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A19520 / ATS19520 SENSOR IC OUTPUTS UNDER VIBRATION CONDITIONS

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INTRODUCTION

This application note details the Allegro A19520 and ATS19520 sensor IC outputs for general target and sensor vibration scenarios.

SENSOR OPTIONS

The following character pairs, as observed in A/ATS19520 datasheets, will be outlined throughout the document:

- **Vibration Immunity/Direction Change:**

  L – Low vibration immunity with immediate direction change detection

  H – High vibration immunity

- **Running Mode Non-Direction Pulses**

  B – Blanked, no output during Running mode

  P – Pulses allowed during Running mode

- **Calibration Mode Non-Direction Pulses**

  O – Blanked, no output during Calibration

  Y – Pulses allowed during Calibration

A19520LUB
2-Pin SIP
(package suffix UB)
Not to scale

ATS19520LSN
3-Pin SIP with integrated back-biased magnet
(package suffix SN)
Not to scale

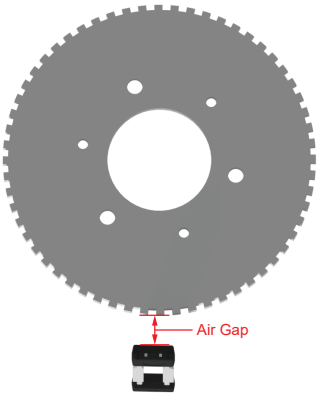

Figure 1: Air Gap

VIBRATION DEFINITION

Oscillatory (back-and-forth) motion of the target angle or air gap position without net displacement. Vibration considered is either angular or air gap variation, and not the combination of the two. Sensor outputs contained herein are only for in-specification target and sensor motions.

IMMUNITY DEFINITION

The sensor shall not have unexpected output direction pulses when exposed only to air gap or angular vibration with amplitude at least up to datasheet specified values.

T_{CYCLE} DEFINITION

This Allegro-specific term is used when the sensed target has the same tooth-valley pitch around its circumference. When this condition is true, it is valid to specify multiple tooth-valley pairs as (n × T_{CYCLE}) because each T_{CYCLE} is the same amount of angular target rotation. Looking at Figure 2, a single T_{CYCLE} is observed as one "peak" of B_{DIFF} to an immediate next "peak" of B_{DIFF}. Figure 2 shows a single B_{DIFF} channel. In the A/ATS19520, two channels exist and are referred to as "Channel A" and "Channel B".

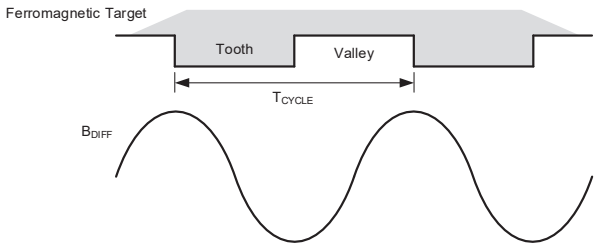

Figure 2: T_{CYCLE} Reference

AIR GAP VIBRATION DEFINITION

Air gap vibration is defined as vibration of the distance between the sensor and a stationary target. Reference Figure 1 indicating how air gap is determined, and Figure 3 which depicts example magnetic signals of the A/ATS19520 under this air gap vibration condition. This example shows the two sensor channels are experiencing a 180° out-of-phase signal relationship during the air gap only vibration sequence. Air gap vibrations do not always have this effect; magnetic channels are impacted differently based on the position of the tooth versus the sensor. Each magnetic channel of the A/ATS19520 are differential, making it an "edge detector"; therefore, air gap vibrations over a tooth edge will have a much larger impact as compared to any other location on the target.

