ALLEGRO microsystems

ATS679LSL

Self-Calibrating TPOS Camshaft Speed Sensor IC

FEATURES AND BENEFITS

- SL package provides a fully integrated solution with a non-rare-earth back-biasing magnet and EMC protection circuit
- True target state recognition at device power-on (TPOS)
- EEPROM programming for performance optimization, temperature compensation, and production traceability
- Fully synchronous digital logic with Scan Path and IDDQ testing for high quality and reliability
- Chopper stabilization reduces offset drift
- Absolute zero-speed performance

PACKAGE:

3-pin SIP (suffix SL)

Not to scale

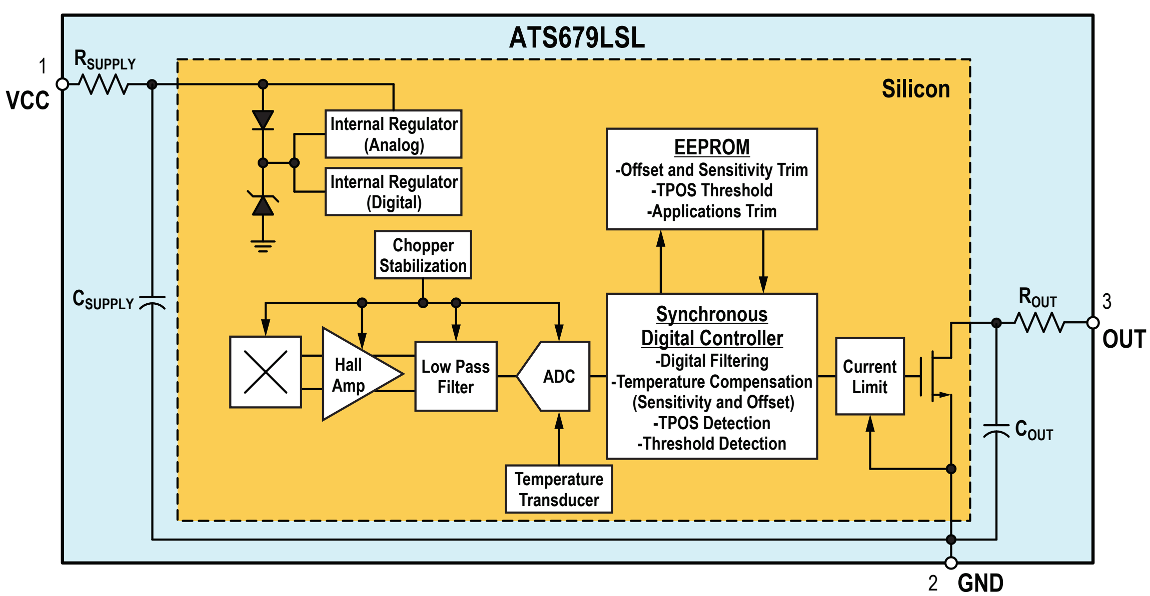
DESCRIPTION

The ATS679LSL is a True Power-On State camshaft sensor incorporating a non-rare-earth back-biasing magnet, advanced fully synchronous digital IC, and EMC protection circuit all in a single sensing solution.

The ATS679 incorporates a single element Hall IC with an optimized custom magnetic circuit that switches in response to magnetic signals induced by a ferromagnetic target. The IC contains a sophisticated digital circuit designed to match the temperature behavior of the IC with the integrated magnet. Signal processing is used to provide zero-speed performance independent of air gap and is designed for the typical operating conditions found in automotive camshaft sensing applications. The resulting output of the device is a digital representation of the ferromagnetic target profile.

The ATS679 is provided in a 3-pin SIP package (SL) that is lead (Pb) free, with 100% matte-tin leadframe plating.

Some commercial restrictions apply to this product—contact Allegro Sales for details.



