



User Manual – AS5510 Adapterboard

AS5510

**10-bit Linear Incremental Position Sensor with Digital
Angle output**

Table of Contents

1	General Description	3
2	List of content.....	3
3	Board Description.....	3
4	Pinout	4
5	Mounting the AS5510 Adapterboard.....	6
6	Connecting the AS5510 Adapterboard	8
7	Software example	9
8	Schematic and Layout	11
9	Copyright.....	12
10	Disclaimer	12
11	Contact Information.....	12

Revision History

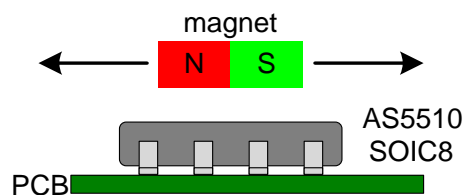
Revision	Date	Owner	Description
1.0	01.09.2010		Initial revision
1.1	28.11.2012		New Template
1.2	22.08.2013	AZEN	Updated to SOIC8 Package

1 General Description

The AS5510 is a linear Hall sensor with 10 bit resolution and I²C interface. It can measure absolute position of lateral movement of a simple 2-pole magnet. The typical arrangement is shown below in (Figure 1).

Depending on the magnet size, a lateral stroke of 0.5~2mm can be measured with air gaps around 1.0mm. To conserve power, the AS5510 may be switched to a power down state when it is not used.

Figure 1:
Linear Position Sensor AS5510 + Magnet



2 List of content

Figure 2:
List of content

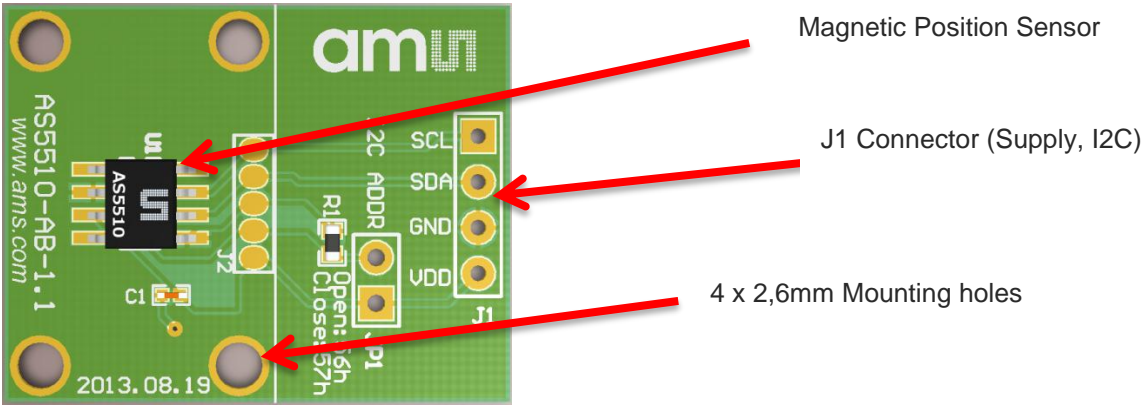
Name	Description
AS5510-SOIC8-AB	Adapterboard with AS5510 on it
AS5000-MA4x2H-1	Axial magnet 4x2x1mm

3 Board Description

The AS5510 adapter board is a simple circuit allowing to test and evaluate the AS5510 linear encoder quickly without having to build a test fixture or PCB.

The adapterboard must be attached to a microcontroller via the I²C bus, and supplied with a voltage of 2.5V ~ 3.6V. A simple 2-pole magnet is placed on the top of the encoder.

