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AS5263

12-Bit Redundant Automotive Angle Position Sensor

General Description

The AS5263 is a contactless magnetic angle position sensor for accurate angular measurement over a full turn of 360º. A sub range can be programmed to achieve the best resolution for the application. The AS5263 includes two AS5163 in one MLF package.

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 0.087º = 4096 positions per revolution. The start and end point of the sub segment will be programmed with a resolution of 14-bit (0.022º= 16384 steps 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 signal or 12-bit ratiometric analog output.

An internal voltage regulator with over voltage protection and reverse polarity protection allows the AS5263 to operate in automotive application up to a voltage to 27V. Programmability over the output pin reduces the number of pins on the application connector. The AS5263 is the ideal solution for safety critical applications due to the redundant approach.

Ordering Information and Content Guide appear at end of datasheet.

Key Benefits & Features

The benefits and features of AS5263, 12-Bit Redundant Automotive Angle Position Sensor are listed below:

Figure 1:
Added Value of Using AS5263

Benefits	Features
• Great flexibility on angular excursion	• 360º contactless high resolution angular position sensing
• Simple programming	• User programmable start and end point of the application region • Saw tooth mode 1-4 slopes per revolution • Clamping levels • Transition point
• Failure diagnostics	• Broken GND and VDD detection for all external load cases
• Selectable output signal	• Analog output ratiometric to VDD or PWM-encoded digital output
• Ideal for applications in harsh environments due to contactless position sensing	• Wide temperature range: - 40°C to 150°C
• Stacked die redundant approach	• 32-pin MLF (7x7mm) dimple package

Applications

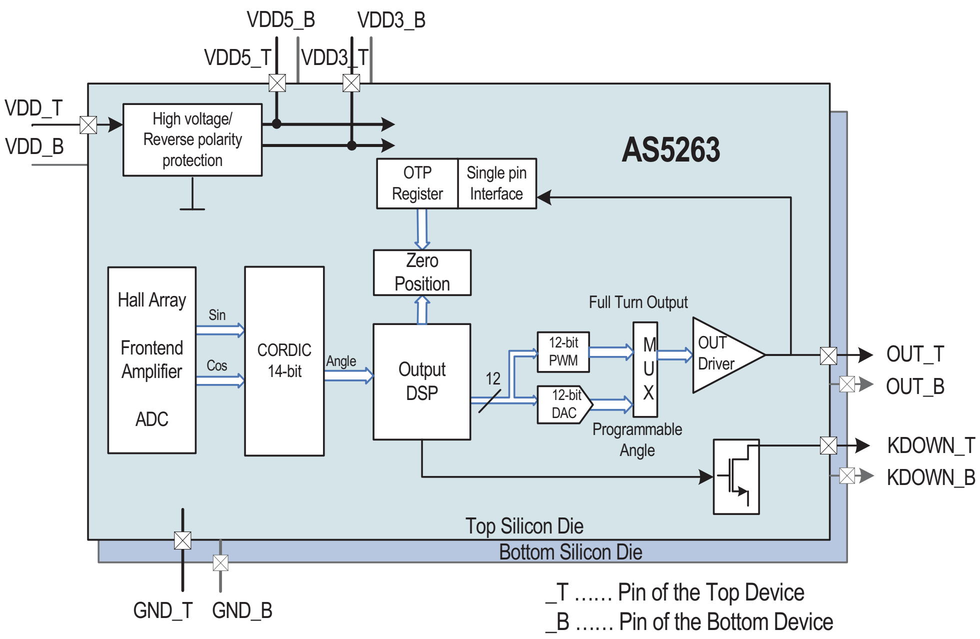
AS5263 is ideal for automotive applications like:

- Transmission gearbox position sensor
- Headlight position control
- Torque sensing
- Valve position sensing
- Pedal position sensing
- Throttle position sensing
- Non-contact potentiometers

Block Diagram

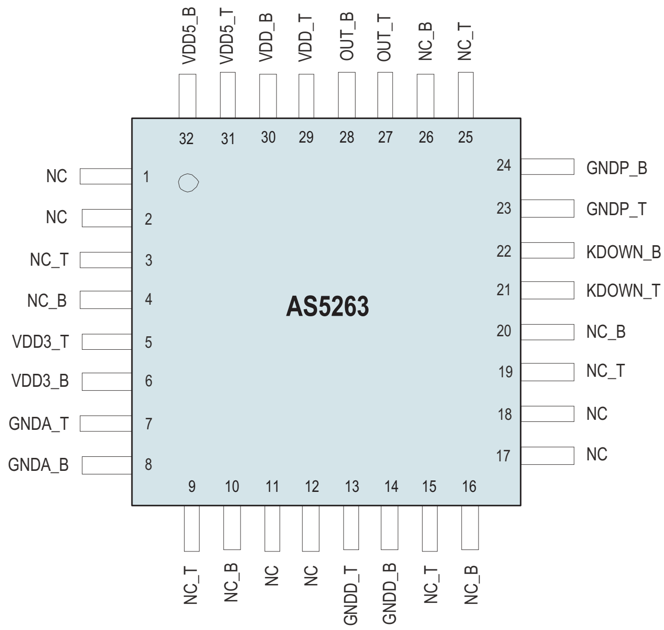
The functional blocks of this device are shown below:

Figure 2:
AS5263 Block Diagram



Pin Assignment

Figure 3:
Pin Diagram (Top View)



Pin Description

Figure 4 provides the description of each pin of the standard 32-pin MLF (7x7mm) Dimple package. It is recommended to keep the electrical separation as well on the printed circuit board (PCB) in the application (see Figure 4).

Figure 4:
Pin Descriptions

Pin Number	Pin Name	Pin Type	Description
1	NC	-	Not bonded
2	NC	-	Not bonded
3	NC_T	DIO/AIO multi purpose pin	**Test pin for fabrication.** Connected to top ground in the application.
4	NC_B		**Test pin for fabrication.** Connected to bottom ground in the application.

Pin Number	Pin Name	Pin Type	Description
5	VDD3_T	Supply pin	**3.45V- Regulator output, internally regulated from VDD5.** This pin needs an external ceramic capacitor of 2.2µF. Connect second terminal of capacitor to GND intended for the top die.
6	VDD3_B		**3.45V- Regulator output, internally regulated from VDD5.** This pin needs an external ceramic capacitor of 2.2µF. Connect second terminal of capacitor to GND intended for the bottom die.
7	GNDA_T		**Analog ground pin.** Connected to GND for the top die in the application.
8	GNDA_B		**Analog ground pin.** Connected to GND intended for the bottom die in the application.
9	NC_T	DIO/AIO multi purpose pin	**Test pin for fabrication.** Connected to GND intended for the top die in the application.
10	NC_B		**Test pin for fabrication.** Connected to GND intended for the bottom die in the application.
11	NC		**Test pin for fabrication.** Open in the application.
12	NC		**Test pin for fabrication.** Open in the application.
13	GNDD_T	Supply pin	**Digital ground pin.** Connected to GND intended for the top die in the application.
14	GNDD_B		**Digital ground pin.** Connected to GND intended for the bottom die in the application.
15	NC_T	DIO/AIO multi purpose pin	**Test pin for fabrication.** Connected to GND intended for the top die in the application.
16	NC_B		**Test pin for fabrication.** Connected to GND intended for the bottom die in the application.
17	NC	-	Not bonded
18	NC	-	Not bonded
19	NC_T	DIO/AIO multi purpose pin	**Test pin for fabrication.** Connected to GND intended for the top die in the application.
20	NC_B		**Test pin for fabrication.** Connected to GND intended for the bottom die in the application.
21	KDOWN_T	Digital output open drain	**Kick down functionality.** Open drain user pull-up resistor connected to the intended VDD top supply.
22	KDOWN_B		**Kick down functionality.** Open drain user pull-up resistor connected to the intended VDD bottom supply.

Pin Number	Pin Name	Pin Type	Description
23	GNDP_T	Supply pin	**Analog ground pin.** Connected to GND for the top die in the application.
24	GNDP_B		**Analog ground pin.** Connected to GND intended for the bottom die in the application.
25	NC_T	DIO/AIO multi purpose pin	**Test pin for fabrication.** Connected to GND intended for the top die in the application.
26	NC_B		**Test pin for fabrication.** Connected to GND intended for the bottom die in the application.
27	OUT_T		**Output pin.** Can be programmed as analog output or PWM output. Over this pin the programming of the top die is possible.
28	OUT_B		**Output pin.** Can be programmed as analog output or PWM output. Over this pin the programming of the bottom die is possible.
29	VDD_T	Supply pin	**Positive supply pin.** This pin is over voltage protected.
30	VDD_B		**Positive supply pin.** This pin is over voltage protected.
31	VDD5_T		**4.5V- Regulator output, internally regulated from VDD.** This pin needs an external ceramic capacitor of 2.2µF. Connect second terminal of capacitor to GND intended for the top die.
32	VDD5_B		**4.5V- Regulator output, internally regulated from VDD.** This pin needs an external ceramic capacitor of 2.2µF. Connect second terminal of capacitor to GND intended for the bottom die.

