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# AS5261

## 12-Bit Automotive Angle Position Sensor

### General Description

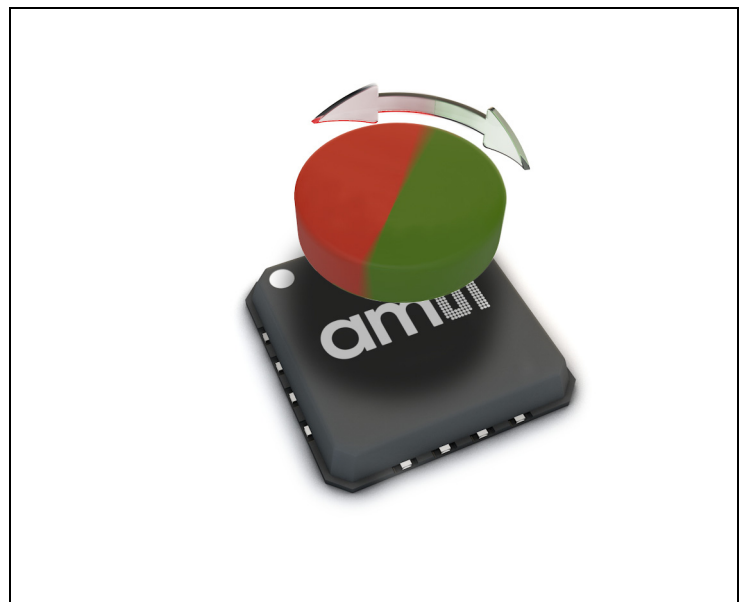
The AS5261 is a contactless magnetic angle position sensor for accurate angular measurement over a full turn of 360°. A sub range can be programmed to achieve the best resolution for the application. It is a system-on-chip, combining integrated Hall elements, analog front end, digital signal processing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



*Ordering Information and Content Guide appear at end of datasheet.*

## Key Benefits & Features

The benefits and features of AS5261, 12-Bit Automatic Angle Position Sensor are listed below:

**Figure 2:**  
**Added Value of Using AS5261**

Benefits	Features
<ul style="list-style-type: none"> <li>• Great flexibility on angular excursion</li> </ul>	<ul style="list-style-type: none"> <li>• 360° contactless high resolution angular position sensing</li> </ul>
<ul style="list-style-type: none"> <li>• Simple programming</li> </ul>	<ul style="list-style-type: none"> <li>• User programmable start and end point of the application region</li> <li>• Saw tooth mode 1-4 slopes per revolution</li> <li>• Clamping levels</li> <li>• Transition point</li> </ul>
<ul style="list-style-type: none"> <li>• Failure diagnostics</li> </ul>	<ul style="list-style-type: none"> <li>• Broken GND and VDD detection for all external load cases</li> </ul>
<ul style="list-style-type: none"> <li>• High-Resolution output signal</li> </ul>	<ul style="list-style-type: none"> <li>• 12-Bit pulse width modulated (PWM) output</li> </ul>
<ul style="list-style-type: none"> <li>• Ideal for applications in harsh environments due to contactless position sensing</li> </ul>	<ul style="list-style-type: none"> <li>• Wide temperature range: - 40°C to 150°C</li> </ul>
<ul style="list-style-type: none"> <li>• Stacked die redundant approach</li> </ul>	<ul style="list-style-type: none"> <li>• Small Pb-free package: MLF 16 6x6 (with dimple)</li> </ul>