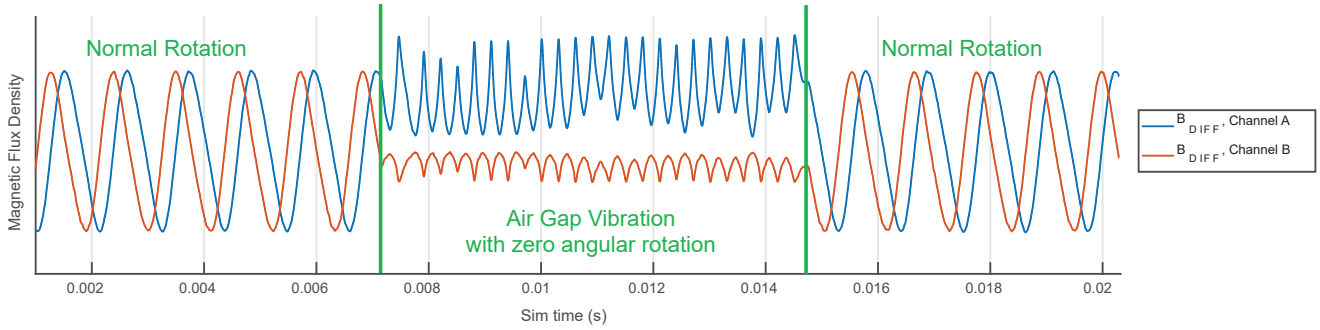

Figure 3: Magnetic profiles for example of air gap vibration

ANGULAR VIBRATION DEFINITON

Angular vibration is defined as vibration of only the target angular motion. Reference Figure 4 which depicts the magnetic signals of the A/ATS19520 under this target angular vibration condition. This example shows target angular motion where the maximum amount of rotation between each direction change is less than 1 T_{CYCLE}.

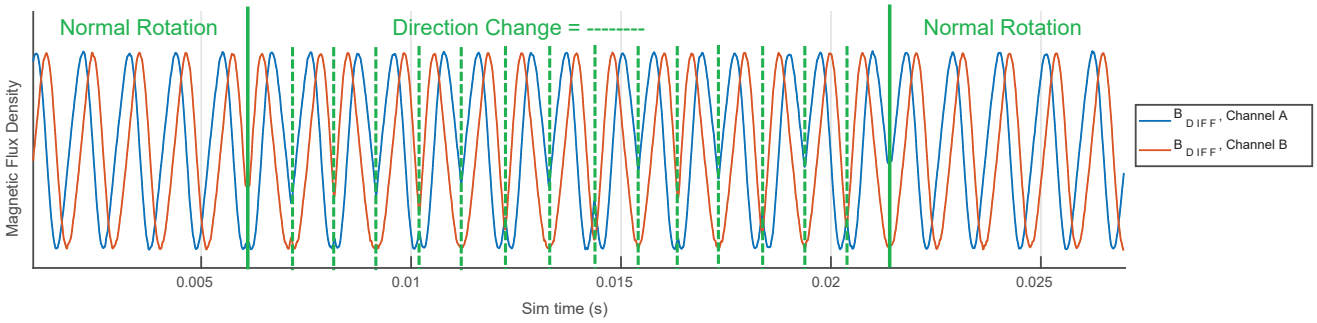

Figure 4: Target angular vibration example

Calibration Mode

Calibration mode is the state the sensor starts at immediately following a power-on event. In this mode of operation, the sensor is in the process of validating target direction and is already in a state of "vibration detected". Due to this condition, the immunity to vibrating stimulus, whether it be air gap or angular motion, will be the same for both "-L" and "-H" options with performance attributes matching that of "-H" in running mode. From the datasheet, it is guaranteed the sensor will give proper direction information by 4 T_{CYCLE}, given continuous target rotation of the same direction. The option exists to blank or give non-directional pulses in Calibration mode; see Figure 5. Upon the delivery of proper direction information, the sensor will leave Calibration mode and enter Running mode.

