# APS11753

# Low-Voltage Micropower Switch for Industrial Applications

## FEATURES AND BENEFITS

- 2.2 to 5.5 V operation
- Ultra-low power consumption (micropower)
- Omnipolar and unipolar switch threshold options
- Sleep time options
- High and low sensitivity magnetic switch point options
- Choice of output polarity
- Chopper stabilization
  - □ Low switch point drift over temperature
  - □ Insensitive to physical stress
- Push-pull output
- Solid-state reliability
- Industry-standard package and pinout

## APPLICATIONS

- Battery-critical applications
- Cell phones, laptops, e-locks, smoke detectors
- Medical equipment
- Doors, covers, lids, and tray position detection
- E-mobility
- Valves position detection
- Smart meters
- Home appliances

## DESCRIPTION

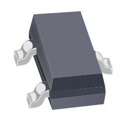
The APS11753 micropower Hall-effect switch ICs are qualified for low-voltage applications. These sensors are temperature-stable and suited for operation over extended junction temperature ranges up to 165°C. This family of Hall-effect switches provides contactless control of a push-pull output, which actuates in response to a magnetic field applied to the branded package face. Additionally, the micropower logic allows ultra-low power consumption and operation from 2.2 to 5.5 V.

These devices are equipped with chopper stabilization, which reduces the residual offset normally caused by device overmolding, temperature dependencies, and thermal stress, allowing superior high-temperature performance.

The APS11753 is offered in package type MD-3, a standard 3-pin SOT23-3 surface-mount package. The package is lead (Pb) free.

## PACKAGE

*Not to scale*



3-pin SOT23-3
(suffix MD)

