

## High-Feature GMR Transmission Gear Tooth Sensor IC with Far Air Gap Range, Vibration Suppression, EMC Circuit, Test Pin Access

### FEATURES AND BENEFITS

- GMR technology senses at near or far air gap for optimal design-in flexibility
- Integrated EMC circuit protects against harsh supply line transients eliminating the need for a large bypass capacitor and twisted pair harness
- System compensation for vibration, mechanical shifts, and thermal gradients to ease controller burden and increase signal reliability
- Single-in-line overmolded package reduces tolerance stack of GMR IC, EMC protection, and magnet
- Test pin access for system characterization within application environment
- Speed or Speed and Direction output protocol allows single qualification to cover multiple applications

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### PACKAGE: 3-pin SIP (suffix ST)



*Not to scale*

### DESCRIPTION

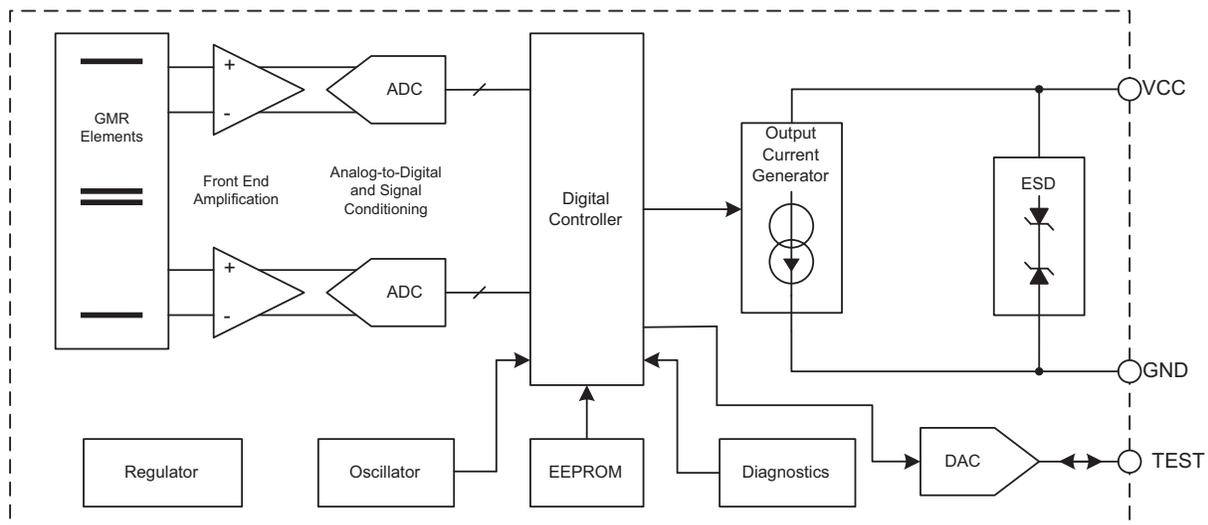
The ATS19581 is a giant magnetoresistance (GMR) integrated circuit (IC) with an extensive feature set for high levels of flexibility, reliability, and performance in transmission applications, including electric vehicles (EV), where speed or speed and direction information is required using ferromagnetic gear tooth targets.

Designed specifically for Automotive transmission applications, the ATS19581 has an on-chip EMC circuit and a small bypass capacitor capable of handling the harshest automotive requirements, including wire-to-wire coupling from unintended transient disturbances.

Built on Allegro's SolidSpeed digital architecture and state-of-the-art GMR technology, the sensor IC offers robust and reliable gear tooth sensing on a diverse set of ferromagnetic target geometries. Extensive application experience has been put into the algorithms, making the ATS19581 capable of compensating for system dynamics such as startup and running mode vibration, mechanical air gap jumps, and thermal gradients ensuring robust signal integrity and easing controller burden. Two available air gap ranges maximize installation flexibility and compatibility for small, spatially constrained systems.

To ensure robust performance in each unique system, the ATS19581 has test pin access to integral IC signals, making it possible to assess signal integrity and system-level compatibility

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**Figure 1: Functional Block Diagram**

### FEATURES AND BENEFITS (continued)

- IC measures differentially to reject common-mode stray magnetic fields
- Orientation compatible with Hall-effect technology for ease of drop-in replacement in existing designs
- Integrated ASIL diagnostics and certified safety design process (optional fault reporting)

### DESCRIPTION (continued)

during the development cycle, or for debug of production returns. To further simplify design-in to applications which have historically used Hall effect, the GMR-based IC is orientation-compatible with Hall-effect technology.

Keeping safety in mind, the ATS19581 has integrated diagnostics to detect an IC failure that would impact the output protocol's accuracy, providing coverage compatible with ASIL B(C). ASIL reporting can be enabled or disabled as a product offering, depending on the application's needs. In addition, EEPROM scratch memory provides factory traceability throughout the IC's product lifecycle.

The ATS19581 is provided in a single overmolded lead (Pb) free 3-pin SIP package (ST) with tin leadframe plating. The ST package includes a GMR IC, a magnet, and the EMC circuit, including the bypass capacitor. To maintain the sensor IC lead integrity, there is an additional molded lead-stabilizing bar for robust shipping and ease of assembly.