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 5:
Absolute Maximum Ratings

Symbol	Parameter	Min	Max	Units	Comments
Electrical Parameters					
V_{DD}	DC supply voltage at pin VDD Overvoltage	-18	27	V	No operation
V_{OUT}	Output voltage OUT	-0.3	27	V	Permanent
V_{KDOWN}	Output voltage KDOWN	-0.3	27	V	
VDD3	DC supply voltage at pin VDD3	-0.3	5	V	
VDD5	DC supply voltage at pin VDD5	-0.3	7	V	
I_{scr}	Input current (latchup immunity)	-100	100	mA	JEDEC 78
Electrostatic Discharge					
ESD	Electrostatic discharge	±4		kV	MIL 883 E method 3015 This value is applicable to pins VDD, GND, OUT, and KDOWN. All other pins ±2 kV.
Temperature Ranges and Storage Conditions					
T_{Strg}	Storage temperature	-55	150	ºC	Min -67ºF; Max 302ºF
T_{Body}	Body temperature (lead-free package)		260	ºC	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.

T_{AMB} = -40°C to 150°C, V_{DD} = +4.5V to +5.5V, C_{LREG5} = 2.2µF, C_{LREG3} = 2.2µF, R_{PU} = 1KΩ, R_{PD} = 1KΩ to 5.6KΩ, (Analog only), C_{LOAD} =0 to 42nF, R_{PUKDWN} = 1KΩ to 5.6KΩ, C_{LOAD_KDWN} = 0 to 42nF, unless otherwise specified. A positive current is intended to flow into the pin.

Figure 6:
Operating Conditions

Symbol	Parameter	Condition	Min	Typ	Max	Units
T_{AMB}	Ambient temperature	-40ºF to 302ºF	-40		150	ºC
I_{supp}	Supply current	Lowest magnetic input field			20	mA

Magnetic Input Specification

T_{AMB} = -40ºC to 150ºC, V_{DD} = 4.5V to 5.5V (5V operation), unless otherwise noted.

Two-Pole Cylindrical Diametrically Magnetized Source

Figure 7:
Magnetic Input Specification

Symbol	Parameter	Condition	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 1.1mm	30		70	mT
B_{off}	Magnetic offset	Constant magnetic stray field			±10	mT
	Field non-linearity	Including offset gradient			5	%

Electrical System Specifications

T_{AMB} = -40°C to 150°C, V_{DD} = 4.5V to 5.5V (5V operation), Magnetic Input Specification, unless otherwise noted.

Figure 8:
Electrical System Specifications

Symbol	Parameter	Conditions	Min	Typ	Max	Units
RES	Resolution Analog and PWM Output	Angular operating range ≥ 90°C			12	bit
INL_{opt}	Integral non-linearity (optimum) 360 degree full turn	Maximum error with respect to the best line fit. Centered magnet without calibration, T_{AMB}=25°C			±0.5	deg
INL_{temp}	Integral non-linearity (optimum) 360 degree full turn	Maximum error with respect to the best line fit. Centered magnet without calibration, T_{AMB} = -40°C to 150°C			±0.9	deg
INL	Integral non-linearity 360 degree full turn	Best line fit = $(Err_{max} – Err_{min})/2$ Over displacement tolerance with 6mm diameter magnet, without calibration, T_{AMB} = -40°C to 150°C (1)		±1.4		deg
TN	Transition noise	1 sigma (2)		0.06		deg RMS
$VDD5_{LowTH}$	Undervoltage lower threshold	VDD5 = 5V	3.1	3.4	3.7	V
$VDD5_{HighTH}$	Undervoltage higher threshold	VDD5 = 5V	3.6	3.9	4.2	V
t_{PwrUp}	Power-up time	Fast mode, times 2 in slow mode			10	ms
t_{delay}	System propagation delay absolute output: delay of ADC, DSP and absolute interface	Fast mode, times 2 in slow mode			100	µs

Note(s):

1. This parameter is a system parameter and is dependant on the selected magnet.
2. The noise performance is dependent on the programming of the output characteristic.
3. The INL performance is specified over the full turn of 360 degrees. An operation in an angle segment increases the accuracy.

Timing Characteristics

Figure 9:
Timing Conditions

Symbol	Parameter	Conditions	Min	Typ	Max	Units
FRCOT	Internal Master Clock		4.05	4.5	4.95	MHz
TCLK	Interface Clock Time	TCLK = 1/ FRCOT	202	222.2	247	ns
TDETWD	WatchDog error detection time				12	ms

Detailed Description

The AS5263 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.

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 AS5263 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 (see Figure 46).

The AS5263 senses the orientation of the magnetic field and calculates a 14-bit binary code. This code is mapped to a programmable output characteristic. The type of output is programmable and can be selected as PWM or analog output. This signal is available at the pins 27, 28 **(OUT_T, OUT_B)**.

