

# ATS643LSH – Conceptual

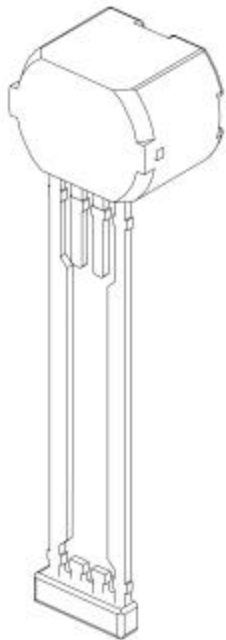
CONCEPTUAL DATASHEET  
(subject to change without notice)

## True Zero-Speed, Two-Wire, Miniature Gear Tooth Sensor

The ATS643LSH is an optimized Hall-effect sensing integrated circuit and magnet combination that provides a user-friendly solution for true zero-speed digital gear-tooth sensing in two-wire applications. The sensor consists of a single-shot molded plastic package that includes a samarium cobalt magnet, a pole piece, and a Hall effect IC that has been optimized to the magnetic circuit. This small package can be easily assembled and used in conjunction with a wide variety of gear shapes and sizes.

The integrated circuit incorporates a dual element Hall-effect sensor and signal processing circuitry that switches in response to differential magnetic signals created by ferrous targets. The device contains a sophisticated compensating circuit to eliminate magnet and system offsets. Digital tracking of the analog signal is used to achieve true zero speed operation. A-D and D-A converters are used to adjust the device gain and offset at power up resulting in air gap independent switch-points, which greatly improves output accuracy.

The regulated current output is configured for two-wire operation. This sensor is ideal for obtaining speed and duty cycle information in gear-tooth-based applications such as transmission speed sensing.



Pin 1: Supply/Current Output  
Pin 2: NC  
Pin 3: Test Pin  
Pin 4: Ground

### ABSOLUTE MAXIMUM RATINGS

Supply Voltage, $V_{CC}$	26.5 V*
Reverse Supply Voltage, $V_R$	-18 V
Operating Temperature Range, $T_A$	-40 °C to 150 °C*
Storage Temperature, $T_S$	170 °C
Package Power Rating, $\theta_{JA}$	126 °C/W
Maximum Junction Temperature, $T_{J, continuous}$	165 °C

\* Operation at increased supply voltages and temperatures is described in the Applications Information.

### BENEFITS / FEATURES

- ♦ Fully optimized differential digital gear tooth sensor
- ♦ Single chip sensing IC for high reliability
- ♦ Internal current regulator for 2-wire operation
- ♦ Vibration immunity
- ♦ Small mechanical size (8 mm dia x 5.5 mm length)
- ♦ Air gap independent switch-points
- ♦ Digital output representing gear profile
- ♦ Precise duty cycle over temperature
- ♦ Large operating air gaps
- ♦ <2 ms power up time
- ♦ AGC and reference adjust circuit
- ♦ True zero-speed operation
- ♦ Under-voltage lockout
- ♦ Wide operating voltage range
- ♦ Defined power-on state

# ATS643LSH TRUE ZERO-SPEED GEAR TOOTH SENSOR – Allegro Confidential

**Operating Characteristics:** Valid over operating temperature range unless otherwise noted.

Characteristics	Symbol	Test Conditions	Limits			
			Min.	Typ.	Max.	Units
<b>ELECTRICAL CHARACTERISTICS</b>						
Supply Voltage	$V_{CC}$	Operating, $T_J < 165^\circ\text{C}$	4.0		24	V
Under Voltage Lockout	$V_{CC(UV)}$	$V_{CC} 0 \rightarrow 5\text{ V}$	-	3.5	$V_{CC} < V_{CC_{Min}}$	V
Supply Zener Clamp Voltage	$V_Z$	$I_{ZT} = 1\text{ mA}$ Continuous	26.5	30	-	V
Max Zener Pulse Current	$I_Z$	$t=20\text{mS}$ Pulse Mode	-	-	50	mA
Supply Zener Resistance	$R_Z$		-	50	-	$\Omega$
Supply Current ATS643LSH – I1	$I_{CC}$	Low Current State: $I_{CC_{Low}}$	4.0	6	8.0	mA
		High Current State: $I_{CC_{High}}$	12.0	14.0	16.0	mA
Supply Current ATS643LSH – I2	$I_{CC}$	Low Current State: $I_{CC_{Low}}$	5.9	7	8.4	mA
		High Current State: $I_{CC_{High}}$	11.8	14.0	16.8	mA
Supply Current Ratio	$I_{CC_{High}} / I_{CC_{Low}}$	Ratio of High Current to Low Current	TBD	-	-	
<b>POWER-ON STATE CHARACTERISTICS</b>						
Power-On State	$S_{PO}$	$V_{CC} 0 \rightarrow 5\text{ V}$	-	$I_{CC_{High}}$	-	-
Power-On Time <sup>1</sup>	$t_{on}$	Gear speed < 100 rpm	-	1	2	ms
<b>OUTPUT STAGE</b>						
Output Slew Rate	$t_s$	$R_S = 100\ \Omega, C_S = 10\ \text{pF}$	-	7	-	mA/ $\mu\text{s}$

