

# AS5261

## 12-Bit Automotive Angle Position Sensor

### 1 General Description

The AS5261 is a contactless magnetic angle position sensor for accurate angular measurement over a full turn of 360°. A sub range can be programmed to achieve the best resolution for the application. It is a system-on-chip, combining integrated Hall elements, analog front end, digital signal processing and best in class automotive protection features in a single device.

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.

The absolute angle measurement provides instant indication of the magnet's angular position with a resolution of  $0.022^\circ = 16384$  positions per revolution. According to this resolution the adjustment of the application specific mechanical positions are possible. The angular output data is available over a 12 bit PWM output.

The AS5261 operates at a supply voltage of 5V and the supply and output pins are protected against overvoltage up to +20V. In addition the supply pins are protected against reverse polarity up to -20V.

Figure 1. Typical Arrangement of AS5261 and magnet



### 2 Key Features

- 360° contactless high resolution angular position encoding
- User programmable start and end point of the application region + linearization.
- User programmable clamping levels and programming of the transition point.
- Wide temperature range: - 40°C to + 150°C
- Small Pb-free package: MLF 16 6x6 (with dimple)
- Broken GND and VDD detection

### 3 Benefits

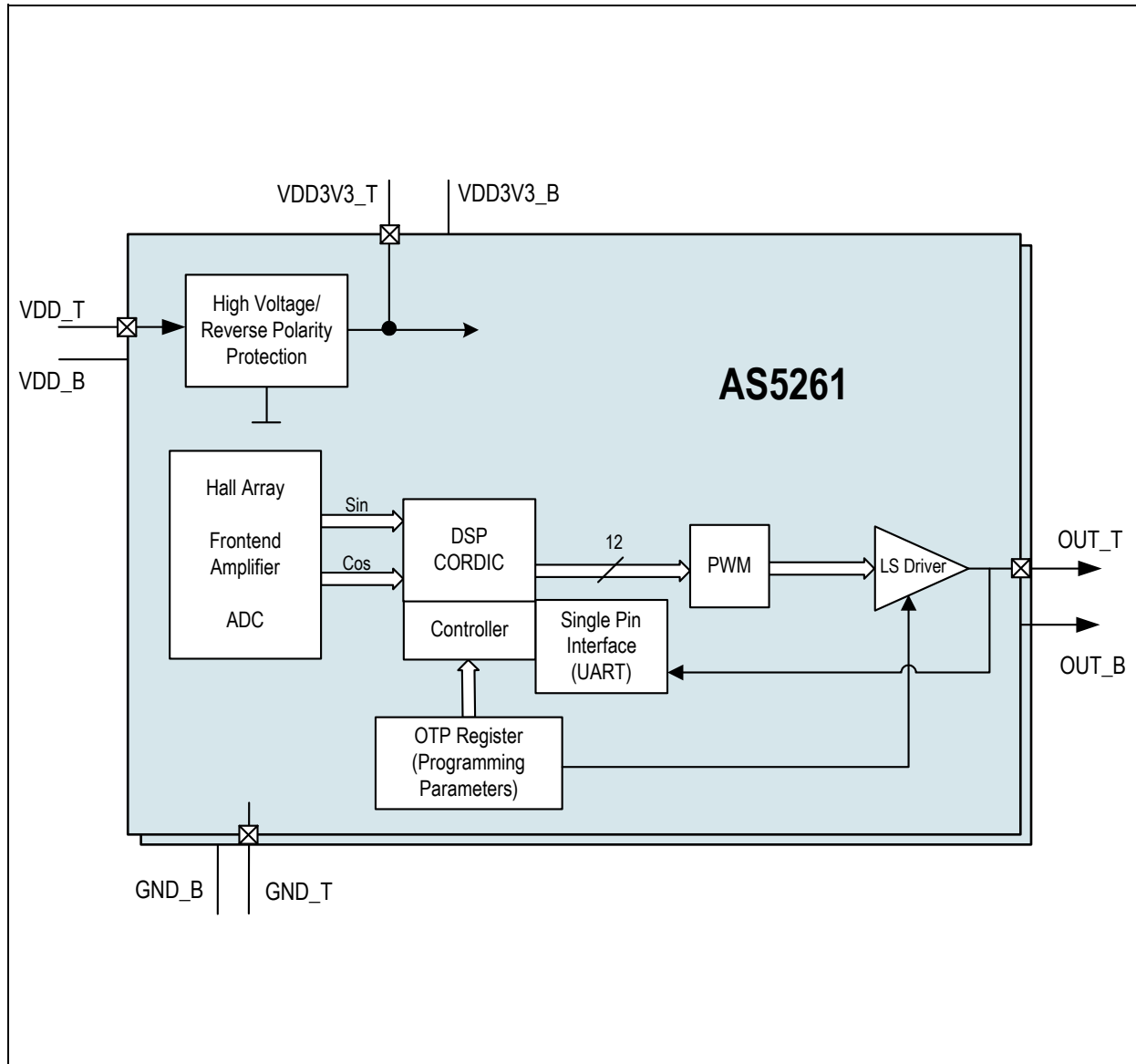
- Unique fully differential solution
- Best protections for automotive applications
- Easy to program
- Additional linearization points for output characteristic
- Ideal for applications in harsh environments due to contactless position sensing
- Robust system, tolerant to magnet misalignment, air gap variations, temperature variations and external magnetic fields
- High inherent accuracy
- Stacked die redundant approach

### 4 Applications

The AS5261 is ideal for automotive applications like throttle and valve position sensing, gearbox position sensor, pedal position sensing and contactless potentiometers.



Figure 2. AS5261 Block Diagram





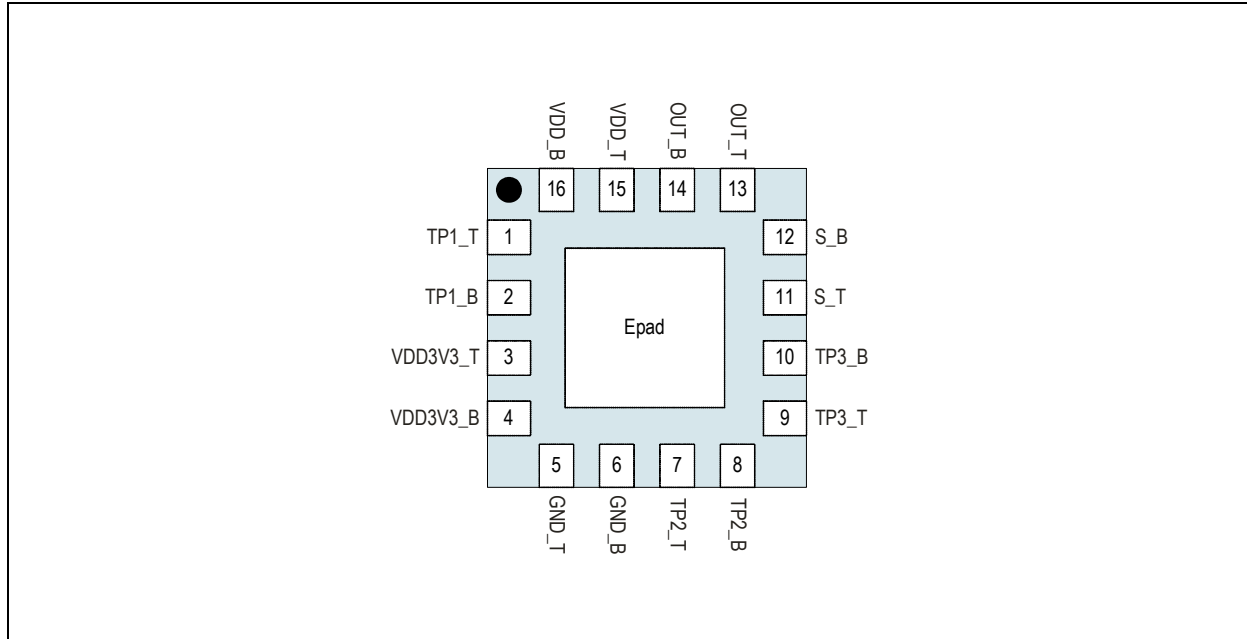
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## 5 Pin Assignments

Figure 3. MLF-16 Pin Configuration (View from Top)



### 5.1 Pin Descriptions

Table 1. MLF-16 Pin Descriptions

| Pin Number | Pin Name | Pin Type                             | Description                                                                                                                   |
|------------|----------|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| 1          | TP1_T    | DIO/AIO<br>Multi purpose pin         | Test pin for fabrication. Connected to ground in the application.                                                             |
| 2          | TP1_B    |                                      | Test pin for fabrication. Connected to ground in the application.                                                             |
| 3          | VDD3V3_T | AIO                                  | Output of the LDO. 1µF required.                                                                                              |
| 4          | VDD3V3_B |                                      | Output of the LDO. 1µF required.                                                                                              |
| 5          | GND_T    | Supply pin                           | Ground pin. Connected to ground in the application.                                                                           |
| 6          | GND_B    |                                      | Ground pin. Connected to ground in the application.                                                                           |
| 7          | TP2_T    | DIO/AIO<br>Multi purpose pin         | Test pin for fabrication. Connected to ground in the application.                                                             |
| 8          | TP2_B    |                                      | Test pin for fabrication. Connected to ground in the application.                                                             |
| 9          | TP3_T    |                                      | Test pin for fabrication. Left open in the application.                                                                       |
| 10         | TP3_B    |                                      | Test pin for fabrication. Left open in the application.                                                                       |
| 11         | S_T      | AIO                                  | Test pin for fabrication. Connected to OUT_T in the application.<br>( special case for the connection possible → 4-wire mode) |
| 12         | S_B      |                                      | Test pin for fabrication. Connected to OUT_B in the application.<br>( special case for the connection possible → 4-wire mode) |
| 13         | OUT_T    | Digital output/Digital<br>PWM output | PWM output pin. Open drain configuration. Programming pin.                                                                    |
| 14         | OUT_B    |                                      | PWM output pin. Open drain configuration. Programming pin.                                                                    |
| 15         | VDD_T    | Supply pin                           | Positive supply pin. This pin is over voltage protected.                                                                      |
| 16         | VDD_B    |                                      | Positive supply pin. This pin is over voltage protected.                                                                      |



## 6 Absolute Maximum Ratings

Stresses beyond those listed in [Table 2](#) may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in [Electrical Characteristics on page 6](#) is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Table 2. Absolute Maximum Ratings

| Symbol                                           | Parameter                                   | Min  | Max  | Units | Comments                                                                                                                                                                                                                                                                          |
|--------------------------------------------------|---------------------------------------------|------|------|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Electrical Parameters</b>                     |                                             |      |      |       |                                                                                                                                                                                                                                                                                   |
| V <sub>DD</sub>                                  | DC supply voltage at pin VDD<br>Overvoltage | -20  | 20   | V     | No operation                                                                                                                                                                                                                                                                      |
| V <sub>OUT</sub>                                 | Output voltage OUT                          | -0.3 | 20   | V     | Permanent                                                                                                                                                                                                                                                                         |
| V <sub>DD3V3</sub>                               | DC supply voltage at pin VDD3V3             | -0.3 | 5    | V     |                                                                                                                                                                                                                                                                                   |
| I <sub>scr</sub>                                 | Input current (latchup immunity)            | -100 | 100  | mA    | Norm: AEC-Q100-004                                                                                                                                                                                                                                                                |
| <b>Electrostatic Discharge</b>                   |                                             |      |      |       |                                                                                                                                                                                                                                                                                   |
| ESD                                              | Electrostatic discharge                     |      | ±2   | kV    | Norm: AEC-Q100-002                                                                                                                                                                                                                                                                |
| <b>Temperature Ranges and Storage Conditions</b> |                                             |      |      |       |                                                                                                                                                                                                                                                                                   |
| T <sub>strg</sub>                                | Storage temperature                         | -55  | +150 | °C    | Min -67°F; Max +257°F                                                                                                                                                                                                                                                             |
| T <sub>Body</sub>                                | Body temperature                            |      | 260  | °C    | The reflow peak soldering temperature (body temperature) specified is in accordance with IPC/JEDEC J-STD-020 "Moisture/Reflow Sensitivity Classification for Non-Hermetic Solid State Surface Mount Devices". The lead finish for Pb-free leaded packages is matte tin (100% Sn). |
| H                                                | Humidity non-condensing                     | 5    | 85   | %     |                                                                                                                                                                                                                                                                                   |
| MSL                                              | Moisture Sensitive Level                    | 3    |      |       | Represents a maximum floor life time of 168h                                                                                                                                                                                                                                      |



## 7 Electrical Characteristics

### 7.1 Operating Conditions

In this specification, all the defined tolerances for external components need to be assured over the whole operation conditions range and also over lifetime.