The analog output and PWM output can be configured in many ways. The application angular region can be programmed in a user friendly way. The starting angle **T1** and the end point **T2** can be set and programmed according to 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 to the application. The transition point 0 to 360 degree can be shifted using the break point parameter **BP**. This point is programmable with a high resolution of 14 bits of 360 degrees. The voltage for clamping level low **CLL** and clamping level high **CLH** can be programmed with a resolution of 7 bits. Both levels are individually adjustable.

These parameters are also used to adjust the PWM duty cycle.

The AS5263 also provides a compare function. The internal angular code is compared to a programmable level using hysteresis. The function is available over the output pins 21, 22 (**KDOWN_T, KDOWN_B**).

The output parameters can be programmed in an OTP register. No additional voltage is required to program the AS5263. 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. Else, the content could be frozen for ever.

The AS5263 is tolerant to magnet misalignment and unwanted external magnetic fields due to differential measurement technique and Hall sensor conditioning circuitry.

It is also tolerant to air gap and temperature variations due to Sin-/Cos- signal evaluation.

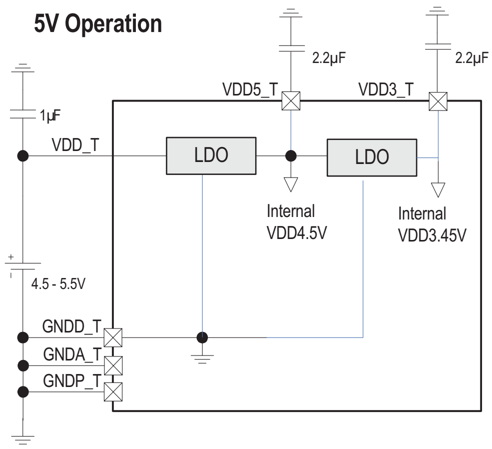
The AS5263 is tolerant to magnet misalignment and magnetic stray fields due to differential measurement technique and Hall sensor conditioning circuitry.

Operation

The AS5263 operates at 5V ±10%, using two internal Low-Dropout (LDO) voltage regulators. For operation, the 5V supply is connected to pin **VDD**. While **VDD3** and **VDD5** (LDO outputs) must be buffered by 2.2µF capacitors, the VDD requires a 1µF capacitor. All capacitors (low ESR ceramic) are supposed to be placed close to the supply pins (see Figure 10).

The **VDD3** and **VDD5** outputs are intended for internal use only. It must not be loaded with an external load.

Figure 10:
External Circuitry for the AS5263 (Figure Shows Only One Sensor Die)



Note(s):

1. The pins VDD3 and VDD5 must always be buffered by a capacitor. These pins must not be left floating, as this may cause unstable internal supply voltages, which may lead to larger output jitter of the measured angle
2. Only VDD is overvoltage protected up to 27V. In addition, the VDD has a reverse polarity protection.

VDD Voltage Monitor

VDD Overvoltage Management

If the voltage applied to the VDD pin exceeds the overvoltage upper threshold for longer than the detection time, then the device enters a low power mode reducing the power consumption. When the overvoltage event has passed and the voltage applied to the VDD pin falls below the overvoltage lower threshold for longer than the recovery time, then the device enters the normal mode.

VDD5 Undervoltage Management.

When the voltage applied to the VDD5 pin falls below the undervoltage lower threshold for longer than the VDD5_ detection time, then the device stops the clock of the digital part and the output drivers are turned OFF to reduce the power consumption. When the voltage applied to the VDD5 pin exceeds the VDD5 undervoltage upper threshold for longer than the VDD5_recovery time, then the clock is restarted and the output drivers are turned ON.

Analog Output

The reference voltage for the Digital-to-Analog converter (DAC) is taken internally from **VDD**. In this mode, the output voltage is ratiometric to the supply voltage.

Programming Parameters

The Analog output voltage modes are programmable by OTP. Depending on the application, the analog 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	Voltage level at the T1 position
T2Y	Voltage level at the T2 position
CLL	Clamping level low
CLH	Clamping level high
BP	Break point (transition point 0 to 360 degree)

The above listed parameters are input parameters. Over the provided programming software and programmer, these parameters are converted and finally written into the AS5263 128-bit OTP memory. More details about the conversion can be found in the AN_AS5163+AS5263_V1.0 application note.

