# 1 MHz, High Accuracy Chopped Current Sensor
## with Low Output Offset in SOICW-16 Package

## FEATURES AND BENEFITS

- High operating bandwidth for fast control loops or where high-speed currents are monitored
  - □ 1 MHz bandwidth
  - □ 0.45 µs typical response time
- High performance for optimized energy applications
  - □ ±1.5% sensitivity error over temperature (25°C to 125°C)
  - □ ±10 mV maximum offset voltage over temperature
  - □ Ratiometric operation
  - □ Differential sensing for high immunity to external magnetic fields
  - □ No magnetic hysteresis
- Adjustable fast overcurrent fault
  - □ 0.5 µs typical response time
  - □ Overcurrent fault available between 50% and 200% full-scale current
- Low internal primary conductor resistance 1 mΩ for better power efficiency
- UL 62368 (edition 3) certification, highly isolated compact SOICW-16 surface mount package
  - □ 4242 $V_{RMS}$ rated withstand voltage
  - □ 1000 $V_{RMS}$ /1414 $V_{DC}$ basic isolation
  - □ 500 $V_{RMS}$ /707 $V_{DC}$ reinforced isolation
- High-withstand surge power ratings
- Wide operating temperature, –40°C to 125°C
- AEC-Q100 Grade 1, automotive qualified

**PACKAGE:**  16-Pin SOICW (suffix LA)

*Not to scale*
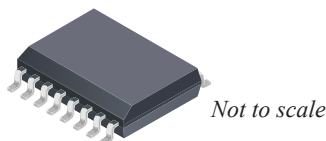
## DESCRIPTION

The ACS37035 is a fully integrated Hall-effect current sensor in a SOICW-16 package that is factory-trimmed to provide high accuracy over the entire operating range without the need for customer programming. This sensor provides a compact, fast, and accurate solution for measuring high-frequency currents in a wide array of applications.

The package construction provides high isolation by magnetically coupling the field generated by the current in the conductor to the monolithic Hall sensor IC which has no physical connection to the integrated current conductor. Applied current flowing through the copper conduction path generates a magnetic field that is sensed by the IC and converted to a proportional voltage. Current is sensed differentially in order to reject external common-mode fields. A precise, proportional voltage is provided by the Hall IC.

The ACS37035 offers high bandwidth Hall-effect-based current sensing with a user-configurable overcurrent FAULT detection allowing short-circuit detection for system protection with a fault threshold that is proportional to the current range.

The ACS37035 is suitable for all markets, including automotive, industrial, commercial, and communications systems.

Devices are RoHS compliant and lead (Pb) free with 100% matte-tin-plated leadframes.

## APPLICATIONS

- Motor control
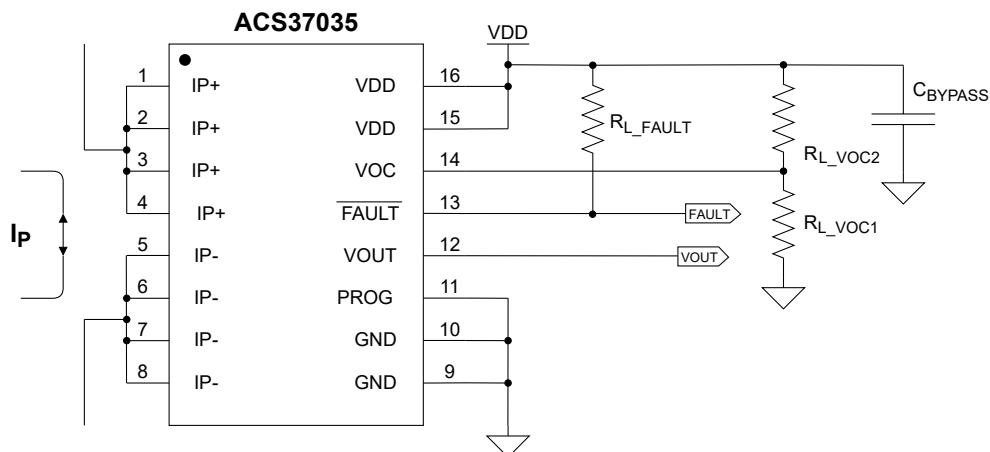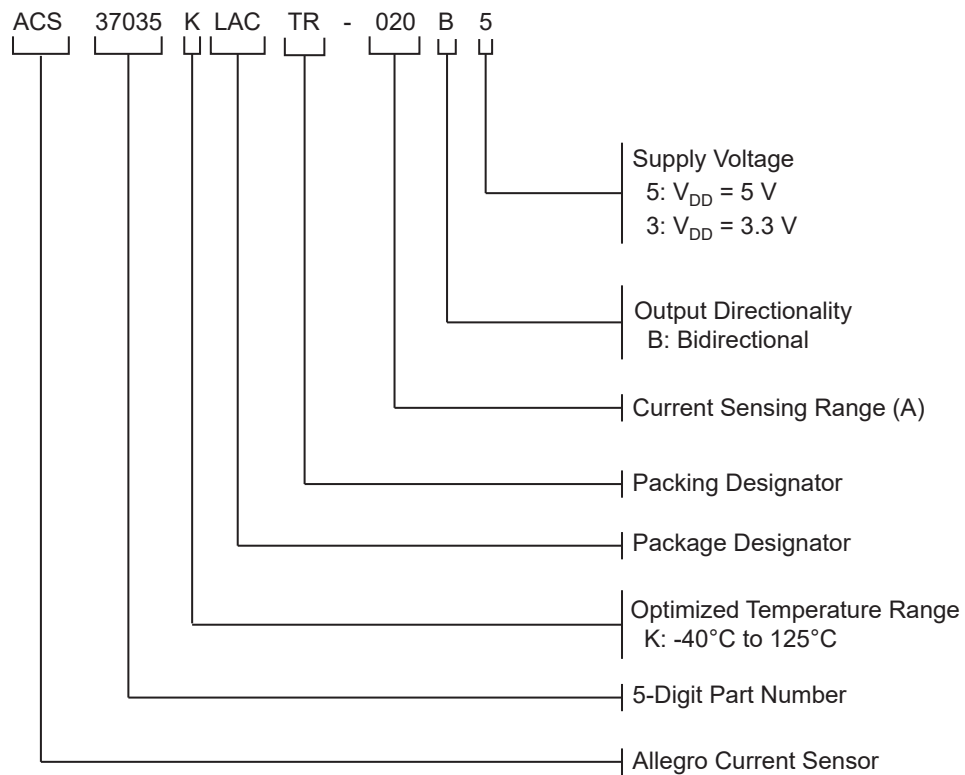- Load detection and management
- Switch-mode power supplies



**Figure 1: Typical Application Circuit**

The device outputs an analog signal at VOUT that varies linearly with the primary current, $I_P$, within the specified ranges.