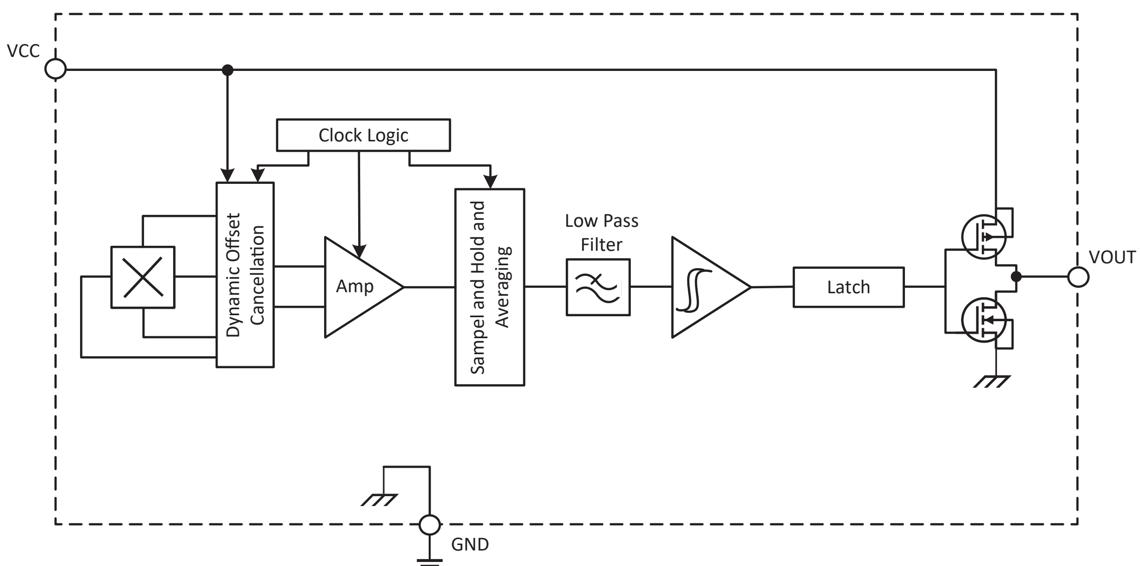


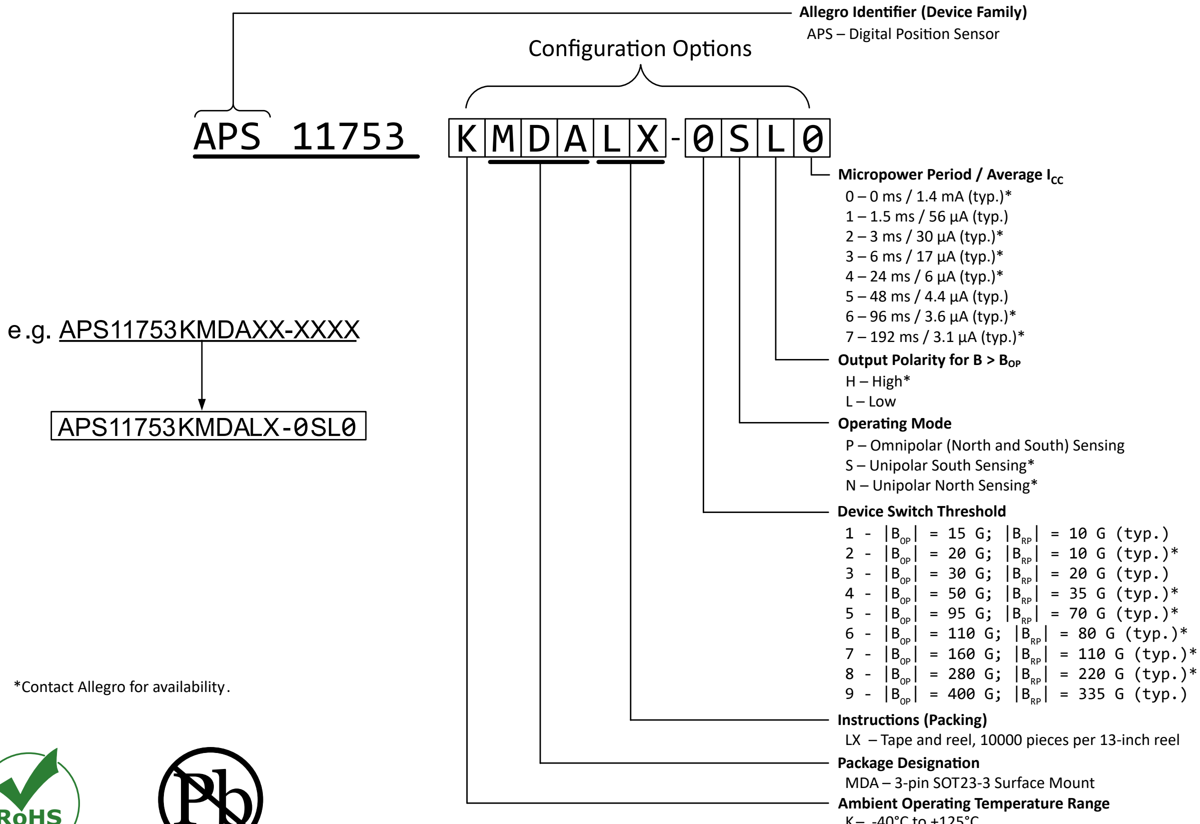

**Figure 1: Functional Block Diagram**

## SELECTION GUIDE

| Part Number [1] | Sleep Time (ms) | Average Supply Current (µA) | Typ. Switch Point Magnitude | | Operating Temperature (°C) | Mounting | Packing [2] |
|---|---|---|---|---|---|---|---|
| | | | $B_{OP}$ (G) | $B_{RP}$ (G) | | | |
| APS11753KMDALX-3PL5 | 50 | 4.4 | 30 | 20 | –40 to 125 | 3-pin SOT23-3 surface mount | Tape and Reel, 10,000 pieces per 13-inch reel |
| APS11753KMDALX-1PL5 | 50 | 4.4 | 15 | 10 | | | |
| APS11753KMDALX-9PL5 | 50 | 4.4 | 400 | 335 | | | |
| APS11753KMDALX-3PL1 | 1.5 | 56 | 30 | 20 | | | |

[1] Contact Allegro MicroSystems for options not listed in the selection guide.
[2] Contact Allegro MicroSystems for additional packing options.

**Complete Part Number Format**



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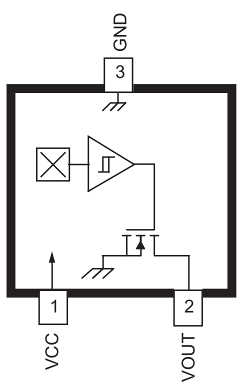
## ABSOLUTE MAXIMUM RATINGS

| Characteristic | Symbol | Notes | Rating | Units |
|---|---|---|---|---|
| Supply Voltage | $V_{CC}$ | | 6 | V |
| Reverse Supply Voltage | $V_{RCC}$ | | –0.3 | V |
| Output Current | $I_{OUT}$ | Source or sink | ±5 | mA |
| Operating Ambient Temperature | $T_A$ | Range K | –40 to 125 | °C |
| Maximum Junction Temperature | $T_{J(max)}$ | | 165 | °C |
| Storage Temperature | $T_{stg}$ | | –65 to 170 | °C |

## PINOUT DIAGRAM AND TERMINAL LIST

**(View from branded face)**




3-pin SOT23-3
(suffix MD)

**Terminal List**

| Name | Description | Number |
|---|---|---|
| VCC | Connects power supply to chip | 1 |
| VOUT | Output from circuit | 2 |
| GND | Terminal for ground connection | 3 |

## TYPICAL APPLICATION CIRCUIT

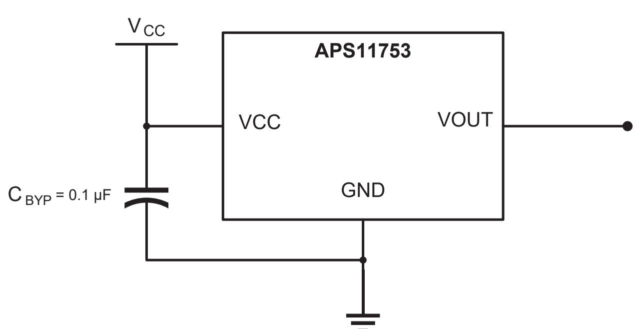



**Figure 2: Typical Application Circuit**



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**ELECTRICAL CHARACTERISTICS [1]:** Valid over full operating voltage and ambient temperature ranges for $T_J < T_J$(max) and $C_{BYP}$ = 0.1 µF, unless otherwise specified