Table 3. Operating Conditions

| Symbol            | Parameter                 | Conditions                                | Min | Typ | Max  | Units |
|-------------------|---------------------------|-------------------------------------------|-----|-----|------|-------|
| T <sub>AMB</sub>  | Ambient temperature       | -40°F...+302°F                            | -40 |     | +150 | °C    |
| I <sub>supp</sub> | Supply current            | Only for one die. Must be multiplied by 2 |     |     | 10   | mA    |
| V <sub>DD</sub>   | Supply voltage at pin VDD |                                           | 4.5 | 5.0 | 5.5  | V     |

### 7.2 Magnetic Input Specification

T<sub>AMB</sub> = -40 to +150°C, V<sub>DD</sub> = 4.5 to 5.5V (5V operation), unless otherwise noted.

**Two-pole cylindrical diametrically magnetized source:**

Table 4. Magnetic Input Specification

| Symbol             | Parameter                                                 | Conditions                                                                                                                                                                   | Min | Typ | Max | Units |
|--------------------|-----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-------|
| B <sub>pk</sub>    | Magnetic input field amplitude                            | Required vertical component of the magnetic field strength on the die's surface, measured along a concentric circle with a radius of 1.25 mm                                 | 30  |     | 70  | mT    |
| B <sub>pkext</sub> | Magnetic input field amplitude (extended) default setting | Required vertical component of the magnetic field strength on the die's surface, measured along a concentric circle with a radius of 1.25 mm. Increased sensor output noise. | 10  |     | 90  | mT    |
| B <sub>off</sub>   | Magnetic offset                                           | Constant magnetic stray field                                                                                                                                                |     |     | ± 5 | mT    |
| D <sub>isp</sub>   | Displacement radius                                       | Offset between defined device center and magnet axis. Dependent on the selected magnet. Including Eccentricity.                                                              |     | 1   |     | mm    |



### 7.3 Electrical System Specifications

T<sub>AMB</sub> = -40 to +150°C, VDD = 4.5 - 5.5V (5V operation), [Magnetic Input Specification](#), unless otherwise noted.

Table 5. Electrical System Specifications

| Symbol              | Parameter                                                                                | Conditions                                                                                    | Min | Typ | Max  | Units |
|---------------------|------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|-----|-----|------|-------|
| RES                 | Resolution PWM Output                                                                    | Range > 90°                                                                                   |     |     | 12   | bit   |
| INL <sub>opt</sub>  | Integral non-linearity (optimum)                                                         | Best aligned reference magnet at 25°C over full turn 360°.                                    |     |     | 0.5  | deg   |
| INL <sub>temp</sub> | Integral non-linearity (optimum)                                                         | Best aligned reference magnet over temperature -40 -150° over full turn 360°.                 |     |     | 0.9  | deg   |
| INL                 | Integral non-linearity                                                                   | Best aligned reference magnet over temperature -40 -150° over full turn 360° and displacement |     |     | 1.4  | deg   |
| ON <sub>F0</sub>    | Output Noise                                                                             | At 14 bit angular information, 360° mode. Internal Filter disabled.                           |     |     | ±5   | LSB   |
| ON <sub>F1</sub>    |                                                                                          | At 14 bit angular information, 360° mode. Filter setting 1.                                   |     |     | ±3   | LSB   |
| ON <sub>F2</sub>    |                                                                                          | At 14 bit angular information, 360° mode. Filter setting 2.                                   |     |     | ±2   | LSB   |
| ON <sub>F3</sub>    |                                                                                          | At 14 bit angular information, 360° mode. Filter setting 3. Jitter free.                      |     |     | ±0.5 | LSB   |
| t <sub>PwrUp</sub>  | Power-up time 0-5V                                                                       | Power up time 5V operation. Default Power up.                                                 |     |     | 10   | ms    |
| t <sub>delay</sub>  | System propagation delay<br>absolute output: delay of ADC,<br>DSP and absolute interface |                                                                                               |     |     | 300  | µs    |

### 7.4 Timing Characteristics

Table 6. Timing Conditions

| Symbol            | Parameter                    | Conditions | Min | Typ | Max | Units |
|-------------------|------------------------------|------------|-----|-----|-----|-------|
| T <sub>DETD</sub> | WachDog error detection time |            |     |     | 12  | ms    |



## 8 Detailed Description

The AS5261 is manufactured in a CMOS process and uses a spinning current Hall technology for sensing the magnetic field distribution across the surface of the chip. This IC consists of two galvanic isolated dies. All following in and register names refers to one die.

The integrated Hall elements are placed around the center of the device and deliver a voltage representation of the magnetic field at the surface of the IC.

Through Sigma-Delta Analog / Digital Conversion and Digital Signal-Processing (DSP) algorithms, the AS5261 provides accurate high-resolution absolute angular position information. For this purpose a Coordinate Rotation Digital Computer (CORDIC) calculates the angle and the magnitude of the Hall array signals.

The DSP is also used to provide digital information at the outputs that indicate movements of the used magnet towards or away from the device's surface.

A small low cost diametrically magnetized (two-pole) standard magnet provides the angular position information.

The AS5261 senses the orientation of the magnetic field and calculates a 14-bit binary code. This code is mapped to a programmable output characteristic in a PWM duty cycle format. This signal is available at the pin (**OUT**).

The application angular region can be programmed in a user friendly way. The start angle position **T1** and the end point **T2** can be set and programmed according the mechanical range of the application with a resolution of 14 bits. In addition the **T1Y** and **T2Y** parameter can be set and programmed according the application. The transition point 0 to 360 degree can be shifted using the break point parameter **BP**. The voltage for clamping level low **CLL** and clamping level high **CLH** can be programmed with a resolution of 9 bits. Both levels are individually adjustable. Two additional linearization points can be used to improve the system linearity. These points **C1** and **C2** are programmable.

The output parameters can be programmed in an OTP register. No additional voltage is required to program the AS5261. The setting may be overwritten at any time and will be reset to default when power is cycled. To make the setting permanent, the OTP register must be programmed by using a lock bit the content could be frozen for ever.

The AS5261 is tolerant to magnet misalignment and unwanted external magnetic fields due to differential measurement technique and Hall sensor conditioning circuitry.

### 8.1 Operation

#### 8.1.1 VDD Voltage Monitor

**VDD Over Voltage Management.** If the voltage applied to the **VDD** pin exceeds the over-voltage upper threshold for longer than the detection time the output is turned off. When the over voltage event has passed and the voltage applied to the **VDD** pin falls below the over-voltage lower threshold for longer than the recovery time the device enters the normal mode and the output is enabled.

**VDD Under Voltage Management.** When the voltage applied to the **VDD** pin falls below the under-voltage lower threshold for longer than the detection time the output is turned off. When the voltage applied to the **VDD** pin exceeds the under-voltage upper threshold for longer than the detection time the device enters the normal mode and the output is enabled.

### 8.2 PWM Output

By default (after programmed **CUST\_LOCK** OTP bit) the PWM output mode is selected. The pin **OUT** provides a modulated signal that is proportional to the angle of the rotating magnet. Due to an intelligent approach a permanent short circuit will not damage the device. This is also feasible in a high voltage condition up to 20 V and at the highest specified ambient temperature.

After the digital signal processing (DSP) a PWM engine provides the output signal.

The DSP maps the application range to the output characteristic. An inversion of the slope is also programmable to allow inversion of the rotation direction.

An on-chip diagnostic feature handles the error state at the output. Depending on the failure the output is in HiZ condition or indicates a PWM signal within the failure bands of 4 – 96 % duty cycle. (see Table 8)





### 8.2.1 Programming Parameters

The PWM output characteristic is programmable by OTP. Depending on the application, the output can be adjusted. The user can program the following application specific parameters:

|     |                                          |
|-----|------------------------------------------|
| T1  | Mechanical angle start point             |
| T2  | Mechanical angle end point               |
| T1Y | % duty cycle level at the T1 position    |
| T2Y | % duty cycle level at the T2 position    |
| CLL | Clamping Level Low                       |
| CLH | Clamping Level High                      |
| BP  | Break point (transition point 0 to 360°) |
| C1  | Calibration Point 1                      |
| C2  | Calibration Point 2                      |
| C1Y | Trim value for C1                        |
| C2Y | Trim value for C2                        |

These parameters are input parameters. Using the available programming software and programmer these parameters are converted and finally written into the AS5261 128 bit OTP memory.

### 8.2.2 Application Specific Angular Range Programming

The application range can be selected by programming **T1** with a related **T1Y** and **T2** with a related **T2Y** into the AS5261. The clamping levels **CLL** and **CLH** can be programmed independent from the **T1** and **T2** position and both levels can be separately adjusted.

