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**is now**

**ams AG**

The technical content of this austriamicrosystems application note is still valid.

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## 1 General Overview

The AS5311 is a contactless high resolution magnetic linear encoder for accurate linear motion and off-axis rotary sensing with a resolution down to  $<0.5\mu\text{m}$ . It is a system-on-chip, combining integrated Hall elements, analog front end and digital signal processing on a single chip, packaged in a small 20-pin TSSOP package.

A multipole magnetic strip or ring with a pole length of 1.0mm is required to sense the rotational or linear motion. The magnetic strip is placed above the IC at a distance of typ. 0.3mm.

The absolute measurement provides instant indication of the magnet position within one pole pair with a resolution of 488nm per step (12-bit over 2.0mm). This digital data is available as a serial bit stream and as a PWM signal. Furthermore, an incremental output is available with a resolution of  $1.95\mu\text{m}$  per step. An index pulse is generated once for every pole pair (once per 2.0mm). The travelling speed in incremental mode is up to 650mm/second. An internal voltage regulator allows the AS5311 to operate at either 3.3 V or 5 V supplies.

Depending on the application the AS5311 accepts multi-pole strip magnets as well as multi-pole ring magnets, both radial and axial magnetized.

## 2 The AS5311 Demoboard

The AS5311 demoboard is a complete linear encoder system with built-in microcontroller, USB interface, graphical LCD display, incremental indicators, incremental counter serial communication and PWM output LED.

The board is USB powered or externally supplied with a 9V battery for standalone operation.