## SELECTION GUIDE

| Part Number | Current Sensing Range (A) | Sensitivity (mV/A) | Supply Voltage $V_{DD}$ (V) | Quiescent Voltage Output $V_{QVO}$ (V) | Optimized Temperature Range $T_A$ (°C) | Packing |
|---|---|---|---|---|---|---|
| ACS37035KLACTR-065B3 | ±65 | 20 | 3.3 | $V_{DD}$/2 | –40°C to 125°C | 1000 pieces per 13-inch reel |
| ACS37035KLACTR-020B5 | ±20 | 100 | 5 | | | |
| ACS37035KLACTR-040B5 | ±40 | 50 | | | | |
| ACS37035KLACTR-065B5 | ±65 | 30 | | | | |

## PART NAMING SPECIFICATION

ACS  37035  K  LAC  TR  -  020  B  5

Supply Voltage
5: $V_{DD}$ = 5 V
3: $V_{DD}$ = 3.3 V

Output Directionality
B: Bidirectional

Current Sensing Range (A)

Packing Designator

Package Designator

Optimized Temperature Range
K: -40°C to 125°C

5-Digit Part Number

Allegro Current Sensor

## ABSOLUTE MAXIMUM RATINGS [1]

| Characteristic | Symbol | Notes | Min. | Max. | Unit |
|---|---|---|---|---|---|
| Supply Voltage | $V_{DD}$ | | −0.5 | 6.5 | V |
| Output Voltage | $V_O$ | Applies to VOUT, VOC, and $\overline{\text{FAULT}}$ | −0.5 | $(V_{DD} + 0.7) < 6.5$ | V |
| Input Voltage | $V_I$ | Applies to VOC | −0.5 | $(V_{DD} + 0.7) < 6.5$ | V |
| Operating Ambient Temperature | $T_A$ | | −40 | 150 | °C |
| Storage Temperature | $T_{STG}$ | | −65 | 165 | °C |
| Maximum Junction Temperature | $T_{JMAX}$ | Sensing range of sensor is limited by $T_{JMAX} = 165°C$ | − | 165 | °C |

[1] Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum ratings for extended periods may affect device reliability.

## ISOLATION CHARACTERISTICS

| Characteristic | Symbol | Notes | Rating | Unit |
|---|---|---|---|---|
| Withstand Voltage [1][2] | $V_{ISO}$ | Agency rated for 60 seconds per UL 62368-1 (edition 3) | 4242 | $V_{RMS}$ |
| Working Voltage for Basic Isolation [2] | $V_{WVBI}$ | Maximum approved working voltage for basic (single) isolation according to UL 62368-1 (edition 3) | 1414 | $V_{PK}$ or $V_{DC}$ |
| | | | 1000 | $V_{RMS}$ |
| Working Voltage for Reinforced Isolation [2] | $V_{WVRI}$ | Maximum approved working voltage for reinforced isolation according to UL 62368-1 (edition 3) | 707 | $V_{PK}$ or $V_{DC}$ |
| | | | 500 | $V_{RMS}$ |
| Surge Voltage | $V_{SURGE}$ | 1.2/50 µs waveform, tested in dielectric fluid to determine the intrinsic surge immunity of the isolation barrier | 10000 | $V_{PK}$ |
| Impulse Voltage | $V_{IMPULSE}$ | 1.2/50 µs waveform, tested in air | 6000 | $V_{PK}$ |
| Clearance | $D_{CL}$ | Minimum distance through air from IP leads to signal leads | 8 | mm |
| Creepage | $D_{CR}$ | Minimum distance along package body from IP leads to signal leads | 8 | mm |
| Distance Through Insulation | DTI | Minimum internal distance through insulation | 59 | µm |
| Comparative Tracking Index | CTI | Material Group II | 400 to 599 | V |

[1] 100% production-tested for 1 second in accordance with UL 62368-1 (edition 3).
[2] Certification pending.

## THERMAL CHARACTERISTICS

| Characteristic | Symbol | Notes | Value | Unit |
|---|---|---|---|---|
| Package Thermal Resistance (Junction to Ambient) | $R_{\theta JA}$ | Mounted on the standard MA/LA Current Sensor Evaluation Board (ACSEVB-MA16-LA16) | 19 | °C/W |
| Package Thermal Metric (Junction to Top) | $\Psi_{JT}$ | | 0.5 | °C/W |
| Package Thermal Resistance (Junction to Case) | $R_{\theta JC}$ | Simulated per the methods in JESD51-1 | 10 | °C/W |
| Package Thermal Resistance (Junction to Board) | $R_{\theta JB}$ | Simulated per the methods in JESD51-8 | 8 | °C/W |

## PACKAGE CHARACTERISTICS

| Characteristic | Symbol | Notes | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Internal Conductor Resistance | $R_{IC}$ | $T_A$ = 25°C | – | 1 | – | mΩ |
| Internal Conductor Inductance | $L_{IC}$ | $T_A$ = 25°C | – | 5 | – | nH |
| Moisture Sensitivity Level | MSL | Per IPC/JEDEC J-STD-020 | – | 3 | – | – |

# PINOUT DIAGRAM AND TERMINAL LIST

**Terminal List Table**

| Number | Name | Description |
|---|---|---|
| 1, 2, 3, 4 | IP+ | Positive terminal for current being sensed |
| 5, 6, 7, 8 | IP- | Negative terminal for current being sensed |
| 9 | GND | Device ground terminal |
| 10 | GND | Device ground terminal |
| 11 | PROG | Factory calibration terminal, connect to GND for optimal ESD performance |
| 12 | VOUT | Analog output signal |
| 13 | $\overline{\text{FAULT}}$ | Overcurrent fault output, active low |
| 14 | VOC | Overcurrent fault operation point analog input |
| 15 | VDD | Device power supply terminal |
| 16 | VDD | Device power supply terminal |
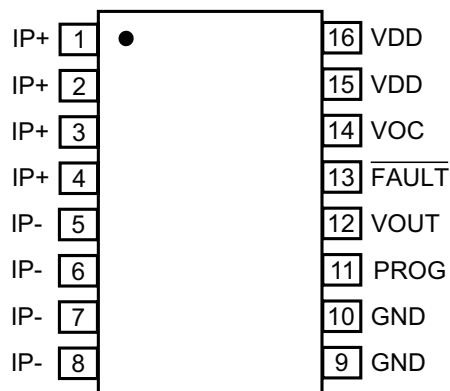