Figure 3:
AS5510-AB



4 Pinout

Figure 4:
Pin Configuration of AS5510 (Top View)

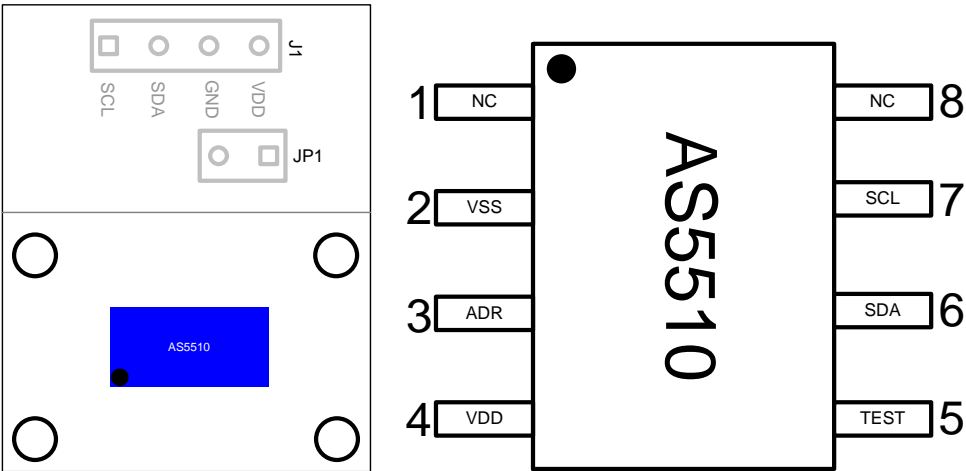


Table 1:
Pin Description

Pin AS5510	Symbol	Type	Description
1	NC	-	Not Connected
2	VSS	S	Ground Pin
3	ADR	DI	I ² C address selection pin. Pull down by default (56h). Close JP1 for (57h).

4	VDD	S	2.8V – 3.6V supply Voltage
5	Test	DIO	Test pin, connected to VSS
6	SCL	DI	I ² C Clock
7	SDA	DI/DO_OD	I ² C data I/O, 20mA driving capability
8	NC	-	Not Connected

DO_OD ... digital output open drain

DI ... digital input

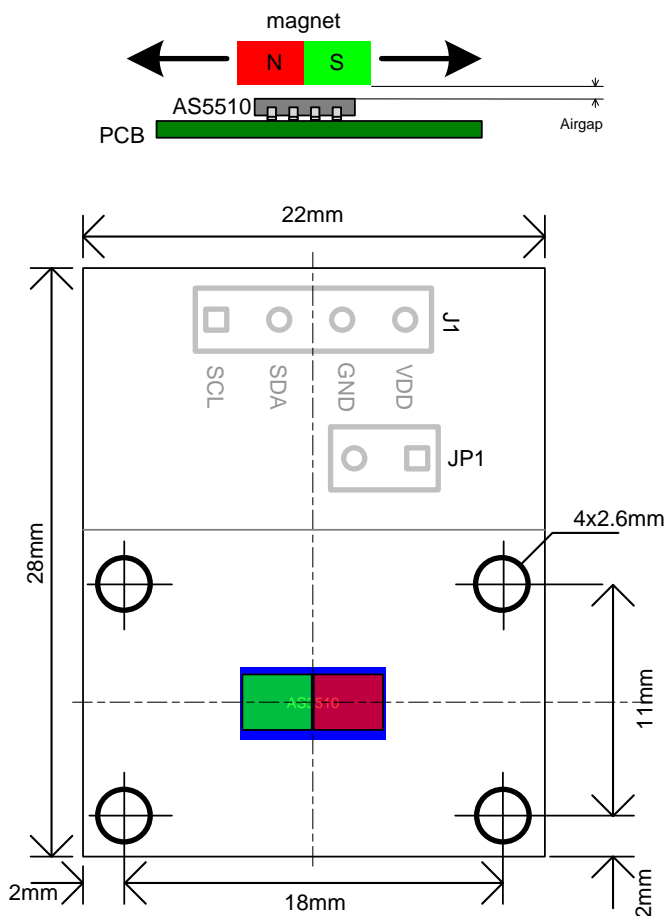
DIO ... digital input/output

S ... supply pin

5 Mounting the AS5510 Adapterboard

The AS5510-AB can be fixed to an existing mechanical system by its four mounting holes. A simple 2-poles magnet placed over or under the IC can be used.

Figure 5:
AS5510 adapter board mounting and dimension



The maximum horizontal travel amplitude depends on the magnet shape and size and magnetic strength (magnet material and airgap).