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 AS5263. The internal gain factor is calculated automatically. 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

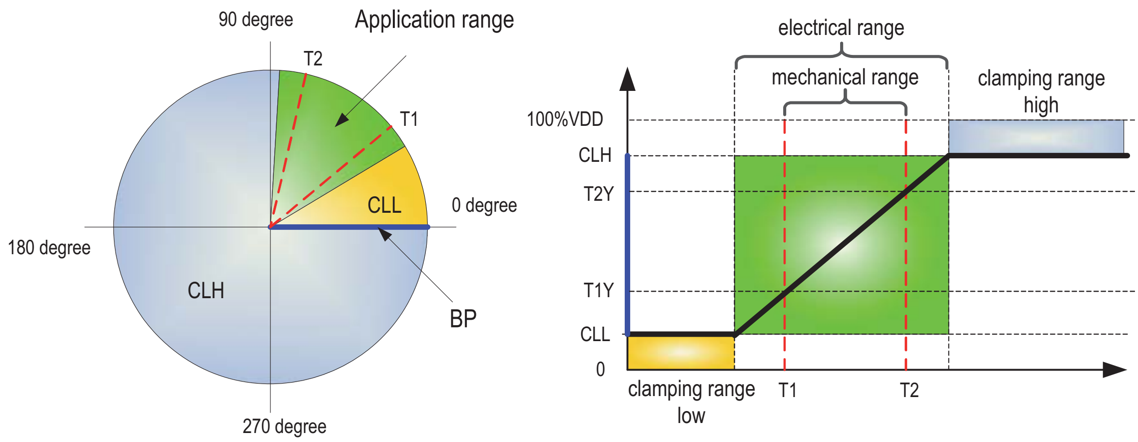
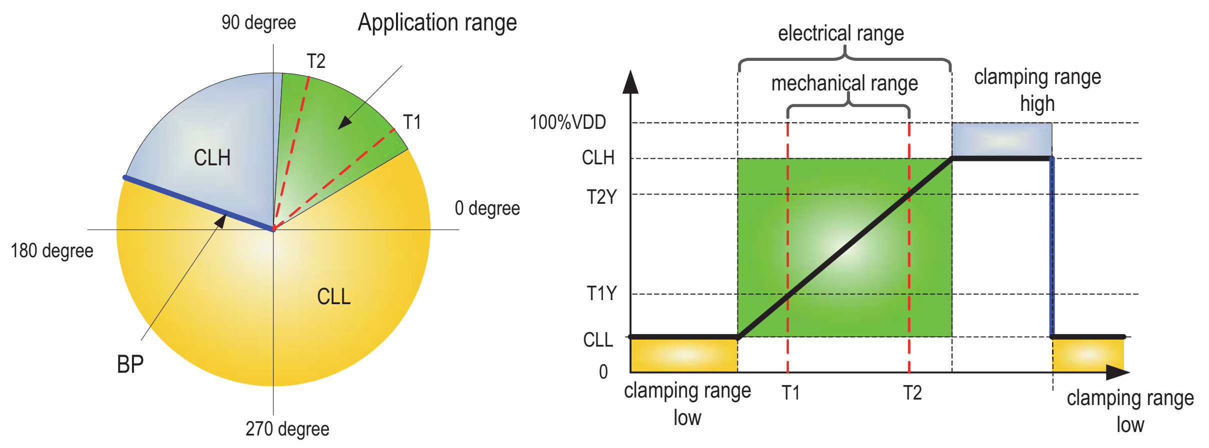


Figure 12 shows a simple example of the selection of the range. The mechanical starting point **T1** and the mechanical end point **T2** define the mechanical range. A sub range of the internal CORDIC output range is used and mapped to the needed output characteristic. The analog output signal has 12 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 degree. 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 form each other. The minimum application range is 12 degrees.

Application Specific Programming of the Break Point

The break point **BP** can be programmed as well with a resolution of 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. The function can be used also for an ON-OFF indication.

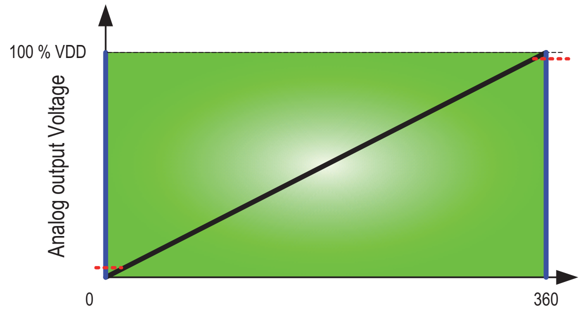
Figure 13:
Individual Programming of the Break Point BP



Full Scale Mode

The AS5263 can be programmed as well in the full scale mode. The **BP** parameter defines the position of the transition.