**Figure 2: LA Pinout Diagram**

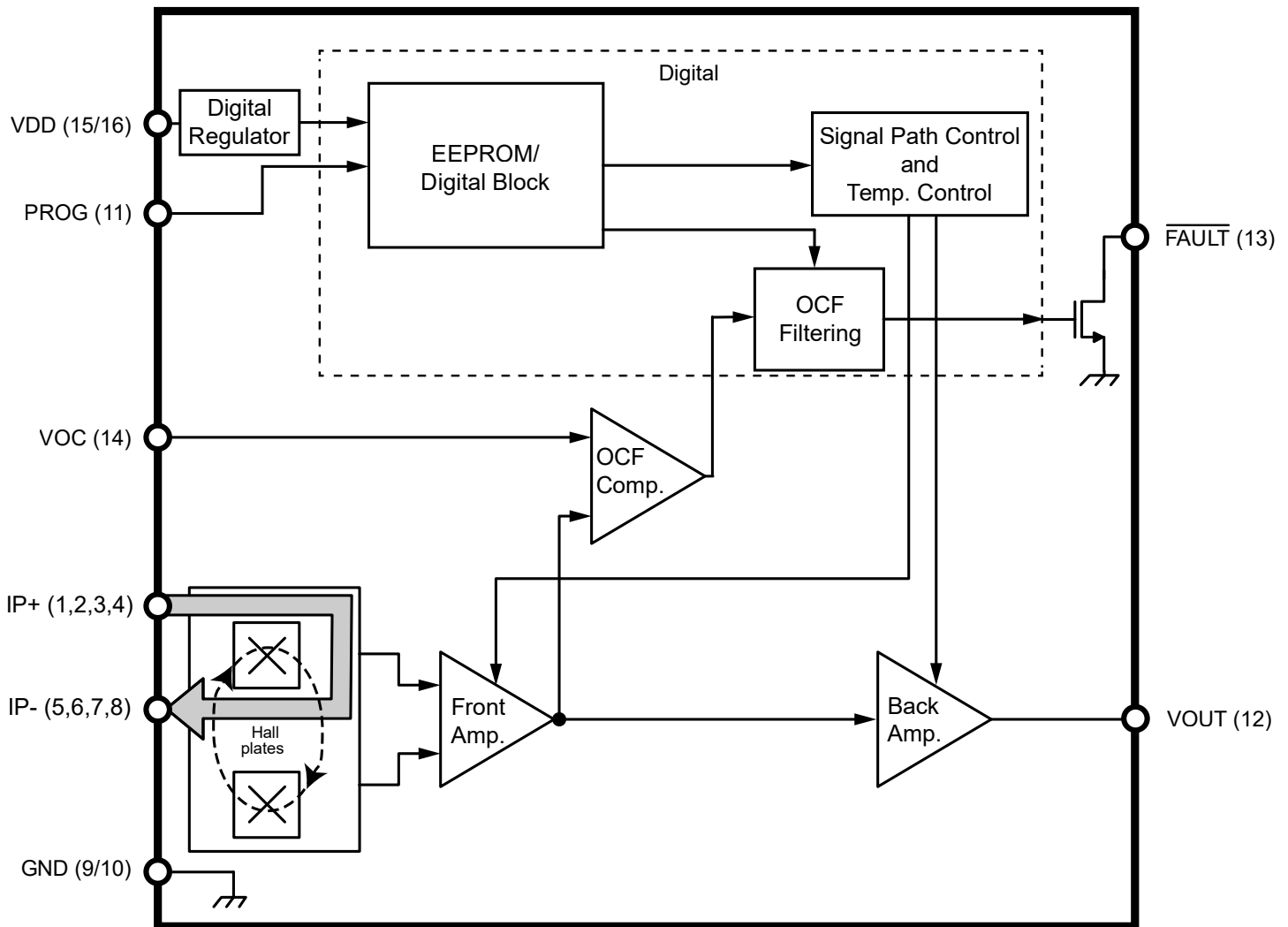**Figure 3: Functional Block Diagram**

**COMMON ELECTRICAL CHARACTERISTICS:** Valid through the full operating temperature range, $T_A$ = –40°C to 125°C, $C_{BYPASS}$ = 0.1µF, and typical $V_{DD}$, unless specified otherwise. Minimum and maximum values are tested in production or validated by design and characterization.

| Characteristic | Symbol | Test Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Supply Voltage | $V_{DD}$ | 5 V variant | 4.5 | 5 | 5.5 | V |
| | | 3.3 V variant | 3.0 | 3.3 | 3.6 | V |
| Supply Current | $I_{CC}$ | 5 V variant, no load on VOUT, $\overline{OCF}$, and VOC | – | 18 | 30 | mA |
| | | 3.3 V variant, no load on VOUT, $\overline{OCF}$, and VOC | – | 15 | 25 | mA |
| Supply Bypass Capacitor | $C_{BYPASS}$ | | 0.1 | – | – | µF |
| Output Resistive Load [1] | $R_{L\_VOUT}$ | | 10 | – | – | kΩ |
| Output Capacitive Load [1] | $C_{L\_VOUT}$ | | – | – | 1 | nF |
| Power-On Reset Voltage | $V_{POR}$ | $T_A$ = 25°C, $V_{DD}$ rising 1 V/ms | 2.6 | 2.8 | 2.9 | V |
| Power-On Hysteresis | $V_{POR\_HYS}$ | | 0.2 | 0.25 | – | mV |
| Power-On Time | $t_{PO}$ | | – | – | 100 | µs |
| Undervoltage Detection Threshold | $V_{UVD}$ | 5 V variant | 3.8 | 4.0 | 4.2 | V |
| Undervoltage Detection Hysteresis | $V_{UVD\_HYS}$ | 5 V variant | 0.2 | 0.25 | – | V |
| Undervoltage Delay Time | $t_{UVD\_E}$ | 5 V variant | 60 | – | 70 | µs |
| | $t_{UVD\_D}$ | 5 V variant | – | – | 10 | µs |
| Overvoltage Detection (OVD) Threshold | $V_{OVD\_H}$ | $T_A$ = 25°C, $V_{DD}$ rising 1 V/ms | 6 | 6.2 | 6.5 | V |
| Overvoltage Detection Hysteresis | $V_{OVD\_HYS}$ | | 0.35 | 0.45 | – | mV |
| OVD Delay Time | $t_{OVD\_E}$ | | 60 | – | 70 | µs |
| | $t_{OVD\_D}$ | | – | – | 10 | µs |
| **OUTPUT SIGNAL CHARACTERISTICS (VOUT)** | | | | | | |
| Saturation Voltage [2] | $V_{SAT\_H}$ | $R_L$ = 10 kΩ to GND | $V_{DD}$ – 0.2 | – | – | V |
| | $V_{SAT\_L}$ | $R_L$ = 10 kΩ to GND | – | – | 0.15 | V |
| Short Circuit Current | $I_{SC\_VOUT}$ | VOUT to GND | – | 25 | 50 | mA |
| | | VOUT to VDD | | –25 | –50 | mA |
| Bandwidth | BW | Small signal –3 dB, $C_{L\_VOUT}$ = 1 nF | – | 1 | – | MHz |
| Rise Time | $t_R$ | $T_A$ = 25°C, $C_{L\_VOUT}$ = 1 nF | – | 0.45 | 1 | µs |
| Response Time | $t_{RESP}$ | $T_A$ = 25°C, $C_{L\_VOUT}$ = 1 nF | – | 0.45 | 1 | µs |
| Propagation Delay | $t_{PD}$ | $T_A$ = 25°C, $C_{L\_VOUT}$ = 1 nF | – | 0.4 | 1 | µs |
| Noise Density | $N_D$ | 5 V variant, $T_A$ = 25°C, $C_{L\_VOUT}$ = 1 nF, 100 mV/A | – | 50 | – | µA/√Hz |
| | | 3.3 V variant, $T_A$ = 25°C, $C_{L\_VOUT}$ = 1 nF, 20 mV/A | – | 88 | – | µA/√Hz |
| Noise | N | 5 V variant, $T_A$ = 25°C, $C_{L\_VOUT}$ = 1 nF, 100 mV/A | – | 63 | – | $mA_{RMS}$ |
| | | 3.3 V variant, $T_A$ = 25°C, $C_{L\_VOUT}$ = 1 nF, 20 mV/A | – | 110 | – | $mA_{RMS}$ |
| Common-Mode Field Rejection | CMFR | Input-referred error due to common-mode field | – | 4 | – | mA/G |
| VOUT Output Resistance | $R_O$ | | – | 7.3 | – | Ω |