| Characteristics | Symbol | Test Conditions | Min. | Typ. [2] | Max. | Unit |
|---|---|---|---|---|---|---|
| **SUPPLY AND STARTUP** | | | | | | |
| Supply Voltage | $V_{CC}$ | Operating, $T_J$ < 165°C | 2.2 | – | 5.5 | V |
| Supply Current | $I_{CC(AVG)}$ [3] | -xxx5 option: 48 ms sleep period | – | 4.4 | 11.5 | µA |
| | | -xxx1 option: 1.5 ms sleep period | – | 56.4 | 251.8 | µA |
| | $I_{CC(AWAKE)}$ | Device is awake, $V_{CC}$ = 2.2 V | – | 1 | 1.5 | mA |
| | | Device is awake, $V_{CC}$ = 3.5 V | – | 1.4 | 2.3 | mA |
| | | Device is awake, $V_{CC}$ = 5.5 V | – | 2.2 | 3.5 | mA |
| | $I_{CC(SLEEP)}$ | Device is asleep | – | 2.7 | 6 | µA |
| Power-On State [4] | POS | $t < t_{PO}$, $V_{CC} \geq V_{CC(min)}$ | | Low | | – |
| Power-On Time [4] | $t_{PO}$ | $V_{CC} \geq V_{CC(min)}$ | – | 60 | 100 | µs |
| **MICROPOWER OPERATION (See Figure 6)** | | | | | | |
| Awake | $t_{AWAKE}$ | | – | – | 60 | µs |
| Sleep | $t_{SLEEP}$ | -xxx5 option | 25 | 48 | 90 | ms |
| | | -xxx1 option | 0.5 | 1.5 | 2.5 | ms |
| **CHOPPER STABILIZATION AND OUTPUT CHARACTERISTICS** | | | | | | |
| Chopping Frequency | $f_c$ | | – | 250 | – | kHz |
| Output Saturation Voltage | $V_{OUT(SAT)HIGH}$ | $I_{OUT}$ = 1 mA (Sink) | $V_{CC}$ – 300 | $V_{CC}$ – 150 | – | mV |
| | $V_{OUT(SAT)LOW}$ | $I_{OUT}$ = 1 mA (Source) | – | 150 | 300 | mV |
| Supply Slew Rate | SR | | 20 | – | – | V/ms |

[1] Temperature performance is guaranteed by design and characterization.
[2] Typical data is at $T_A$ = 25°C and $V_{CC}$ = 3.5 V unless otherwise noted.
[3] $I_{CC}$ average is calculated with the equation:

$$\frac{I_{CC(awake)} \times t_{awake} + I_{CC(sleep)} \times t_{sleep}}{t_{awake} + t_{sleep}}$$

[4] Guaranteed by device design and characterization; not tested in final production.

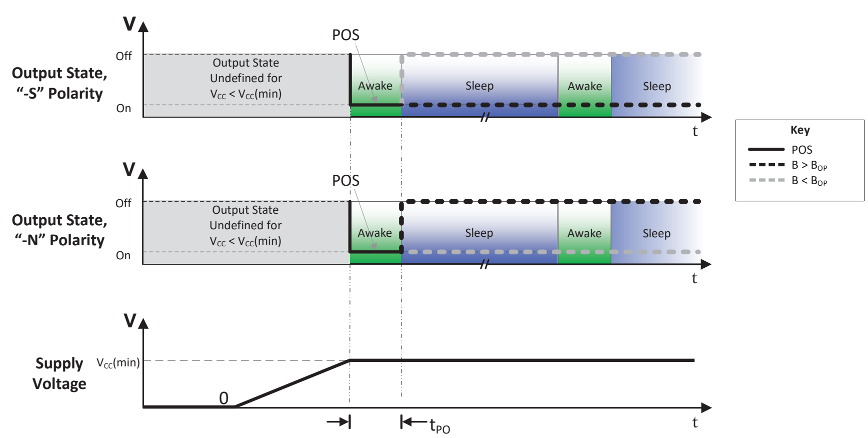


**Figure 3: Device Power-on Behavior ("L" Polarity Shown)**
**The output remains latched in the last sampled state during the sleep time (output on or output off).**



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**MAGNETIC SWITCH CHARACTERISTICS [1]:** Valid over full operating voltage and ambient temperature ranges for $T_J < T_J$(max) and $C_{BYP}$ = 0.1 µF, unless otherwise specified

| Characteristics | Symbol | Test Conditions | Min. | Typ. [2] | Max. | Unit [3] |
|---|---|---|---|---|---|---|
| Operate Point | $B_{OP}$ | -1xxx Option, $T_A$ 25°C | 5 | 15 | 25 | G |
| | | -1xxx Option, $T_A$ 150°C | 8 | 17 | 33 | G |
| | | -3xxx Option | 10 | 30 | 50 | G |
| | | -9xxx Option | 280 | 400 | 520 | G |
| Release Point | $B_{RP}$ | -1xxx Option, $T_A$ 25°C | 1 | 10 | 20 | G |
| | | -1xxx Option, $T_A$ 150°C | 1 | 11 | 24 | G |
| | | -3xxx Option | 5 | 20 | 35 | G |
| | | -9xxx Option | 235 | 335 | 435 | G |
| Hysteresis | $B_{HYS}$ | -1xxx Option, $T_A$ 25°C | – | 5 | – | G |
| | | -1xxx Option, $T_A$ 150°C | – | 6 | – | G |
| | | -3xxx Option | – | 10 | – | G |
| | | -9xxx Option | 30 | 65 | 110 | G |

[1] Temperature performance is guaranteed by design and characterization.
[2] Typical data is at $T_A$ = 25°C and $V_{CC}$ = 3.5 V, unless otherwise noted.
[3] Magnetic flux density, B, is indicated as a negative value for north-polarity magnetic fields, and a positive value for south-polarity magnetic fields.