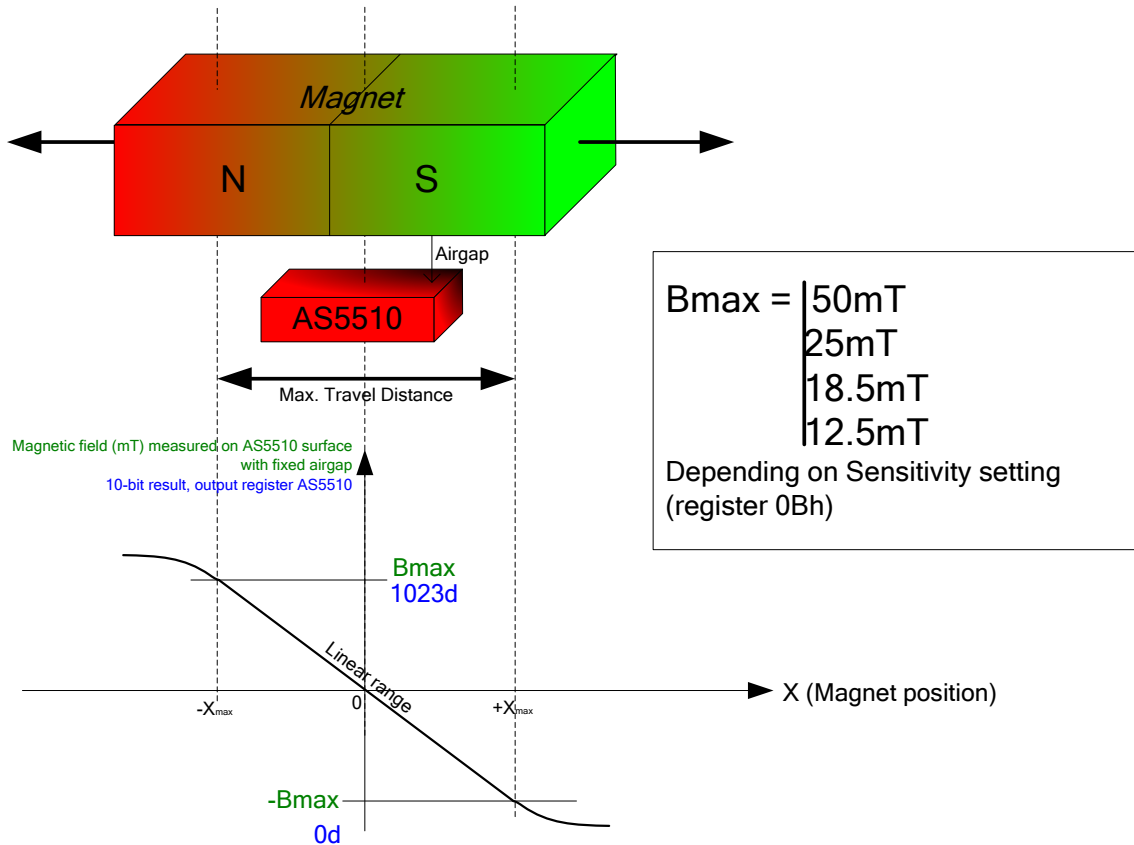
In order to measure a mechanical movement with a linear response, the magnetic field shape at a fixed airgap must be like on

Figure 6: Magnet requirement.

The linear range width of the magnetic field between North and South poles determines the maximum travel size of the magnet. The minimum (-Bmax) and maximum (+Bmax) magnetic field values of the linear range must be lower or equal to one of the four sensitivities available on the AS5510 (register 0Bh): Sensitivity = $\pm 50\text{mT}$, $\pm 25\text{mT}$, $\pm 18.5\text{mT}$, $\pm 12.5\text{mT}$

The 10-bit output register D[9..0] $\text{OUTPUT} = \text{Field(mT)} * (511/\text{Sensitivity}) + 511$

Figure 6:
Magnet requirement



Example 1:

This is the ideal case: the linear range of the magnet is $\pm 25\text{mT}$, which fits to the $\pm 25\text{mT}$ sensitivity setting of the AS5510. The resolution of displacement vs. output value is optimal.