<sup>1</sup> Power Up Time is the time required to complete the internal automatic offset adjust; the DAC's are then ready for peak acquisition.

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Operating Characteristics: Valid with Reference Target unless otherwise specified

Characteristics	Symbol	Test Conditions	Limits			Units
			Min.	Typ.	Max.	
<b>SWITCH POINT CHARACTERISTICS</b>						
Rotation Speed	$S_{max}$	Reference Target	0		12,000	RPM
Bandwidth	f-3db		25	40	-	kHz
Operate Point	Bop%	% of peak to peak referenced from PDAC to NDAC, AG < Agmax;		+65		%
Release Point	Brp%	% of peak to peak referenced from PDAC to NDAC, AG < Agmax;		+35		%

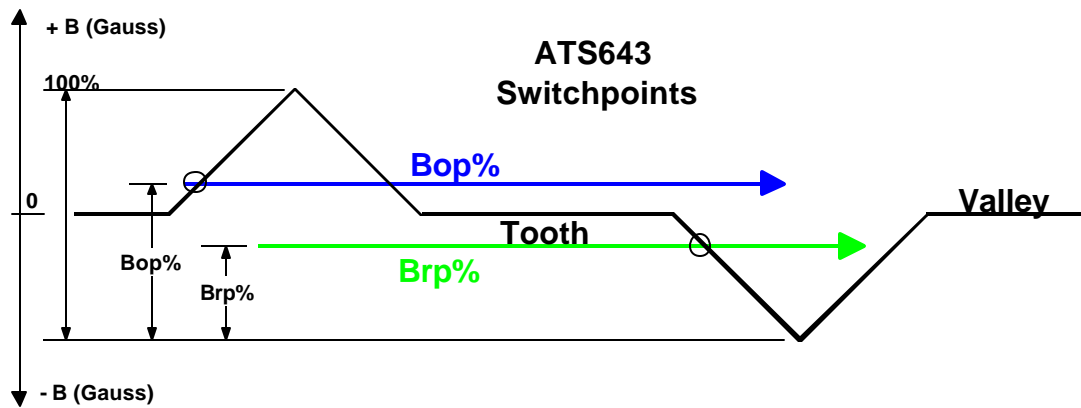
<b>CALIBRATION</b>						
Initial Calibration	$C_i$	Rising Output Edges for Accurate Edge Detection			3	Edges
AGC Disable	$C_f$	Rising Output Edges			3	Edges

<b>DAC CHARACTERISTICS</b>						
Dynamic Offset Cancellation <sup>2</sup>				±60	-	G
PDAC / NDAC		Number of Bits for Tracking Both Positive and Negative Signal Peaks		9		Bit

<sup>2</sup> The device will compensate magnetic and installation offsets up to ±80 gauss. Offsets greater than ±80 gauss may cause inaccuracies in the output.

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Characteristics	Symbol	Test Conditions	Limits			Units
			Min.	Typ.	Max.	
<b>OPERATING CHARACTERISTICS: Using Reference Target and Valid Over Operating Temperature Range</b>						
Operational Air Gap Range <sup>3</sup>	$Op_{AG}$	Duty cycle within specification	0.5	-	2.5	mm
Maximum Operational Air Gap Range	$Op_{MaxAG}$	Output Switching: Duty cycle NOT within specifications	TBD	-	-	mm
Duty Cycle Variation	DC	Wobble < 0.5mm Valid over operating air gap range			±10	%DC
Operating Signal Range	Sig	Duty cycle within Specification	TBD	-	1400	G
Minimum Operating Signal	$Sig_{Min}$	Output Switching: Duty Cycle Not in Specification	TBD	-	-	G