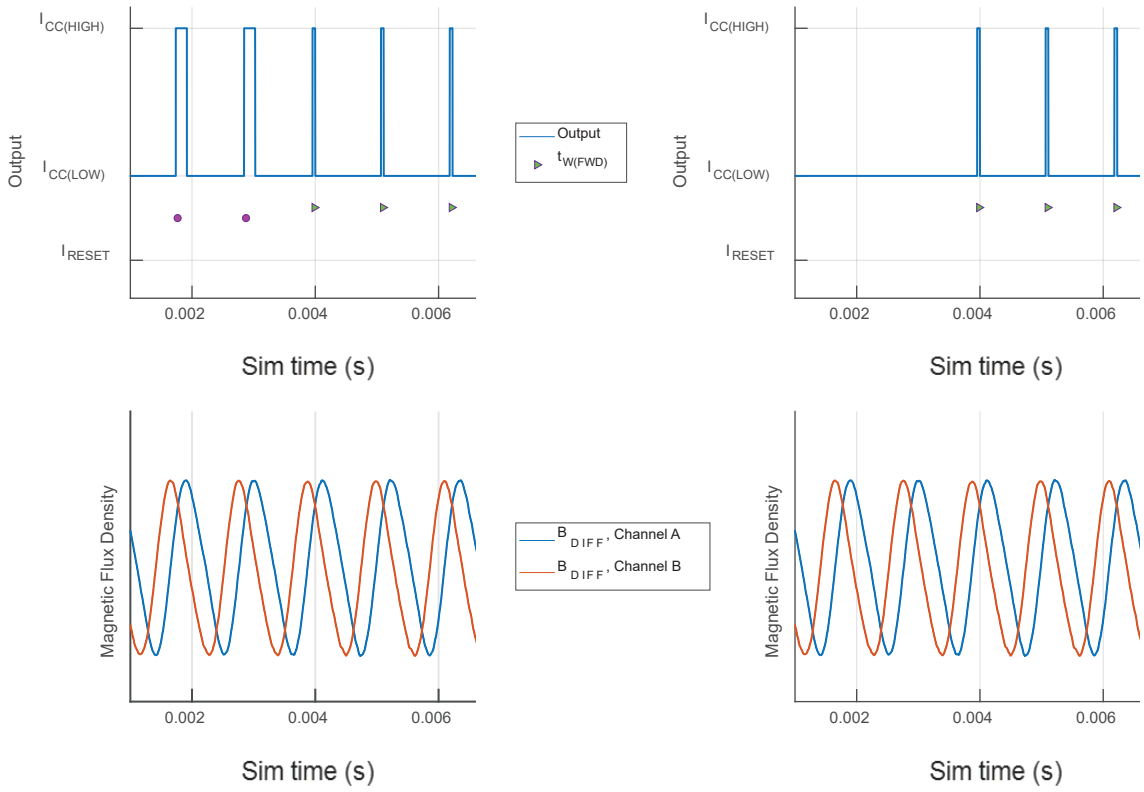

Figure 5: Calibration mode "-O" vs. "-Y"

"-H" and "-L" with Air Gap Vibration (Running Mode)

For an air gap only vibration scenario, the A/ATS19520 will be immune to giving repeated directional pulse information. The "-H" and "-L" options may have different behavior.Reference Figure 6 where the sensor IC output is observed showing no direction information communicated between time 7.2 to 14.7 ms. The "-P" option is allowing for non-directional pulses to persist if Channel A is crossing the calculated switch point during the detected vibration sequence. For the case of the "-L" option, Figure 7 shows a directional pulse was communicated by the sensor IC during air gap vibration. Because this is the "-L" option, a single pulse occurrence during the sequence may occur.

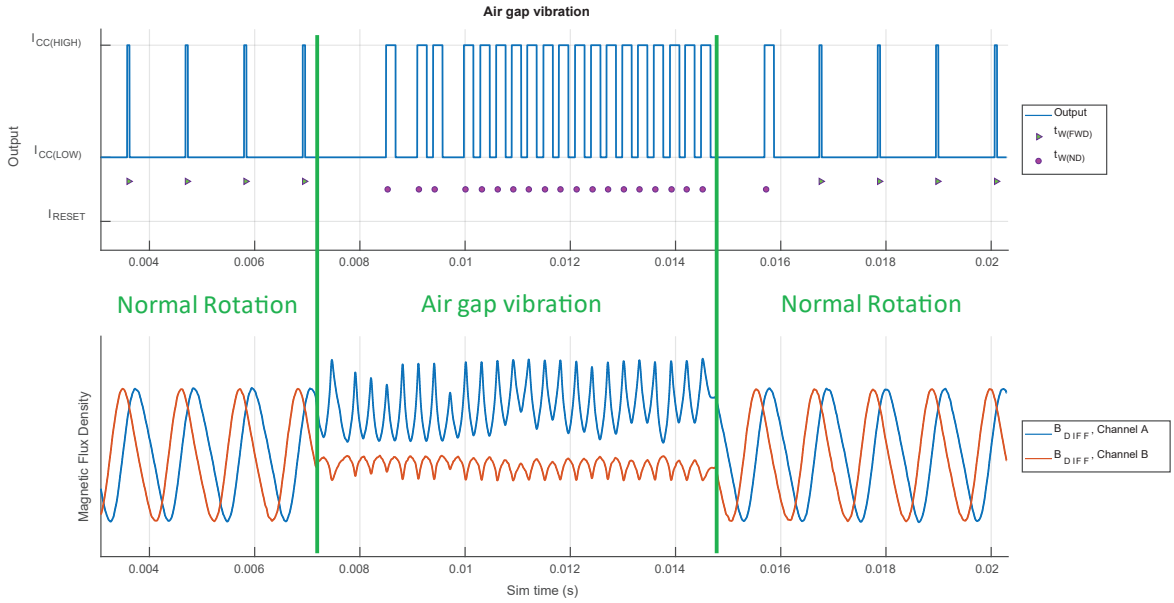

Figure 6: "-HP" option under air gap vibration (non-direction pulses are blanked for "-HB" option)