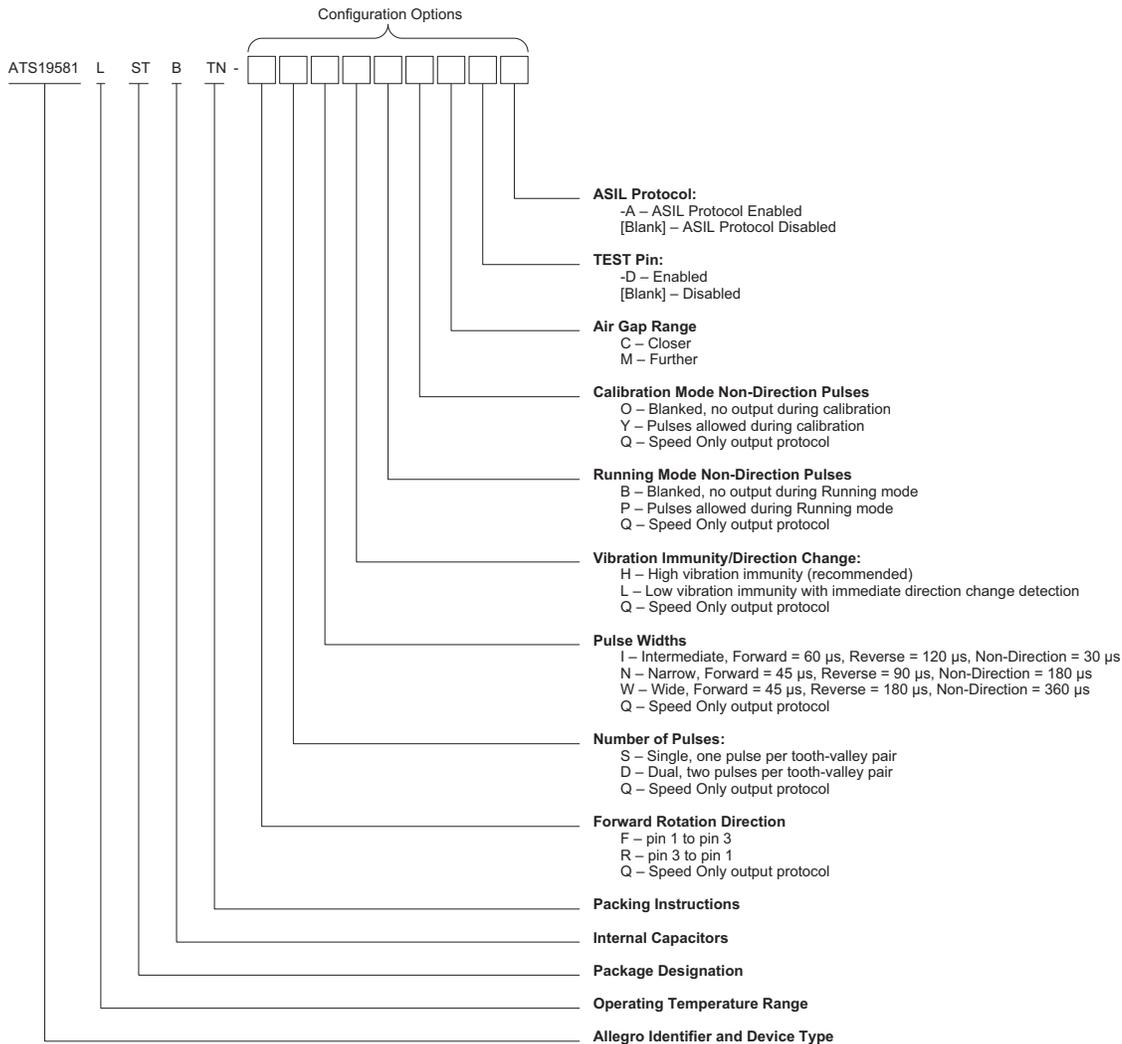
# ATS19581

## High-Feature GMR Transmission Gear Tooth Sensor IC with Far Air Gap Range, Vibration Suppression, EMC Circuit, Test Pin Access

### SELECTION GUIDE\*

Part Number	Packing	Fault Detection Mode	TEST Pin
ATS19581LSTBTN-FSWHPYM-A	Tape and reel, 13-in. reel, 800 pieces per reel	Enabled	Disabled
ATS19581LSTBTN-RSWHPYM	Tape and reel, 13-in. reel, 800 pieces per reel	Enabled	Disabled

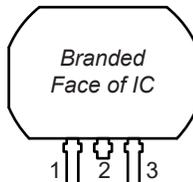
\* Not all combinations are available. Contact Allegro sales for availability and pricing of custom programming options.



### ABSOLUTE MAXIMUM RATINGS

Characteristic	Symbol	Notes	Rating	Units
Supply Voltage	$V_{CC}$	Refer to Power Derating section	28	V
Reverse Supply Voltage	$V_{RCC}$		-18	V
Test Pin Voltage	$V_{TEST}$		7	V
Test Pin Reverse Voltage	$V_{R(TEST)}$		0	V
Operating Ambient Temperature	$T_A$	Range L	-40 to 150	°C
Maximum Junction Temperature	$T_{J(max)}$		165	°C
Storage Temperature	$T_{stg}$		-65 to 170	°C
Externally Applied Magnetic Flux Density	B	In any direction	500	G

### PINOUT DIAGRAM AND TABLE



Package ST, 3-Pin SIP Pinout Diagram

Pinout Table

Number	Name	Function
1	VCC	Supply Voltage
2	TEST	Test Signals
3	GND	Ground

### Internal Components

Characteristic	Symbol	Notes	Rating	Units
Nominal Capacitance	$C_{SUPPLY}$	Connected between VCC and GND; refer to Figure 2	10	nF

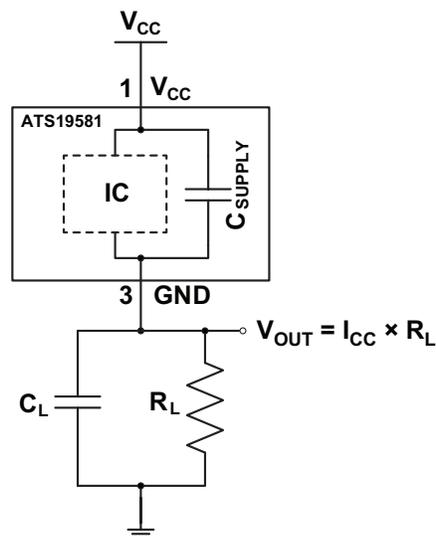


Figure 2: Typical Application Circuit

### OPERATING CHARACTERISTICS: Valid throughout full operating and temperature ranges, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ. [1]	Max.	Unit
<b>ELECTRICAL SUPPLY CHARACTERISTICS</b>						
Supply Voltage [2]	$V_{CC}$	Voltage across pin 1 and pin 3; does not include voltage across $R_L$	4	–	24	V
Undervoltage Lockout	$V_{CC(UV)}$		–	–	3.99	V
Reverse Supply Current [3]	$I_{RCC}$	$V_{CC} = -18$ V	-10	–	–	mA
Supply Current	$I_{CC(Low)}$	Non -D variants; low-current state	5.9	–	8	mA
	$I_{CC(HIGH)}$	Non -D variants; high-current state	12	–	16	mA
Supply Current Transient	$I_{CC(STEP)}$	See Functional Description	5.9	–	8.5	mA
Supply Current Ratio	$I_{CC(HIGH)} / I_{CC(Low)}$	Non -D variants; ratio of high current to low current (isothermal)	1.9	–	–	–
ASIL Safety Current	$I_{FAULT}$	Non -D variants	1.5	–	3.9	mA
<b>ELECTRICAL PROTECTION CHARACTERISTICS</b>						
Supply Zener Clamp Voltage	$V_{Zsupply}$	$I_{CC} = 19$ mA	28	–	–	V
Reverse Supply Zener Clamp Voltage	$V_{RZSUPPLY}$	$I_{CC} = -3$ mA	–	–	-18	V
<b>POWER-ON STATE CHARACTERISTICS</b>						
Power-On State	POS	$V_{CC} > V_{CC(min)}$		$I_{CC(Low)}$		–
Power-On Time [4]	$t_{PO}$	Time from $V_{CC} > V_{CC(min)}$ , until device has entered Calibration mode	–	–	1	ms
<b>OUTPUT CHARACTERISTICS</b>						
Output Rise Time	$t_r$	Voltage measured at pin 3 (see Figure 2), $R_L = 100 \Omega$ , $C_L = 10$ pF, measured between 10% and 90% of signal	0	2	4	$\mu$ s
Output Fall Time	$t_f$	Voltage measured at pin 3 (see Figure 2), $R_L = 100 \Omega$ , $C_L = 10$ pF, measured between 10% and 90% of signal	0	2	4	$\mu$ s
Overshoot	$I_{OS}$	Largest deviation of output signal from the final steady state value; rising or falling output transition; $R_L = 100 \Omega$ and $C_L = 10$ pF	–	10	–	%
Pulse Width, Fault	$t_{w(FAULT)}$	$R_L = 100 \Omega$ , $C_L = 10$ pF, pulse duration measured at threshold of $(I_{CC(Low)} + I_{FAULT}) / 2$	4	–	8	ms
				-A (ASIL) variant		