Figure 14:
Full Scale Mode

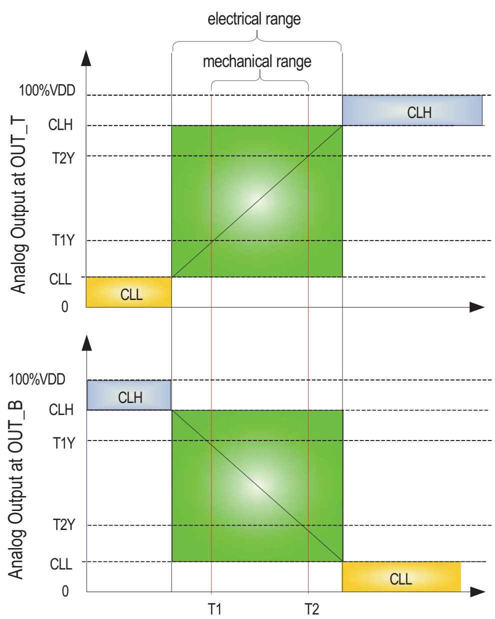


For simplification, Figure 14 describes a linear output voltage from rail to rail (0V to VDD) over the complete rotation range. In practice, this is not feasible due to saturation effects of the output stage transistors. The actual curve will be rounded towards the supply rails (as indicated Figure 14).

Inverted Dual Channel Output

The AS5263 can be programmed as described in Figure 15.

Figure 15:
Inverted Slope Output



Resolution of the 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	7 bits	4096 LSBs is the maximum level
CLH	Clamping level high	7 bits	31 LSBs is the minimum level
BP	Break point	14 bits	

Figure 17:
Overview of the Angular Output Voltage

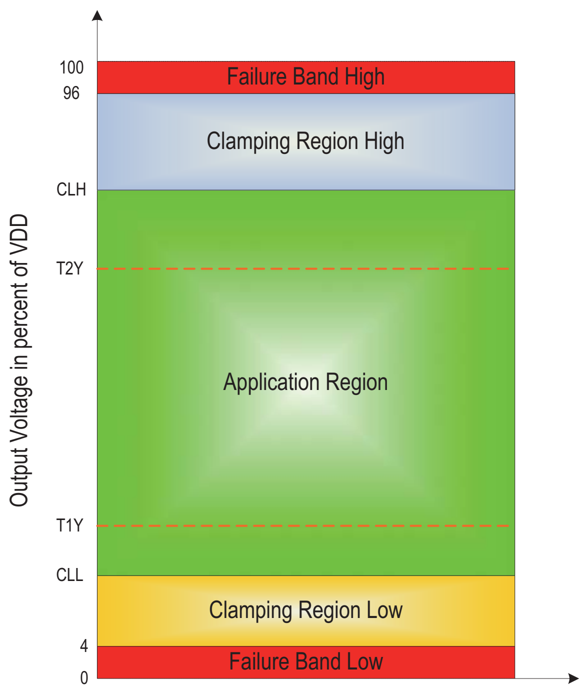


Figure 17 gives an overview of the different ranges. The failure bands are used to indicate a wrong operation of the AS5263. This can be caused due to a broken supply line. By using the specified load resistors, the output level will remain in these bands during a fail. It is recommended to set the clamping level **CLL** above the lower failure band and the clamping level **CLH** below the higher failure band.

Analog Output Diagnostic Mode

Due to the low pin count in the application, a wrong operation must be indicated by the output pin **OUT_T, OUT_B**. This could be realized using the failure bands. The failure band is defined with a fixed level. The failure band low is specified from 0% to 4% of the supply range. The failure band high is defined from 100% to 96%. Several failures can happen during operation. The output signal remains in these bands over the specified operating and load conditions. All the different failures can be grouped into the internal alarms (failures) and the application related failures.

$C_{LOAD} \leq 42nF$, R_{PU}= 2kΩ to 5.6kΩ

R_{PD}= 2kΩ to 5.6kΩ load pull-up

Figure 18:
Different Failure Cases of AS5263

Type	Failure Mode	Symbol	Failure Band	Note
Internal alarms (failures)	Out of magnetic range (too less or too high magnetic input)	MAGRng	High/Low	Could be switched OFF by one OTP bit **EXT_RANGE**. Programmable by OTP bit **DIAG_HIGH**
	CORDIC overflow	COF	High/Low	Programmable by OTP bit **DIAG_HIGH**
	Offset compensation finished	OCF	High/Low	Programmable by OTP bit **DIAG_HIGH**
	Watchdog fail	WDF	High/Low	Programmable by OTP bit **DIAG_HIGH**
	Oscillator fail	OF	High/Low	Programmable by OTP bit **DIAG_HIGH**
Application related failures	Overvoltage condition	OV	High/Low	Dependant on the load resistor Pull up->failure band high Pull down->failure band low
	Broken VDD	BVDD		
	Broken VSS	BVSS		
	Short circuit output	SCO	High/Low	Switch OFF-> short circuit dependent

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

Analog Output Driver Parameters

The output stage is configured in a push-pull output. Therefore it is possible to sink and source currents.