Figure 4. Programming of an Individual Application Range

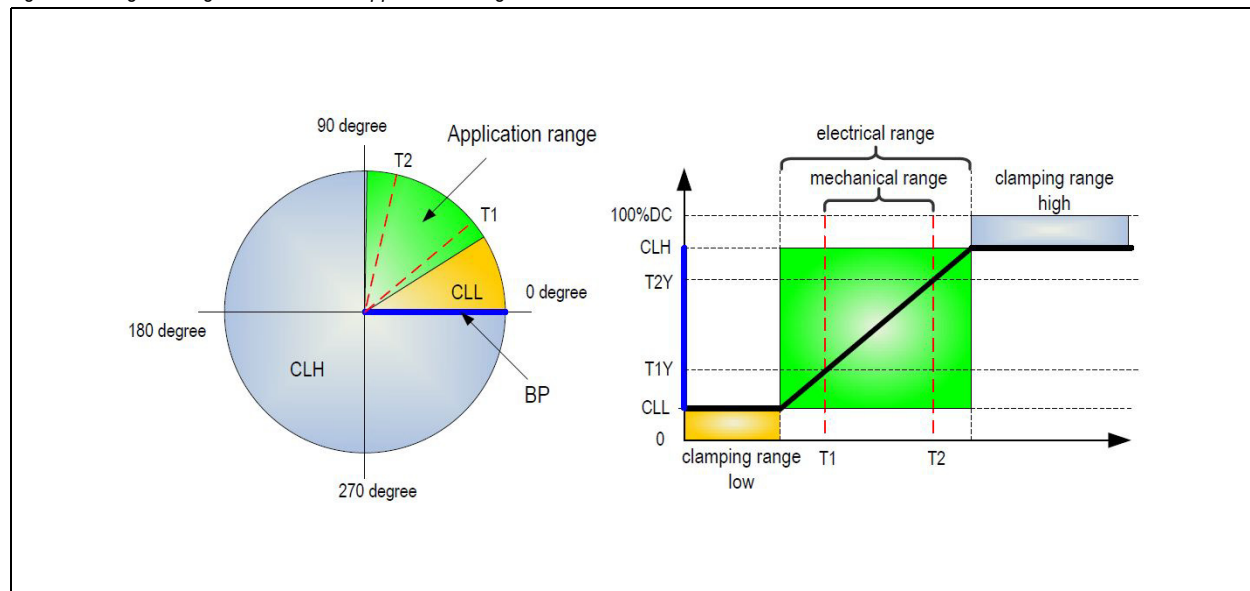


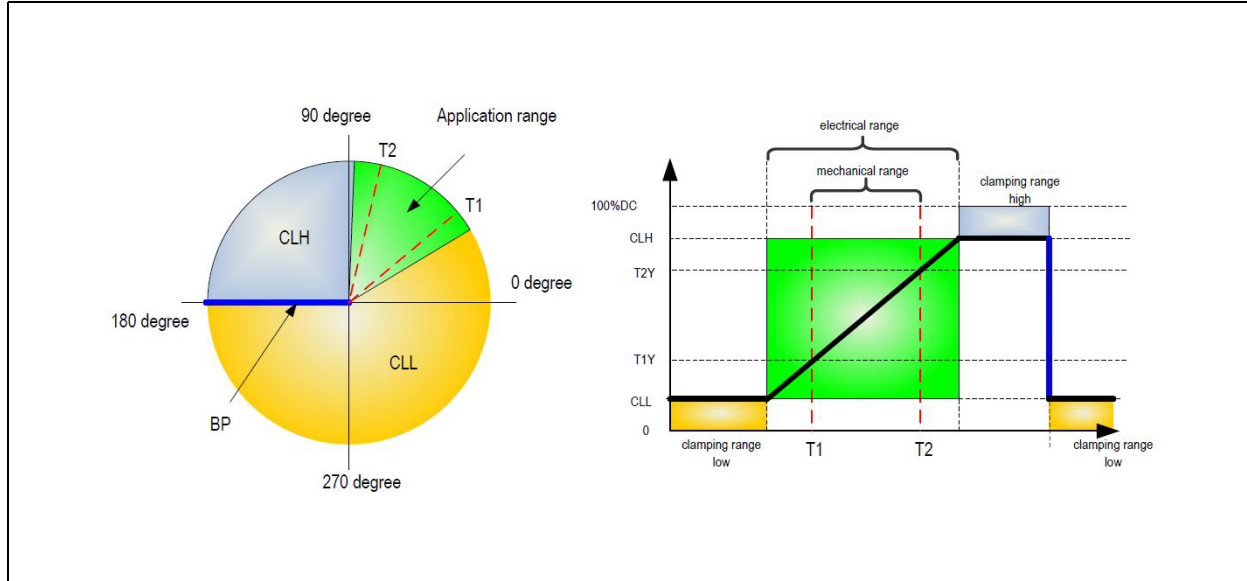
Figure 4 shows a simple example of the selection of the range. The mechanical starting point **T1** and the mechanical end point **T2** are defining the mechanical range. A sub range of the internal Cordic output range is used and mapped to the needed output characteristic. The PWM output signal has 12 bit, hence the level **T1Y** and **T2Y** can be adjusted with this resolution. As a result of this level and the calculated slope the clamping region low is defined. The break point **BP** defines the transition between **CLL** and **CLH**. In this example the **BP** is set to 0°. The **BP** is also the end point of the clamping level high **CLH**. This range is defined by the level **CLH** and the calculated slope. Both clamping levels can be set independently from each other. The minimum application range is 9.8°.



### 8.2.3 Application Specific Programming of the Break Point

The break point **BP** can be programmed as well with 14 bits. This is important when the default transition point is inside the application range. In such a case the default transition point must be shifted out of the application range. The parameter **BP** defines the new position.

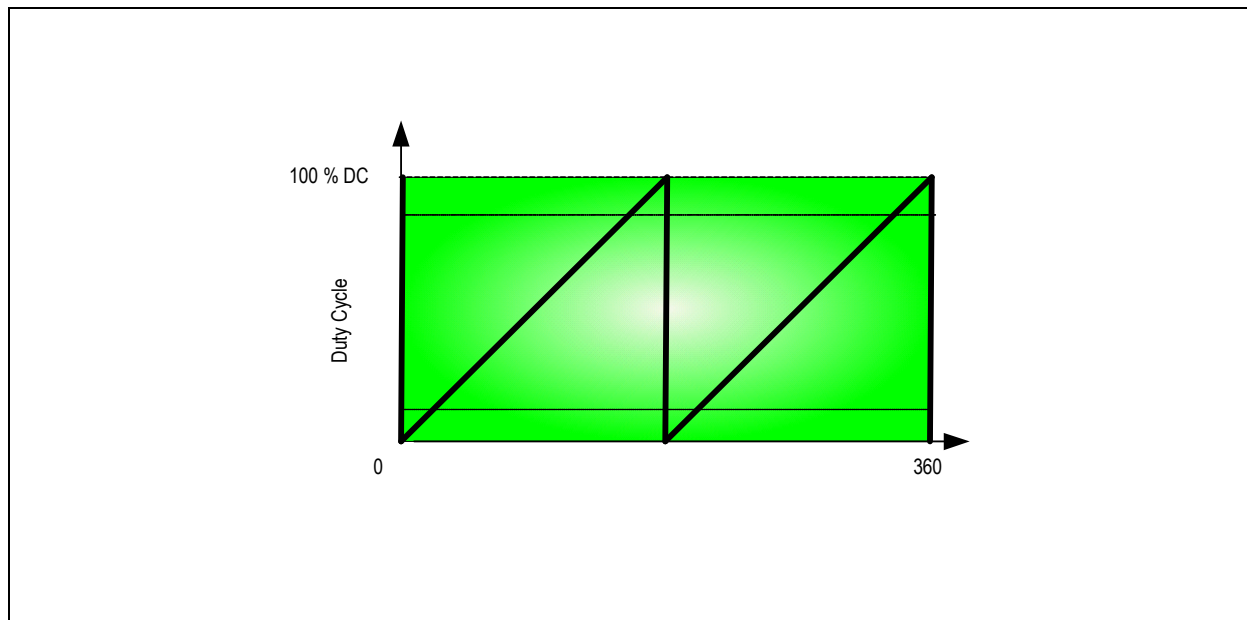
Figure 5. Individual Programming of the Break Point BP

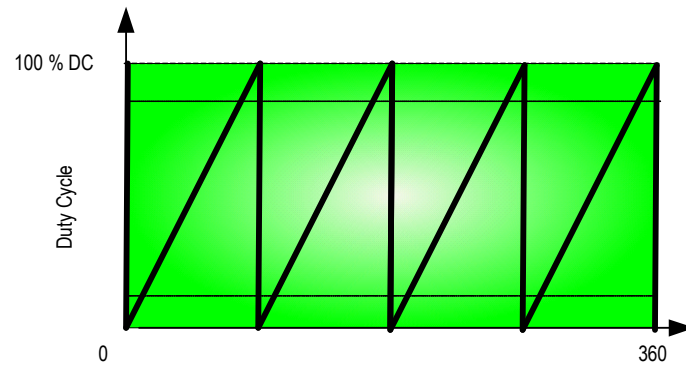


### 8.2.4 Multiple Slope Output

The AS5261 can be programmed to multiple slopes. Where one programmed reference slope characteristic is copied to multiple slopes. Two, three and four slopes are selectable by the user OTP bits **QUADEN (1:0)**. In addition to the steepness of the slope the clamping levels can be programmed as well.

Figure 6. Two Slope Mode



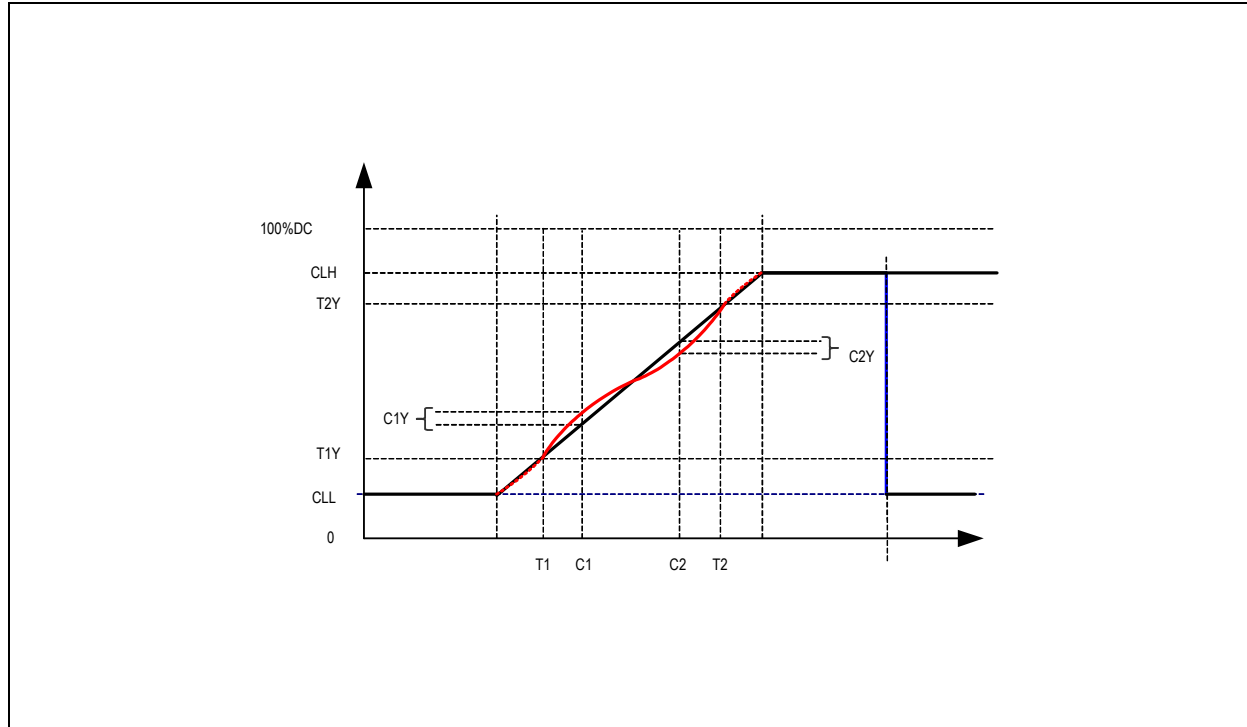
*Figure 7. Four Slope Mode*



### 8.2.5 Linearization of the Output

To improve the system linearity an additional 2 point linearization function is implemented in the AS5261.

Figure 8. Linearization of the Output Characteristic



### 8.2.6 Resolution of Parameters

The programming parameters have a wide resolution of up to 14 bits.