## Applications

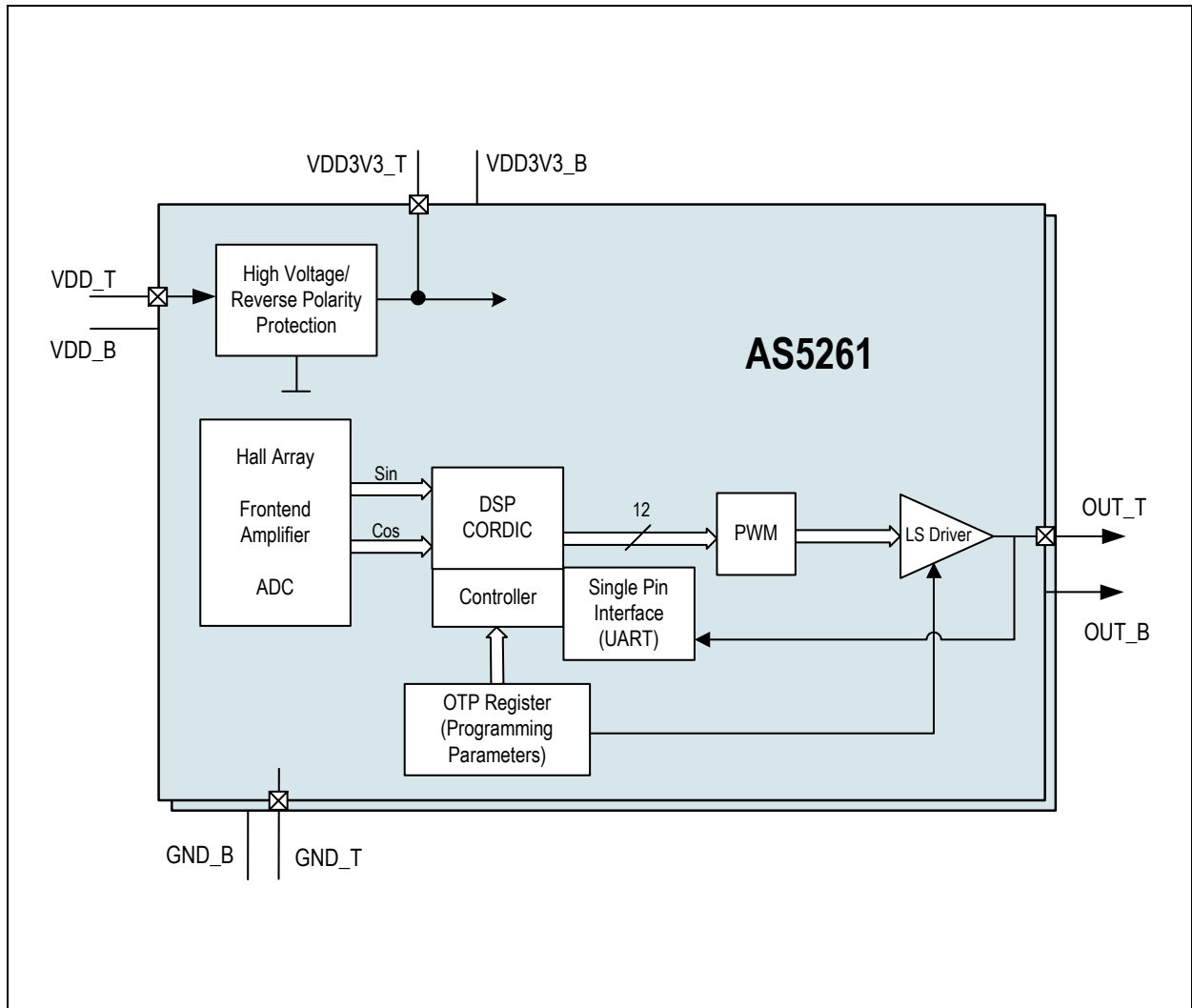
The AS5261 is ideal for automotive applications like:

- Throttle and valve position sensing
- Gearbox position sensor
- Pedal position sensing
- Contactless potentiometers

### Block Diagram

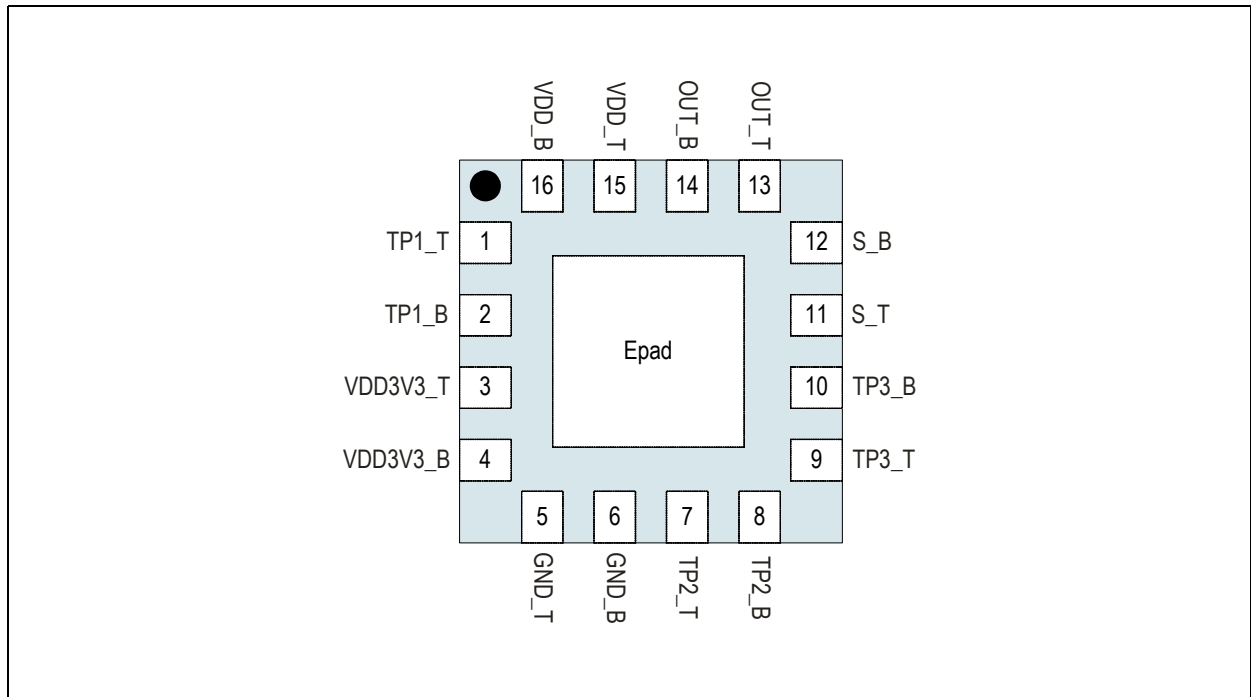
The functional blocks of this device are shown below:

**Figure 3:**  
**AS5261 Block Diagram**



## Pin Assignment

Figure 4:  
MLF-16 Pin Configuration (Top View)



## Pin Description

Figure 5:  
MLF-16 Pin Description

Pin Number	Pin Name	Pin Type	Description
1	TP1_T	DIO/AIO 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.