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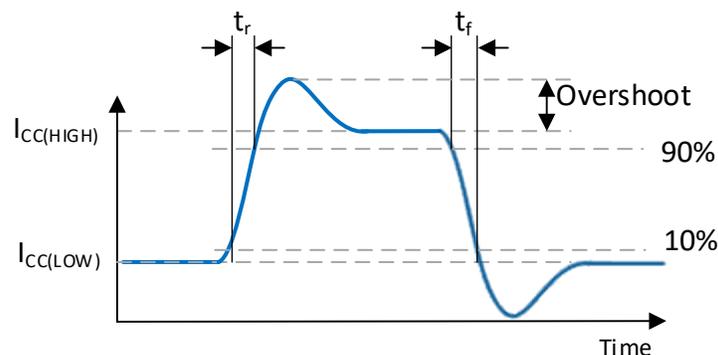


Figure 3: Definition of Rise Time, Fall Time, and Overshoot

**OPERATING CHARACTERISTICS (continued):** Valid throughout full operating and temperature ranges, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ. [1]	Max.	Unit
<b>NARROW PULSE WIDTH OPTION (-xSNxxxx variants) [5]</b>						
Pulse Width, Forward Rotation	$t_{W(FWD)}$		38	45	52	$\mu\text{s}$
Pulse Width, Reverse Rotation	$t_{W(REV)}$		76	90	104	$\mu\text{s}$
Pulse Width, Non-Direction	$t_{W(ND)}$		153	180	207	$\mu\text{s}$
Operating Frequency, Forward Rotation	$f_{FWD}$		0	–	12	kHz
Operating Frequency, Reverse Rotation [6]	$f_{REV}$		0	–	7	kHz
Operating Frequency, Non-Direction Pulses [6]	$f_{ND}$		0	–	4	kHz
<b>WIDE PULSE WIDTH OPTION (-xSWxxxx variants) [5]</b>						
Pulse Width, Forward Rotation	$t_{W(FWD)}$		38	45	52	$\mu\text{s}$
Pulse Width, Reverse Rotation	$t_{W(REV)}$		153	180	207	$\mu\text{s}$
Pulse Width, Non-Direction	$t_{W(ND)}$		306	360	414	$\mu\text{s}$
Operating Frequency, Forward Rotation	$f_{FWD}$		0	–	12	kHz
Operating Frequency, Reverse Rotation [6]	$f_{REV}$		0	–	4	kHz
Operating Frequency, Non-Direction Pulses [6]	$f_{ND}$		0	–	2.2	kHz
<b>INTERMEDIATE PULSE WIDTH OPTION (-xSIxxxx variants) [5][7]</b>						
Threshold to Enter High-Speed Mode	$f_{HIGH}$	Increasing $T_{CYCLE}$ frequency	0.935	1.1	1.265	kHz
Threshold to Exit High-Speed Mode	$f_{LOW}$	Decreasing $T_{CYCLE}$ frequency	0.85	1	1.15	kHz
Pulse Pre-Low Length	$t_{W(PRE)}$		25	30	35	$\mu\text{s}$
Pulse Width, Forward Rotation	$t_{W(FWD)}$	$T_{CYCLE}$ frequency < $f_{LOW}$	51	60	69	$\mu\text{s}$
Pulse Width, Reverse Rotation	$t_{W(REV)}$	$T_{CYCLE}$ frequency < $f_{LOW}$	102	120	138	$\mu\text{s}$
Pulse Width, Non-Direction	$t_{W(ND)}$		25	30	35	$\mu\text{s}$
Pulse Width, High Speed	$t_{W(HS)}$	$T_{CYCLE}$ frequency > $f_{HIGH}$	25	30	35	$\mu\text{s}$
Operating Frequency, Forward Rotation	$f_{FWD}$	Direction information is not available when frequency > $f_{HIGH}$	0	–	12	kHz
Operating Frequency, Reverse Rotation	$f_{REV}$	Direction information is not available when frequency > $f_{HIGH}$	0	–	12	kHz
Operating Frequency, Non-Direction Pulses	$f_{ND}$	Direction information is not available when frequency > $f_{HIGH}$	0	–	12	kHz

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**OPERATING CHARACTERISTICS (continued):** Valid throughout full operating and temperature ranges, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ. [1]	Max.	Unit	
<b>DIRECTION DETECTION OPTIONS (-FXXXXXX AND -RXXXXXX VARIANTS)</b>							
Operational Air Gap Range [8]	AG	Using Reference Target 60-0, tested at 1000 rpm	-xxxxxC variant	0.8	–	3.8	mm
			-xxxxxM variant	1.5	–	4.5	mm
Operate Point	B <sub>OP</sub>	Percentage of IC processed magnetic signals; see Figure 5	–	70	–	%	
Release Point	B <sub>RP</sub>	Percentage of IC processed magnetic signals; see Figure 5	–	30	–	%	
<b>PERFORMANCE CHARACTERISTICS (-FXXXXXX AND -RXXXXXX VARIANTS)</b>							
Initial Calibration	T <sub>CAL</sub>	Amount of target rotation (constant direction) after t <sub>PO</sub> to first valid speed and direction output; see Figure 4	–	–	4	T <sub>CYCLE</sub>	
Vibration Immunity (Startup)		Refer to Functional Description section	1	–	–	T <sub>CYCLE</sub>	
Vibration Immunity (Running Mode)		Refer to Functional Description section	1	–	–	T <sub>CYCLE</sub>	
Switch Point Separation			See Target Design Section				
Target Tooth-to-tooth Variation		Using Reference Target 60-0 [9], correct output sequence	–	0.25	–	mm	
Total Air Gap Variation During Operation		Momentary interruptions in output sequence permitted; operation within AG range	–3	–	3	mm	
<b>SPEED ONLY OUTPUT PROTOCOL OPTION (-QQQQQX VARIANTS)</b>							
Operational Air Gap Range [8]	AG	Using Reference Target 60-0, tested at 1000 rpm	-QQQQQXM variant	1.5	–	4.5	mm
Extended Air Gap Range	AG <sub>EXT</sub>	Output duty cycle may be degraded	-QQQQQXM variant	0.5	–	–	mm
Operate Point	B <sub>OP</sub>	Percentage of IC processed magnetic signal. See Figure 5	–	70	–	%	
Release Point	B <sub>RP</sub>	Percentage of IC processed magnetic signal. See Figure 5	–	30	–	%	
<b>PERFORMANCE CHARACTERISTICS (-QQQQQX VARIANTS)</b>							
Initial Calibration	T <sub>CAL</sub>	Amount of target rotation (constant direction) following t <sub>PO</sub> until first electrical output transition see Figure 4	–	–	1.5	T <sub>CYCLE</sub>	
Target Tooth-to-Tooth Variation		Using Reference Target 60-0 [9], Correct output sequence	–	0.25	–	mm	
Total Air Gap Variation During Operation		Momentary interruptions in output sequence permitted; operation within AG range	–4	–	4	mm	
Output Duty Cycle Tolerance [10]	ΔD	Using Reference Target 60-0 at any static air gap within AG. Limits applied to maximum and minimum measurement for one full revolution of the target, around a mean value established by average value of the IC population at the given AG.	–10	–	10	%	