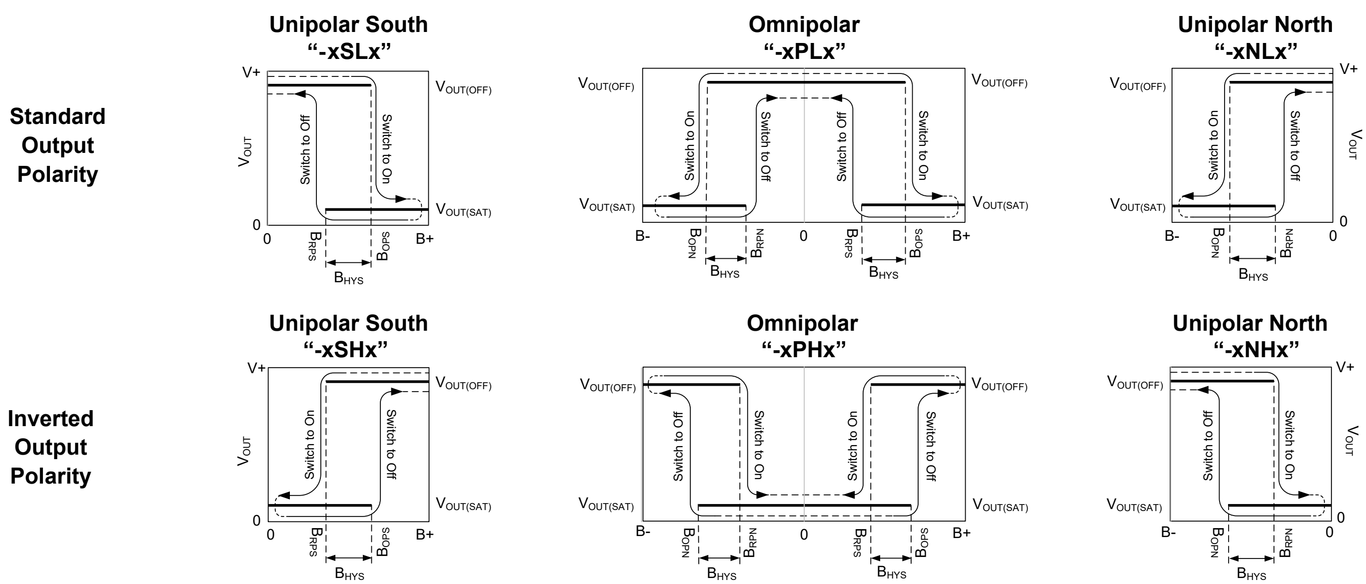


**Figure 4: Hall Switch Output State vs. Magnetic Field**

**B- indicates increasing north polarity magnetic field strength, and B+ indicates increasing south polarity magnetic field strength.**



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**PACKAGE THERMAL CHARACTERISTICS:** Device power consumption is extremely low. On-chip power dissipation will not be an issue under normal operating conditions.

| Characteristic | Symbol | Test Conditions | Value | Units |
|---|---|---|---|---|
| Package Thermal Resistance | $R_{\theta JA}$ | Package MD, 2-layer PCB (1S0P) | 331.5 | °C/W |
| | | Package MD, 4-layer PCB (2S2P) | 203.6 | °C/W |