Functional Block Diagram

SELECTION GUIDE

Part Number	Output Polarity	Packing
ATS679LSLTN-LT-T	Low opposite target tooth	Tape and reel, 13-in. reel, 500 pieces per reel
ATS679LSLTN-HT-T	High opposite target tooth	

ABSOLUTE MAXIMUM RATINGS

Characteristic	Symbol	Notes	Rating	Units
Supply Voltage	V_{CC}		27	V
Reverse Supply Voltage	V_{RCC}		–18	V
Output Voltage	V_{OUT}		27	V
Reverse Output Voltage	V_{ROUT}	$R_{PU} \geq 1000\ \Omega$	–0.5	V
Output Current	I_{OUT}	Internal current limiting is intended to protect the device from output short circuits, but is not intended for continuous operation.	25	mA
Reverse Output Current	I_{ROUT}	$V_{OUT} > -0.5$ V, $T_A = 25°C$	–50	mA
Operating Ambient Temperature	T_A	Range L	–40 to 150	°C
Maximum Junction Temperature	$T_J(max)$	Contact Allegro for extended junction temperature data	165	°C
Storage Temperature	T_{stg}		–65 to 170	°C

INTERNAL DISCRETE COMPONENT RATINGS

Symbol	Characteristic	Rating	Units
C_{SUPPLY}	Nominal Capacitance	220000	pF
C_{OUT}	Nominal Capacitance	1800	pF
R_{SUPPLY}	Nominal Resistance	50	Ω
R_{OUT}	Nominal Resistance	50	Ω

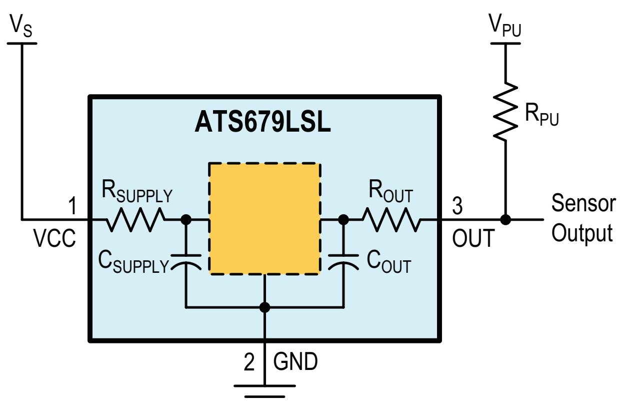


Figure 1: Typical Application Circuit

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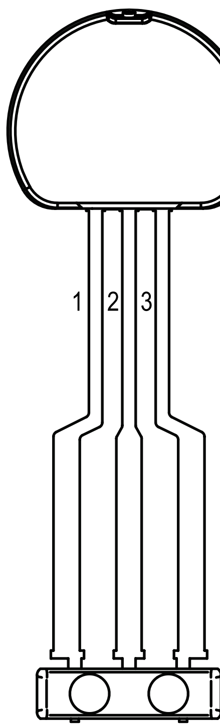
PINOUT DIAGRAM AND TERMINAL LIST TABLE