Pin Number	Pin Name	Pin Type	Description
7	TP2_T	DIO/AIO 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. (special case for the connection possible → 4-wire mode)
12	S_B		Test pin for fabrication. Connected to OUT_B in the application. (special case for the connection possible → 4-wire mode)
13	OUT_T	Digital output/Digital 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.

## Absolute Maximum Ratings

Stresses beyond those listed in [Absolute Maximum Ratings](#) 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](#) is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

**Figure 6:**  
Absolute Maximum Ratings

Symbol	Parameter	Min	Max	Units	Comments
<b>Electrical Parameters</b>					
$V_{DD}$	DC supply voltage at pin VDD Overvoltage	-20	20	V	No operation
$V_{OUT}$	Output voltage OUT	-0.3	20	V	Permanent
$V_{DD3V3}$	DC supply voltage at pin $V_{DD3V3}$	-0.3	5	V	
$I_{scr}$	Input current (latchup immunity)	-100	100	mA	Norm: AEC-Q100-004
<b>Electrostatic Discharge</b>					
ESD	Electrostatic discharge	$\pm 2$		kV	Norm: AEC-Q100-002
<b>Temperature Ranges and Storage Conditions</b>					
$T_{Strg}$	Storage temperature	-55	150	°C	Min -67°F; Max 257°F
$T_{Body}$	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).
$RH_{NC}$	Relative humidity non-condensing	5	85	%	
MSL	Moisture Sensitivity Level	3			Represents a maximum floor life time of 168h

## Electrical Characteristics

### 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.

**Figure 7:**  
Operating Conditions

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$T_{AMB}$	Ambient temperature	-40°F to 302°F	-40		150	°C
$I_{supp}$	Supply current	Only for one die. Must be multiplied by 2			10	mA
$V_{DD}$	Supply voltage at pin VDD		4.5	5.0	5.5	V

### Magnetic Input Specification

$T_{AMB} = -40^{\circ}\text{C}$  to  $150^{\circ}\text{C}$ ,  $V_{DD} = 4.5\text{V}$  to  $5.5\text{V}$  (5V operation), unless otherwise noted.

**Two-Pole Cylindrical Diametrically Magnetized Source**

**Figure 8:**  
Magnetic Input Specification

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$B_{pk}$	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
$B_{pkext}$	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
$B_{off}$	Magnetic offset	Constant magnetic stray field			$\pm 5$	mT
$D_{isp}$	Displacement radius	Offset between defined device center and magnet axis. Dependent on the selected magnet. Including Eccentricity		1		mm



### Electrical System Specifications

$T_{AMB} = -40^{\circ}\text{C}$  to  $150^{\circ}\text{C}$ ,  $V_{DD} = 4.5\text{V} - 5.5\text{V}$  (5V operation), [Magnetic Input Specification](#), unless otherwise noted.

**Figure 9:**  
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 absolute output: delay of ADC, DSP and absolute interface				300	µs

### Timing Characteristics

**Figure 10:**  
Timing Conditions

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

## 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.

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.

## Operation

### **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.

### **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 20V 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 [Figure 18](#)).

### **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.

**Figure 11:**  
**Programming 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°)

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.