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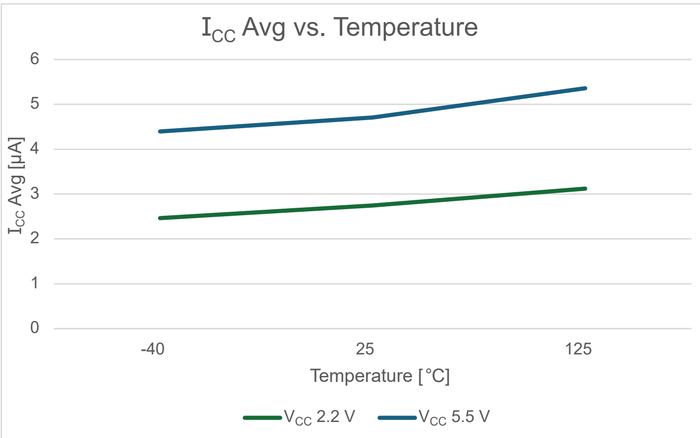
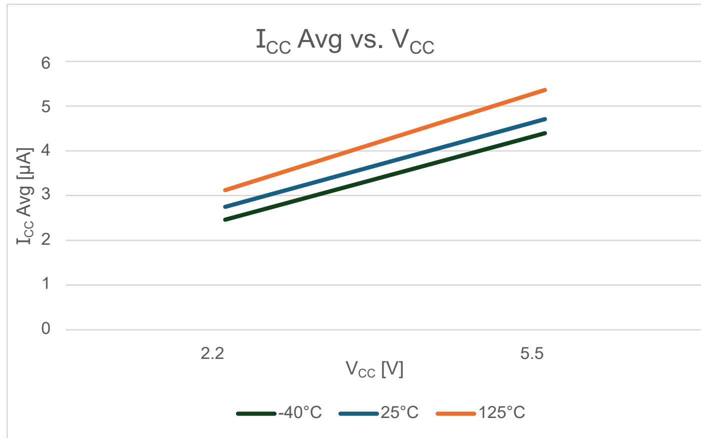
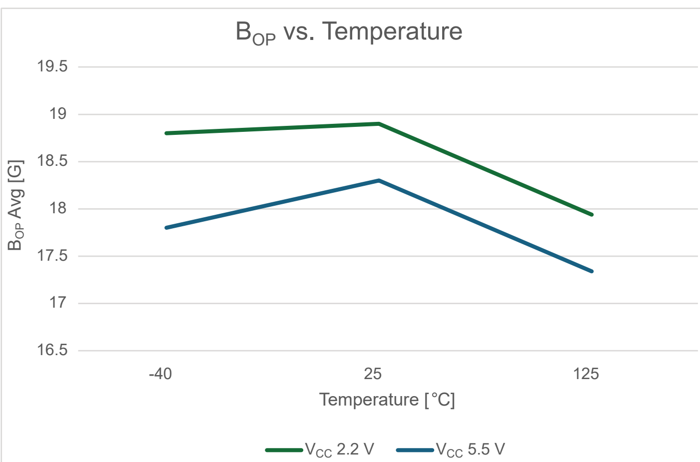
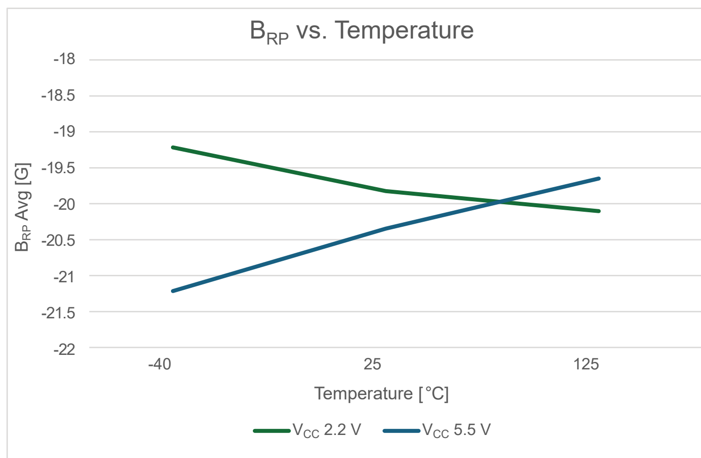
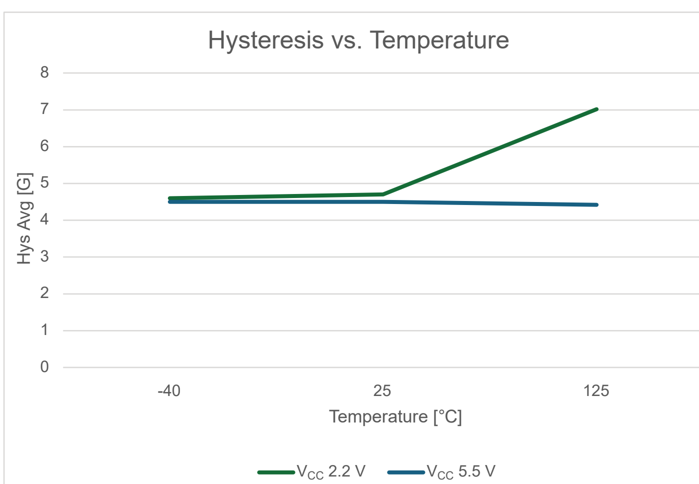
## APS11753-1PL5 CHARACTERIZATION PLOTS