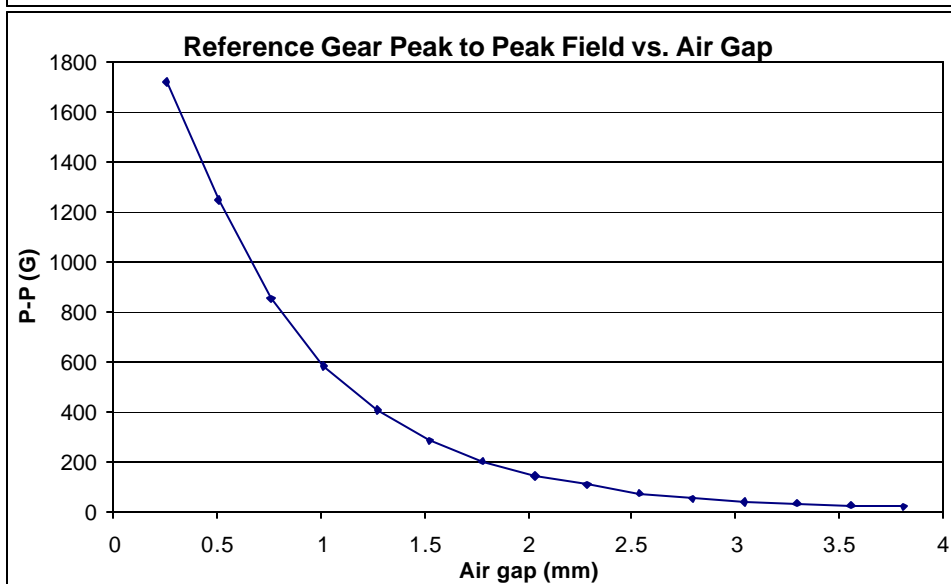
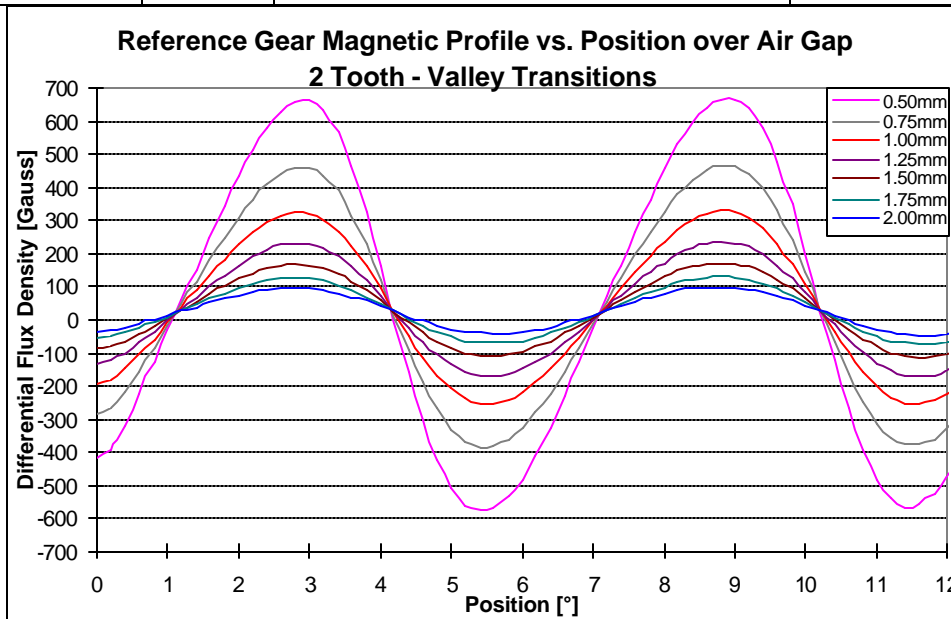


<sup>3</sup> Operating air gap is dependent on the available magnetic field. The available field is target geometry and material dependent and should be independently characterized. The field available from the reference target is given in the reference gear parameter section of the datasheet.

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## Reference Gear Parameters

Characteristics	Symbol	Test Conditions	Limits			Units
			Min.	Typ.	Max.	
<b>REFERENCE GEAR DIMENSIONS (60-0)</b>						
Diameter	$G_d$		-	120	-	mm
Thickness	$G_t$		-	6	-	mm
Tooth Width	$T_w$		-	3	-	mm
Valley Width	$V_w$		-	3	-	mm
Valley Depth	$V_d$		-	3	-	mm
Material		Low Carbon Steel				



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## MECHANICAL INFORMATION

Component	Material	Function	Value
Sensor Package Material	Thermoset Epoxy	Max. Temperature	170°C <sup>1</sup>
Leads	Copper, 0.016" dia, 0.050" spacing		
Lead Coating	Solder, Tin / Lead 90/10 <sup>2</sup>		

<sup>1</sup> Temperature excursions of up to 225°C for 2 minutes or less are permitted.