[1] Validated by design and characterization.
[2] The sensor may continue to respond to current beyond the specified Current Sensing Range, $I_{PR}$, until the output saturates at the high or low saturation voltage; however, the linearity and sensitivity error beyond the specified Current Sensing Range are not validated.

**OVERCURRENT CHARACTERISTICS:** Valid through the full operating temperature range, $T_A$ = –40°C to 125°C, $C_{BYPASS}$ = 0.1 µF, and typical $V_{DD}$, unless specified otherwise. Minimum and maximum values are tested in production or validated by design and characterization.

| Characteristic | Symbol | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Overcurrent FAULT Threshold Range | $I_{OCR}$ | | 50 | – | 200 | $\%I_{PR}$ |
| Overcurrent FAULT Pull-Up Resistor | $R_{L\_FAULT}$ | | 10 | – | 500 | kΩ |
| Overcurrent Error | $E_{OC}$ | | –10 | – | 10 | $\%I_{OCR}$ [2] |
| FAULT Output Low Voltage | $V_{FAULT\_L}$ | $R_{L\_FAULT}$ = 10 kΩ, fault condition present | – | – | 0.4 | V |
| FAULT Leakage Current | $I_{FAULT\_OFF}$ | $R_{L\_FAULT}$ = 10 kΩ, no fault condition present | – | – | 1 | µA |
| Overcurrent Response Time [1] | $t_{OC\_RESP}$ | $T_A$ = 25°C, $R_{L\_FAULT}$ = 10 kΩ | – | 0.5 | 0.75 | µs |
| VOC Input Linear Operating Range | $V_{OR\_VOC}$ | | 0.1 x $V_{DD}$ | – | 0.4 x $V_{DD}$ | V |
| VOC Input Current | $I_{VOC}$ | | – | – | 1 | µA |

[1] Validated by design and characterization.
[2] Where $I_{OCR}$ is the specific point at which the OCF trigger will occur and is set by $V_{OC}$ voltage within $V_{OR\_VOC}$.

**ACS37035KLACTR-065B3 PERFORMANCE CHARACTERISTICS:** Valid through the full operating temperature range, $T_A$ = –40°C to 125°C, $C_{BYPASS}$ = 0.1 µF, and typical $V_{DD}$, unless specified otherwise. Minimum and maximum values are tested in production or validated by design and characterization.

| Characteristic | Symbol | Test Conditions | Min. [1] | Typ. | Max. [1] | Unit |
|---|---|---|---|---|---|---|
| **NOMINAL PERFORMANCE** | | | | | | |
| Current Sensing Range [2] | $I_{PR}$ | Limited by $T_{J(MAX)}$ = 165°C | –65 | – | 65 | A |
| Sensitivity | Sens | $I_{PR(min)} < I_P < I_{PR(max)}$ | – | 20 | – | mV/A |
| Quiescent Voltage Output | $V_{QVO}$ | $I_P$ = 0 A | – | 0.5 x $V_{DD}$ | – | V |
| Overcurrent FAULT Threshold | $I_{OC}$ | | – | 100 | – | %$I_{PR}$ |
| Overcurrent FAULT Hysteresis | $I_{OC\_HYS}$ | | – | 4.8 | – | A |
| **FAULT ERROR** | | | | | | |
| Overcurrent Fault Error | $I_{OC\_E}$ | | –6.5 | – | 6.5 | A |
| **ERROR COMPONENTS** | | | | | | |
| Sensitivity Error | $E_{SENS}$ | $I_P = I_{PR(max)}$, $T_A$ = 25°C to 125°C | –1.5 | – | 1.5 | % |
| | | $I_P = I_{PR(max)}$, $T_A$ = –40°C to 25°C | –3 | – | 3 | % |
| Quiescent Voltage Output Error | $V_{QVO\_E}$ | $I_P$ = 0 A, $T_A$ = 25°C to 125°C | –10 | – | 10 | mV |
| | | $I_P$ = 0 A, $T_A$ = –40°C to 25°C | –15 | – | 15 | mV |
| Noise | N | $T_A$ = 25°C, $C_{L\_VOUT}$ = 1 nF, BW = 1 MHz | – | 2.2 | – | mV$_{RMS}$ |
| | | $T_A$ = 125°C, $C_{L\_VOUT}$ = 1 nF, BW = 1 MHz | – | 4.2 | – | mV$_{RMS}$ |
| Sensitivity Ratiometry Error | $E_{SENS\_RAT}$ | $V_{DD(Typ.)}$ ± 5% | –2 | – | 2 | % |
| Quiescent Voltage Output Ratiometry Error | $V_{QVO\_RAT}$ | $V_{DD(Typ.)}$ ± 5% | –12 | – | 12 | mV |
| Output Voltage Ripple [3] | $V_{RIPPLE}$ | $T_A$ = 25°C,  = 2.5 MHz | – | 3 | – | mV$_{PP}$ |
| **LIFETIME DRIFT [2]** | | | | | | |
| Sensitivity Drift Over Lifetime | $E_{SENS\_LT}$ | Based on the mean drift of worst-case distribution observed after AEC-Q100 qualification stresses | – | 0.5 | – | % |
| Quiescent Voltage Drift Over Lifetime | $V_{QVO\_LT}$ | Based on the mean drift of worst-case distribution observed after AEC-Q100 qualification stresses | – | 2.2 | – | mV |

[1] Absolute minimum ("Min." or "min") and absolute maximum ("Max." or "max") are the production limits that the device must not exceed.
[2] Validated by design and characterization.
[3] The output may display residual chopping frequency as a ripple at 2.5 MHz.