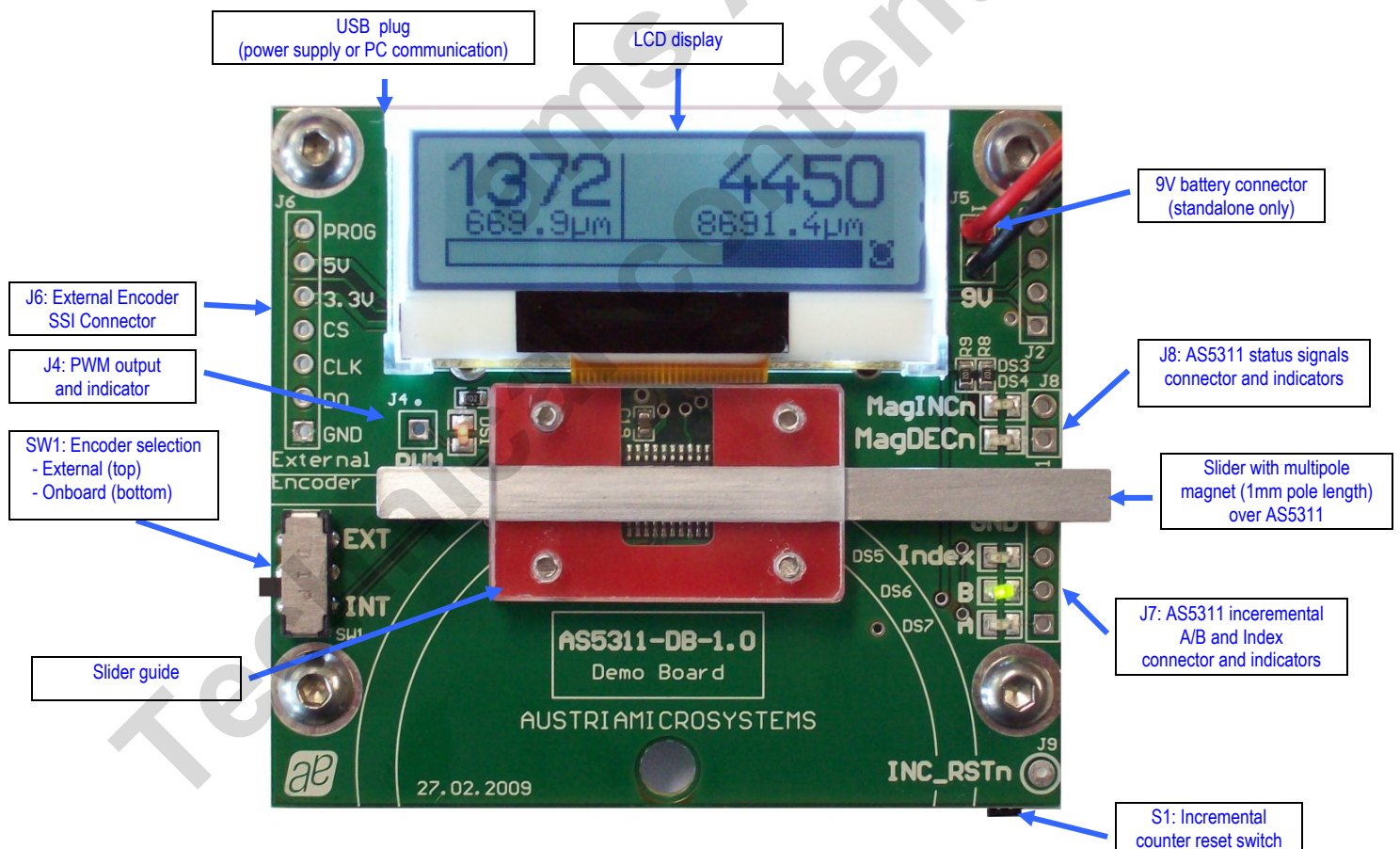


Figure 1: AS5311 Demoboard hardware with mounted magnet knob

### 3 Operating the AS5311 Demoboard

The AS5311 demoboard can be used in several ways:

- As standalone unit supplied by a 9V battery

Connect a 9V battery to the battery connector on the top right side of the board. No other connections are required.

- As standalone unit supplied by an USB port

Connect the demoboard to a PC using a USB/USB cable (included in demoboard shipment). The board is supplied by the 5V supply of the USB port. No other connections are required.

#### 3.1 Hardware Indicators and Connectors

##### 3.1.1 Graphic LCD display

The LCD display shows the realtime absolute and relative position of the magnet:

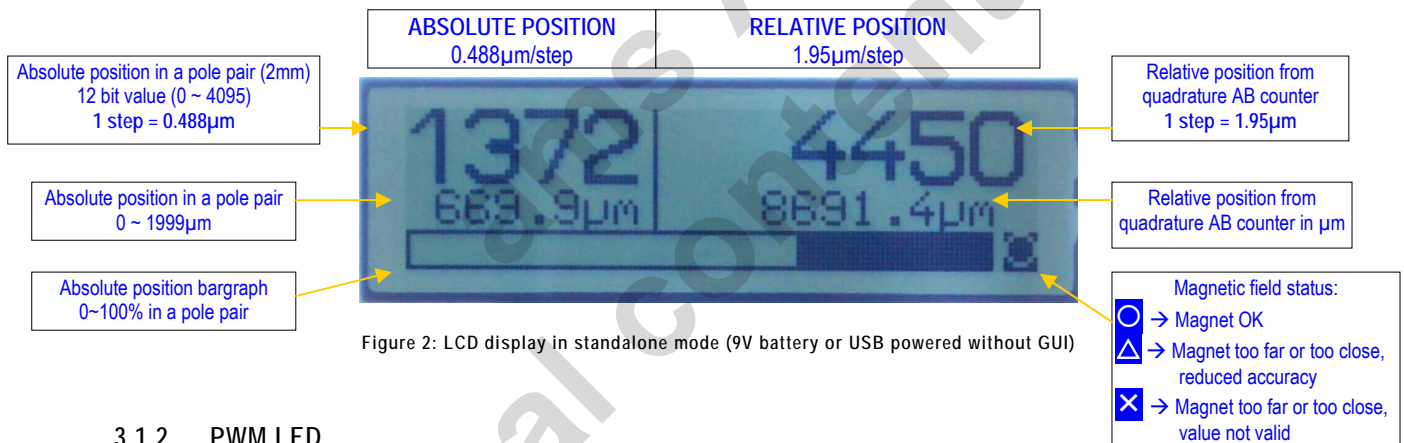
- The absolute position is read from the AS5311 serial output. The resolution is  $0.488\mu\text{m} = 4096$  positions per pole pair (2mm). To use this feature with the onboard encoder, switch SW1 must be on position INT.

- The relative position is read from the incremental counter connected on the AB outputs of the AS5311. The resolution is  $1.95\mu\text{m} / \text{step}$ . To use this feature with the onboard encoder, jumpers P1 and P2 (Bottom side) must be CLOSED.