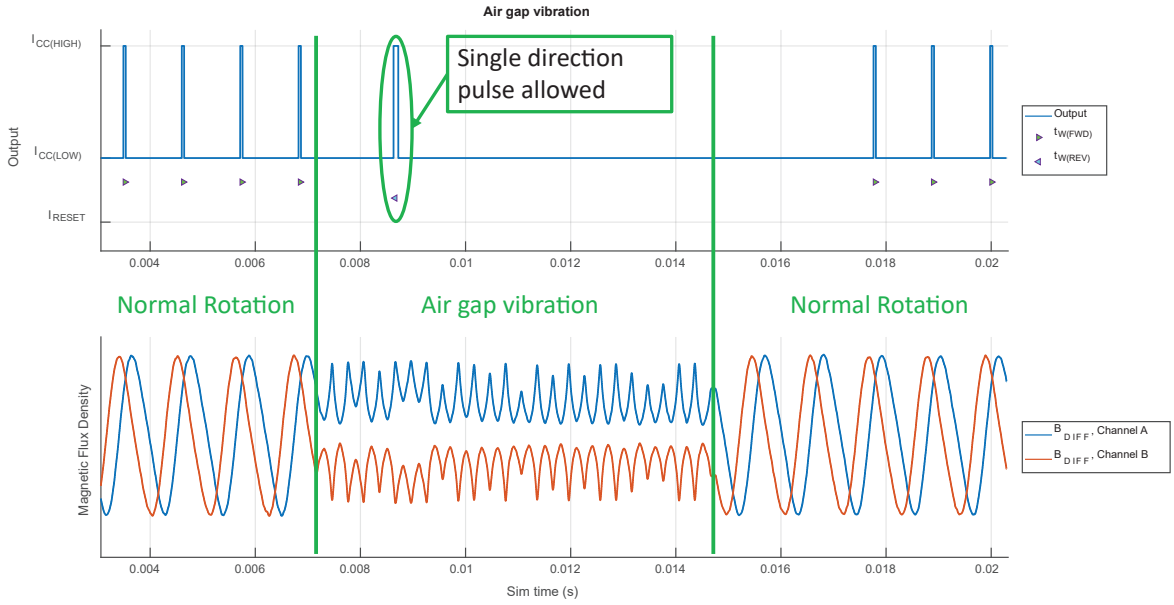

Figure 7: "-LB" option under air gap vibration (non-direction pulses may be output depending on magnetic signal profile for the "-LP" option)

"-H" and "-L" with Angular Vibration (Running Mode)

Angular target motion captures a clear picture of the performance difference between the "-L" and "-H" options. The "-H" option observed in Figure 8, is designed to immediately detect vibration, which means that any time the sensor observes a single change in direction, it will cease to communicate direction information until a target rotational movement of continuous direction for 3.5 T_{CYCLE} [1] (worst case) is observed. The key advantage of this option is if 1 T_{CYCLE} or less of angular vibration is occurring, no directional information will be communicated during this vibration.