Max. Travel Distance $TD_{\text{max}} = \pm 1\text{mm}$ ($X_{\text{max}} = 1\text{mm}$)

Sensitivity = $\pm 25\text{mT}$ (Register 0Bh \leftarrow 01h)

$B_{\text{max}} = 25\text{mT} \rightarrow X = -1\text{mm} (= -X_{\text{max}})$	Field _(mT) = -25mT	OUTPUT = 0
$\rightarrow X = 0\text{mm}$	Field _(mT) = 0mT	OUTPUT = 511
$\rightarrow X = +1\text{mm} (= +X_{\text{max}})$	Field _(mT) = +25mT	OUTPUT = 1023

Dynamic range of OUTPUT over $\pm 1\text{mm}$: $\text{DELTA} = 1023 - 0 = 1023 \text{ LSB}$

Resolution = $TD_{\text{max}} / \text{DELTA} = 2\text{mm} / 1024 = 1.95\mu\text{m/LSB}$

Example 2:

Using the same settings on the AS5510, the linear range of the magnet over the same displacement of $\pm 1\text{mm}$ is now $\pm 20\text{mT}$ instead of $\pm 25\text{mT}$ due to a higher airgap or a weaker magnet. In that case the resolution of displacement vs. output value is lower.

Max. Travel Distance $\text{TD}_{\text{max}} = \pm 1\text{mm}$ ($X_{\text{max}} = 1\text{mm}$): unchanged

Sensitivity = $\pm 25\text{mT}$ (Register 0Bh \leftarrow 01h) : unchanged

$B_{\text{max}} = 20\text{mT} \rightarrow X = -1\text{mm} (= -X_{\text{max}})$	$\text{Field}_{(\text{mT})} = -20\text{mT}$	OUTPUT = 102
$\rightarrow X = 0\text{mm}$	$\text{Field}_{(\text{mT})} = 0\text{mT}$	OUTPUT = 511
$\rightarrow X = +1\text{mm} (= +X_{\text{max}})$	$\text{Field}_{(\text{mT})} = +20\text{mT}$	OUTPUT = 920

Dynamic range of OUTPUT over $\pm 1\text{mm}$: $\text{DELTA} = 920 - 102 = 818 \text{ LSB}$

Resolution = $\text{TD}_{\text{max}} / \text{DELTA} = 2\text{mm} / 818 = \underline{2.44\mu\text{m/LSB}}$

In order to keep the best resolution of the system, it is recommended to adapt the sensitivity as close as the B_{max} of the magnet, with $B_{\text{max}} < \text{Sensitivity}$ to avoid the saturation of the output value.

If a magnet holder is used, it must be made of a non-ferromagnetic material in order to keep the maximum magnetic field strength and maximum linearity. Materials as brass, copper, aluminium, stainless steel are the best choices to make this part.