Table 7. Resolution of the Programming Parameters

| Symbol | Parameter                      | Resolution | Note |
|--------|--------------------------------|------------|------|
| T1     | Mechanical angle start point   | 14 bits    |      |
| T2     | Mechanical angle stop point    | 14 bits    |      |
| T1Y    | Mechanical start voltage level | 12 bits    |      |
| T2Y    | Mechanical stop voltage level  | 12 bits    |      |
| CLL    | Clamping level low             | 9 bits     |      |
| CLH    | Clamping level high            | 9 bits     |      |
| BP     | Break point                    | 14 bits    |      |
| C1     | Calibration Point 1            | 4 bits     |      |
| C2     | Calibration Point 2            | 4 bits     |      |
| C1Y    | Trim value C1                  | 3 bits     |      |
| C2Y    | Trim value C2                  | 3 bits     |      |



Figure 9. Overview Output Range

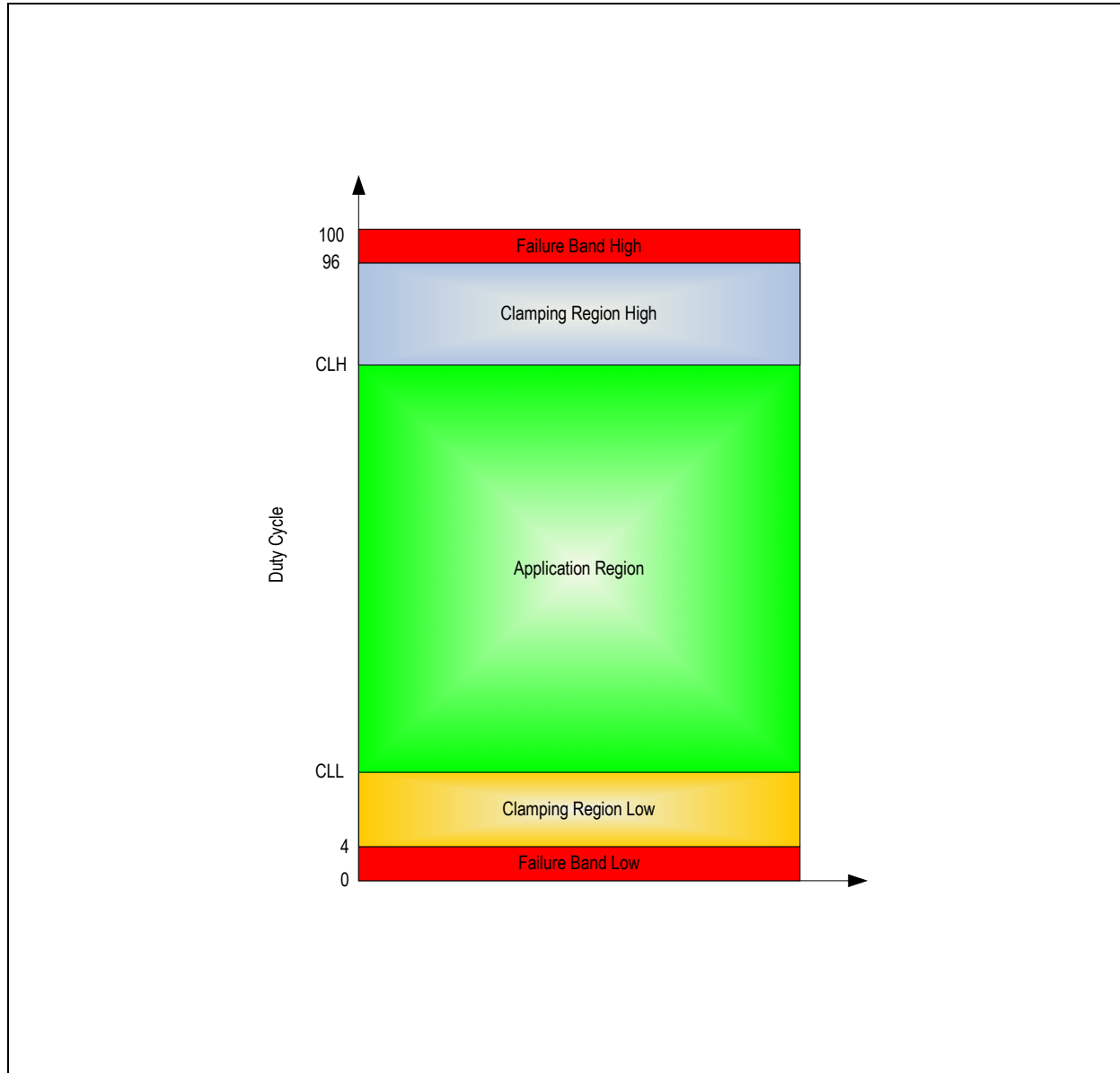


Figure 9 gives an overview about the different ranges. The failure bands are used to indicate a wrong operation of the AS5261. This can be caused due to a broken supply line. By using the specified load resistors the output level will remain in these bands during a fail. It is recommended to set the clamping level **CLL** above the lower failure band and the clamping level **CLH** below the higher failure band.

- $C_{LOAD} \leq 33 \text{ nF}$ ,  $R_{PU} = 1\text{k}\dots 10\text{k}\Omega$



Table 8. Different Failure Cases of AS5261

| Type                         | Failure Mode                                                   | Symbol | Failure Band | Note                                                          |
|------------------------------|----------------------------------------------------------------|--------|--------------|---------------------------------------------------------------|
| Internal alarms (failures)   | Out of magnetic range<br>(too less or too high magnetic input) | MAGRng | High/Low     | Programmable by OTP bit <b>DIAG_HIGH</b>                      |
|                              | Cordic overflow                                                | COF    | High/Low     | Programmable by OTP bit <b>DIAG_HIGH</b>                      |
|                              | Offset compensation finished                                   | OCF    | High/Low     | Programmable by OTP bit <b>DIAG_HIGH</b>                      |
|                              | Watchdog fail                                                  | WDF    | High/Low     | Programmable by OTP bit <b>DIAG_HIGH</b>                      |
|                              | Oscillator fail                                                | OF     | High/Low     | Programmable by OTP bit <b>DIAG_HIGH</b>                      |
| Application related failures | Overvoltage condition                                          | OV     | High         | Dependant on the load resistor<br>Pull up → failure band high |
|                              | Broken VDD                                                     | BVDD   |              |                                                               |
|                              | Broken VSS                                                     | BVSS   |              |                                                               |
|                              | Short circuit output                                           | SCO    | High         | Switch off → short circuit dependent                          |

For efficient use of diagnostics, it is recommended to program to clamping levels **CLL** and **CLH**.

### 8.2.7 Noise Suppressor

The noise suppressor is inserted on two levels of the DSP chain. The first stage, on the output of the Cordic block, is capable to reduce the noise level up to 1 LSB peak to peak. The second stage, on the output of the straight-line tracer, reduces the impact of the post processing. In fact depending on the programmed operating angular sector the gain module amplifies also the noise level up to 8 LSB peak to peak and the second stage of the noise suppressor reduces it again to 1 LSB peak to peak.

Four possible configurations of the noise suppressor can be selected via the OTP bits **FILTERCFG<1:0>**.

### 8.2.8 Hysteresis Function

AS5261 device includes a hysteresis function to avoid sudden jumps from CLH to CLL and vice versa caused by noise in the full turn configuration.

The hysteresis amplitude can be selected via the OTP bits **HYSTSEL<1:0>**.

## 8.3 PWM Output Driver Parameters

The output stage is configured in a open drain output.

The PWM duty cycle represents the angular output data. All programming features are available for the PWM mode as well. The PWM period is programmable in four steps and can be programmed by **PWMF<2:0>**.

$C_{LOAD} \leq 33 \text{ nF}$ ,  $R_{PU} = 1k \dots 10k\Omega$

Table 9. PWM Parameters Output Driver

| Symbol | Parameter                    | Conditions                                                                         | Min     | Typ  | Max     | Units             |
|--------|------------------------------|------------------------------------------------------------------------------------|---------|------|---------|-------------------|
| PWMF1  | PWM frequency 7              | $PWMF<2:0>=111$                                                                    | 109.86  | 122  | 134.28  | Hz                |
| PWMF2  | PWM frequency 6              | $PWMF<2:0>=110$                                                                    | 179.78  | 200  | 219.73  | Hz                |
| PWMF3  | PWM frequency 5              | $PWMF<2:0>=101$                                                                    | 219.73  | 244  | 268.55  | Hz                |
| PWMF4  | PWM frequency 4              | $PWMF<2:0>=100$                                                                    | 329.59  | 366  | 402.83  | Hz                |
| PWMF5  | PWM frequency 3              | $PWMF<2:0>=011$                                                                    | 494.38  | 549  | 604.25  | Hz                |
| PWMF6  | PWM frequency 2              | $PWMF<2:0>=010$                                                                    | 659.18  | 732  | 805.66  | Hz                |
| PWMF7  | PWM frequency 1              | $PWMF<2:0>=001$                                                                    | 988.77  | 1100 | 1208.50 | Hz                |
| PWMF8  | PWM frequency 0              | $PWMF<2:0>=000$                                                                    | 1977.54 | 2197 | 2416.2  | Hz                |
| PWMDC  | PWM duty cycle range         | info parameter                                                                     | 4       |      | 96      | %                 |
| PWMVOL | Output voltage low           | $I_{OUT}=5\text{mA}$                                                               | 0       |      | 0.4     | V                 |
| PWMSRF | PWM slew rate (falling edge) | Between 75% and 25%<br>$R_{PUOUT}=4K\Omega$ ; $C_{LOUT}=1\text{nF}$<br>$V_{DD}=5V$ | 1       | 2    | 4       | V / $\mu\text{s}$ |



## 9 Application Information

### 9.1 Recommended Application Schematic

Figure 10 shows the recommended schematic in the application. All components marked with (\*) are optional and can be used to further increase the EMC.

Figure 10. AS5261 6-Wire Connection with Pull-Up Resistors

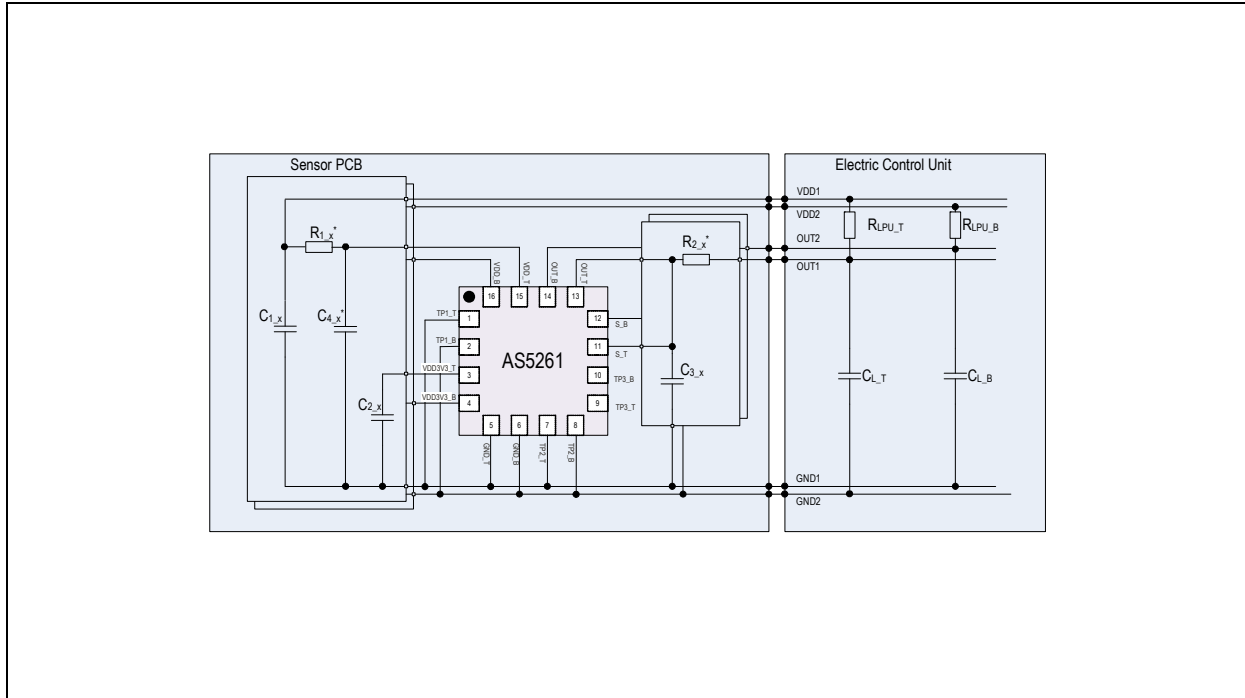


Table 10. External Components

| Symbol                      | Parameter                       | Min | Typ | Max | Unit | Note                                            |
|-----------------------------|---------------------------------|-----|-----|-----|------|-------------------------------------------------|
| C <sub>1</sub>              | VDD buffer capacitor            | 0.8 | 1   | 1.2 | μF   | Low ESR 0.3 Ω                                   |
| C <sub>2</sub>              | VDD3V3 regulator capacitor      | 0.8 | 1   | 1.2 | μF   | Low ESR 0.3 Ω                                   |
| C <sub>3</sub>              | OUT load capacitor (sensor PCB) | 0   |     | 4.7 | nF   |                                                 |
| C <sub>4</sub> <sup>*</sup> | VDD capacitor (optional)        |     | 4.7 |     | nF   | Do not increase due to programming over output. |
| R <sub>1</sub> <sup>*</sup> | VDD serial resistor (optional)  |     | 10  |     | Ω    |                                                 |
| C <sub>L</sub>              | OUT load capacitor (ECU)        | 0   |     | 33  | nF   |                                                 |
| R <sub>2</sub> <sup>*</sup> | OUT serial resistor (optional)  |     | 50  |     | Ω    |                                                 |
| R <sub>LPU</sub>            | OUT pull-up resistance          | 4   |     | 10  | kΩ   |                                                 |