**ACS37035KLACTR-020B5 PERFORMANCE CHARACTERISTICS:** Valid through the full operating temperature range, $T_A$ = –40°C to 125°C, $C_{BYPASS}$ = 0.1 µF, and typical $V_{DD}$, unless specified otherwise. Minimum and maximum values are tested in production or validated by design and characterization.

| Characteristic | Symbol | Test Conditions | Min. [1] | Typ. | Max. [1] | Unit |
|---|---|---|---|---|---|---|
| **NOMINAL PERFORMANCE** | | | | | | |
| Current Sensing Range [2] | $I_{PR}$ | Limited by $T_{J(MAX)}$ = 165°C | –20 | – | 20 | A |
| Sensitivity | Sens | $I_{PR(min)}$ < $I_P$ < $I_{PR(max)}$ | – | 100 | – | mV/A |
| Quiescent Voltage Output | $V_{QVO}$ | $I_P$ = 0A | – | 0.5 x $V_{DD}$ | – | V |
| Overcurrent FAULT Threshold | $I_{OC}$ | | – | 100 | – | %$I_{PR}$ |
| Overcurrent FAULT Hysteresis | $I_{OC\_HYS}$ | | – | 1.5 | – | A |
| **FAULT ERROR** | | | | | | |
| Overcurrent Fault Error | $I_{OC\_E}$ | | –2 | – | 2 | A |
| **ERROR COMPONENTS** | | | | | | |
| Sensitivity Error | $E_{SENS}$ | $I_P$ = $I_{PR(max)}$, $T_A$ = 25°C to 125°C | –1.5 | – | 1.5 | % |
| | | $I_P$ = $I_{PR(max)}$, $T_A$ = –40°C to 25°C | –3 | – | 3 | % |
| Quiescent Voltage Output Error | $V_{QVO\_E}$ | $I_P$ = 0 A, $T_A$ = 25°C to 125°C | –10 | – | 10 | mV |
| | | $I_P$ = 0 A, $T_A$ = –40°C to 25°C | –15 | – | 15 | mV |
| Noise | N | $T_A$ = 25°C, $C_{L\_VOUT}$ = 1 nF, BW = 1 MHz | – | 6.3 | – | mV$_{RMS}$ |
| | | $T_A$ = 125°C, $C_{L\_VOUT}$ = 1 nF, BW = 1 MHz | – | 12.5 | – | mV$_{RMS}$ |
| Sensitivity Ratiometry Error | $E_{SENS\_RAT}$ | $V_{DD(typ)}$ ± 5% | –2 | – | 2 | % |
| Quiescent Voltage Output Ratiometry Error | $V_{QVO\_RAT}$ | $V_{DD(typ)}$ ± 5% | –12 | – | 12 | mV |
| Output Voltage Ripple [3] | $V_{RIPPLE}$ | $T_A$ = 25°C,  = 2.5 MHz | – | 17 | – | mV$_{PP}$ |
| **LIFETIME DRIFT** [2] | | | | | | |
| Sensitivity Drift Over Lifetime | $E_{SENS\_LT}$ | Based on the mean drift of worst-case distribution observed after AEC-Q100 qualification stresses | – | 0.5 | – | % |
| Quiescent Voltage Drift Over Lifetime | $V_{QVO\_LT}$ | Based on the mean drift of worst-case distribution observed after AEC-Q100 qualification stresses | – | 2.2 | – | mV |

[1] Absolute minimum ("Min." or "min") and absolute maximum ("Max." or "max") are the production limits that the device must not exceed.
[2] Validated by design and characterization.
[3] The output may display residual chopping frequency as a ripple at 2.5 MHz.

**ACS37035KLACTR-040B5 PERFORMANCE CHARACTERISTICS:** Valid through the full operating temperature range, $T_A = -40°C$ to 125°C, $C_{BYPASS} = 0.1$ μF, and typical $V_{DD}$, unless specified otherwise. Minimum and maximum values are tested in production or validated by design and characterization.

| Characteristic | Symbol | Test Conditions | Min. [1] | Typ. | Max. [1] | Unit |
|---|---|---|---|---|---|---|
| **NOMINAL PERFORMANCE** | | | | | | |
| Current Sensing Range [2] | $I_{PR}$ | Limited by $T_{J(MAX)} = 165°C$ | –40 | – | 40 | A |
| Sensitivity | Sens | $I_{PR(min)} < I_P < I_{PR(max)}$ | – | 50 | – | mV/A |
| Quiescent Voltage Output | $V_{QVO}$ | $I_P = 0A$ | – | $0.5 \times V_{DD}$ | – | V |
| Overcurrent FAULT Threshold | $I_{OC}$ | | – | 100 | – | $\%I_{PR}$ |
| Overcurrent FAULT Hysteresis | $I_{OC\_HYS}$ | | – | 2.8 | – | A |
| **FAULT ERROR** | | | | | | |
| Overcurrent Fault Error | $I_{OC\_E}$ | | –4 | – | 4 | A |
| **ERROR COMPONENTS** | | | | | | |
| Sensitivity Error | $E_{SENS}$ | $I_P = I_{PR(max)}$, $T_A = 25°C$ to 125°C | –1.5 | – | 1.5 | % |
| | | $I_P = I_{PR(max)}$, $T_A = –40°C$ to 25°C | –3 | – | 3 | % |
| Quiescent Voltage Output Error | $V_{QVO\_E}$ | $I_P = 0$ A, $T_A = 25°C$ to 125°C | –10 | – | 10 | mV |
| | | $I_P = 0$ A, $T_A = –40°C$ to 25°C | –15 | – | 15 | mV |
| Noise | N | $T_A = 25°C$, $C_L = 1$ nF, BW = 1 MHz | – | 3.4 | – | $mV_{RMS}$ |
| | | $T_A = 125°C$, $C_L = 1$ nF, BW = 1 MHz | – | 6.6 | – | $mV_{RMS}$ |
| Sensitivity Ratiometry Error | $E_{SENS\_RAT}$ | $V_{DD(typ)} \pm 5\%$ | –2 | – | 2 | % |
| Quiescent Voltage Output Ratiometry Error | $V_{QVO\_RAT}$ | $V_{DD(typ)} \pm 5\%$ | –12 | – | 12 | mV |
| Output Voltage Ripple [3] | $V_{RIPPLE}$ | $T_A = 25°C$, = 2.5 MHz | – | 7.4 | – | $mV_{PP}$ |
| **LIFETIME DRIFT [2]** | | | | | | |
| Sensitivity Drift Over Lifetime | $E_{SENS\_LT}$ | Based on the mean drift of worst-case distribution observed after AEC-Q100 qualification stresses | – | 0.5 | – | % |
| Quiescent Voltage Drift Over Lifetime | $V_{QVO\_LT}$ | Based on the mean drift of worst-case distribution observed after AEC-Q100 qualification stresses | – | 2.2 | – | mV |

[1] Absolute minimum ("Min." or "min") and absolute maximum ("Max." or "max") are the production limits that the device must not exceed.
[2] Validated by design and characterization.
[3] The output may display residual chopping frequency as a ripple at 2.5 MHz.