Package SL, 3-Pin SIP Pinout Diagram



Terminal List Table

Number	Name	Function
1	VCC	Supply voltage
2	GND	Ground
3	OUT	Open drain output

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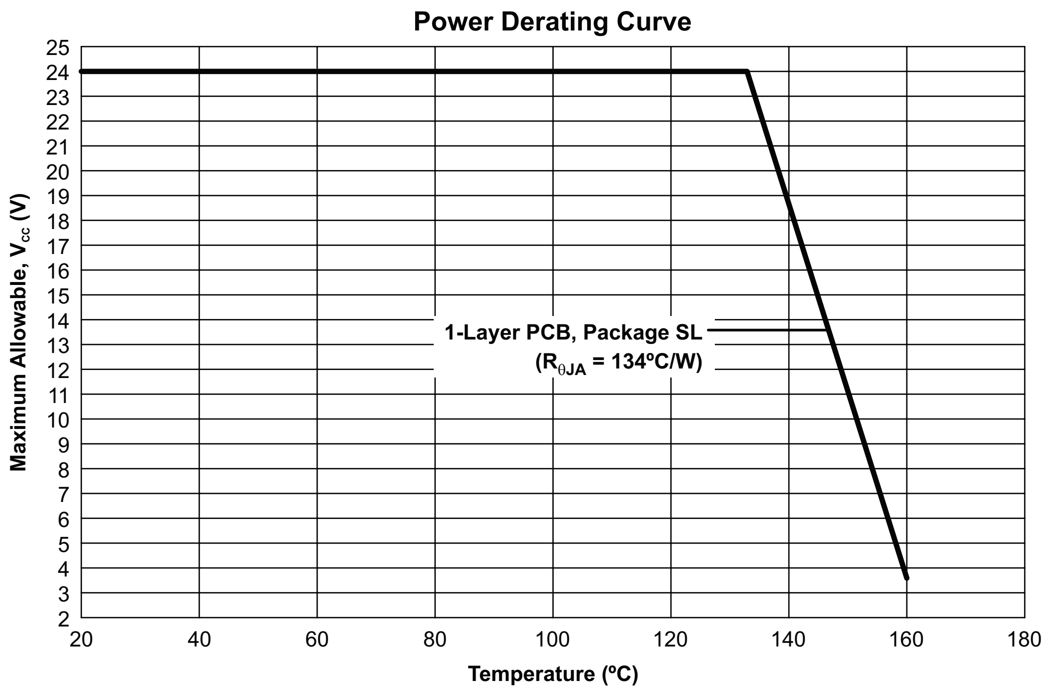
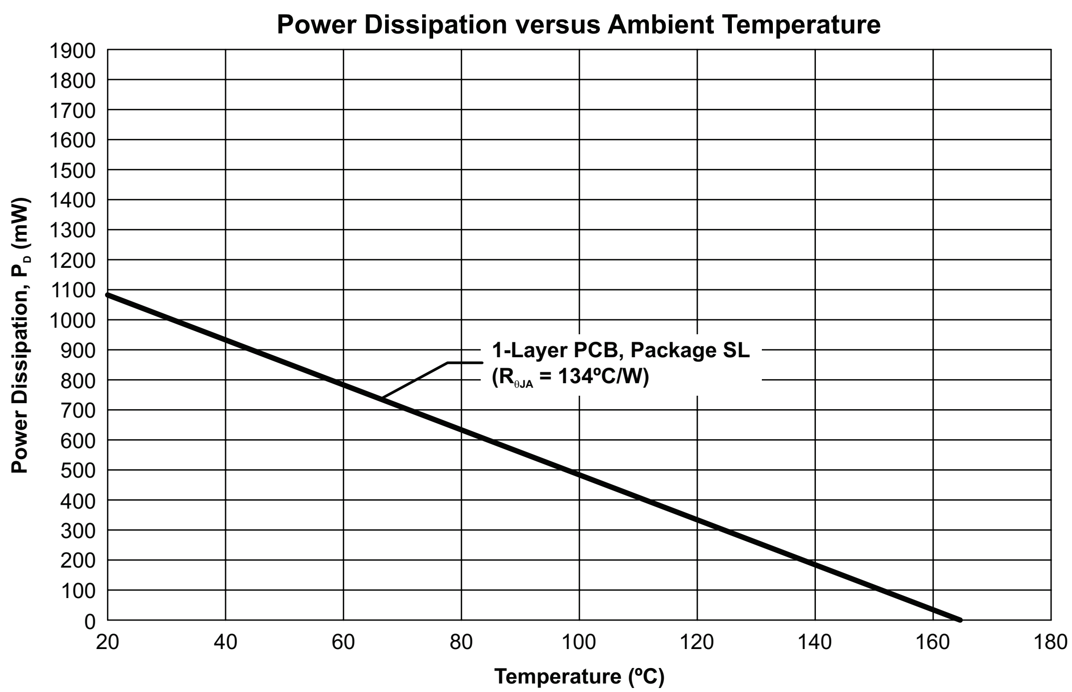
THERMAL CHARACTERISTICS: May require derating at maximum conditions; see Power Derating section

Characteristic	Symbol	Test Conditions*	Value	Unit
Package Thermal Resistance	$R_{\theta JA}$	Single-layer PCB, with copper limited to solder pads	134	°C/W

*Additional thermal information is available on the Allegro website.