Moving the slider from right to left will increase the absolute value until 4095 ( $1999\mu\text{m}$ ) with  $0.488\mu\text{m}$  steps, then returns to 0.

The incremental counter will increment on the same way with  $1.95\mu\text{m}$  steps. To reset the relative position, press the push button S1.

The magnet status indicator  $\odot$  (magnet OK),  $\triangle$  (magnet too close or too far, reduced accuracy),  $\times$  (magnet too close or too far, values not valid and display stopped) is related to the magnet position.



##### 3.1.2 PWM LED

This LED is connected to the PWM output of the AS5311. The PWM output is a pulse width that is proportional to the position of a pole-pair of the magnet.

The pulse width varies from  $1\mu\text{s}$  to  $4096\mu\text{s}$  typ with a repetition rate of 244 Hz typ.. When the position of the pole-pair is 0, the LED is almost dark, as it is  $1\mu\text{s}$  on and  $4095\mu\text{s}$  off. Moving the magnet to the left increases the brightness of the PWM LED, since the ON-pulse becomes longer and the OFF-pulse becomes shorter. The brightness of the PWM LED follows the absolute position bargraph.

Likewise, the PWM output can be used as an analog output proportional to the angle, when the PWM signal is filtered by a RC (or active) lowpass filter.

The PWM signal (0 ~ 3V3) can be directly taken from the connector J4.

##### 3.1.3 Incremental quadrature AB-Index LED

The phase shift between channel A and B indicates the direction of the magnet movement. Channel A leads channel B during a right-to-left movement of the magnet by 90 electrical degrees. Channel B leads channel A during a left-to-right movement.




One Index pulse (3V3) is generated at each pole pair changes (see AS5311 datasheet Figure 9).

The AB-Index LEDs are directly connected to the A B Index outputs of the AS5311. These quadrature signals (0 ~ 3V3) are available on connector J7.

### 3.1.4 MagINCn and MagDECn

MagINCn and MagDECn are the magnetic field change indicators (magnetic field strength increase or decrease through variation of the distance between the magnet and the device).

These outputs can be used to detect the valid magnetic field range.

- LEDs MagINC and MagDEC OFF, the magnet is correctly positioned  
→ LCD indicator 
- LED MagINC ON and MagDEC OFF, magnet too close or too far, reduced accuracy  
→ LCD indicator 
- LEDs MagINC and MagDEC ON, magnet too close or too far, values not valid and display stopped →  
LCD indicator 

### 3.1.5 Encoder selection switch

The switch SW1 selects the encoder which communicates with the microcontroller through the SSI bus (Absolute position):

1. INT (Bottom position, default): Onboard AS5311
2. EXT (Top Position): External AS5311 connected on J6  
The signals of the synchronous serial interface (DO, CLK, CSn) and the power supply (3.3V, GND) of an external device can be connected directly to J6. In this configuration, the data of the serial interface (absolute position) are displayed on the GUI or the LCD.

If the incremental AB position of the external encoder is used, remove the jumpers P1 and P2 (bottom side of the board), and connect the AB signals from the encoder to the jumpers as shown on figure 3 below.