**ACS37035KLACTR-065B5 PERFORMANCE CHARACTERISTICS:** Valid through the full operating temperature range, $T_A$ = –40°C to 125°C, $C_{BYPASS}$ = 0.1 µF, and typical $V_{DD}$, unless specified otherwise. Minimum and maximum values are tested in production or validated by design and characterization.

| Characteristic | Symbol | Test Conditions | Min. [1] | Typ. | Max. [1] | Unit |
|---|---|---|---|---|---|---|
| **NOMINAL PERFORMANCE** | | | | | | |
| Current Sensing Range [2] | $I_{PR}$ | Limited by $T_{J(MAX)}$ = 165°C | –65 | – | 65 | A |
| Sensitivity | Sens | $I_{PR(min)} < I_P < I_{PR(max)}$ | – | 30 | – | mV/A |
| Quiescent Voltage Output | $V_{QVO}$ | $I_P$ = 0A | – | 0.5 x $V_{DD}$ | – | V |
| Overcurrent FAULT Threshold | $I_{OC}$ | | – | 100 | – | %$I_{PR}$ |
| Overcurrent FAULT Hysteresis | $I_{OC\_HYS}$ | | – | 5.0 | – | A |
| **FAULT ERROR** | | | | | | |
| Overcurrent Fault Error | $I_{OC\_E}$ | | –6.5 | – | 6.5 | A |
| **ERROR COMPONENTS** | | | | | | |
| Sensitivity Error | $E_{SENS}$ | $I_P$ = $I_{PR(max)}$, $T_A$ = 25°C to 125°C | –1.5 | – | 1.5 | % |
| | | $I_P$ = $I_{PR(max)}$, $T_A$ = –40°C to 25°C | –3 | – | 3 | % |
| Quiescent Voltage Output Error | $V_{QVO\_E}$ | $I_P$ = 0 A, $T_A$ = 25°C to 125°C | –10 | – | 10 | mV |
| | | $I_P$ = 0 A, $T_A$ = –40°C to 25°C | –15 | – | 15 | mV |
| Noise | N | $T_A$ = 25°C, $C_L$ = 1 nF, BW = 1 MHz | – | 2.4 | – | mV$_{RMS}$ |
| | | $T_A$ = 125°C, $C_L$ = 1 nF, BW = 1 MHz | – | 4.3 | – | mV$_{RMS}$ |
| Sensitivity Ratiometry Error | $E_{SENS\_RAT}$ | $V_{DD(typ)}$ ± 5% | –2 | – | 2 | % |
| Quiescent Voltage Output Ratiometry Error | $V_{QVO\_RAT}$ | $V_{DD(typ)}$ ± 5% | –12 | – | 12 | mV |
| Output Voltage Ripple [3] | $V_{RIPPLE}$ | $T_A$ = 25°C, = 2.5 MHz | – | 2.3 | – | mV$_{PP}$ |
| **LIFETIME DRIFT [2]** | | | | | | |
| Sensitivity Drift Over Lifetime | $E_{SENS\_LT}$ | Based on the mean drift of worst-case distribution observed after AEC-Q100 qualification stresses | – | 0.5 | – | % |
| Quiescent Voltage Drift Over Lifetime | $V_{QVO\_LT}$ | Based on the mean drift of worst-case distribution observed after AEC-Q100 qualification stresses | – | 2.2 | – | mV |

[1] Absolute minimum ("Min." or "min") and absolute maximum ("Max." or "max") are the production limits that the device must not exceed.
[2] Validated by design and characterization.
[3] The output may display residual chopping frequency as a ripple at 2.5 MHz.

## DESCRIPTIONS OF POWER ON/OFF OPERATION

### Introduction

To ensure that the device output is reporting accurately, the sensors contains an overvoltage and an undervoltage detection flag (undervoltage detection is enabled on 5 V device). This internal flag on $V_{OUT}$ can be used to alert the system when the supply voltage for the device is outside of the operational range by putting the output into a known high-impedance (high Z) state.

The provided graphs in this section show $V_{OUT}$ moving with $V_{DD}$. The voltage of $V_{OUT}$ during a high-impedance state will be most consistent with a known load ($R_{L\_VOUT}$, $C_{L\_VOUT}$). All figures below all use the same labeling scheme for different power thresholds. References in brackets "[ ]" are valid for Figure 5, Figure 4, and Figure 6.

### POWER-ON OPERATION

As $V_{DD}$ ramps up, the $V_{OUT}$ pin is high Z until $V_{DD}$ reaches and passes $V_{UVD}$ [2]. Once $V_{DD}$ passes [2], the device takes some time without $V_{DD}$ dropping below $V_{POR} - V_{POR\_HYS}$ [8] before the device enters normal operation.

### POWER-OFF OPERATION

Before the device powers off, it will force $V_{OUT}$ to GND if $V_{DD}$ reaches less than $V_{UVD} - V_{UVD\_HYS}$ [6]. When $V_{POR} - V_{POR\_HYS}$ [8] is reached, $V_{OUT}$ will go high Z.

NOTE: Because the device is entering a high Z state and not driving the output, the time it takes the output to reach a steady state will depend on the external circuitry used.

### POWER-ON RESET VOLTAGE ($V_{POR}$)

If $V_{DD}$ falls below $V_{POR} - V_{POR\_HYS}$ [8] while in operation, the digital circuitry turns off and the output will re-enter a high Z state. After $V_{DD}$ recovers and exceeds $V_{UVD}$ [2], the output will begin reporting again after the delay of $t_{PO}$.

### UNDERVOLTAGE DETECTION THRESHOLD ($V_{UVD}$)

The 5 V devices are factory-programmed with UVD. It is important to note that, when powering up the device for the first time after a Power-On Reset event, $V_{OUT}$ will remain high Z until $V_{DD}$ is raised above $V_{UVD}$ [2], at which point the $V_{OUT}$ output will begin to resume normal operation. If it is a 3.3 V device, $V_{OUT}$ will begin normal operation after $V_{DD}$ rises above $V_{POR}$ [1] under the same conditions.

If $V_{DD}$ drops below $V_{UVD} - V_{UVD\_HYS}$ [6] after normal operation, $V_{OUT}$ will pull to GND regardless of $R_{L\_VOUT}$ configuration. The $V_{OUT}$ will remain at GND until $V_{DD}$ rises above $V_{UVD}$ [7] or $V_{DD}$ falls below $V_{POR} - V_{POR\_HYS}$ [8]. If $V_{DD}$ rises above $V_{UVD}$ [7] after a UVD event, the $V_{OUT}$ output will resume operation. If $V_{DD}$ drops below $V_{PO} - V_{POR\_HYS}$ [8], the device will enter a POR event and reset; $V_{OUT}$ will switch to high Z if this occurs.

### OVERVOLTAGE DETECTION THRESHOLD ($V_{OVD}$)

When $V_{DD}$ rises above $V_{OVD}$ [4], the output of the $V_{OUT}$ pin will go high Z and will be pulled to either VDD or GND, depending on the configuration (pull-up vs. pull-down) of $R_{L\_VOUT}$.