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OPERATING CHARACTERISTICS: T_A and V_{CC} within specifications, using Reference Target 8X, unless otherwise noted

Characteristics	Symbol	Test Conditions		Min.	Typ. [1]	Max.	Unit
ELECTRICAL CHARACTERISTICS							
Supply Voltage	V_{CC}	Continuous operation, $T_J < T_{J(MAX)}$	R_{SUPPLY} = 50 Ω	3.9	–	24	V
Undervoltage Lockout [2]	$V_{CC(UV)rise}$	Rising V_{CC} (0 V → 5 V)	R_{SUPPLY} = 50 Ω	–	3.5	–	V
	$V_{CC(UV)fall}$	Falling V_{CC} (5 V → 0 V)		–	3	–	V
Supply Zener Clamp Voltage	$V_{Zsupply}$	$I_{CC} = I_{CC(MAX)}$ + 3 mA		27	–	–	V
Reverse Supply Zener Clamp Voltage	$V_{RZsupply}$	I_{CC} = –3 mA, T_A = 25°C		–	–	–18	V
Supply Current	I_{CC}			5	8	10	mA
OUTPUT STAGE CHARACTERISTICS							
Output On Voltage	$V_{OUT(SAT)}$	I_{OUT} = 5 mA, Output = on state (V_{OUT} = Low)	R_{OUT} = 50 Ω	–	–	500	mV
		I_{OUT} = 15 mA, Output = on state (V_{OUT} = Low)	R_{OUT} = 50 Ω	–	–	1300	mV
Output Zener Clamp Voltage	$V_{Zoutput}$	I_{OUT} = 3 mA, T_A = 25°C		27	–	–	V
Output Current Limit	$I_{OUT(LIM)}$	Output = on state (V_{OUT} = Low)		30	–	80	mA
Output Leakage Current	$I_{OUT(OFF)}$	V_{OUT} = 24 V, Output = off state (V_{OUT} = High)		–	–	10	μA
Output Rise Time	t_r	Measured 10% to 90% of V_{OUT}; R_{PU} = 1 kΩ; V_{PU} = 5 V	R_{OUT} = 50 Ω, C_{OUT} = 1.8 nF	–	4	–	μs
Output Fall Time	t_f	Measured 90% to 10% of V_{OUT}; R_{PU} = 1 kΩ; V_{PU} = 5 V		2.5	5	9	μs
		Measured 90% to 10% of V_{OUT}; R_{PU} = 1 kΩ; V_{PU} = 12 V		–	8	–	μs

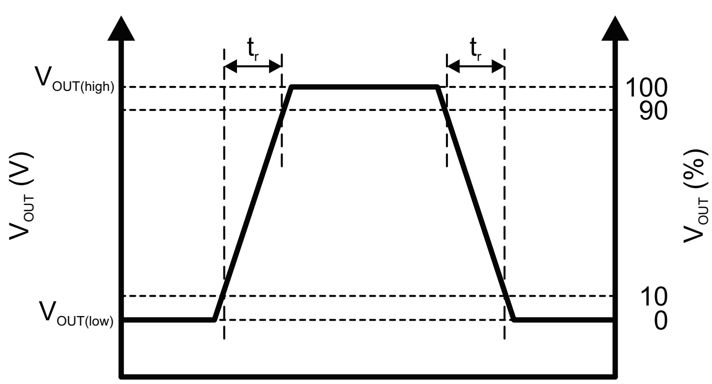

Figure 2: Output Rise Time and Output Fall Time

[1] Typical values are at T_A = 25°C and V_{CC} = 12 V. Performance may vary for individual units, within the specified maximum and minimum limits.
[2] Between $V_{CC(min)}$ and $V_{CC(UV)}$ output switching continues to occur but device performance is not guaranteed.

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OPERATING CHARACTERISTICS (continued): T_A and V_{CC} within specifications, using Reference Target 8X, unless otherwise noted

Characteristics	Symbol	Note	Min.	Typ.	Max.	Unit
MAGNETIC CHARACTERISTICS						
Allowable External Magnetic Field		Exceeding this level could result in permanent damage to SL magnet	–500	–	500	G
PERFORMANCE CHARACTERISTICS						
Operational Air Gap Range	AG	TPOS guaranteed; Allegro 8X reference target	0.5	–	2.75	mm
Extended Operational Air Gap Range		Running mode switching; TPOS not guaranteed; Allegro 8X reference target	–	–	3.5	mm
Signal Bandwidth	BW	Equivalent to –3 dB cutoff frequency	–	8	–	kHz
Chopper Frequency	f_C		–	333	–	kHz
Phase Delay [3]	ΔErr_{SRELF}	Electrical falling edges; R_{PU} = 1 kΩ, V_{PU} = 5 V	–	2.8×10^{-4}	–	°/rpm
	ΔErr_{SRELR}	Electrical rising edges; R_{PU} = 1 kΩ, V_{PU} = 5 V	–	2.8×10^{-4}	–	°/rpm
Relative Repeatability	$T_{\theta E}$	Allegro 8X reference target; 1000 RPM; 0.5 mm < AG < 2.75 mm	–	±0.08	–	°
POWER-ON CHARACTERISTICS						
Power-On Time [4]	t_{PO}	$V_{CC} > V_{CC(MIN)}$	–	–	1	ms
TPOS Mode		Number of mechanical edges after power-on with output switching on TPOS threshold	2	–	3	edge
Learning Mode		Number of target teeth after TPOS Mode with reduced accuracy threshold based output switching	–	–	1	tooth