$C_{LOAD} \leq 42nF$, R_{PU}= 2kΩ to 5.6kΩ

R_{PD}= 2kΩ to 5.6kΩ load pull-up

Figure 19:
General Parameters for the Output Driver

Symbol	Parameter	Min	Typ	Max	Unit	Note
IOUTSCL	Short circuit output current (low side driver)	8		32	mA	V_{OUT}=27V
IOUTSCH	Short circuit output current (high side driver)	-8		-32	mA	V_{OUT}=0V
TSCDET	Short circuit detection time	20		600	µs	Output stage turned OFF
TSCREC	Short circuit recovery time	2		20	ms	Output stage turned ON
ILEAKOUT	Output leakage current	-20		20	µA	V_{OUT}=VDD=5V
BGNDPU	Output voltage broken GND with pull-up	96		100	%VDD	R_{PU} = 2k to 5.6k
BGNDPD	Output voltage broken GND with pull-down	0		4	%VDD	R_{PD} = 2k to 5.6k
BVDDPU	Output voltage broken VDD with pull-up	96		100	%VDD	R_{PU} = 2k to 5.6k
BVDDPD	Output voltage broken VDD with pull-down	0		4	%VDD	R_{PD} = 2k to 5.6k

Note(s):

1. A Pull-Up/Down load is up to 1kΩ with increased diagnostic bands from 0%-6% and 94%-100%.

Figure 20:
Electrical Parameters for the Analog Output Stage

Symbol	Parameter	Min	Typ	Max	Units	Note
VOUT	Output voltage range	4		96	%VDD	
		6		94		Valid when 1k ≤ R_{LOAD} < 2k
VOUTINL	Output integral nonlinearity			10	LSB	
VOUTDNL	Output differential nonlinearity	-10		10	LSB	
VOUTOFF	Output offset	-50		50	mV	At 2048 LSB level
VOUTUD	Update rate of the output		100		µs	Info parameter
VOUTSTEP	Output step response			550	µs	Between 10% and 90%, R_{PD} =1kΩ, C_{LOAD}=1nF; V_{DD}=5V
VOUTDRIFT	Output voltage temperature drift	2		2	%	Of value at mid code
VOUTRATE	Output ratiometricity error	-1.5		1.5	%VDD	0.04*VDD ≤ VOUT ≤ 0.96*VDD
VOUTNOISE	Noise[1]			10	mVpp	1Hz to 30kHz; at 2048 LSB level

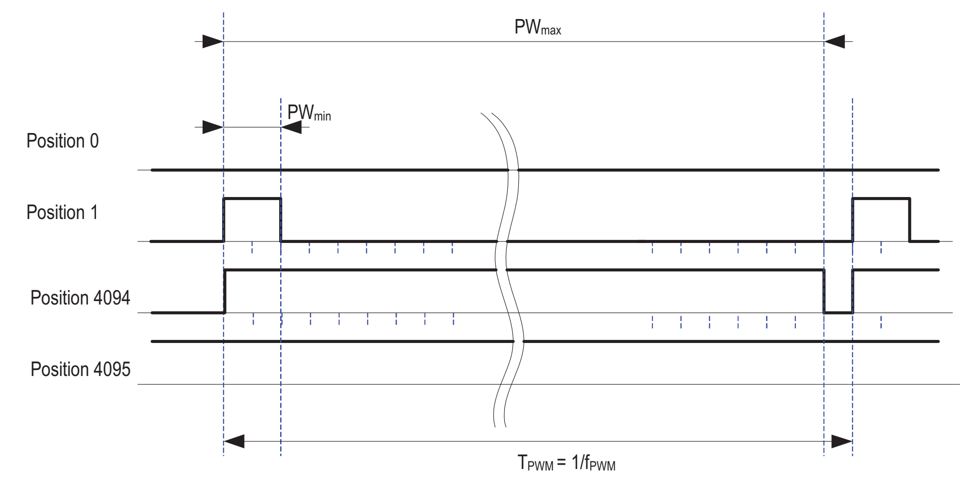
Note(s):

1. Not tested in production; characterization only.

Pulse Width Modulation (PWM) Output

The AS5263 provides a pulse width modulated output (PWM), whose duty cycle is proportional to the measured angle. This output format is selectable over the OTP memory. If output pins **OUT_T, OUT_B** is configured as open drain configuration, then an external load resistor (pull up) is required. The PWM frequency is internally trimmed to an accuracy of ±10% over full temperature range. This tolerance can be cancelled by measuring the ratio between the ON and OFF state. In addition, the programmed clamping levels **CLL** and **CLH** will also adjust the PWM signal characteristic.

Figure 21:
PWM Output Signal



The PWM frequency can be programmed by the OTP bits **PWM_ frequency (1:0)**. Therefore, four different frequencies are possible.