### 9.2 Programming the AS5261

The AS5261 programming is a one-time-programming (OTP) method, based on polysilicon fuses. The advantage of this method is that no additional programming voltage is needed. The internal LDO provides the current for programming.

The OTP consists of 128 bits; several bits are available for user programming. In addition factory settings are stored in the OTP memory. Both regions are independently lockable by build in lock bits.

A single OTP cell can be programmed only once. Per default, the cell is "0"; a programmed cell will contain a "1". While it is not possible to reset a programmed bit from "1" to "0", multiple OTP writes are possible, as long as only unprogrammed "0"-bits are programmed to "1".

Independent of the OTP programming, it is possible to overwrite the OTP register temporarily with an OTP write command. This is possible only if the user lock bit is not programmed.



Due to the programming over the output pin the device will initially start in the communication mode. In this mode the digital angle value can be read with a specific protocol format. It is a bidirectional communication possible. Parameters can be written into the device. A programming of the device is triggered by a specific command. With another command (pass2func) the device can be switched into operation mode. In case of a programmed user lock bit the AS5261 automatically starts up in the functional operation mode. No communication of the specific protocol is possible after this.

A standard half duplex UART protocol is used to exchange data with the device in the communication mode.

### 9.2.1 UART Interface for Programming

The AS5261 uses a standard UART interface with a byte for address and two bytes for the data content. The read or write mode is selected in the first byte. An even parity for every byte. The timing (baudrate) is selected by the AS5261 over an initial command from the master. The baud rate register can be read and overwritten. The keep synchronization it AS5261 synchronizes art every Start bit. This happens during a standard write access 3 times.

A time out function detects not complete commands and resets the AS5261 UART after the timeout period.

### 9.2.2 Frame Organization

Each frame is composed by 24 bits. The first byte (Address or Command) of the frame specifies the read/write operation with the register address or is used for a command. 16 data bits contains the communication data. There will be no operation in case of the usage of a not specified CMD. The UART programming interface block of the AS5261 can operate in slave communication or master communication mode. In the slave communication mode the AS5261 receives the data. The programming tool is the driver of the single communication line. In case of the master communication mode the AS5261 transmits data in the frame format. The single communication line can be pulled down by the AS5261.

Table 11. OTP Commands and Communication

| Possible Interface Commands | Address / Command                                              | AS5X63 Communication Mode | Description                                           |
|-----------------------------|----------------------------------------------------------------|---------------------------|-------------------------------------------------------|
| WRITE                       | 0x00-0x0F (OTP)<br>0x10-0x1F (SFR)<br>0x20-0xFF (Special Mode) | SLAVE                     | Write related to the address the user data            |
| READ                        | 0x00-0x0F (OTP)<br>0x10-0x1F (SFR)<br>0x20-0xFF (Special Mode) | SLAVE and MASTER          | Read related to the address the user data             |
| FUSE                        | 0x22+ key                                                      | SLAVE                     | Command for permanent programming                     |
| PASS2FUNC                   | 0x23+ key                                                      | SLAVE                     | Change operation mode from communication to operation |

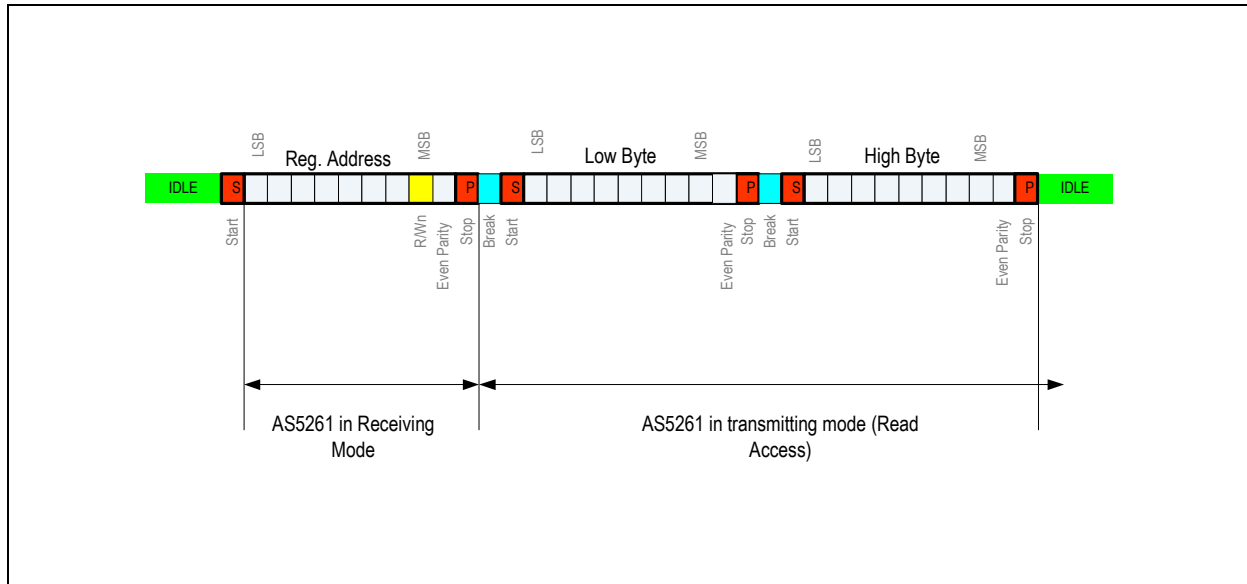




### 9.2.3 READ

Figure 11 shows the format of the frame:

Figure 11. Organization of the READ Command



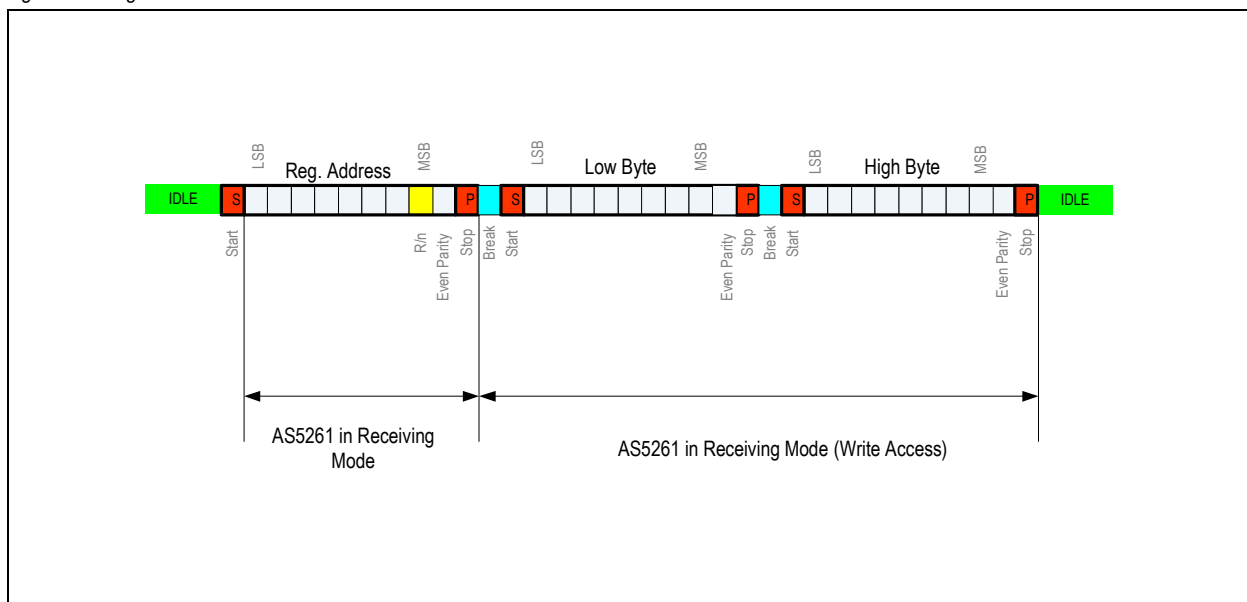
The R/Wn bit in the first byte selects the mode. Between the data packets is always a break state. The break state has the same length as the other data bits.

An even parity bit is used to guarantee a correct data transmission. The parity bit is generated by the 8 bits.

### 9.2.4 WRITE

Figure 12 shows the format of the frame:

Figure 12. Organization of the READ Command

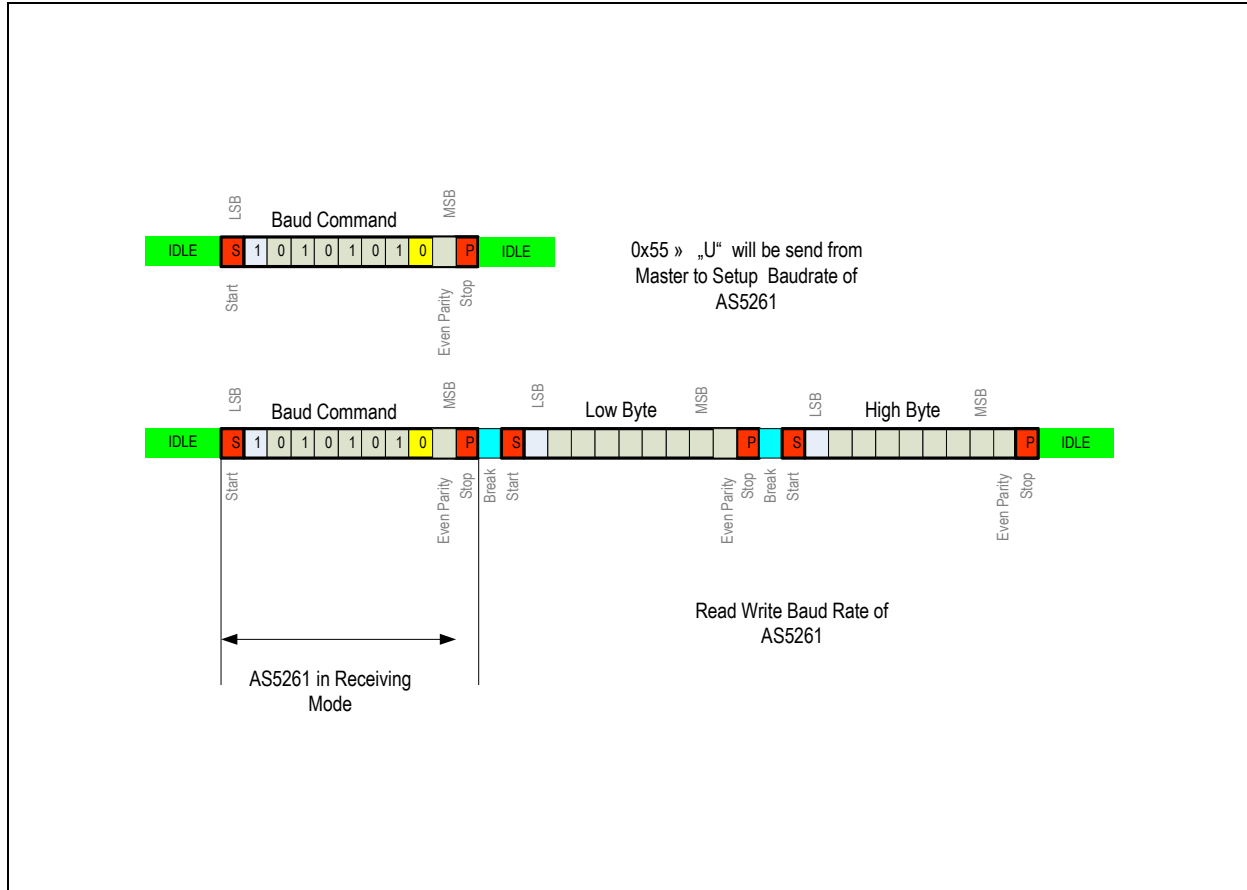




### 9.2.5 Baud Rate Setup

Due to the internal RC oscillator the AS5261 needs to synchronize to the master. This happens after startup with the first baud rate command. This register address is reserved after the first successful setup for a possible manual setting of the baud rate.

Figure 13. Baud Rate Setup





### 9.3 OTP Programming Data

Table 12. OTP Memory Map

| Data Byte     | Bit Number | Symbol           | Default | Description                        |                   |
|---------------|------------|------------------|---------|------------------------------------|-------------------|
| DATA15 (0x0F) | 0          | Factory Settings | 0       | AMS (reserved)                     | Factory Settings  |
|               | 1          |                  | 0       |                                    |                   |
|               | 2          |                  | 0       |                                    |                   |
|               | 3          |                  | 0       |                                    |                   |
|               | 4          |                  | 0       |                                    |                   |
|               | 5          |                  | 0       |                                    |                   |
|               | 6          |                  | 0       |                                    |                   |
|               | 7          |                  | 0       |                                    |                   |
| DATA14 (0x0E) | 0          |                  | 0       |                                    |                   |
|               | 1          |                  | 0       |                                    |                   |
|               | 2          |                  | 0       |                                    |                   |
|               | 3          |                  | 0       |                                    |                   |
|               | 4          |                  | 0       |                                    |                   |
|               | 5          |                  | 0       |                                    |                   |
|               | 6          |                  | 0       |                                    |                   |
|               | 7          |                  | 0       |                                    |                   |
| DATA13 (0x0D) | 0          | 0                |         |                                    |                   |
|               | 1          | 0                |         |                                    |                   |
|               | 2          | CUSTID<0>        | 0       | Customer Identifier                | Customer Settings |
|               | 3          | CUSTID<1>        | 0       |                                    |                   |
|               | 4          | CUSTID<2>        | 0       |                                    |                   |
|               | 5          | CUSTID<3>        | 0       |                                    |                   |
|               | 6          | CUSTID<4>        | 0       |                                    |                   |
|               | 7          | CUSTID<5>        | 0       |                                    |                   |
| DATA12 (0x0C) | 0          | CUSTID<6>        | 0       |                                    |                   |
|               | 1          | X2LIN<0>         | 0       |                                    |                   |
|               | 2          | X2LIN<1>         | 0       |                                    |                   |
|               | 3          | X2LIN<2>         | 0       |                                    |                   |
|               | 4          | X2LIN<3>         | 0       |                                    |                   |
|               | 5          | X1LIN<0>         | 0       | First linearization point (X-axis) |                   |
|               | 6          | X1LIN<1>         | 0       |                                    |                   |
|               | 7          | X1LIN<2>         | 0       |                                    |                   |
| DATA11 (0x0B) | 0          | X1LIN<3>         | 0       |                                    |                   |
|               | 1          | Y1LIN<0>         | 0       |                                    |                   |



Table 12. OTP Memory Map

| Data Byte     | Bit Number | Symbol     | Default | Description                         |                   |
|---------------|------------|------------|---------|-------------------------------------|-------------------|
|               | 2          | Y1LIN<1>   | 0       | First linearization point (Y-axis)  | Customer Settings |
|               | 3          | Y1LIN<2>   | 0       |                                     |                   |
|               | 4          | Y2LIN<0>   | 0       | Second linearization point (Y-axis) |                   |
|               | 5          | Y2LIN<1>   | 0       |                                     |                   |
|               | 6          | Y2LIN<2>   | 0       |                                     |                   |
|               | 7          | CLH<0>     | 0       | Clamping Level High                 |                   |
| DATA10 (0x0A) | 0          | CLH<1>     | 0       |                                     |                   |
|               | 1          | CLH<2>     | 0       |                                     |                   |
|               | 2          | CLH<3>     | 0       |                                     |                   |
|               | 3          | CLH<4>     | 0       |                                     |                   |
|               | 4          | CLH<5>     | 0       |                                     |                   |
|               | 5          | CLH<6>     | 0       |                                     |                   |
|               | 6          | CLH<7>     | 0       |                                     |                   |
| 7             | CLH<8>     | 0          |         |                                     |                   |
| DATA9 (0x09)  | 0          | CLL<0>     | 0       | Clamping Level Low                  |                   |
|               | 1          | CLL<1>     | 0       |                                     |                   |
|               | 2          | CLL<2>     | 0       |                                     |                   |
|               | 3          | CLL<3>     | 0       |                                     |                   |
|               | 4          | CLL<4>     | 0       |                                     |                   |
|               | 5          | CLL<5>     | 0       |                                     |                   |
|               | 6          | CLL<6>     | 0       |                                     |                   |
|               | 7          | CLL<7>     | 0       |                                     |                   |
| DATA8 (0x08)  | 0          | CLL<8>     | 0       | Offset                              |                   |
|               | 1          | OFFSET<0>  | 0       |                                     |                   |
|               | 2          | OFFSET<1>  | 0       |                                     |                   |
|               | 3          | OFFSET<2>  | 0       |                                     |                   |
|               | 4          | OFFSET<3>  | 0       |                                     |                   |
|               | 5          | OFFSET<4>  | 0       |                                     |                   |
|               | 6          | OFFSET<5>  | 0       |                                     |                   |
|               | 7          | OFFSET<6>  | 0       |                                     |                   |
| DATA7 (0x07)  | 0          | OFFSET<7>  | 0       |                                     |                   |
|               | 1          | OFFSET<8>  | 0       |                                     |                   |
|               | 2          | OFFSET<9>  | 0       |                                     |                   |
|               | 3          | OFFSET<10> | 0       |                                     |                   |
|               | 4          | OFFSET<11> | 0       |                                     |                   |
|               | 5          | OFFSET<12> | 0       |                                     |                   |
|               | 6          | OFFSET<13> | 0       |                                     |                   |
|               | 7          | OFFSET<14> | 0       |                                     |                   |



Table 12. OTP Memory Map

| Data Byte     | Bit Number | Symbol     | Default | Description                                                                         |                   |             |
|---------------|------------|------------|---------|-------------------------------------------------------------------------------------|-------------------|-------------|
| DATA6 (0x06)  | 0          | OFFSET<15> | 0       | Offset                                                                              | Customer Settings |             |
|               | 1          | OFFSET<16> | 0       |                                                                                     |                   |             |
|               | 2          | OFFSET<17> | 0       |                                                                                     |                   |             |
|               | 3          | OFFSET<18> | 0       |                                                                                     |                   |             |
|               | 4          | OFFSET<19> | 0       | Scale Factor                                                                        |                   |             |
|               | 5          | GAIN<0>    | 0       |                                                                                     |                   |             |
|               | 6          | GAIN<1>    | 0       |                                                                                     |                   |             |
|               | 7          | GAIN<2>    | 0       |                                                                                     |                   |             |
| DATA5 (0x05)  | 0          | GAIN<3>    | 0       |                                                                                     |                   |             |
|               | 1          | GAIN<4>    | 0       |                                                                                     |                   |             |
|               | 2          | GAIN<5>    | 0       |                                                                                     |                   |             |
|               | 3          | GAIN<6>    | 0       |                                                                                     |                   |             |
|               | 4          | GAIN<7>    | 0       |                                                                                     |                   |             |
|               | 5          | GAIN<8>    | 0       |                                                                                     |                   |             |
|               | 6          | GAIN<9>    | 0       |                                                                                     |                   |             |
|               | 7          | GAIN<10>   | 0       |                                                                                     |                   |             |
| DATA4 (0x04)  | 0          | GAIN<11>   | 0       |                                                                                     |                   | Break Point |
|               | 1          | GAIN<12>   | 0       |                                                                                     |                   |             |
|               | 2          | GAIN<13>   | 0       |                                                                                     |                   |             |
|               | 3          | GAIN<14>   | 0       |                                                                                     |                   |             |
|               | 4          | GAIN<15>   | 0       |                                                                                     |                   |             |
|               | 5          | GAIN<16>   | 0       |                                                                                     |                   |             |
|               | 6          | BP<0>      | 0       |                                                                                     |                   |             |
|               | 7          | BP<1>      | 0       |                                                                                     |                   |             |
| DATA3 (0x003) | 0          | BP<2>      | 0       |                                                                                     |                   |             |
|               | 1          | BP<3>      | 0       |                                                                                     |                   |             |
|               | 2          | BP<4>      | 0       |                                                                                     |                   |             |
|               | 3          | BP<5>      | 0       |                                                                                     |                   |             |
|               | 4          | BP<6>      | 0       |                                                                                     |                   |             |
|               | 5          | BP<7>      | 0       |                                                                                     |                   |             |
|               | 6          | BP<8>      | 0       |                                                                                     |                   |             |
|               | 7          | BP<9>      | 0       |                                                                                     |                   |             |
| DATA2 (0x02)  | 0          | BP<10>     | 0       |                                                                                     |                   |             |
|               | 1          | BP<11>     | 0       |                                                                                     |                   |             |
|               | 2          | BP<12>     | 0       |                                                                                     |                   |             |
|               | 3          | BP<13>     | 0       |                                                                                     |                   |             |
|               | 4          | ANGLERNG   | 0       | Sector selection<br>0=Angular Sector≥22.5 degrees;<br>1=Angular Sector<22.5 degrees |                   |             |
|               | 5          | DIAG_HIGH  | 0       | Failure Band Selection<br>0=Failure Band Low 1=Failure Band High                    |                   |             |