**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 12:**  
Programming of an Individual Application Range

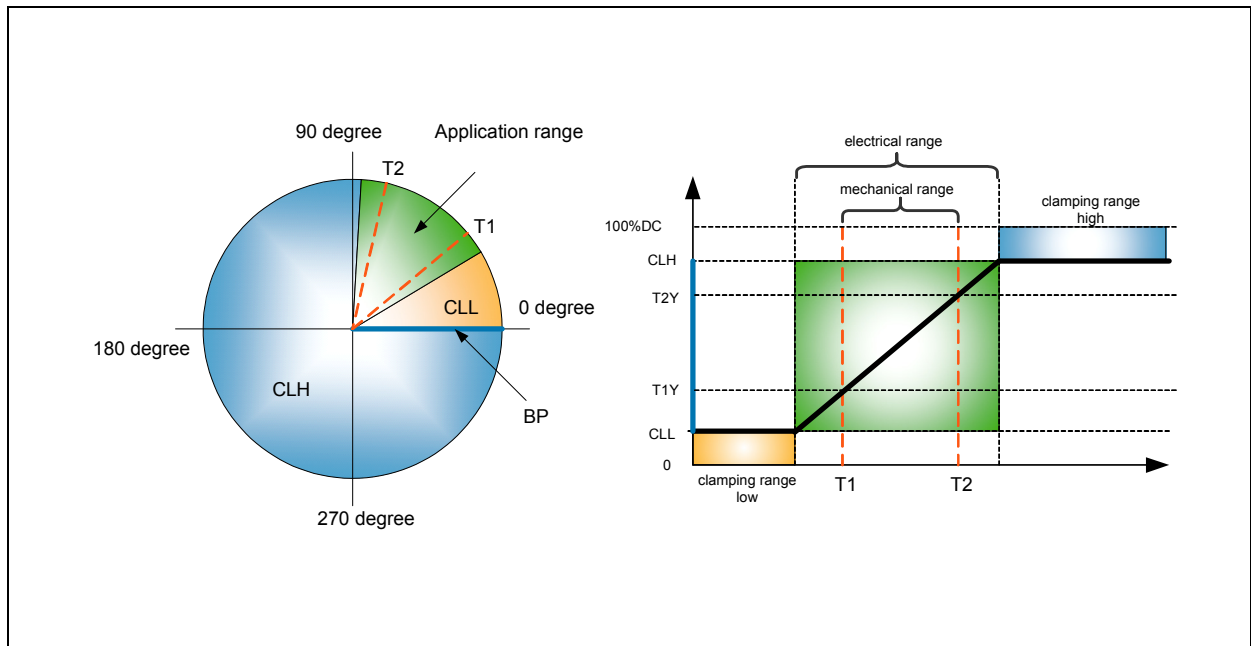
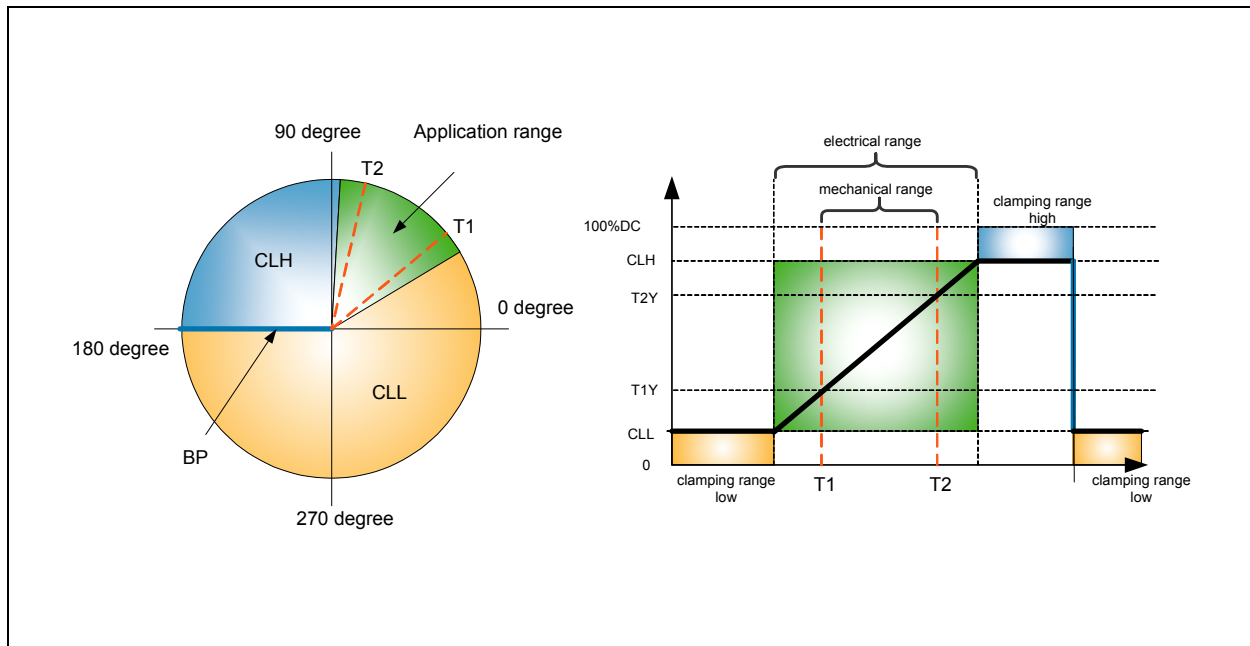


Figure 12 shows a simple example of the selection of the range. The mechanical starting point **T1** and the mechanical end point **T2** are defining the mechanical range. A sub range of the internal CORDIC output range is used and mapped to the needed output characteristic. The PWM output signal has 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°.