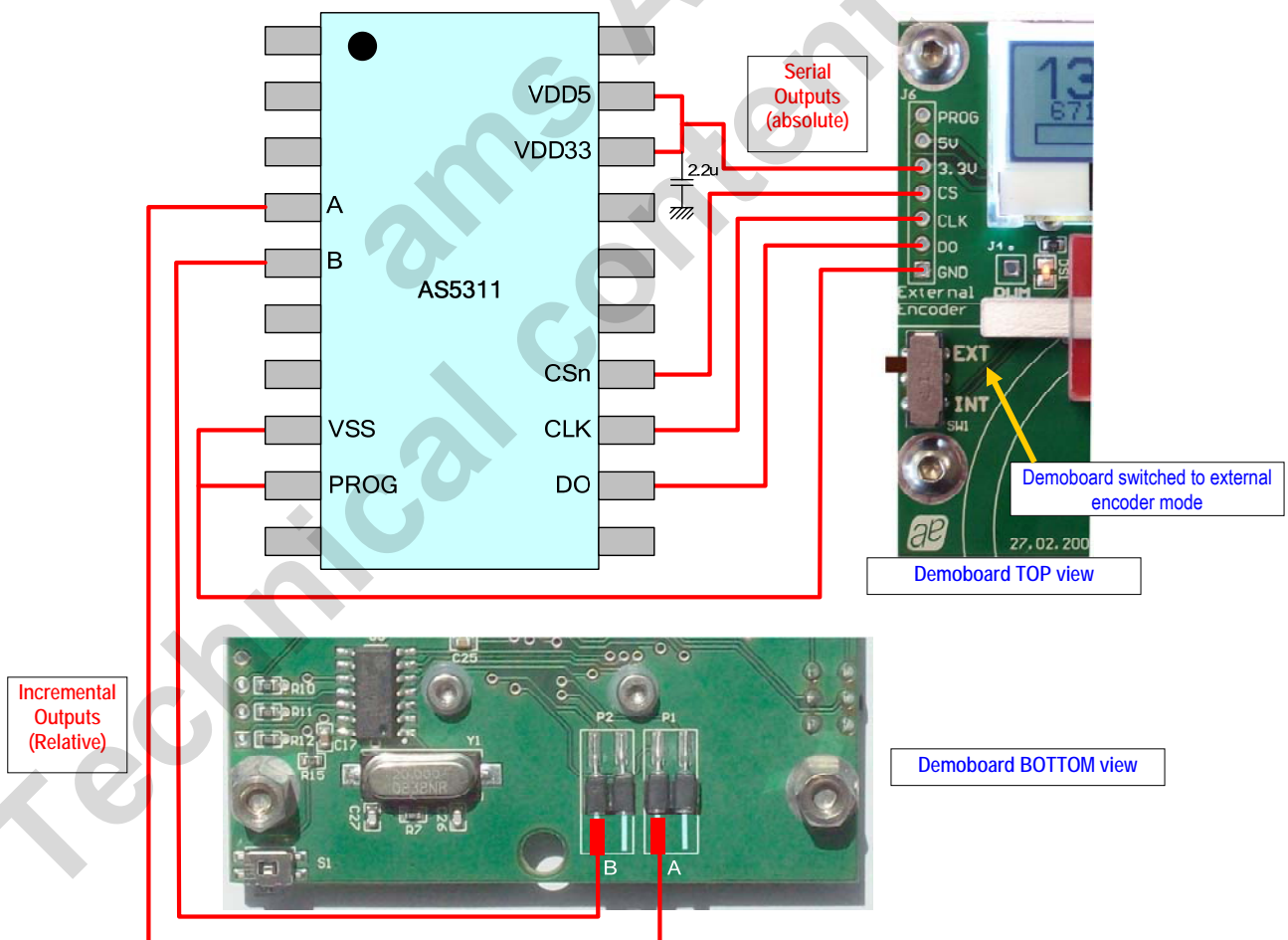


Figure 3: external AS5311 connection to the demoboard (top and bottom view)