Table 12. OTP Memory Map

| Data Byte    | Bit Number | Symbol       | Default | Description                                                                                                    |                   |
|--------------|------------|--------------|---------|----------------------------------------------------------------------------------------------------------------|-------------------|
| DATA2 (0x02) | 6          | QUADEN<0>    | 0       | Quadrant Mode Enable<br>00=1quadrant;01=2quadrants;<br>10=3 quadrants;11=4 quadrants                           | Customer Settings |
|              | 7          | QUADEN<1>    | 0       |                                                                                                                |                   |
| DATA1 (0x01) | 0          | AIRGAPSEL    | 0       | Magnetic input range extension<br>0:extended range;1=normal range                                              |                   |
|              | 1          | HYSTSEL<0>   | 0       | Hysteresis selection<br>00=no hysteresis; 01: 56LSB;<br>10=91LSB; 11=137LSB                                    |                   |
|              | 2          | HYSTSEL<1>   | 0       |                                                                                                                |                   |
|              | 3          | FILTERCFG<0> | 0       | Filter Configuration<br>00=no filter; 01= fast;<br>10=moderate; 11=slow                                        |                   |
|              | 4          | FILTERCFG<1> | 0       |                                                                                                                |                   |
|              | 5          | Not used     | 0       |                                                                                                                |                   |
|              | 6          | Not used     | 0       |                                                                                                                |                   |
|              | 7          | Not used     | 0       |                                                                                                                |                   |
| DATA0 (0x00) | 0          | RED_ADD<0>   | 0       | Redundancy Address<br>Identify the address of the byte<br>containing the bit to be changed                     |                   |
|              | 1          | RED_ADD<1>   | 0       |                                                                                                                |                   |
|              | 2          | RED_ADD<2>   | 0       |                                                                                                                |                   |
|              | 3          | RED_ADD<3>   | 0       |                                                                                                                |                   |
|              | 4          | RED_BIT<0>   | 0       | Redundancy Bit<br>Identify the position of the bit to be<br>changed in the byte at the address<br>RED_ADD<3:0> |                   |
|              | 5          | RED_BIT<1>   | 0       |                                                                                                                |                   |
|              | 6          | RED_BIT<2>   | 0       |                                                                                                                |                   |
|              | 7          | CUST_LOCK    | 0       | Lock bit for Customer Area                                                                                     |                   |



## 9.4 READ / WRITE Register Map

Table 13. Read / Write Registers

| Data Byte    | Bit Number | Symbol     | Default | Description                                                 |                 |
|--------------|------------|------------|---------|-------------------------------------------------------------|-----------------|
| DATA0 (0x20) | 0          | BAUDREG<0> | 0       | UART Baud Rate Register                                     | Read/Write Area |
|              | 1          | BAUDREG<1> | 0       |                                                             |                 |
|              | 2          | BAUDREG<2> | 0       |                                                             |                 |
|              | 3          | BAUDREG<3> | 0       |                                                             |                 |
|              | 4          | BAUDREG<4> | 0       |                                                             |                 |
|              | 5          | BAUDREG<5> | 0       |                                                             |                 |
|              | 6          | BAUDREG<6> | 0       |                                                             |                 |
|              | 7          | BAUDREG<7> | 0       |                                                             |                 |
| DATA1 (0x21) | 0          | BAUDREG<8> | 0       | A read command returns all data bits at 0                   |                 |
|              | 1          | Not used   | 0       |                                                             |                 |
|              | 2          | Not used   | 0       |                                                             |                 |
|              | 3          | Not used   | 0       |                                                             |                 |
|              | 4          | Not used   | 0       |                                                             |                 |
|              | 5          | Not used   | 0       |                                                             |                 |
|              | 6          | Not used   | 0       |                                                             |                 |
|              | 7          | Not used   | 0       |                                                             |                 |
| DATA2 (0x22) | 0          | Not used   | 0       |                                                             |                 |
|              | 1          | Not used   | 0       |                                                             |                 |
|              | 2          | Not used   | 0       |                                                             |                 |
|              | 3          | Not used   | 0       |                                                             |                 |
|              | 4          | Not used   | 0       | Selection of the reference resistance used for OTP download |                 |
|              | 5          | R1K10K<0>  | 0       |                                                             |                 |
|              | 6          | R1K10K<1>  | 0       |                                                             |                 |
|              | 7          | DSPRN      | 0       | Resetrn of the Digital Signal Processing circuit            |                 |



## 9.5 READ Only Register Map

Table 14. Read Only Registers

| Data Byte    | Bit Number | Symbol         | Default | Description                                                                              |           |
|--------------|------------|----------------|---------|------------------------------------------------------------------------------------------|-----------|
| DATA0 (0x28) | 0          | Not used       | 0       | A read command returns 0                                                                 | Read Area |
|              | 1          | OFFSETFINISHED | 0       | Offset compensation finished                                                             |           |
|              | 2          | AGCFINISHED    | 0       | AGC loop compensation finished                                                           |           |
|              | 3          | CORDICOVF      | 0       | Overflow of the Cordic                                                                   |           |
|              | 4          | AGCALARML      | 0       | AGC loop saturation because of B field too strong                                        |           |
|              | 5          | AGCALARMH      | 0       | AGC loop saturation because of B field too weak                                          |           |
|              | 6          | OTP_RES        | 0       | 0=1K resistance selected for OTP download;<br>1=10K resistance selected for OTP download |           |
|              | 7          | PARITY_ERR     | 0       | UART parity error flag                                                                   |           |
| DATA1 (0x29) | 0          | CORDICOUT<0>   | 0       | Cordic Output                                                                            |           |
|              | 1          | CORDICOUT<1>   | 0       |                                                                                          |           |
|              | 2          | CORDICOUT<2>   | 0       |                                                                                          |           |
|              | 3          | CORDICOUT<3>   | 0       |                                                                                          |           |
|              | 4          | CORDICOUT<4>   | 0       |                                                                                          |           |
|              | 5          | CORDICOUT<5>   | 0       |                                                                                          |           |
|              | 6          | CORDICOUT<6>   | 0       |                                                                                          |           |
|              | 7          | CORDICOUT<7>   | 0       |                                                                                          |           |
| DATA2 (0x2A) | 0          | CORDICOUT<8>   | 0       |                                                                                          |           |
|              | 1          | CORDICOUT<9>   | 0       |                                                                                          |           |
|              | 2          | CORDICOUT<10>  | 0       |                                                                                          |           |
|              | 3          | CORDICOUT<11>  | 0       |                                                                                          |           |
|              | 4          | CORDICOUT<12>  | 0       |                                                                                          |           |
|              | 5          | CORDICOUT<13>  | 0       |                                                                                          |           |
|              | 6          | Not used       | 0       | A read command returns all data bits at 0                                                |           |
|              | 7          | Not used       | 0       |                                                                                          |           |
| DATA3 (0x2B) | 0          | DSPOUT<0>      | 0       | DSP Output                                                                               |           |
|              | 1          | DSPOUT<1>      | 0       |                                                                                          |           |
|              | 2          | DSPOUT<2>      | 0       |                                                                                          |           |
|              | 3          | DSPOUT<3>      | 0       |                                                                                          |           |
|              | 4          | DSPOUT<4>      | 0       |                                                                                          |           |
|              | 5          | DSPOUT<5>      | 0       |                                                                                          |           |
|              | 6          | DSPOUT<6>      | 0       |                                                                                          |           |
|              | 7          | DSPOUT<7>      | 0       |                                                                                          |           |





Table 14. Read Only Registers

| Data Byte    | Bit Number | Symbol      | Default | Description                               |           |
|--------------|------------|-------------|---------|-------------------------------------------|-----------|
| DATA4 (0x2C) | 0          | DSPOUT<8>   | 0       | DSP Output                                | Read Area |
|              | 1          | DSPOUT<9>   | 0       |                                           |           |
|              | 2          | DSPOUT<10>  | 0       |                                           |           |
|              | 3          | DSPOUT<11>  | 0       |                                           |           |
|              | 4          | Not used    | 0       | A read command returns all data bits at 0 |           |
|              | 5          | Not used    | 0       |                                           |           |
|              | 6          | Not used    | 0       |                                           |           |
|              | 7          | Not used    | 0       |                                           |           |
| DATA5 (0x2D) | 0          | AGCVALUE<0> | 0       | AGC Value                                 |           |
|              | 1          | AGCVALUE<1> | 0       |                                           |           |
|              | 2          | AGCVALUE<2> | 0       |                                           |           |
|              | 3          | AGCVALUE<3> | 0       |                                           |           |
|              | 4          | AGCVALUE<4> | 0       |                                           |           |
|              | 5          | AGCVALUE<5> | 0       |                                           |           |
|              | 6          | AGCVALUE<6> | 0       |                                           |           |
|              | 7          | AGCVALUE<7> | 0       |                                           |           |
| DATA6 (0x2E) | 0          | MAG<0>      | 0       | Magnitude of magnetic field               |           |
|              | 1          | MAG<1>      | 0       |                                           |           |
|              | 2          | MAG<2>      | 0       |                                           |           |
|              | 3          | MAG<3>      | 0       |                                           |           |
|              | 4          | MAG<4>      | 0       |                                           |           |
|              | 5          | MAG<5>      | 0       |                                           |           |
|              | 6          | MAG<6>      | 0       |                                           |           |
|              | 7          | MAG<7>      | 0       |                                           |           |
| DATA7 (0x2F) | 0          | Not used    | 0       | A read command returns all data bits at 0 |           |
|              | 1          | Not used    | 0       |                                           |           |
|              | 2          | Not used    | 0       |                                           |           |
|              | 3          | Not used    | 0       |                                           |           |
|              | 4          | Not used    | 0       |                                           |           |
|              | 5          | Not used    | 0       |                                           |           |
|              | 6          | Not used    | 0       |                                           |           |
|              | 7          | Not used    | 0       |                                           |           |



## 9.6 Special Registers

Table 15. Special Registers

| Data Byte    | Bit Number | Symbol        | Default | Description                                                                                                                                              |                    |
|--------------|------------|---------------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| DATA0 (0x41) | 0          | AS5261KEY<0>  | 0       | AS5261 KEY<15:0>=0101 0001 0110 0010<br>A write command with data different from AS5261 KEY is not executed<br>A read command returns all data bits at 0 | Fuse Register      |
|              | 1          | AS5261KEY<1>  | 0       |                                                                                                                                                          |                    |
|              | 2          | AS5261KEY<2>  | 0       |                                                                                                                                                          |                    |
|              | 3          | AS5261KEY<3>  | 0       |                                                                                                                                                          |                    |
|              | 4          | AS5261KEY<4>  | 0       |                                                                                                                                                          |                    |
|              | 5          | AS5261KEY<5>  | 0       |                                                                                                                                                          |                    |
|              | 6          | AS5261KEY<6>  | 0       |                                                                                                                                                          |                    |
|              | 7          | AS5261KEY<7>  | 0       |                                                                                                                                                          |                    |
| DATA1 (0x42) | 0          | AS5261KEY<8>  | 0       |                                                                                                                                                          |                    |
|              | 1          | AS5261KEY<9>  | 0       |                                                                                                                                                          |                    |
|              | 2          | AS5261KEY<10> | 0       |                                                                                                                                                          |                    |
|              | 3          | AS5261KEY<11> | 0       |                                                                                                                                                          |                    |
|              | 4          | AS5261KEY<12> | 0       |                                                                                                                                                          |                    |
|              | 5          | AS5261KEY<13> | 0       |                                                                                                                                                          |                    |
|              | 6          | AS5261KEY<14> | 0       |                                                                                                                                                          |                    |
|              | 7          | AS5261KEY<15> | 0       |                                                                                                                                                          |                    |
| DATA0 (0x60) | 0          | AS5261KEY<0>  | 0       | AS5261 KEY<15:0>=0101 0001 0110 0010<br>A write command with data different from AS5261 KEY is not executed<br>A read command returns all data bits at 0 | Pass2Func Register |
|              | 1          | AS5261KEY<1>  | 0       |                                                                                                                                                          |                    |
|              | 2          | AS5261KEY<2>  | 0       |                                                                                                                                                          |                    |
|              | 3          | AS5261KEY<3>  | 0       |                                                                                                                                                          |                    |
|              | 4          | AS5261KEY<4>  | 0       |                                                                                                                                                          |                    |
|              | 5          | AS5261KEY<5>  | 0       |                                                                                                                                                          |                    |
|              | 6          | AS5261KEY<6>  | 0       |                                                                                                                                                          |                    |
|              | 7          | AS5261KEY<7>  | 0       |                                                                                                                                                          |                    |
| DATA1 (0x61) | 0          | AS5261KEY<8>  | 0       |                                                                                                                                                          |                    |
|              | 1          | AS5261KEY<9>  | 0       |                                                                                                                                                          |                    |
|              | 2          | AS5261KEY<10> | 0       |                                                                                                                                                          |                    |
|              | 3          | AS5261KEY<11> | 0       |                                                                                                                                                          |                    |
|              | 4          | AS5261KEY<12> | 0       |                                                                                                                                                          |                    |
|              | 5          | AS5261KEY<13> | 0       |                                                                                                                                                          |                    |
|              | 6          | AS5261KEY<14> | 0       |                                                                                                                                                          |                    |
|              | 7          | AS5261KEY<15> | 0       |                                                                                                                                                          |                    |