### 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 13:**  
Individual Programming of the Break Point BP

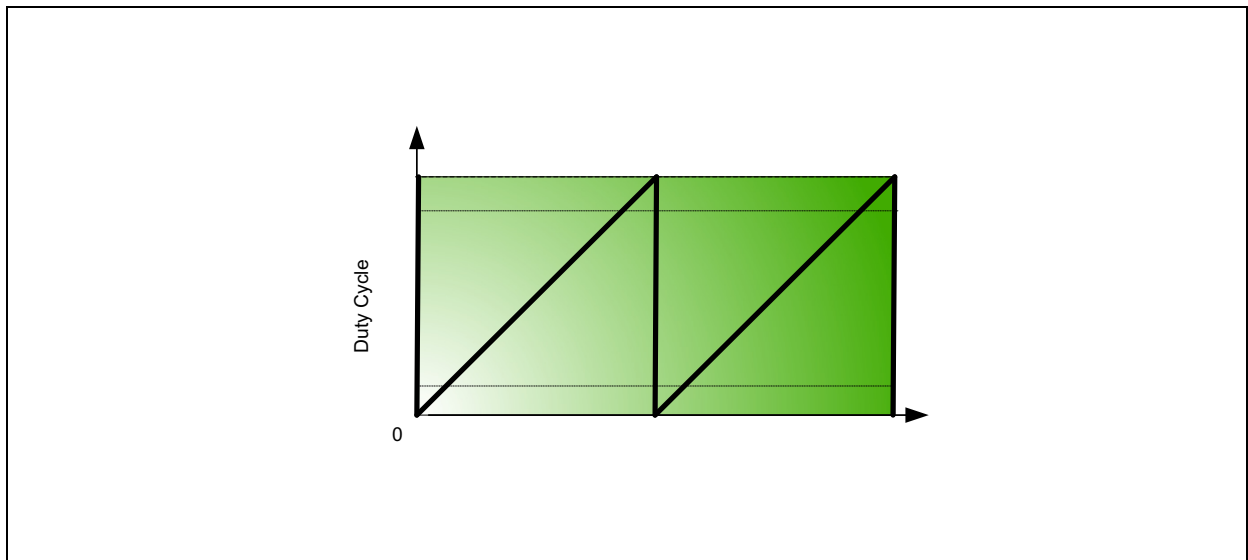




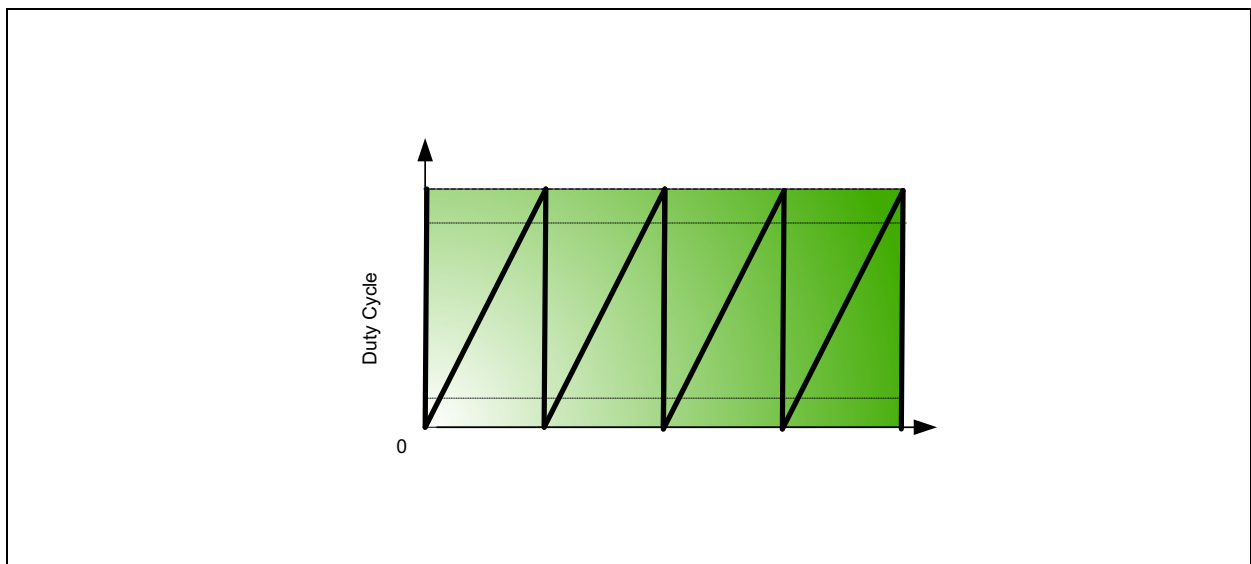
**Multiple Slope Output**

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 14:**  
**Two Slope Mode**



**Figure 15:**  
**Four Slope Mode**



**Resolution of Parameters**

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

**Figure 16:**  
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	

**Figure 17:**  
Overview of the Output Range

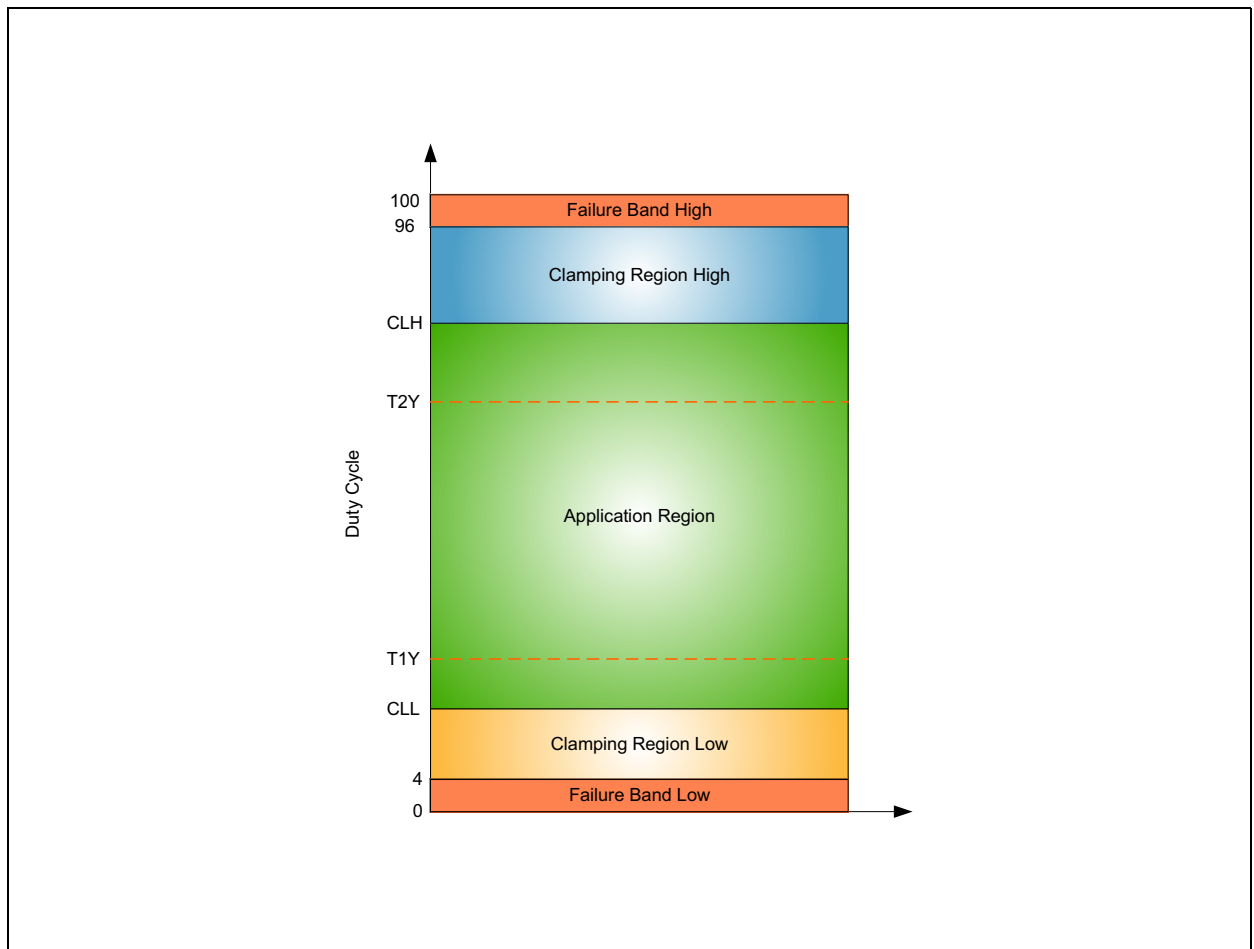


Figure 17 gives an overview about the different ranges. The failure bands are used to indicate a wrong operation of the AS5261. This can be caused due to a broken supply line. By using the specified load resistors the output level will remain in these bands during a fail. It is recommended to set the clamping level **CLL** above the lower failure band and the clamping level **CLH** below the higher failure band.

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