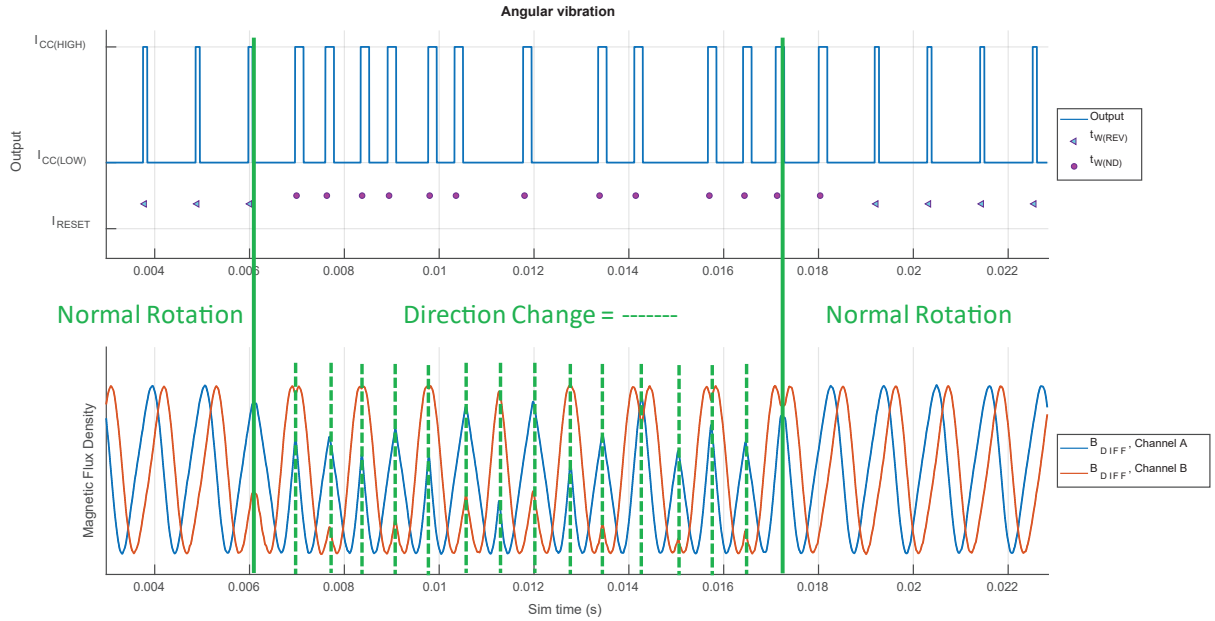

Figure 8: "-HP" option under angular vibration

[1] Based on Allegro Reference Target 60-0 (see ATS19520 datasheet).

The "-L" option observed in Figure 9 is designed to delay the detection of vibration until two direction changes are detected within five switch point crossings on Channel A. This means vibration detection may be delayed until 2.5 T_{CYCLE}[1], although after vibration is detected by the sensor, the 1 T_{CYCLE} immunity remains. This "delayed detection" is seen in Figure 9, where at the beginning of the angular vibration sequence, a single reverse direction pulse is communicated. Because this is the "-L" option, a single pulse occurrence during the vibration sequence is expected. The key advantage of this option is the single direction change case because the indication of a target direction change occurs as soon as a switch point on Channel A is crossed.

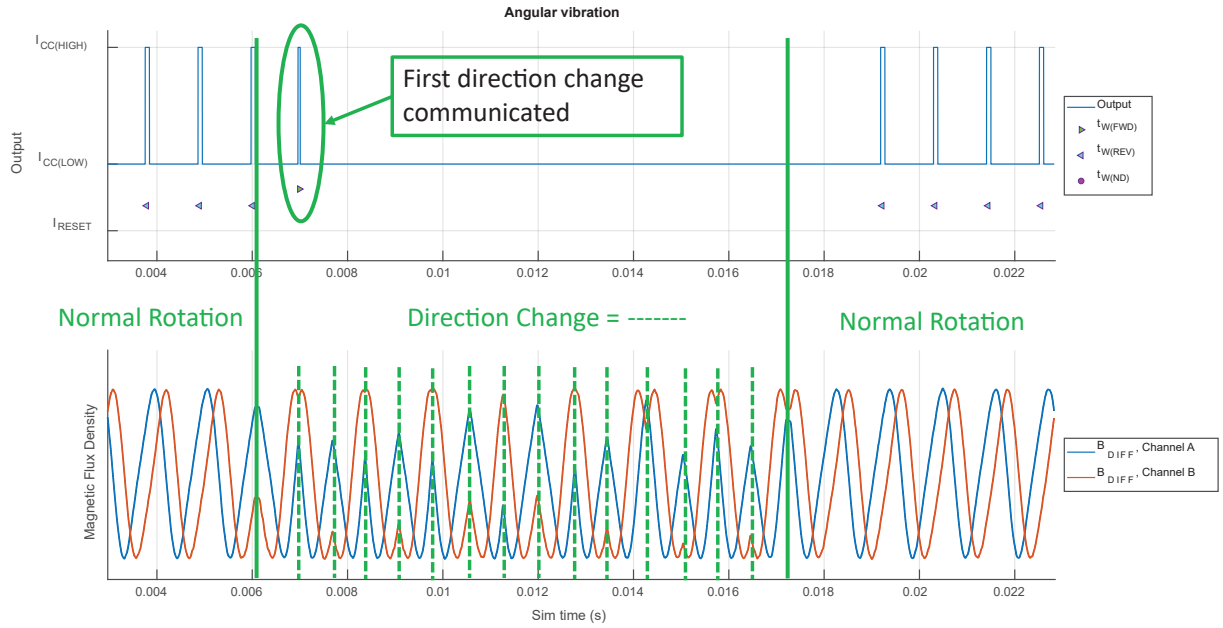

Figure 9: "-LB" behavior under angular vibration

[1] Based on Allegro Reference Target 60-0 (see ATS19520 datasheet).

Revision History

Number	Date	Description	Responsibility
–	September 23, 2021	Initial release	K. Maffei

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