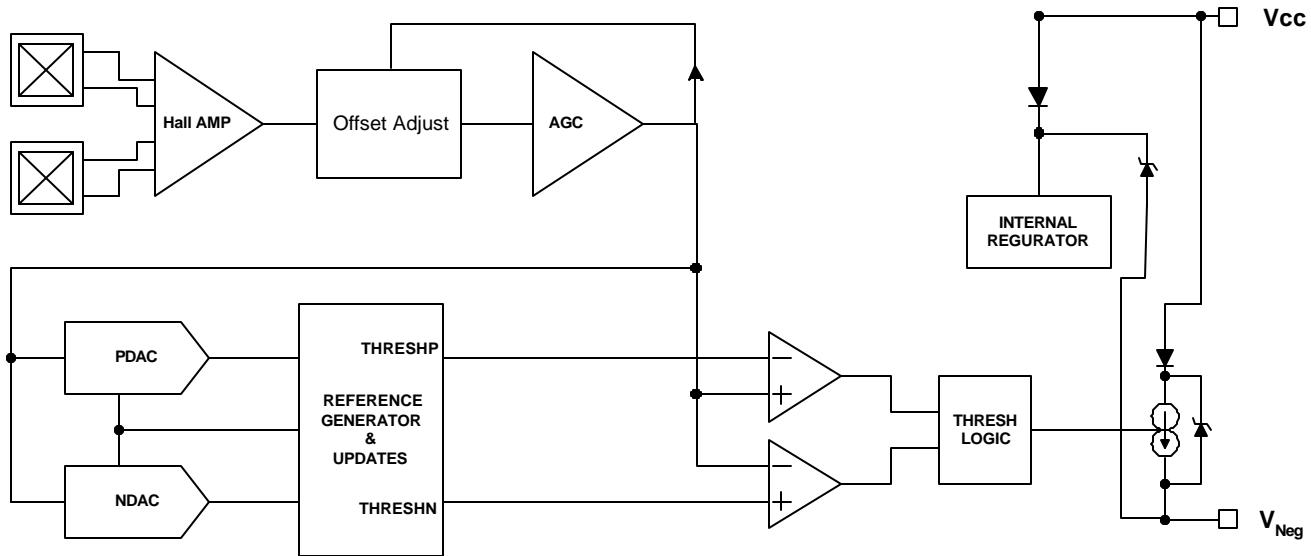
<sup>2</sup> Industry accepted soldering techniques are acceptable for this sub-assembly as long as the indicated maximum temperatures for each component are not exceeded. Please see the Allegro (<http://www.allegromicro.com/>) website for soldering profile.

## DEVICE QUALIFICATION PROGRAM

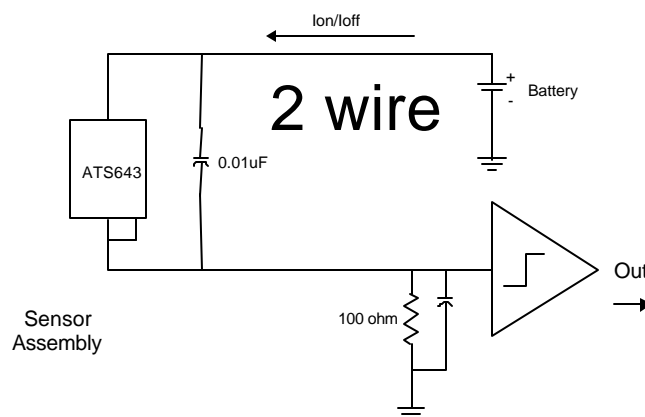
Test Name	Test Conditions	Test Length	# of Lots	Sample / lot	Comments
Pre/Post Test	Ta = room, hot, cold				
High Temperature Operating Life (HTOL)	Ta = 150°C, Tj = 170°C	408 hrs	1	77	JESD22-A108
High Temperature Bake (HTB)	Ta = 170°C	1000 hrs	1	77	JESD22-A103
Pre Conditioning (PC)	85°C/85%RH	168 hrs	1	231	JESD22-A112 & A113
Temperature Humidity Bias (THB) or HAST	85°C/85%RH 130°C/85%RH	1000 hrs 50 hrs	1	77	JESD22-A101 JESD22-A110
Autoclave (AC)	121°C/15 psig	96 hrs	1	77	JESD22-A102
Temperature Cycle (TC)	-65°C to +150°C or -50°C to +150°C	500 cycles 1000 cycles	1	77	JESD22-A104
External Visual (EV)					
Physical Dimensions (PD)			1	30	
Lead Integrity			1	45	
Bond Pull Strength			1	30	
ESD	HBM & MM		1	3 per model per V step	JESD22-A114 & A115, CDF-AEC-Q100-002, 003 & 011
Solderability (SD)			1	15	JESD22-B102
Early Life Failure Rate (ELFR)	125°C or 150°C	48 hrs 24 hrs	1	800	JESD22-A108
Gate Leakage (GL)			1	6	CDF- AEC-Q100-006
Electrical Distributions (ED)	Ta = room, hot, cold		3	30	