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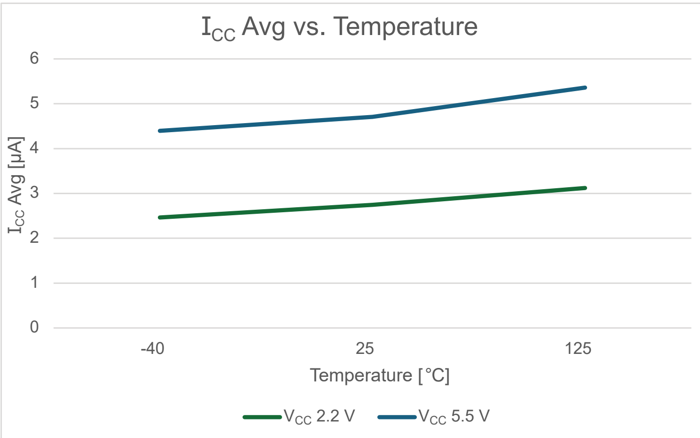
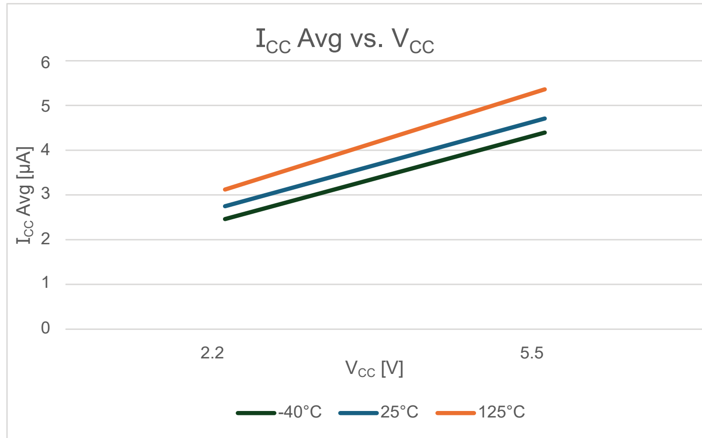
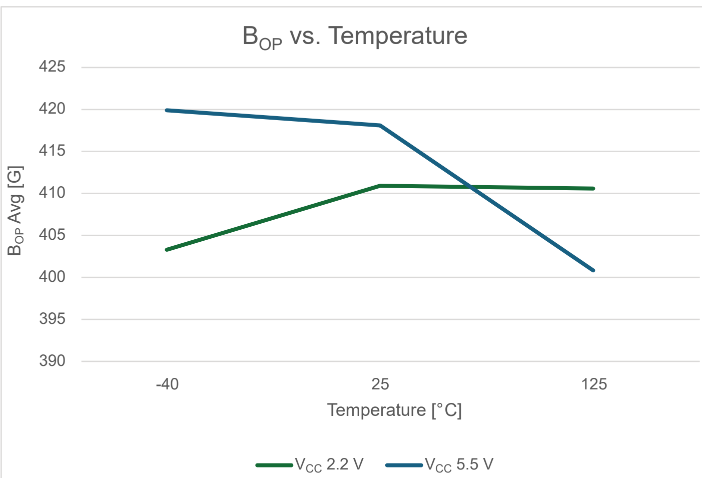
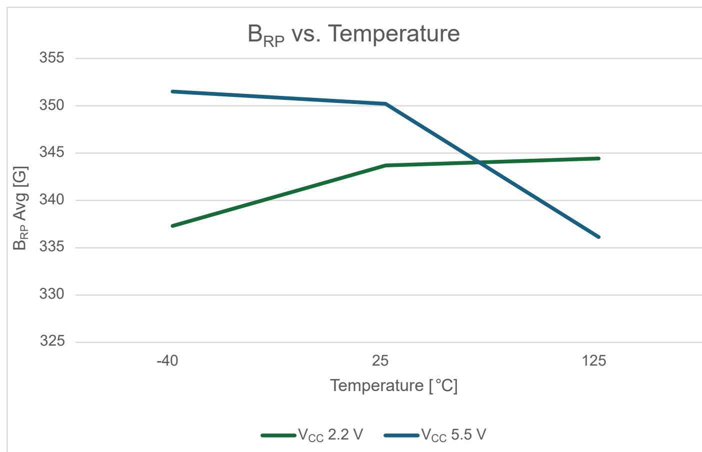
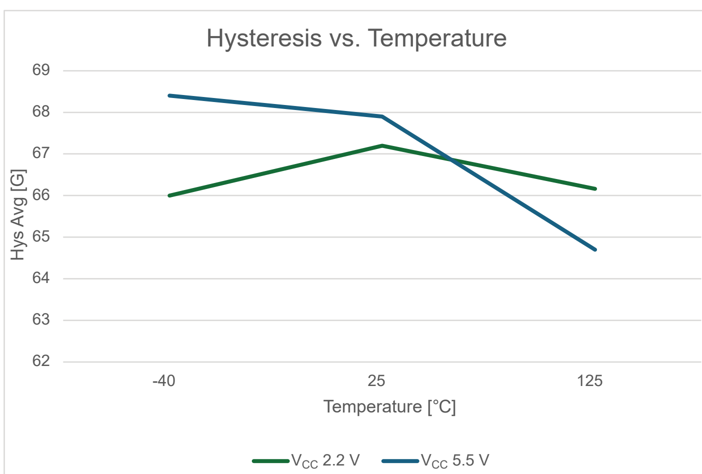
## APS11753-9PL5 CHARACTERIZATION PLOTS



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## FUNCTIONAL DESCRIPTION

### Operation

The APS11753 is an integrated Hall-effect sensor ICs with a switch output. The output is a push-pull configuration that actuates in response to a magnetic field applied to the branded package face (Figure 4). The devices are offered in package with a 3-pin surface-mount configuration. See the Selection Guide for a complete list of available options.

**Unipolar South Pole:** The unipolar output of these devices is actuated when a south polarity magnetic field perpendicular to the Hall element exceeds the operate point threshold, $B_{OPS}$ (see Figure 4 Panels C and F). When $B_{OPS}$ is exceeded, the APS11753 output turns on (goes low). When the magnetic field is removed or reduced below the release point, $B_{RPS}$, the device outputs return to their original state.