[3] Phase Delay is the change in edge position at detection, through the full operational tooth speed range for a single device at a single temperature and installation air gap.
[4] Power-On Time consists of the time from when V_{CC} rises above $V_{CC(MIN)}$ until a valid output state is realized.

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OPERATING CHARACTERISTICS (continued): T_A and V_{CC} within specifications, using Reference Target 8X, unless otherwise noted

Characteristics	Symbol	Note		Min.	Typ.	Max.	Unit
OPERATING MODE CHARACTERISTICS							
Output Polarity	V_{OUT}	Opposite target tooth, connected as in Figure 1	*LT* option		Low		V
			HT option		High		V
		Opposite target valley, connected as in Figure 1	*LT* option		High		V
			HT option		Low		V
Operate Point	B_{OP}	% of peak-to-peak, referenced to tooth signal		–	30	–	%
Release Point	B_{RP}	% of peak-to-peak, referenced to tooth signal		–	30	–	%
Running Mode Hysteresis	$B_{HYS(int)}$	% of peak-to-peak signal		5	10	15	%
Maximum Allowable Signal Reduction	B_{reduce}	Reduction in magnetic signal amplitude between two consecutive peaks; all specifications within range		–	–	B_{OP} – 15%	%
		Reduction in magnetic signal amplitude between two consecutive peaks; output switches, accuracy performance not guaranteed		–	–	B_{OP} – 5%	%

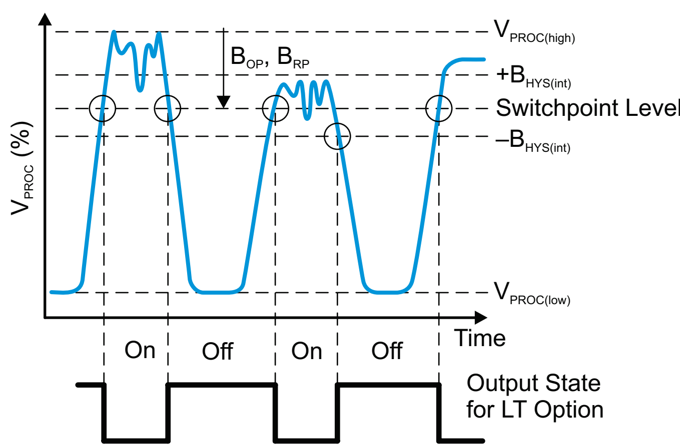

Figure 3: Switch Points with Internal Hysteresis

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FUNCTIONAL DESCRIPTION

Sensing Technology

The ATS679LSL contains a single-chip Hall-effect sensor IC, a 3-pin leadframe with integrated EMC protection components, and a specially designed permanent magnet. The IC includes a self-calibrating, chopper-stabilized Hall element that senses differences in magnetic field strength induced by ferromagnetic target teeth and valleys. The sensor generates a digital output signal that is representative of the target features, independent of the direction of target rotation or rotational orientation. The Hall transducers and the electronics are integrated on the same silicon substrate by a proprietary BiCMOS process. Changes in temperature do not negatively affect this device due to the stable amplifier design and advanced digital temperature compensation. The IC also contains a voltage regulator that provides undervoltage lockout and supply noise rejection over the operating voltage range.

Output Polarity

The polarity of the output is selectable to be either low opposite target teeth (*LT* option) or high opposite target teeth (*HT* option). See Figure 4.