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**OPERATING CHARACTERISTICS (continued): Valid throughout full operating and temperature ranges, unless otherwise specified**

Characteristic	Symbol	Test Conditions	Min.	Typ. [1]	Max.	Unit
<b>THERMAL CHARACTERISTICS</b>						
Package Thermal Resistance [11]	$R_{\theta JA}$	Single-layer PCB with copper limited to solder pads	–	150	–	°C/W

[1] Typical values are at  $V_{CC} = 5\text{ V}$  and  $T_A = 25^\circ\text{C}$ , unless otherwise specified. Performance may vary for individual units, within the maximum and minimum limits.

[2] Maximum voltage must be adjusted for power dissipation and junction temperature; see Power Derating section.

[3] Negative current is defined as conventional current coming out of (sourced from) the specified device terminal.

[4] Output transients prior to  $t_{PO}$  should be ignored.

[5]  $R_L = 100\ \Omega$  and  $C_L = 10\ \text{pF}$ . Pulse duration measured at threshold of  $(I_{CC(HIGH)} + I_{CC(LOW)}) / 2$ .

[6] Maximum Operating Frequency is determined by satisfactory separation of output pulses. If shorter low-state durations can be resolved, the maximum  $f_{REV}$  and  $f_{ND}$  may be higher.

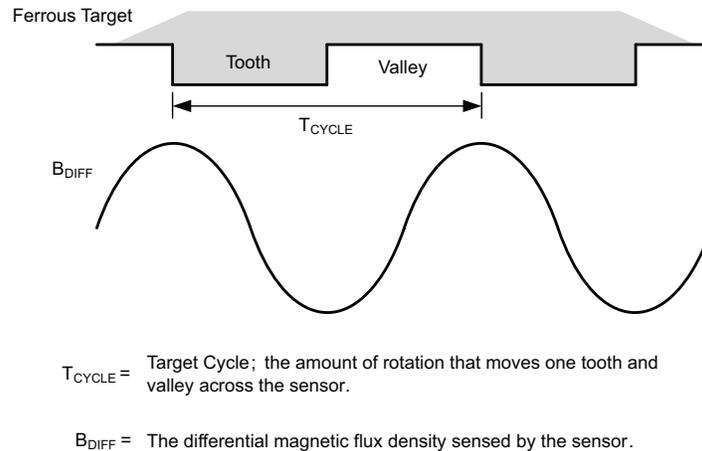
[7] Direction information is not available in High-Speed mode with Intermediate Pulse Width variant.

[8] Operating air gap is dependent on the available magnetic field. The available field is target geometry and material dependent and should be independently characterized.

[9] To determine IC's tolerance to air gap variations on other targets, the complete magnetic system must be analyzed. Due to the nature of the GMR system, contact Allegro for assistance in assessing other targets for use with ATS19581.

[10] Limit applied pertains to full-scale of 0 to 100%, not as a percentage of measured duty cycle.

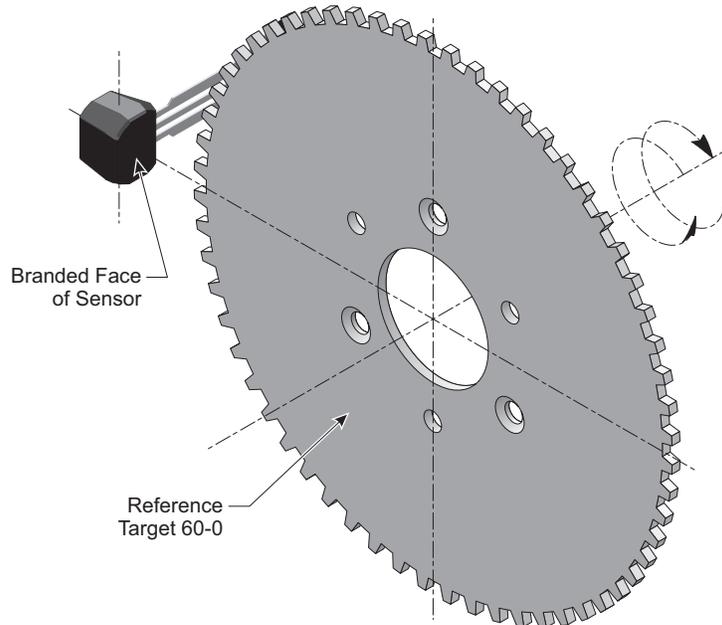
[11] Additional thermal information is available on the Allegro website.



**Figure 4: Definition of  $T_{CYCLE}$**

### REFERENCE TARGET 60-0 (60-TOOTH TARGET)

Characteristics	Symbol	Test Conditions	Typ.	Units	Symbol Key
Outside Diameter	$D_o$	Outside diameter of target	120	mm	
Face Width	F	Breadth of tooth, with respect to branded face	6	mm	
Circular Tooth Length	t	Length of tooth, with respect to branded face	3	degrees	
Circular Valley Width	$t_v$	Length of valley, with respect to branded face	3	degrees	
Tooth Whole Depth	$h_t$		3	mm	
Material		Low Carbon Steel	-	-	



### FUNCTIONAL DESCRIPTION

#### Sensing Technology

The sensor IC contains on-chip GMR elements that are used to detect magnetic signals created by an adjacent target. These transducers provide electrical signals containing information regarding edge position and direction of target rotation. The ATS19581 is intended for use with ferromagnetic targets.

After proper power is applied to the sensor IC, it is capable of providing digital information that is representative of the features of a rotating target. The waveform diagrams in Figure 5 present the automatic translation of the target profiles, through their induced magnetic profiles, to the digital output signal of the sensor IC.