**Unipolar North Pole:** The unipolar output of these devices is actuated when a north polarity magnetic field perpendicular to the Hall element exceeds the operate point threshold, $B_{OPN}$ (see Figure 4 Panels A and D). When $B_{OPN}$ is exceeded, the APS1173 output turns on (goes low). When the magnetic field is removed or reduced below the release point, $B_{RPN}$, the device outputs return to their original state.

**Omnipolar:** The omnipolar operation of these devices allows actuation with either a north or a south polarity field. The APS11753 operates using the standard output polarity convention. Fields exceeding the operating points, $B_{OPS}$ or $B_{OPN}$, will turn the output on (low). When the magnetic field is removed or reduced below the release point, $B_{RPN}$ or $B_{RPS}$, the device output turns off (goes high).

The difference in the magnetic operate and release points is the hysteresis, $B_{HYS}$, of the device. This built-in hysteresis allows clean switching of the output even in the presence of external mechanical vibration and electrical noise.

Powering-on the device in the hysteresis range (less than $B_{OP}$ and higher than $B_{RP}$) will give an output state of $V_{OUT(OFF)}$. In this case, the correct state is attained after the first excursion beyond $B_{OP}$ or $B_{RP}$.

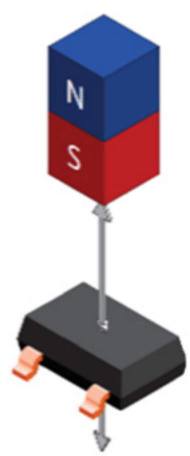


**Figure 5: Magnetic Sensing Orientations**



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## Low Average Power

The built-in micropower control periodically activates the Hall switch circuitry for a short period of time ($t_{AWAKE}$), and deactivates it for the remainder of the period ($t_{PERIOD}$). See Figure 6: Micropower Operation, for an example of the system timing. The short duration awake state allows for sensor stabilization prior to sampling the Hall switch and latching the state on the output. The output is latched on the falling edge of the timing pulse and held in the last sampled state during the sleep period; updates to the output only occur on the falling edge of the timing pulse. The micropower control operates independently of the output driver state. At initial power-on, the APS11753 will sample a $t_{AWAKE}$ cycle before the first $t_{SLEEP}$ cycle (see Figure 6).

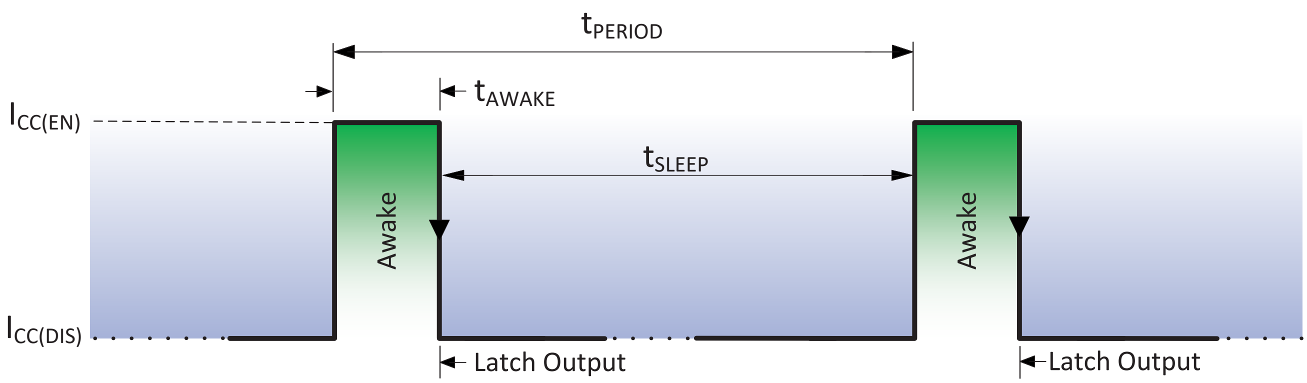


**Figure 6: Micropower Operation**



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## CHOPPER STABILIZATION

A limiting factor for switch point accuracy when using Hall-effect technology is the small signal voltage developed across the Hall plate. This voltage is proportionally small relative to the offset that can be produced at the output of the Hall sensor. This makes it difficult to process the signal and maintain an accurate, reliable output over the specified temperature and voltage range. Chopper Stabilization is a proven approach used to minimize Hall offset.

The Allegro technique, dynamic quadrature offset cancellation, removes key sources of the output drift induced by temperature and package stress. This offset reduction technique is based on a signal modulation-demodulation process. Figure 7: Model of Chopper Stabilization Circuit (Dynamic Offset Cancellation) illustrates how it is implemented.

The undesired offset signal is separated from the magnetically induced signal in the frequency domain through modulation. The subsequent demodulation acts as a modulation process for the

offset causing the magnetically induced signal to recover its original spectrum at baseband while the dc offset becomes a high frequency signal. Then, using a low-pass filter, the signal passes while the modulated DC offset is suppressed. Allegro's innovative chopper-stabilization technique uses a high frequency clock.