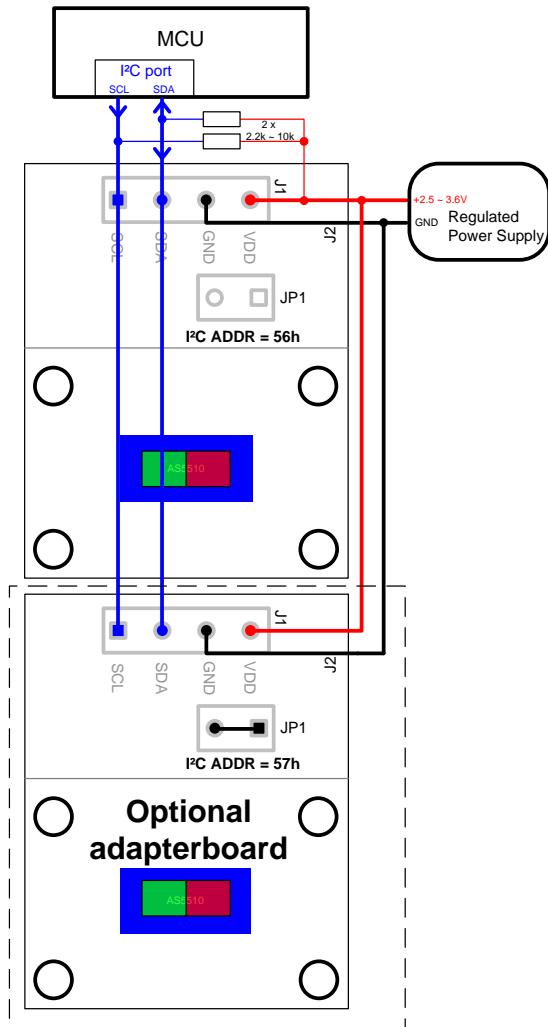
6 Connecting the AS5510 Adapterboard

Two wires (I²C) only are required for the communication with the host MCU. Pull-up resistors are needed on both SCL and SDA line. The value depends on the length of the wires, and the amount of slaves on the same I²C line.

The power supply delivering between 2.7V ~ 3.6V is connected to the adapter board and the pull-up resistors.

A second AS5510 adapterboard (optional) can be connected on the same line. In that case, the I²C address must be changed by closing JP1 with a wire.

Figure 7:
Typical connection to a host MCU (2nd adapterboard is optional)



7 Software example

After powering up the system, a delay of >1.5ms must be performed before the first I2C Read/Write command with the AS5510.

The initialization after power up is optional. It consists of:

- Sensitivity configuration (Register 0Bh)
- Magnet polarity (Register 02h bit 1)
- Slow or Fast mode (Register 02h bit 3)
- Power Down mode (Register 02h bit 0)

Reading the magnetic field value is straight forward. The following source code reads the 10-bit magnetic field value, and converts to the magnetic field strength in mT (millitesla).

Example: Sensitivity configured to +50mT range (97.66mT/LSB); Polarity = 0; default setting:

- D9..0 value = 0 means -50mT on the hall sensor.
- D9..0 value = 511 means 0mT on the hall sensor (no magnetic field, or no magnet).
- D9..0 value = 1023 means +50mT on the hall sensor.

```

Void main_loop(unsigned char Sensitivity_Mode)
{
    unsigned char Data1, Data2;
    short value;           // 10-bit output value (0~1023)
                           // The value 511 is the middle point @ 0mT
    float magnetic_field;  // Value of the magnetic field in mT

    Data_LSB = I2C_Read8(I2C_ADDR, 0x00); // Read D7..0
    Data_MSB = I2C_Read8(I2C_ADDR, 0x01); // Read D9..8 + OCF + Parity

    value = ((Data_MSB & 0x03)<<8) + Data_LSB;

    switch (Sensitivity_Mode) // Sensitivity_Mode is the value stored in
                              // register 0Bh
    {
        case 0:              // Register [0Bh] <= 0 (+- 50mT range, 97.66uT/LSB)
            magnetic_field = (value - 511) * 0.09766;
            break;

        case 1:              // Register [0Bh] <= 0 (+- 25mT range, 48.83uT/LSB)
            magnetic_field = (value - 511) * 0.04883;
            break;

        case 2:              // Register [0Bh] <= 0 (+- 12.5mT range, 24.41uT/LSB)
            magnetic_field = (value - 511) * 0.02441;
            break;

        case 3:              // Register [0Bh] <= 0 (+- 18.7mT range, 36.62uT/LSB)
            magnetic_field = (value - 511) * 0.03662;
            break;
    }

    printf("Decimal 10-bit value = %u \n", value);
    printf("Magnetic field value = %.3fmT \n", magnetic_field);
}