Figure 22:
PWM Signal Parameters

Symbol	Parameter	Min	Typ	Max	Unit	Note
f_{PWM1}	PWM frequency1	123.60	137.33	151.06	Hz	PWM_frequency (1:0) = "11"
f_{PWM2}	PWM frequency2	247.19	274.66	302.13	Hz	PWM_frequency (1:0) = "10"
f_{PWM3}	PWM frequency3	494.39	549.32	604.25	Hz	PWM_frequency (1:0) = "01"
f_{PWM4}	PWM frequency4	988.77	1098.63	1208.50	Hz	PWM_frequency (1:0) = "00"
PW_{MIN}	MIN pulse width		(1+1)*1/ f_{PWM}		µs	
PW_{MAX}	MAX pulse width		(1+4094)*1/ f_{PWM}		ms	

Taking into consideration the AC characteristic of the PWM output including load, it is recommended to use the clamping function. The recommended range is 0% to 4% and 96% to 100%.

Figure 23:
Electrical Parameters for the PWM Output Mode

Symbol	Parameter	Min	Typ	Max	Units	Note
PWMVOL	Output voltage low	0		0.4	V	I_{OUT}=8mA
ILEAK	Output leakage	-20		20	µA	V_{OUT}=V_{DD}=5V
PWMDC	PWM duty cycle range	4		96	%	
PWMSRF	PWM slew rate	1	2	4	V/µs	Between 75% and 25% R_{PU}/R_{PD} = 1kΩ, C_{LOAD} = 1nF, VDD = 5V

Kick Down Function

The AS5263 provides a special compare function. This function is implemented using a programmable angle value with a programmable hysteresis. It will be indicated over the open drain output pin **KDOWN_T, KDOWN_B**. If the actual angle is above the programmable value plus the hysteresis, the output is switched to low. The output will remain at low level until the value KD is reached in the reverse direction.

Figure 24:
Kick Down Hysteresis Implementation

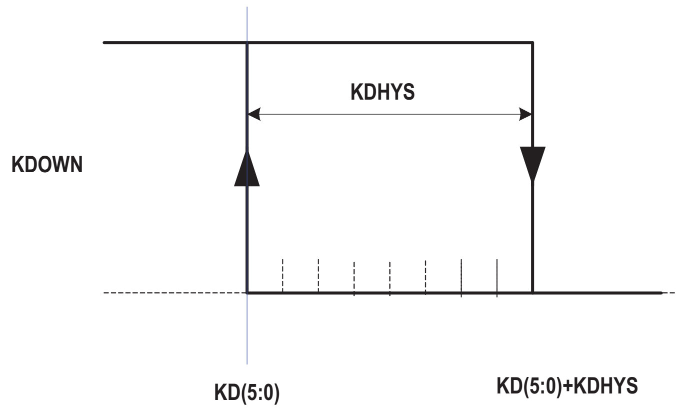


Figure 25:
Programming Parameters for the Kick Down Function

Symbol	Parameter	Resolution	Note
KD	Kick Down Angle	6 bits	
KDHYS	Kick Down Hysteresis	2 bits	KDHYS (1:0) = "00" -> 8 LSB hysteresis KDHYS (1:0) = "01" ->16 LSB hysteresis KDHYS (1:0) = "10" -> 32 LSB hysteresis KDHYS (1:0) = "11" -> 64 LSB hysteresis

Pull-up resistance 1k to 5.6K to VDD

C_{LOAD} max 42nF

Figure 26:
Electrical Parameters of the KDOWN Output

Symbol	Parameter	Min	Typ	Max	Unit	Note
IKDSC	Short circuit output current (low side driver)	6		24	mA	$V_{KDOWN} = 27V$
TSCDET	Short circuit detection time	20		600	µs	Output stage turned OFF
TSCREC	Short circuit recovery time	2		20	ms	Output stage turned ON
KDVOL	Output voltage low	0		1.1	V	$I_{KDOWN} = 6mA$
KDILEAK	Output leakage	-20		20	µA	$V_{KDOWN} = 5V$
KDSRF	KDOWN slew rate (falling edge)	1	2	4	V/µs	Between 75% and 25%, $R_{PUKDWN} = 1k\Omega$, $C_{LOAD\_KDWN} = 1nF$, VDD = 5V

Application Information

Programming the AS5263

The AS5263 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, wherein several bits are available for user programming. In addition, factory settings are stored in the OTP memory. Both regions are independently lockable by built-in lock bits.

A single OTP cell can be programmed only once. By default, each 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 (pass2funcion), the device can be switched into operation mode (analog or PWM output). In case of a programmed user lock bit, the AS5263 automatically starts up in the functional operation mode. No communication of the specific protocol is possible after this.