout

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