The high-frequency operation allows a greater sampling rate that produces higher accuracy, reduced jitter, and faster signal processing. Additionally, filtering is more effective and results in a lower noise analog signal at the sensor output. Devices such as the APS11753 that use this approach have an extremely stable quiescent Hall output voltage, are immune to thermal stress, and have precise recoverability after temperature cycling. This technique is made possible through the use of a BiCMOS process which allows the use of low offset and low noise amplifiers in combination with high-density logic and sample and hold circuits.

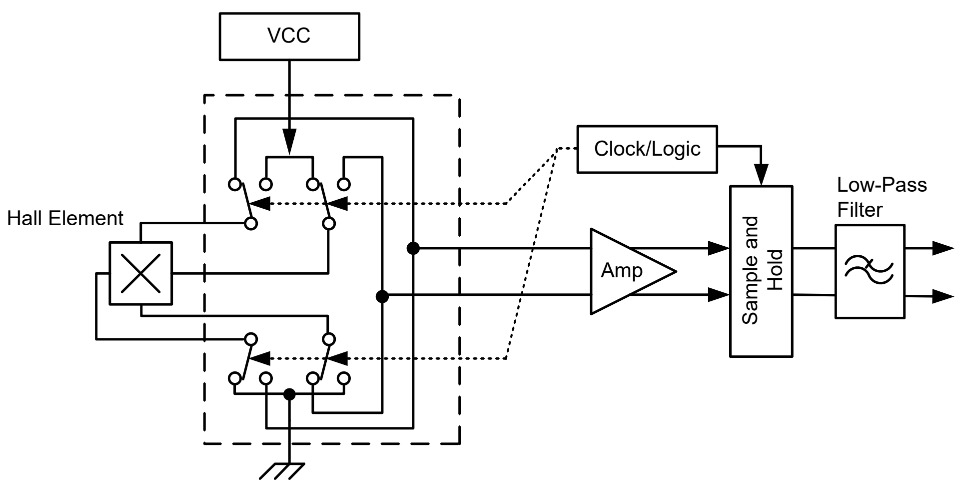


**Figure 7: Model of Chopper Stabilization Circuit (Dynamic Offset Cancellation)**



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## PACKAGE OUTLINE DRAWING

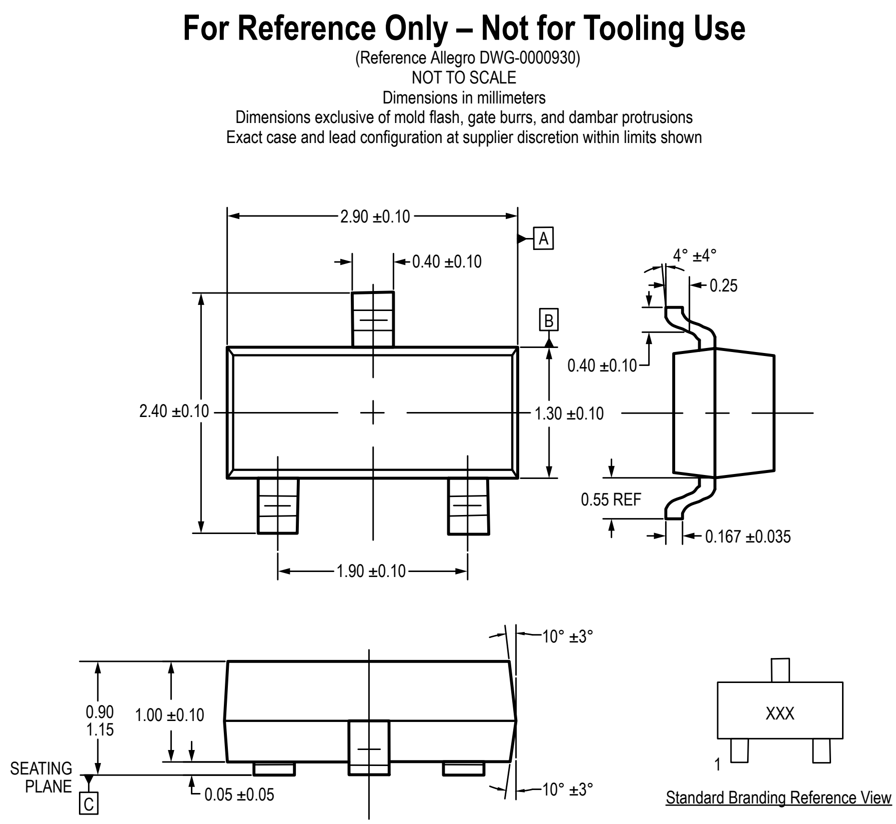


**Figure 8: Package MD, 3-Pin SMD (SOT23-3)**



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## Revision History

| Number | Date | Description |
|---|---|---|
| – | September 26, 2024 | Initial release |
| 1 | October 17, 2024 | Updated title, features and benefits, and description (page 1), selection guide (page 2), absolute maximum ratings table (page 3), characterization plots (pages 7 to 8), and functional description (page 9). |
| 2 | October 30, 2024 | Updated Magnetic Switch Characteristics table (page 5) |
| 3 | December 6, 2024 | Updated -3xxx Option Operate Point typical value (page 5) |



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