### OVERVOLTAGE/UNDERVOLTAGE DETECTION HYSTERESIS ($V_{OVD\_HYS}$, $V_{UVD\_HYS}$)

There is hysteresis between enable and disable thresholds to reduce nuisance flagging and clears.
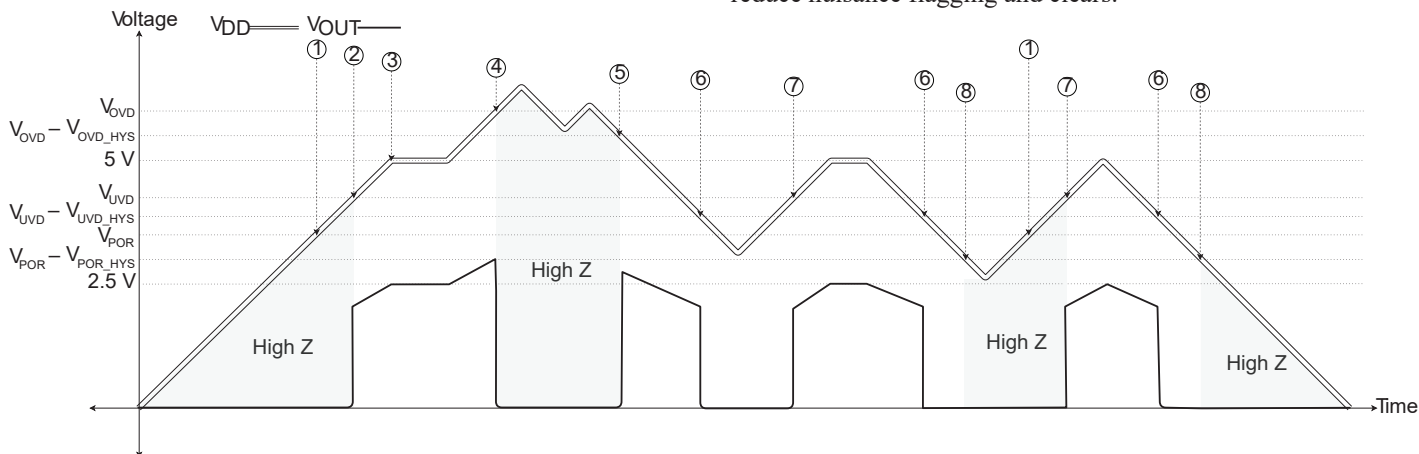


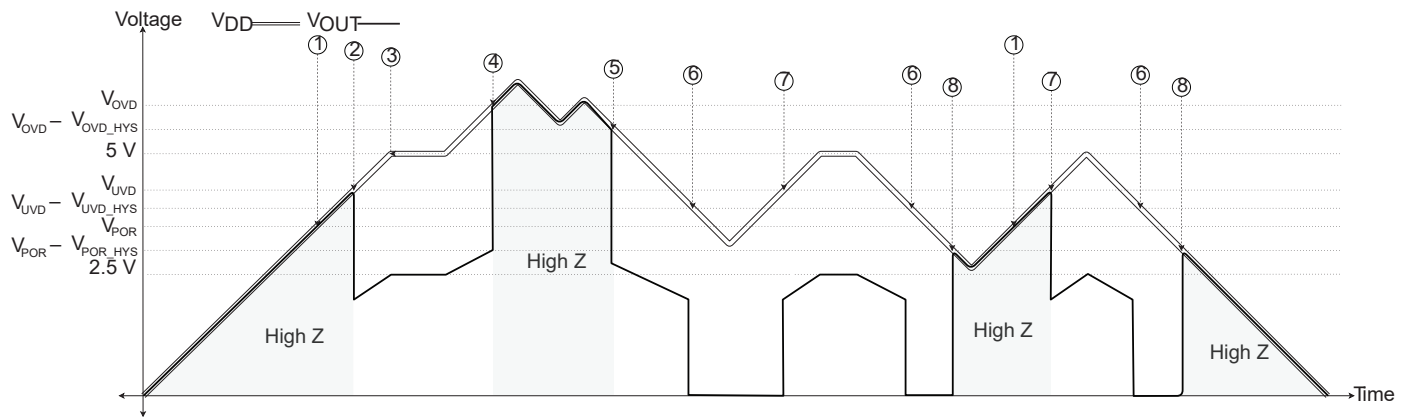**Figure 4: Power States Thresholds with $V_{OUT}$ Behavior for a 5 V Device, $R_{L\_VOUT}$ = Pull-Down**

**Figure 5: Power States Thresholds with $V_{OUT}$ and $V_{REF}$ Behavior, 5 V Device, $R_{L\_VOUT}$ = Pull-Up**
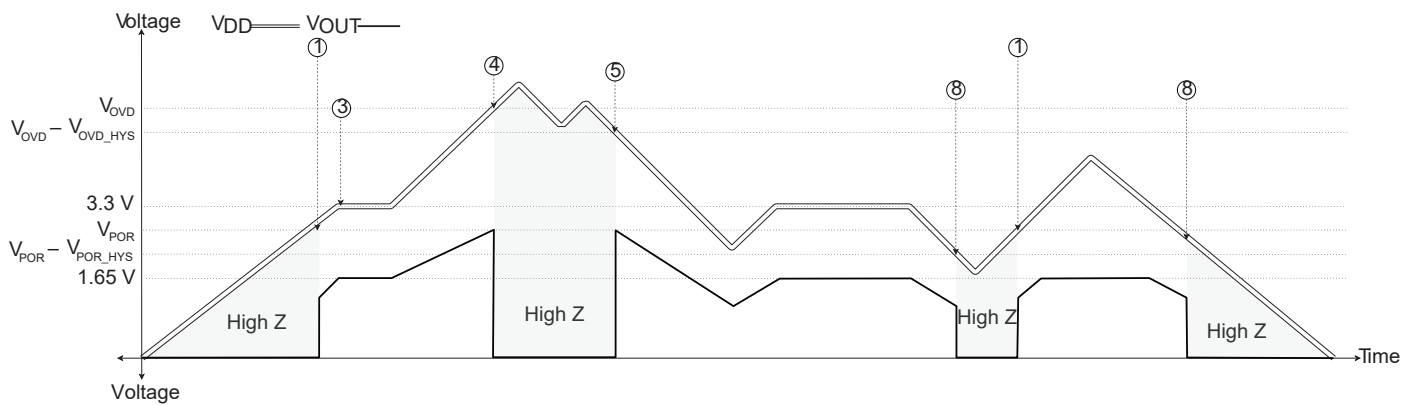
**Figure 6: Power States Thresholds with $V_{OUT}$ and $V_{REF}$ Behavior, 3.3 V Device, $R_L$ = Pull-Down, UVD Disabled**
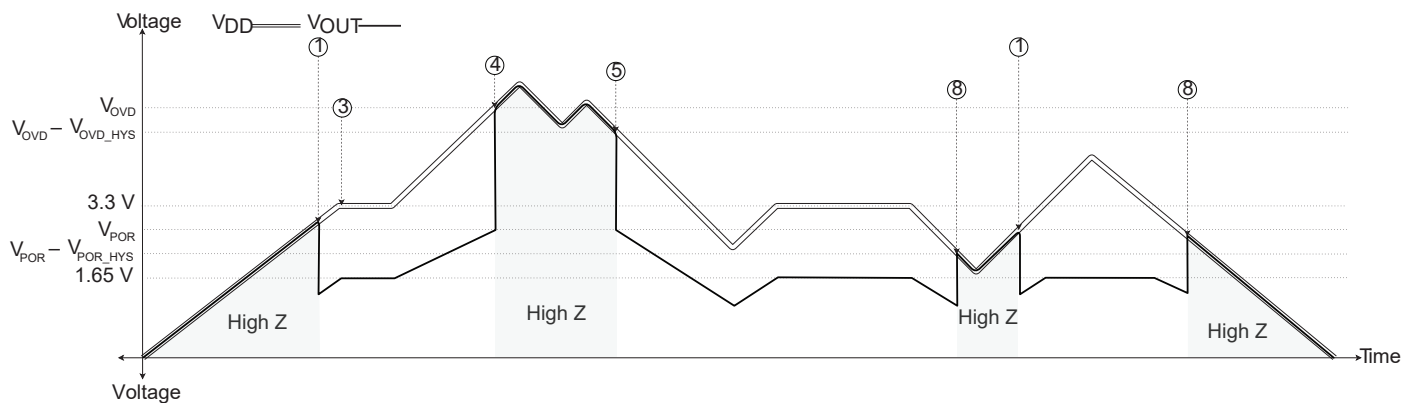
**Figure 7: Power States Thresholds with $V_{OUT}$ and $V_{REF}$ Behavior, 3.3 V Device, $R_L$ = Pull-Up, UVD Disabled**