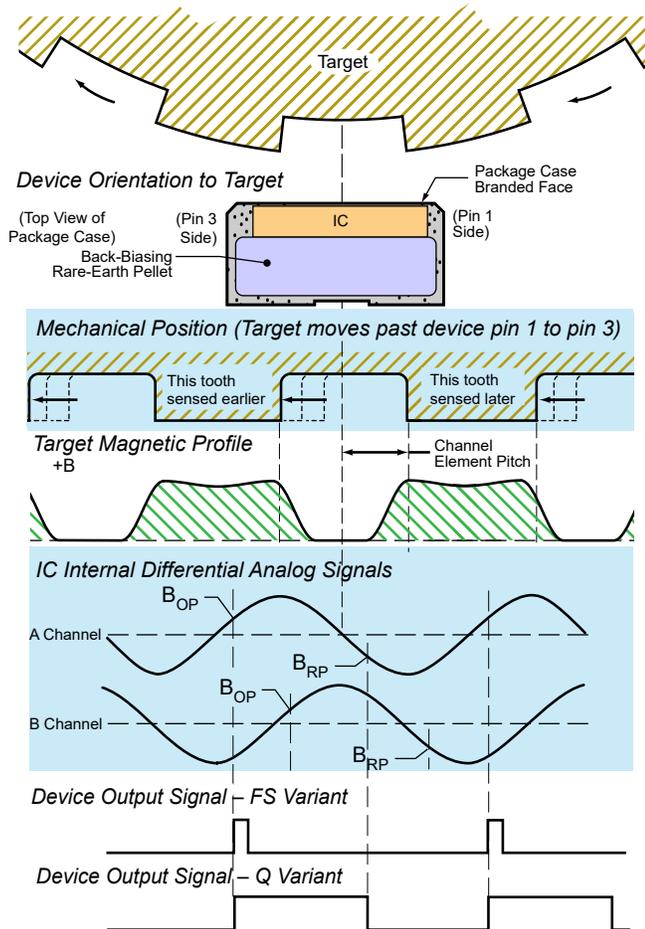


Figure 5: Magnetic Profile

#### Data Protocol – Speed Only

When a target passes in front of the device (opposite the branded face of the package case), the ATS19581 “Q” variant generates one electrical output edge per target mechanical edge.

#### Data Protocol – Direction Detection

When a target passes in front of the device (opposite the branded face of the package case), the ATS19581 “FS” and “RS” variants generate an output pulse for each tooth-valley pair of the target. Speed information is provided by the output pulse rate, while direction of target rotation is provided by the duration of the output pulse. The sensor IC can sense target movement in both the forward and reverse direction.

#### VARIANTS

Figure 6 shows forward and reverse rotation for the “F” variant of the sensor IC, where forward is defined as target motion from pin 1 to 3. The sensor IC can also be factory-programmed for the opposite definition (“R” variant), where forward is defined as target motion from pin 3 to 1.

The “D” variant provides an output pulse for each tooth and each valley of the target. Note that target design is critical in order that periods between each pulse is constant.

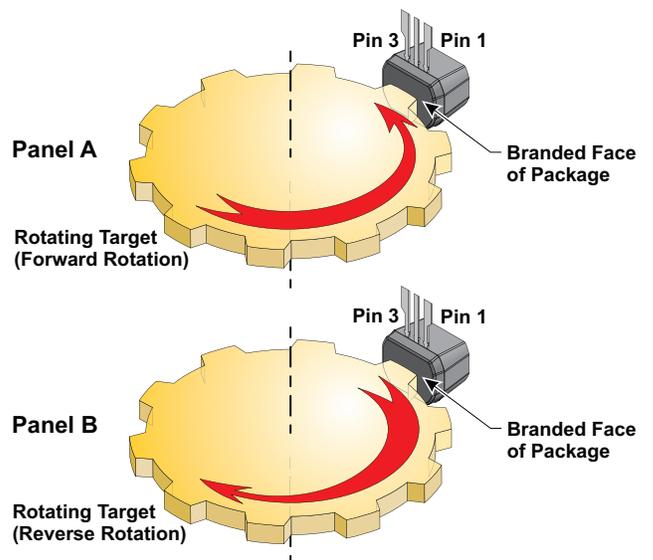


Figure 6: Target Rotation (“F” Variant Shown)

### Power-On (Calibration)

After power is applied to the sensor IC, the IC internally detects the magnetic profile of the target. Operation begins with a calibration period. With direction variants (“-F” or “-R” suffix), the sensor IC does not provide direction information until constant

direction of rotation is determined. With the “Y” variant, non-directional pulses ( $t_{W(ND)}$ ) are present during calibration.

With the speed only protocol, the sensor IC provides output edges during calibration. Full edge accuracy may not be achieved until Calibration is complete.

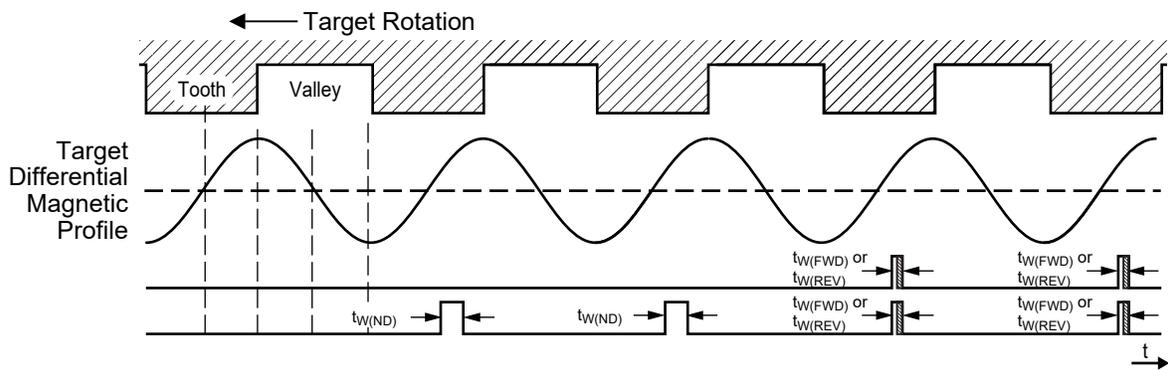


Figure 7: Output options after power-on (“-FS” or “-RS”)

### Vibration

The IC has vibration detection ability, where vibration is defined as multiple changes in target direction within the vibration immunity specification. Two vibration output protocols are available,

where the first change in direction may be provided to the output or may be suppressed. Options are also available such that non-direction pulses may be provided during the vibration event until constant target rotation is validated.