**Figure 18:**  
Different Failure Cases of AS5261

Type	Failure Mode	Symbol	Failure Band	Note
Internal alarms (failures)	Out of magnetic range (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 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**.

**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>**.

## 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>**.

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

**Figure 19:**  
PWM Parameters Output Driver

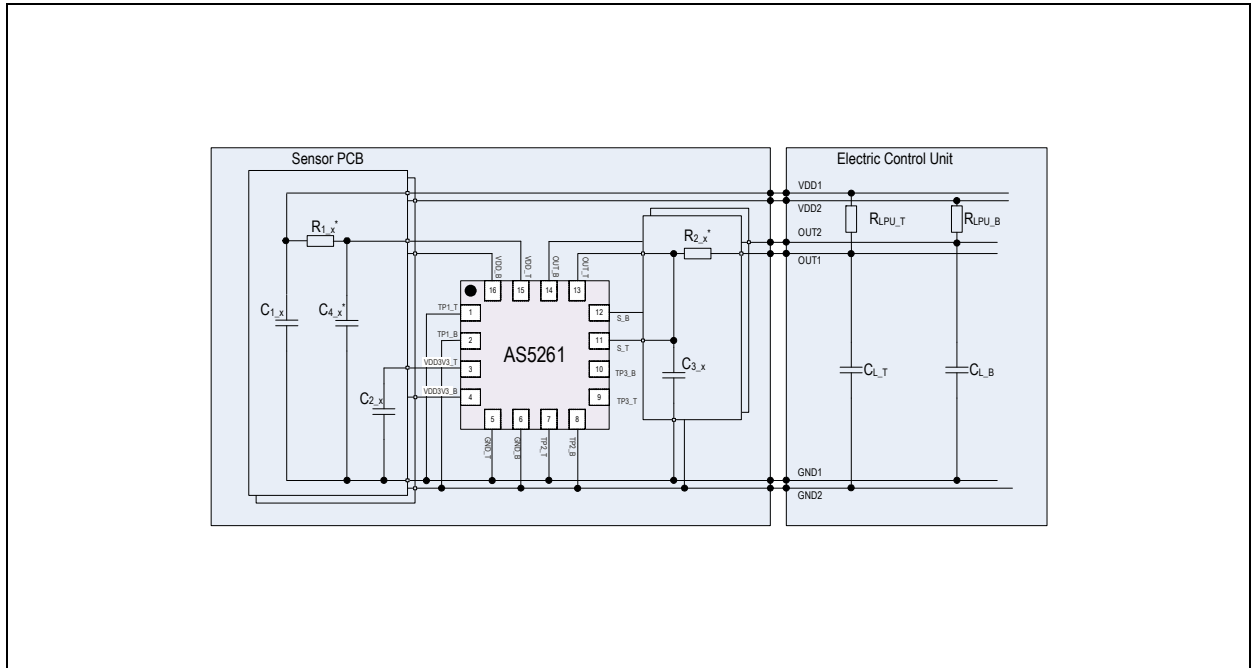
Symbol	Parameter	Conditions	Min	Typ	Max	Units
PWMF1	PWM frequency 7	PWMF<2:0>=111	109.86	122	134.28	Hz
PWMF2	PWM frequency 6	PWMF<2:0>=110	179.78	200	219.73	Hz
PWMF3	PWM frequency 5	PWMF<2:0>=101	219.73	244	268.55	Hz
PWMF4	PWM frequency 4	PWMF<2:0>=100	329.59	366	402.83	Hz
PWMF5	PWM frequency 3	PWMF<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	IOUT=5mA	0		0.4	V
PWMSRF	PWM slew rate (falling edge)	Between 75% and 25% RPUOUT=4K $\Omega$ ; CLOUT=1nF VDD=5V	1	2	4	V / $\mu\text{s}$