## 9.7 Programming Procedure

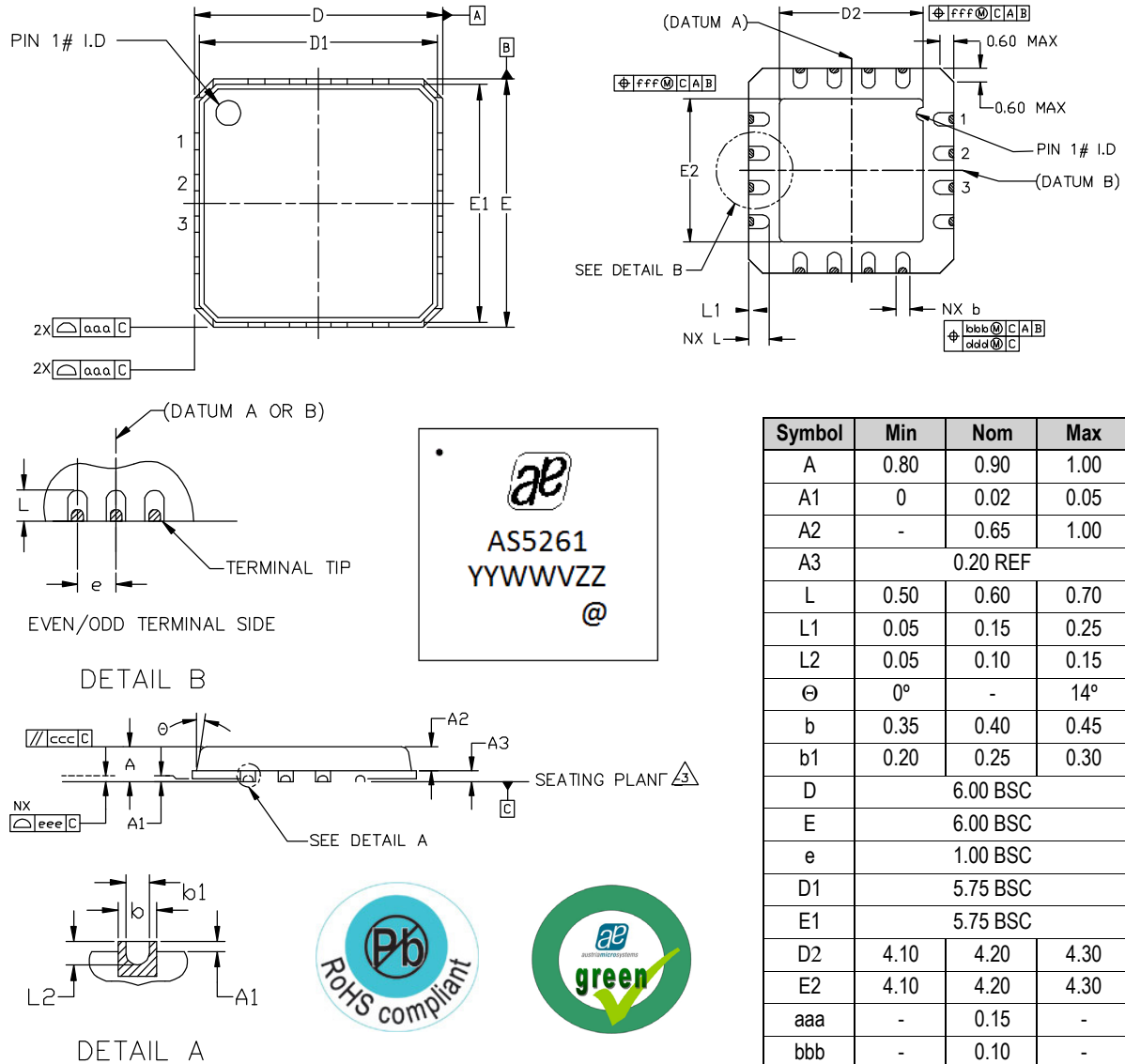
- Pull-up on out pin
- VDD=5V
- Wait 10ms (after the startup time device enters communication mode)
- Write command: Trimming bits are written in the OTP RAM
- Read command: All the trimming bits are read back to check the correctness of the writing procedure.
- Write AS5261KEY in the Fuse register: The OTP RAM content is permanently transferred into the Poly Fuse cells.
- Wait 10 ms (fuse time)
- Write command, R1K\_10K<1:0>=(11)b: Poly Fuse cells are downloaded into the RAM memory using a 10K resistance as reference.
- Wait 5 ms (download time)
- Read R1K\_10K register, the expected value is 00b
- Write command, R1K\_10K<1:0>=(11)b
- Read R1K\_10K register, the expected value is (11)b. NB: Step11 and Step12 have to be consecutive.
- Read command: all the fused bits downloaded with 10K resistance are read back.
- Write command, R1K\_10K=<1:0>=(10)b: Poly Fuse cells are downloaded into the RAM memory using a 1K resistance as reference.
- Wait 5 ms (download time)
- Read R1K\_10K register, the expected value is (00)b
- Write command register, R1K\_10K<1:0>=(10)b
- Read R1K\_10K register, the expected value is (10)b NB: Step18 and Step19 have to be consecutive.
- Read command: All the fused bits downloaded with 1K resistance are read back.
- Check that read commands at Steps 5, 13 and 19 are matching
- Write AS5261 KEY in the Pass2Func register: Device enters normal mode.



## 10 Package Drawings and Markings

The device is available in a *MLF-16* package.

Figure 14. Package Drawings and Dimensions



| Symbol   | Min      | Nom  | Max  |
|----------|----------|------|------|
| A        | 0.80     | 0.90 | 1.00 |
| A1       | 0        | 0.02 | 0.05 |
| A2       | -        | 0.65 | 1.00 |
| A3       | 0.20 REF |      |      |
| L        | 0.50     | 0.60 | 0.70 |
| L1       | 0.05     | 0.15 | 0.25 |
| L2       | 0.05     | 0.10 | 0.15 |
| $\theta$ | 0°       | -    | 14°  |
| b        | 0.35     | 0.40 | 0.45 |
| b1       | 0.20     | 0.25 | 0.30 |
| D        | 6.00 BSC |      |      |
| E        | 6.00 BSC |      |      |
| e        | 1.00 BSC |      |      |
| D1       | 5.75 BSC |      |      |
| E1       | 5.75 BSC |      |      |
| D2       | 4.10     | 4.20 | 4.30 |
| E2       | 4.10     | 4.20 | 4.30 |
| aaa      | -        | 0.15 | -    |
| bbb      | -        | 0.10 | -    |
| ccc      | -        | 0.10 | -    |
| ddd      | -        | 0.05 | -    |
| eee      | -        | 0.08 | -    |
| fff      | -        | 0.10 | -    |
| N        | 16       |      |      |

### Notes:

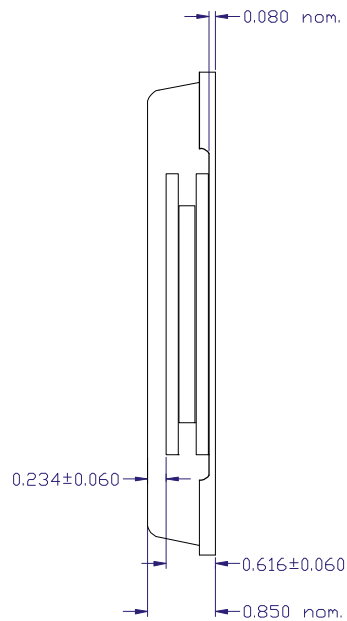
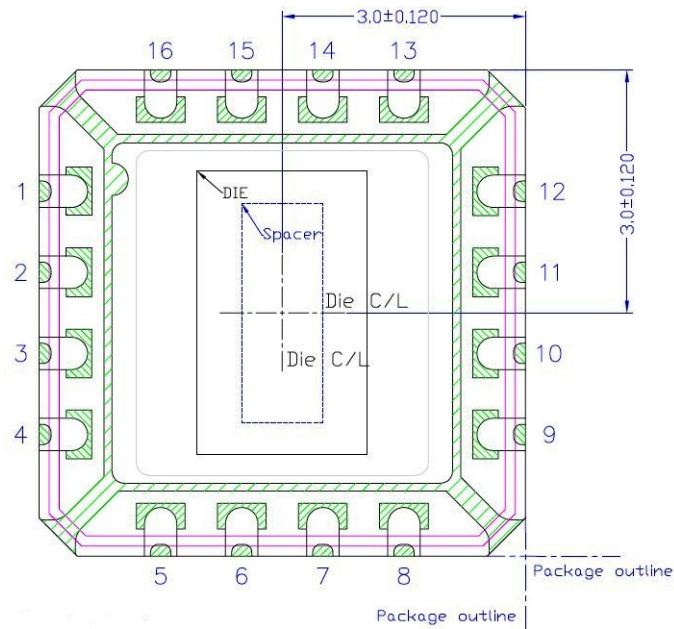
1. Dimensions and tolerancing confirm to ASME Y14.5M-1994.
2. All dimensions are in millimeters. Angles are in degrees.
3. Bilateral coplanarity zone applies to the exposed pad as well as the terminal.
4. Radius on the terminal is optional.
5. N is the total number of terminals.

**Marking: YYWWVZZ.**

| YY   | WW   | V                         | ZZ                         |
|------|------|---------------------------|----------------------------|
| Year | Week | Assembly plant identifier | Assembly traceability code |



Figure 15. Vertical Cross Section of MLF-16

**Notes:**

1. All dimensions in mm.
2. Die thickness  $0.150$  mm nom.
3. Adhesive thickness  $0.011$  mm.
4. Spacer thickness  $0.203$  mm typ.



## Revision History

| Revision | Date         | Owner | Description                                                                                                             |
|----------|--------------|-------|-------------------------------------------------------------------------------------------------------------------------|
| 1.0      | 30 Oct, 2012 | mub   | Initial revision                                                                                                        |
| 1.1      | 31 Oct, 2012 |       | Updated <a href="#">Figure 3</a> , <a href="#">Table 1</a> , <a href="#">Detailed Description</a> and Added Section 9.1 |
|          |              |       |                                                                                                                         |

**Note:** Typos may not be explicitly mentioned under revision history.



## 11 Ordering Information

The device is available as the standard products shown in [Table 16](#).

Table 16. Ordering Information

| Ordering Code | Description                                                          | Delivery Form | Package    |
|---------------|----------------------------------------------------------------------|---------------|------------|
| AS5261-HMFP   | 12-bit programmable redundant angle position sensor with PWM outputs | Tape and Reel | MLF 16 6x6 |

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