Threshold Update

The ATS679 has a continuous (single tooth) positive peak threshold update and a bounded negative peak threshold update. The switching threshold for a tooth is established based on the measured peak value of the previous tooth, and is comparable to the continuous update mode used on many Allegro sensors. Large tooth-to-tooth changes in the negative peak tracking are filtered out and not applied to switching threshold generation, providing improved output accuracy on camshaft targets with narrow valley widths.

Switch Points and Hysteresis

The running mode switch points of the ATS679 are established dynamically as a percentage of the tracked peaks and valleys. Switch points are set at 30% below the tracked positive peaks with internal hysteresis. Internal hysteresis allows for high-performance switching accuracy on both rising and falling edges while maintaining immunity to false switching on noise, vibration, backlash, or other transient events.

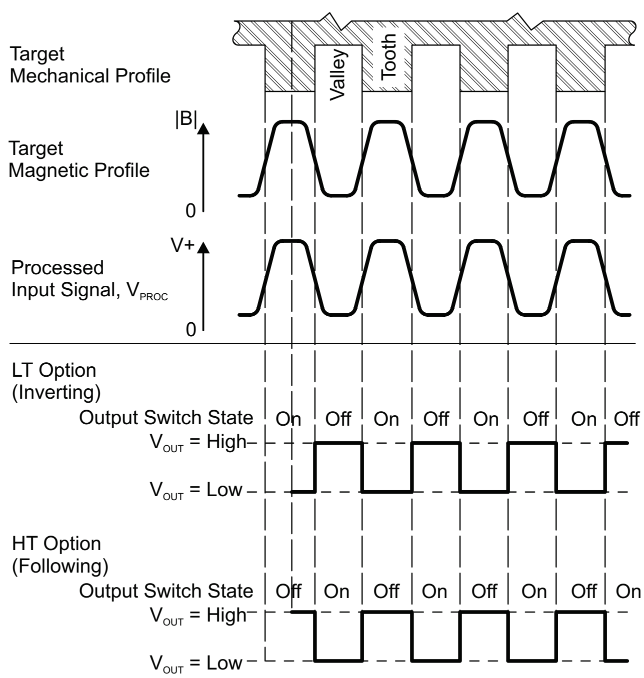

Figure 4: Output Polarity
(when connected as shown in Figure 1)

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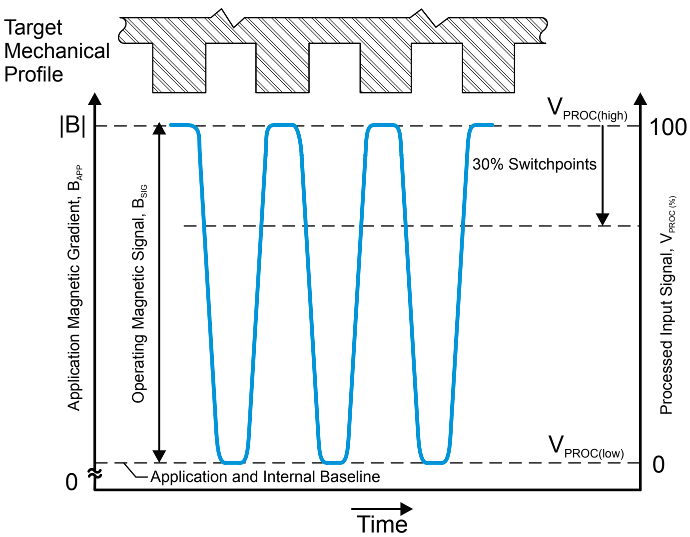

Figure 5: Switch Point Options

Operating Modes

TPOS MODE

After power-on, the output state is determined by the level of the detected magnetic field relative to the fixed-gauss TPOS threshold, which is programmed at Allegro. The device remains in TPOS mode for at least two edges before transitioning to running mode. This transition methodology provides the lowest worst-case output accuracy difference between the first edge and subsequent running mode edges.

CALIBRATION MODE

In calibration mode, the ATS679 uses threshold-based switching with continuous update. This ensures that all teeth and valleys are captured correctly, but it provides slightly reduced accuracy relative to running mode. The device stays in calibration mode long enough to guarantee it has correctly captured enough peaks to fill the running mode threshold memory. After calibration mode is complete, the device transitions to running mode.

RUNNING MODE

In running mode, the ATS679 uses threshold-based switching with conventional or internal hysteresis, as described in the previous Threshold Update and Switch Points and Hysteresis sections. The threshold update is intended to optimize output switching accuracy when used with common camshaft targets, including cases with runout and narrow target valleys.