## Application Information

### Recommended Application Schematic

Figure 20 shows the recommended schematic in the application. All components marked with (\*) are optional and can be used to further increase the EMC.

**Figure 20:**  
Recommended Schematic of Pull-Up Configuration



**Figure 21:**  
External Components

Symbol	Parameter	Min	Typ	Max	Units	Note
$C_1$	VDD buffer capacitor	0.8	1	1.2	$\mu\text{F}$	Low ESR 0.3 $\Omega$
$C_2$	VDD3V3 regulator capacitor	0.8	1	1.2	$\mu\text{F}$	Low ESR 0.3 $\Omega$
$C_3$	OUT load capacitor (sensor PCB)	0		4.7	nF	
$C_4^*$	VDD capacitor (optional)		4.7		nF	Do not increase due to programming over output.
$R_1^*$	VDD serial resistor (optional)		10		$\Omega$	
$C_L$	OUT load capacitor (ECU)	0		33	nF	
$R_2^*$	OUT serial resistor (optional)		50		$\Omega$	
$R_{LPU}$	OUT pull-up resistance	4		10	k $\Omega$	

## **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.

### ***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.



### 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.

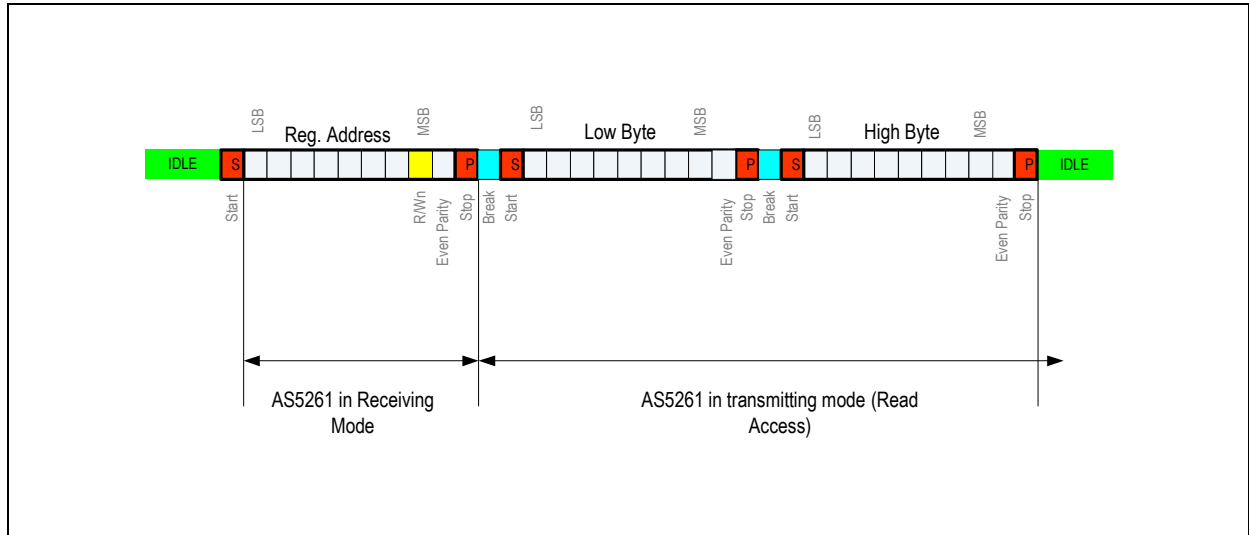
**Figure 22:**  
OTP Commands and Communication

Possible Interface Commands	Address / Command	AS5X63 Communication Mode	Description
WRITE	0x00-0x0F (OTP) 0x10-0x1F (SFR) 0x20-0xFF (Special Mode)	SLAVE	Write related to the address the user data
READ	0x00-0x0F (OTP) 0x10-0x1F (SFR) 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

### READ

Figure 23 shows the format of the frame.