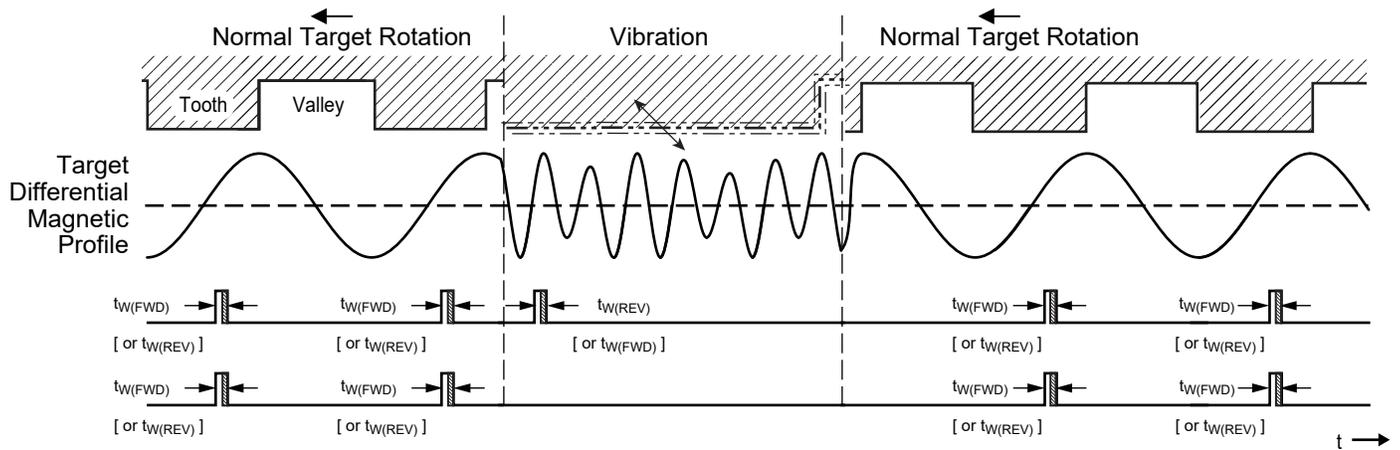


Figure 8: Vibration output protocol options

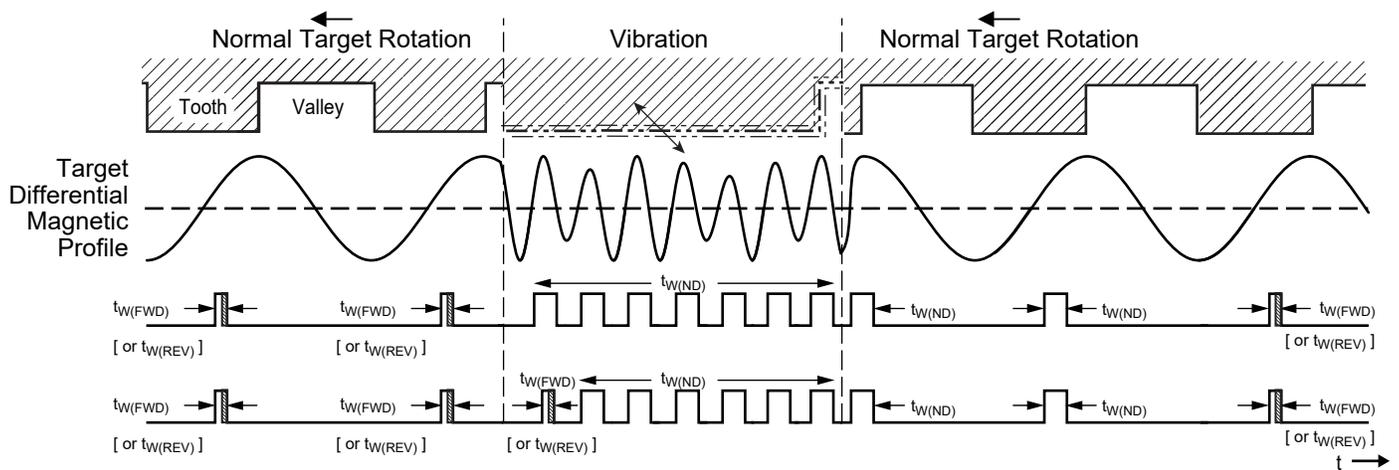


Figure 9: Output protocol options with non-direction pulses

### ASIL Safe State

The ATS19581 sensor IC contains diagnostic circuitry that will continuously monitor occurrences of failure defects within the IC. Refer to Figure 10 for the output protocol of the ASIL Safe.

Refer to the ATS19581 Safety Manual for additional details.

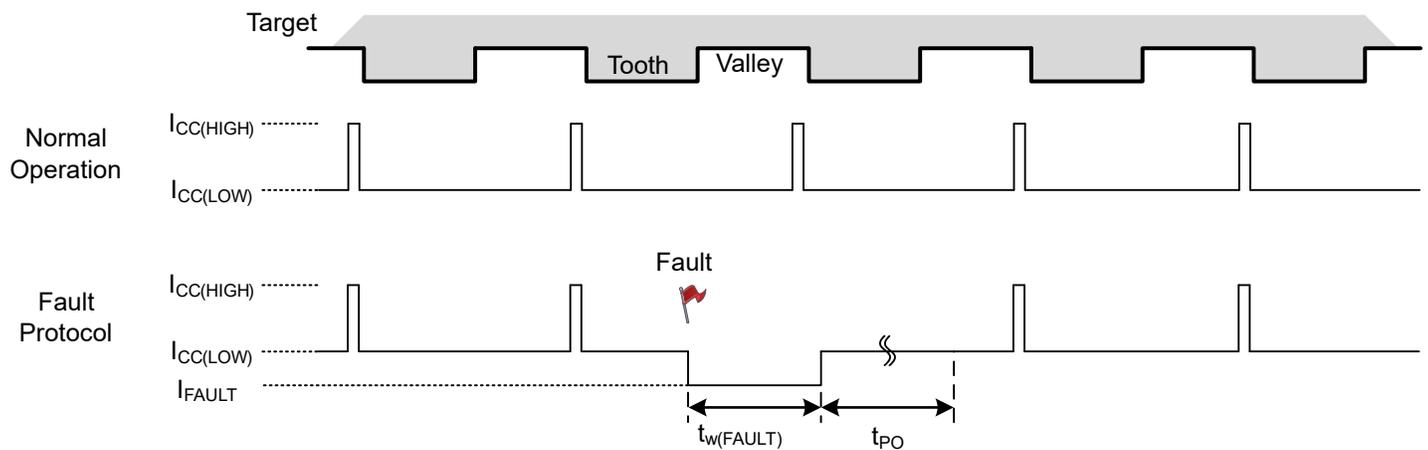


Figure 10: Output Protocol (ASIL Safe State)

### Target Design

The ATS19581 is designed to work with a variety of target shapes and sizes in addition to the Reference Target 60-0 in this data-sheet. To determine the operating air gap range for each target, as well as the suitability for proper direction and vibration detection, the magnetic profile of each must be analyzed. The signals available on the TEST pin of the -D variant can aid in the system compatibility analysis.

### TEST Pin Signals

Multiple signals are available, one at a time, via the TEST pin on the -D variant. These analog signals may be used to judge the robustness of the sensor operation within the system, or to real-time diagnose or characterize system behaviors. The dedicated test pin allows the sensor to continue to operate uninterrupted during these investigations, with the sensor IC sending output signals to the control unit while simultaneously providing diagnostic signals.

Included in the TEST pin signal list are the two detected magnetic channels (A Channel and B Channel, from Figure 5). Figure 11 shows example analog output signals from the TEST pin; note that output and A Channel were collected simultaneously; B Channel was recorded and synchronized to the A Channel using a reference encoder signal (not shown).