```

8 Schematic and Layout

Figure 8:
AS5510-AB Schematic

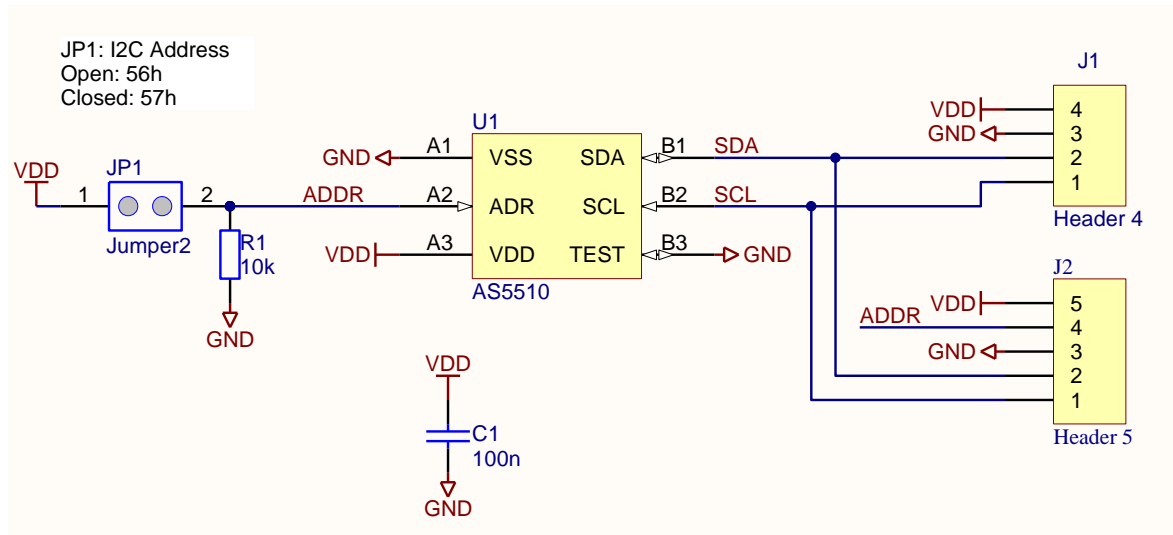
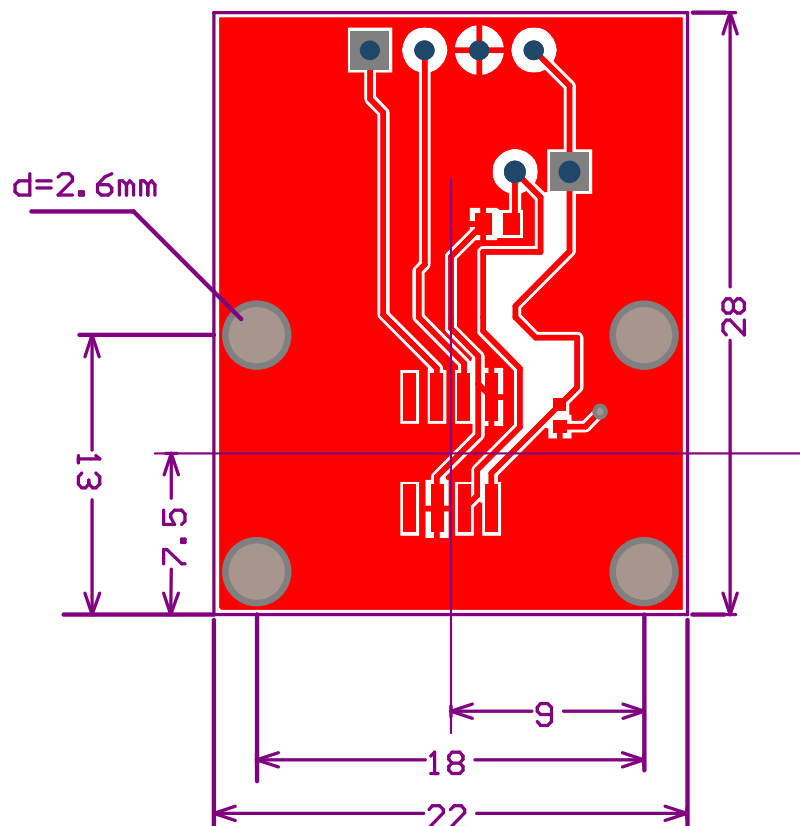


Figure 9:
AS5510-AB Layout



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