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## FUNCTIONAL BLOCK DIAGRAM



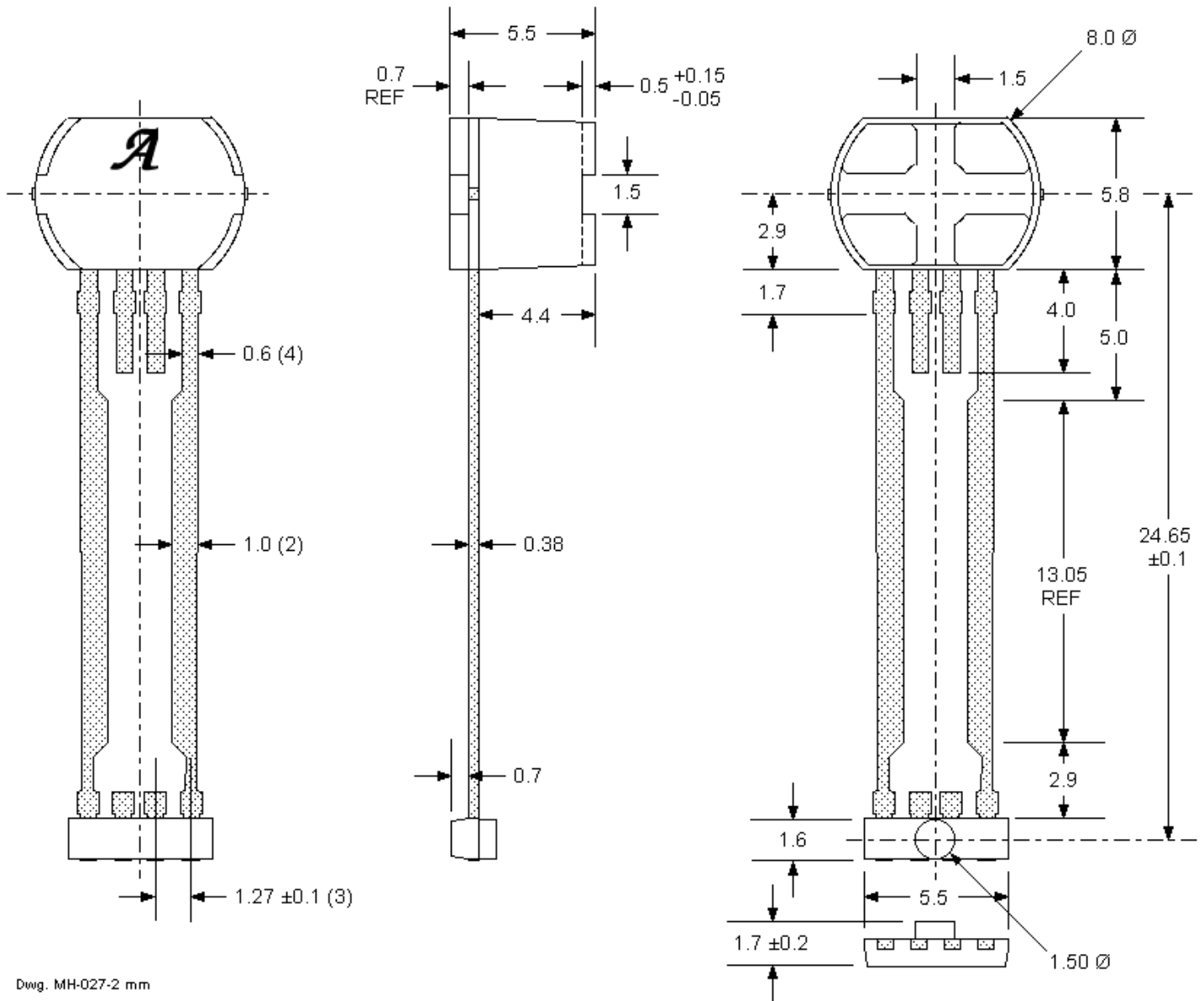
## TYPICAL APPLICATIONS CONFIGURATION



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## SENSOR PACKAGE

**LSH PACKAGE**  
REFERENCE DIMENSIONS ONLY





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