WATCHDOG

The ATS679 has a peak detector continuously tracking the magnetic signal. If a sudden large signal change causes the sensor output to stop switching, but the peak detector continues to detect valid signal movement, the watchdog will be triggered. When it is triggered, the sensor performs a self-reset and returns to initial startup hysteresis mode to regain output switching.

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POWER DERATING

The device must be operated below the maximum junction temperature of the device ($T_{J(max)}$). Under certain combinations of peak conditions, reliable operation may require derating supplied power or improving the heat dissipation properties of the application. This section presents a procedure for correlating factors affecting operating T_J. (Thermal data is also available on the Allegro MicroSystems website.)

The Package Thermal Resistance ($R_{\theta JA}$) is a figure of merit summarizing the ability of the application and the device to dissipate heat from the junction (die), through all paths to the ambient air. Its primary component is the Effective Thermal Conductivity (K) of the printed circuit board, including adjacent devices and traces. Radiation from the die through the device case ($R_{\theta JC}$) is relatively small component of $R_{\theta JA}$. Ambient air temperature (T_A) and air motion are significant external factors, damped by overmolding.

The effect of varying power levels (Power Dissipation, P_D), can be estimated. The following formulas represent the fundamental relationships used to estimate T_J at P_D.

$$P_D = V_{IN} \times I_{IN} \qquad (1)$$

$$\Delta T = P_D \times R_{\theta JA} \qquad (2)$$

$$T_J = T_A + \Delta T \qquad (3)$$

For example, given common conditions such as:

$$T_A = 25°C$$

$$V_{CC} = 12\ V$$

$$R_{\theta JA} = 134°C/W$$

$$I_{CC} = 7\ mA$$

Then:

$$P_D = V_{CC} \times I_{CC} = 12\ V \times 7\ mA = 84\ mW$$

$$\Delta T = P_D \times R_{\theta JA} = 84\ mW \times 134°C/W = 11.3°C$$

$$T_J = T_A + \Delta T = 25°C + 11.3°C = 36.3°C$$

A worst-case estimate, P_D(max), represents the maximum allowable power level, V_{CC}(max), I_{CC}(max), without exceeding T_J(max), at a selected $R_{\theta JA}$ and T_A.

Example: Reliability for V_{CC} at T_A = 150°C.

Observe the worst-case ratings for the device, specifically:

$$R_{\theta JA} = 134°C/W$$

$$T_J(max) = 165°C$$

$$V_{CC}(max) = 24\ V$$

$$I_{CC} = 10\ mA.$$

Calculate the maximum allowable power level, P_D(max). First, invert equation 3:

$$\Delta T(max) = T_J(max) - T_A = 165°C - 150°C = 15°C$$

This provides the allowable increase to T_J resulting from internal power dissipation. Then, invert equation 2:

$$P_D(max) = \Delta T(max) \div R_{\theta JA} = 15°C \div 134°C/W = 112\ mW$$

Finally, invert equation 1 with respect to voltage:

$$V_{CC}(est) = P_D(max) \div I_{CC}(max) = 112\ mW \div 10\ mA = 11.2\ V$$

The result indicates that, at T_A, the application and device can dissipate adequate amounts of heat at voltages ≤ V_{CC}(est).

Compare V_{CC}(est) to V_{CC}(max). If V_{CC}(est) ≤ V_{CC}(max), then reliable operation between V_{CC}(est) and V_{CC}(max) requires enhanced $R_{\theta JA}$. If V_{CC}(est) ≥ V_{CC}(max), then operation between V_{CC}(est) and V_{CC}(max) is reliable under these conditions.