**Figure 23:**  
Organization of the READ Command



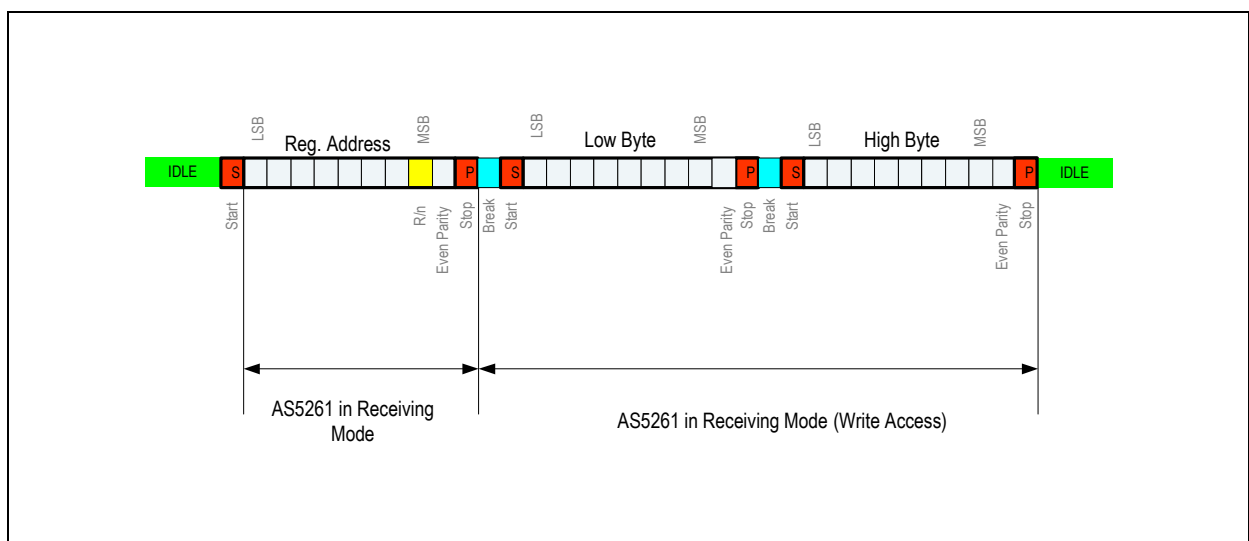
The R/Wn bit in the first byte selects the mode. Between the data packets is always a break state. The break state has the same length as the other data bits.

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

### WRITE

Figure 24 shows the format of the frame.

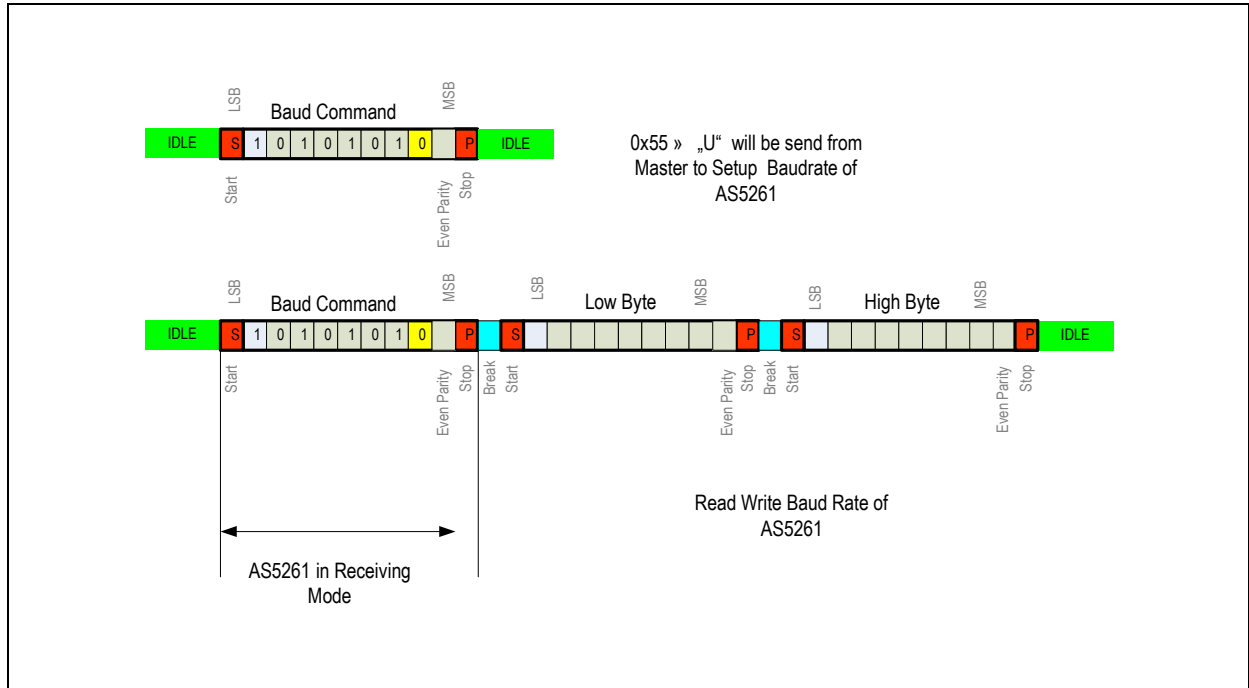
**Figure 24:**  
Organization of the WRITE Command



**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 25:**  
**Baud Rate Setup**



### OTP Programming Data

**Figure 26:**  
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	Factory Settings	0	ams (reserved)	Factory Settings
	1		0		
	2		0		
	3		0		
	4		0		
	5		0		
	6		0		
	7		0		
DATA13 (0x0D)	0	Factory Settings	0	ams (reserved)	Factory Settings
	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		

Data Byte	Bit Number	Symbol	Default	Description	
DATA11 (0x0B)	7	CLH<0>	0	Clamping Level High	Customer Settings
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		

Data Byte	Bit Number	Symbol	Default	Description	
DATA9 (0x09)	0	CLL<0>	0	Clamping Level Low	<b>Customer Settings</b>
	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		
	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	Offset	
	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		