Also available on the test pin are several signals for assessing goodness of magnetic signals by querying the IC's algorithm itself. One example is shown in Figure 12. At the left, output signal is correct; the Target Assessment signal is above the assigned threshold, thus showing magnetic input signals are good. On the right, that Target Assessment signal has fallen below the threshold, indicating insufficient signal margin to operate correctly; this is overtly shown by missing output pulses.

With -D variant, signals are commanded via a sequence of voltages applied to the TEST pin. This allows user to select which signal is active, as well as change offset and gain scaling on some analog signals. Contact your local technical support for more information regarding the use of the TEST pin.

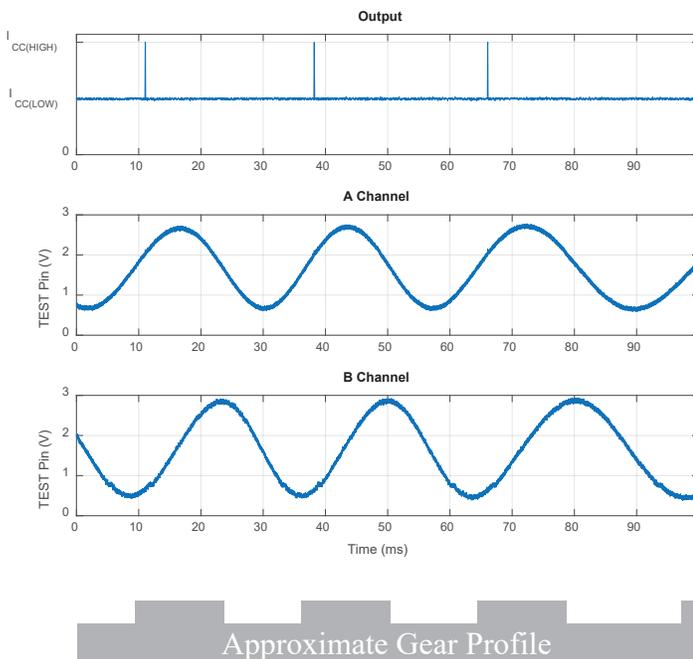


Figure 11: Example TEST Pin Signals

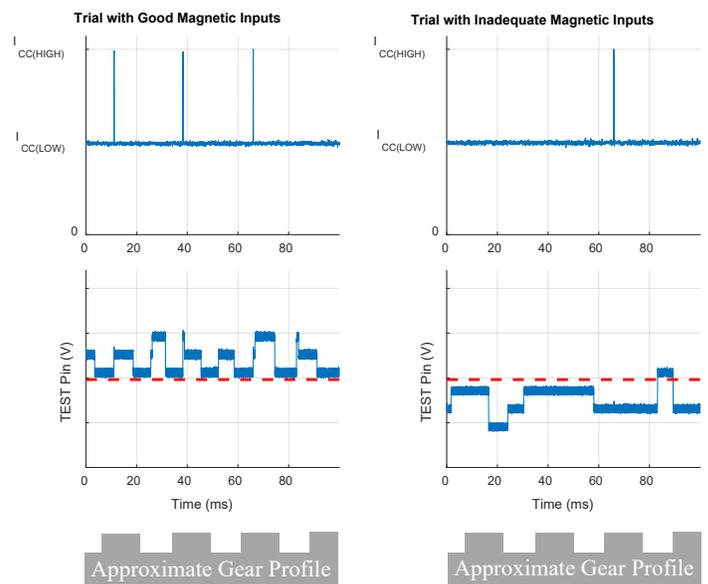


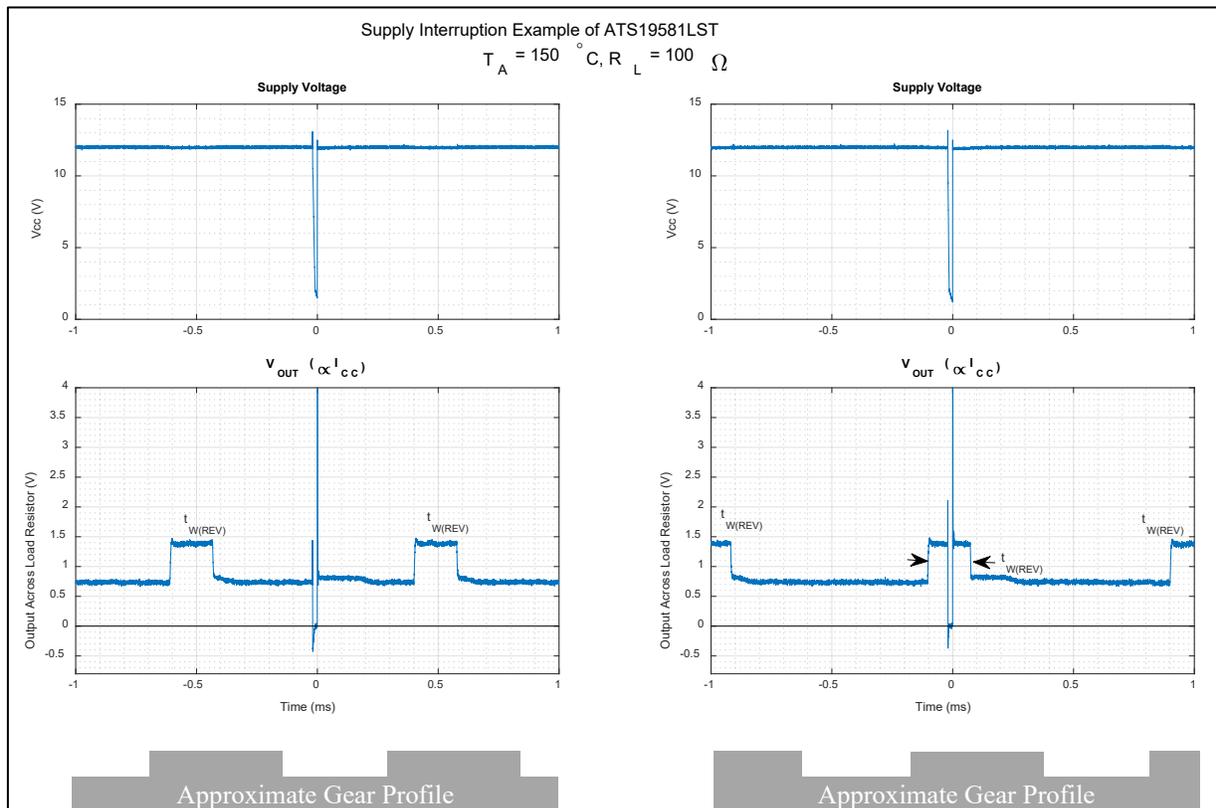
Figure 12: Example of Target Assessment signal. (a) at left, shows good signals, above threshold of goodness (b) at right, signal is below threshold

### Supply Line Interruptions

The integrated EMC capabilities of the ATS19581 in the ST package enables improved performance to momentary supply voltage interruptions.

Figure 13 shows an example of the IC continued operation in the presence of a supply interruption event. Note that the output sequence of pulses continues after the supply disruption, indicating operation of the IC is uninterrupted.