### 4 AS5311 Demoboard bloc diagram, schematics, layout

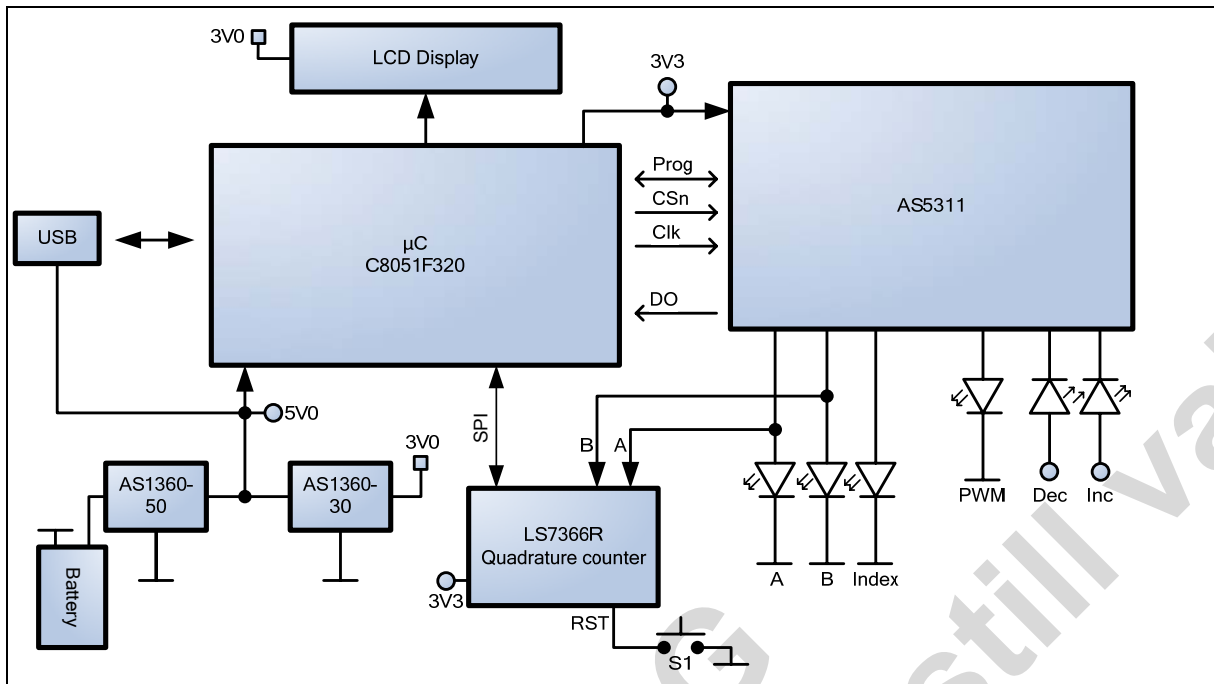


Figure 9: AS5311 bloc diagram

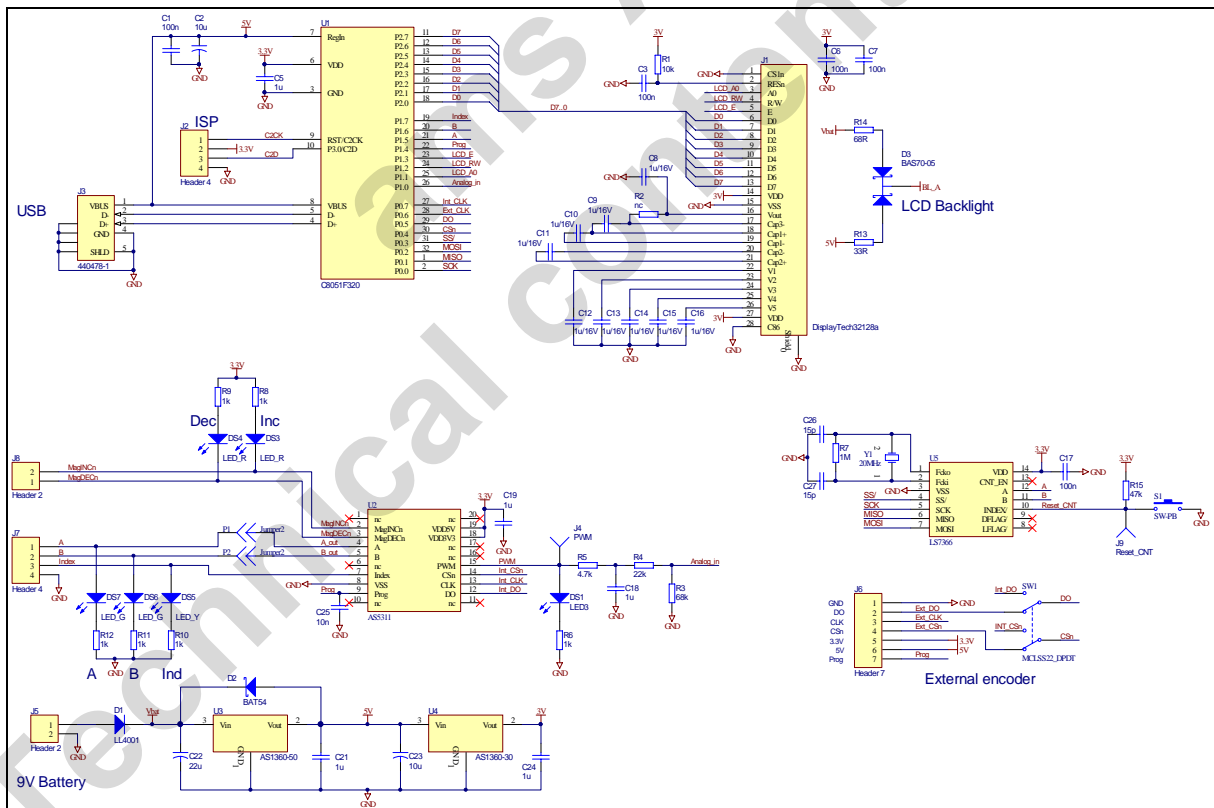


Figure 7: AS5311 Demoboard schematics

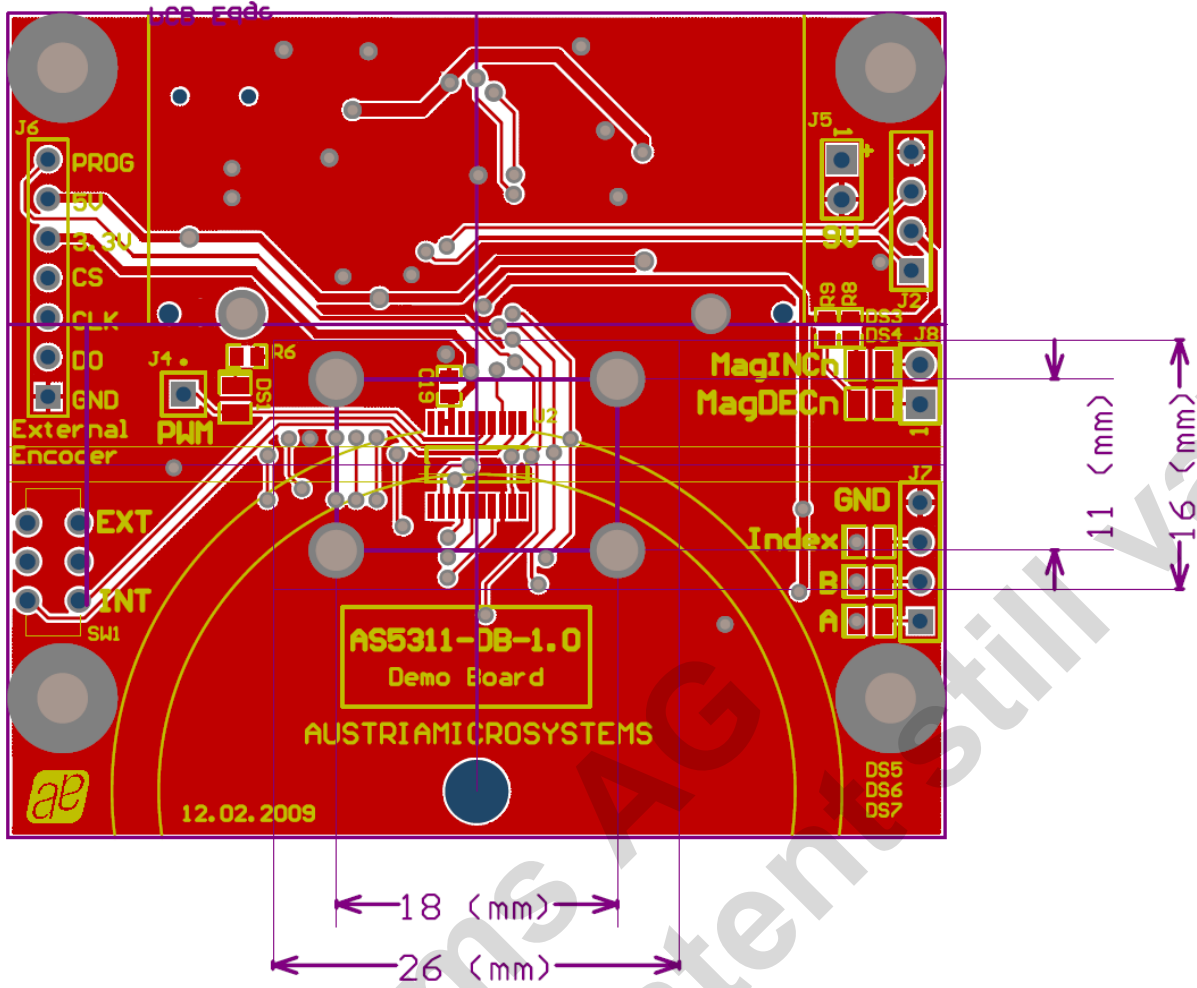


Figure 4: AS5311 Demoboard PCB Layout

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## Revision History

Revision	Date	Description	
R1.0	March.16, 2009	First version	

ams AG  
Technical content still valid



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