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PACKAGE OUTLINE DRAWING

For Reference Only – Not for Tooling Use

(Reference DWG-0000414, Rev. 4)
Dimensions in millimeters. NOT TO SCALE.
Dimensions exclusive of mold flash, gate burrs, and dambar protrusions
Exact case and lead configuration at supplier discretion within limits shown

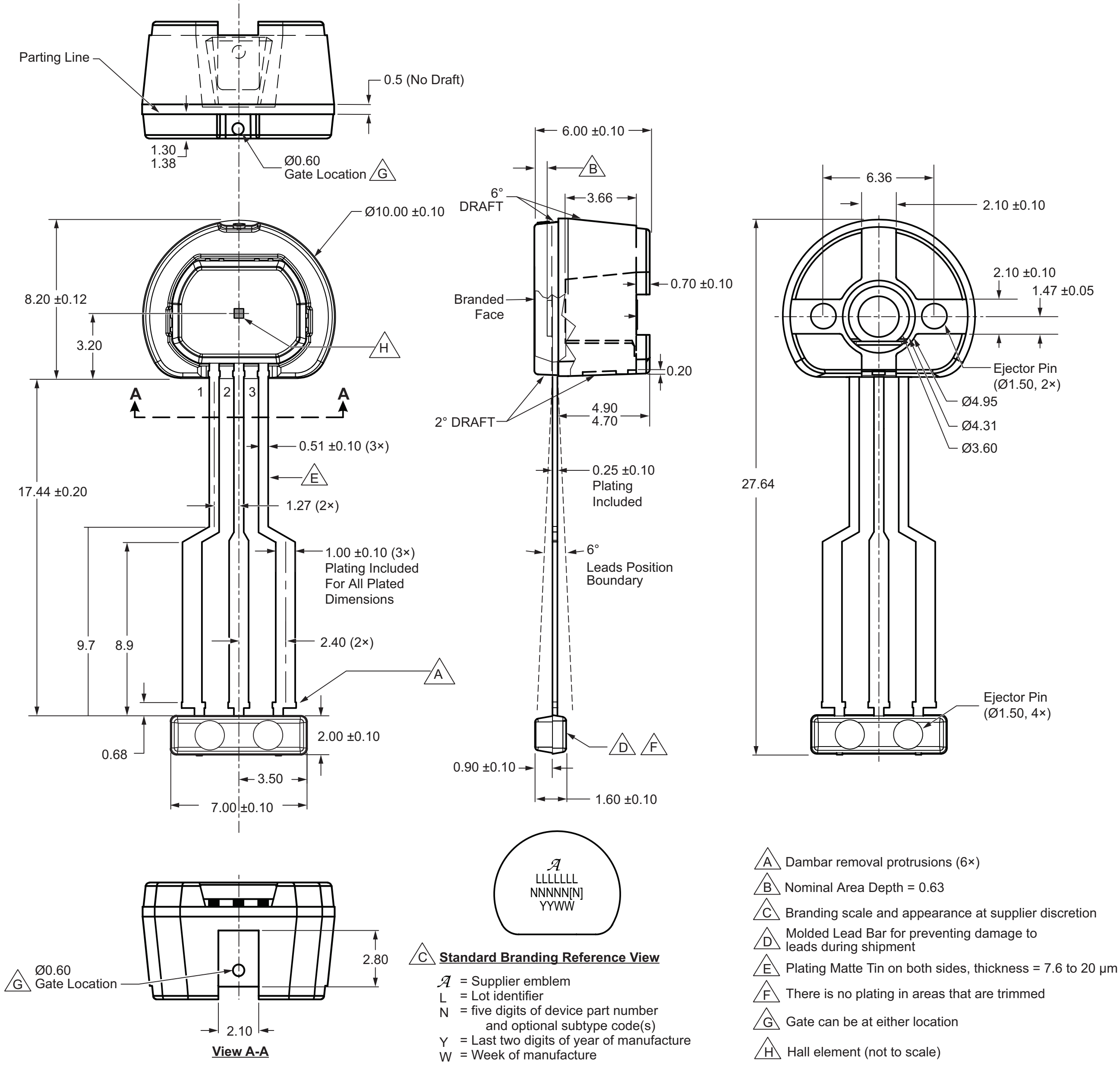

Figure 6: Package SL, 3-Pin SIP

Note: Package is manufactured with two steps. The molded magnet uses a hygroscopic nylon plastic material; therefore customer manufacturing process selection must take this factor into consideration. This package is designed for direct solder and welding attachment methods. If a reflowed solder attachment method is preferred, customers must use an MSL 6 handling protocol.

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Revision History

Number	Date	Description
–	August 4, 2017	Initial release
1	July 30, 2019	Minor editorial updates
2	January 17, 2020	Updated Package Outline Drawing (page 11)

For the latest version of this document, visit our website:

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