Bench characterization has shown uninterrupted operation for supply cuts of  $55 \mu\text{s}$  for  $T_A = 150^\circ\text{C}$ , and in excess of  $90 \mu\text{s}$  at  $T_A = -40^\circ\text{C}$ . Values are expected to be altered with different voltage and resistor values; contact your local technical support for more information regarding micro-cut performance.



**Figure 13: Example of ATS19581 continued operation in presence of  $20 \mu\text{s}$  supply voltage interruption**  
**(a) at left, supply interruption with output in  $I_{CC(Low)}$**   
**(b) at right, supply interruption with output in  $I_{CC(High)}$**

### Supply Current Transient

The IC consumes a small additional current, for a short duration, in response to abrupt increases in supply voltage. In a typical application with a low-side sense resistor (see Figure 2), a small voltage transient occurs on each output pulse. As the specification  $I_{CC(STEP)}$  is intended to cover all voltage transients within allowable  $V_{CC}$  range,  $I_{CC(STEP)}$  magnitudes expected in application are closer to the  $I_{CC(LOW)}$  range. Characteristic output profiles are shown in the following figures, for  $R_L = 100$  and  $250 \Omega$  and  $V_{SUPPLY} = 9$  V.

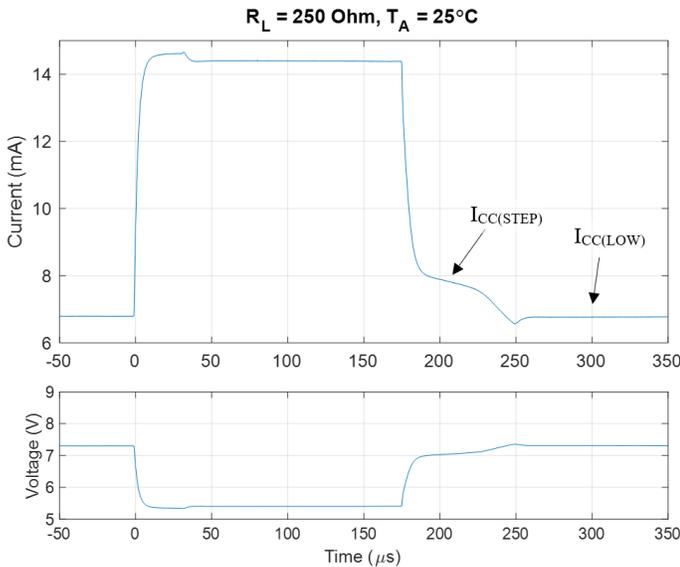


Figure 14

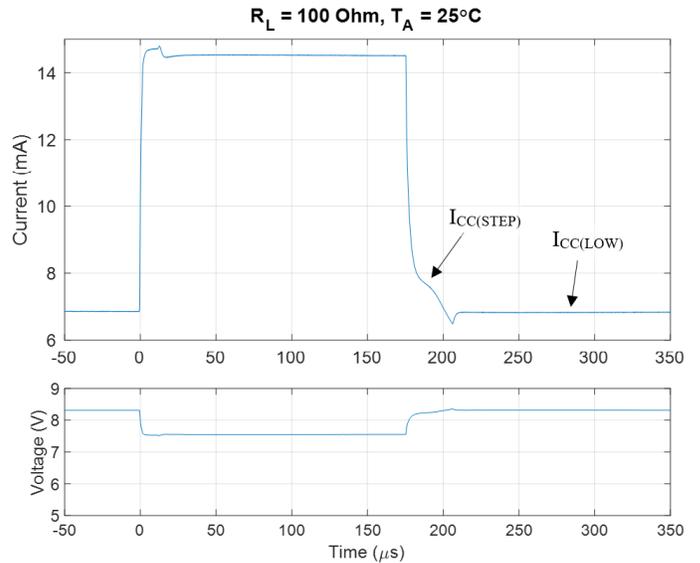


Figure 15

### 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 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  $P_D$ .

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

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

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

For example, given common conditions such as:  $T_A = 25^\circ C$ ,  $V_{CC} = 12 V$ ,  $I_{CC} = 7.0 mA$ , and  $R_{\theta JA} = 150^\circ C/W$ , then:

$$P_D = V_{CC} \times I_{CC} = 12 V \times 7.0 mA = 84 mW$$

$$\Delta T = P_D \times R_{\theta JA} = 84 mW \times 150^\circ C/W = 12.6^\circ C$$

$$T_J = T_A + \Delta T = 25^\circ C + 12.6^\circ C = 37.6^\circ C$$

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  $T_A = 150^\circ C$ , package SN, using a single-layer PCB.

Observe the worst-case ratings for the device, specifically:  $R_{\theta JA} = 150^\circ C/W$ ,  $T_{J(max)} = 165^\circ C$ ,  $V_{CC(max)} = 24 V$ , and  $I_{CC(avg)} = 16 mA$  (using Q variant).

Calculate the maximum allowable power level,  $P_{D(max)}$ . First, invert equation 3:

$$\Delta T_{max} = T_{J(max)} - T_A = 165^\circ C - 150^\circ C = 15^\circ C$$

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

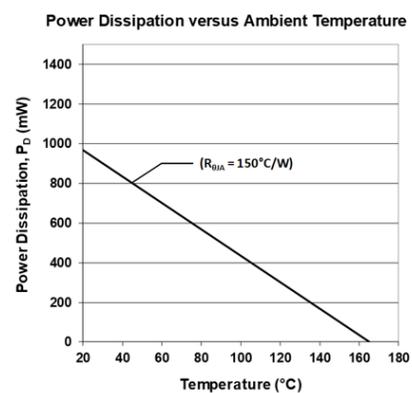
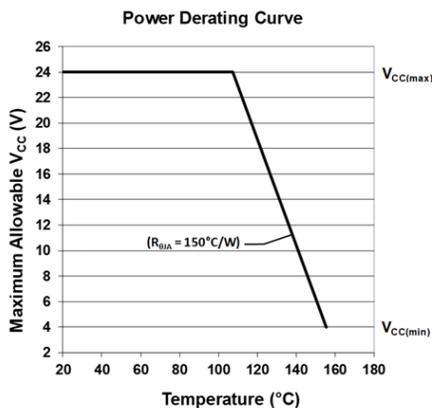
$$P_{D(max)} = \Delta T_{max} \div R_{\theta JA} = 15^\circ C \div 150^\circ C/W = 100 mW$$

Finally, invert equation 1 with respect to voltage:

$$V_{CC(est)} = P_{D(max)} \div I_{CC(avg)} = 100 mW \div 16 mA = 6.3 V$$

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

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





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# ATS19581

## High-Feature GMR Transmission Gear Tooth Sensor IC with Far Air Gap Range, Vibration Suppression, EMC Circuit, Test Pin Access

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### Revision History

Number	Date	Description
–	March 24, 2023	Initial release
1	July 23, 2024	Updated ASIL compatibility (page 2)

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