## DESCRIPTIONS OF TIMING THRESHOLDS

### POWER-ON DELAY ($t_{PO}$)

When the supply is ramped to $V_{UVD}$ [2], the device will require a finite time to power its internal components before the outputs are released from high Z and can respond to an input magnetic field. Power-On Time, $t_{PO}$, is defined as the time it takes for the output voltage to settle within ±10% of its steady-state value under an applied magnetic field, which can be seen as the time from [2] to [A] in Figure 8. After this delay, the output will quickly approach $V_{OUT(IP)} = \text{Sens} \times I_P + V_{REF}$.

### OVERVOLTAGE AND UNDERVOLTAGE DETECTION TIME AND DETECTION RELEASE TIME ($t_{OVD\_E}$/$t_{OVD\_D}$, $t_{UVD\_E}$/$t_{UVD\_D}$)

The enable time for OVD, $t_{OVD\_E}$, is the time from $V_{OVD}$ [4] to OVD flag [B]. The UVD enable time, $t_{UVD\_E}$, is the time from $V_{UVD} - V_{UVD\_HYS}$ [6] to the UVD flag [D].

If $V_{DD}$ ramps from $>V_{UVD} - V_{UVD\_HYS}$ [6] to $<V_{POR} - V_{POR\_HYS}$ [8] faster than $t_{UVD\_E}$, then the device will not have time to report a UVD event before power off occurs.

The detection release time for OVD, $t_{OVD\_R}$, is the time from $V_{OVD} - V_{OVD\_HYS}$ [5] to the OVD clear to normal operation [C]. The UVD disable time, $t_{UVD\_R}$, is the time from $V_{UVD}$ [7] to the point that the UVD flag clears and $V_{OUT}$ returns to nominal operation [E]. The disable time does not have a counter for either OVD or UVD to release the output and resume reporting.
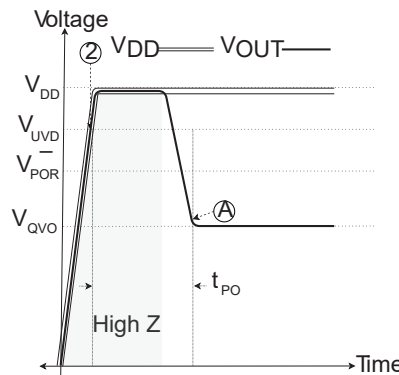


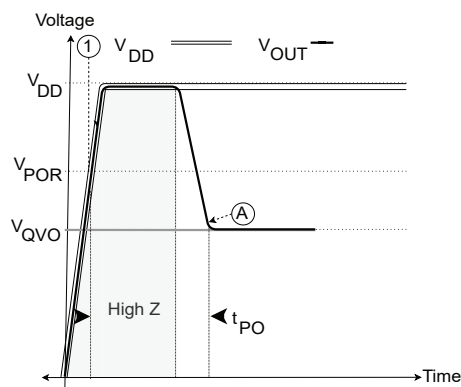**Figure 8: $t_{PO}$ behavior UVD enabled, $R_{L\_VOUT}$ = Pull-Up**



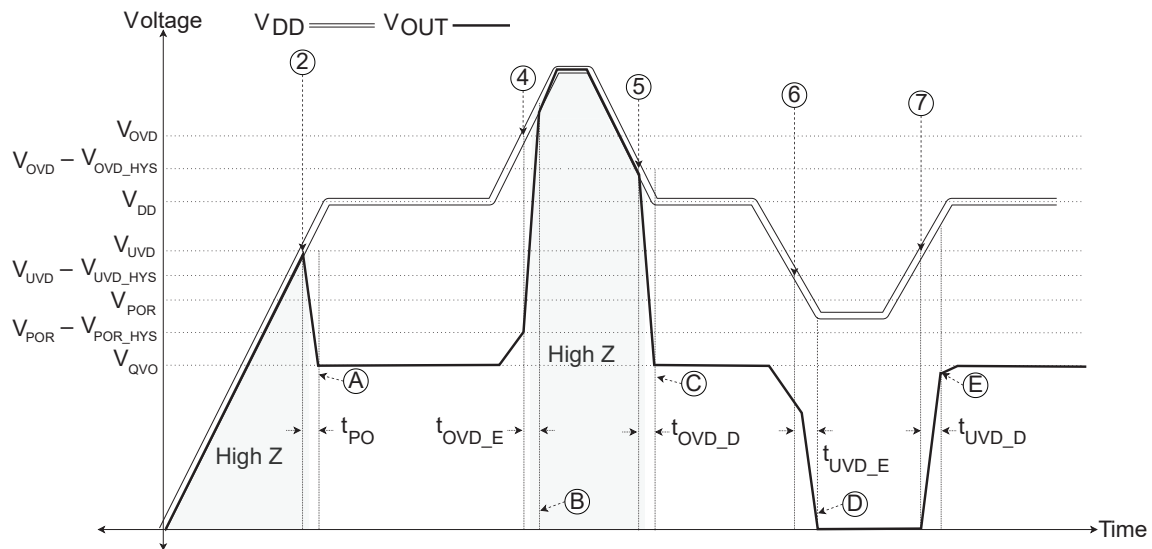**Figure 9: $t_{PO}$ behavior UVD disabled, $R_{L\_VOUT}$ = Pull-Up**

**Figure 10: $t_{PO}$, and $t_{OVD}/t_{OVD\_R}$, and $t_{UVD}/t_{UVD\_R}$ with $R_{L\_VOUT}$ = Pull-Up, 5 V**
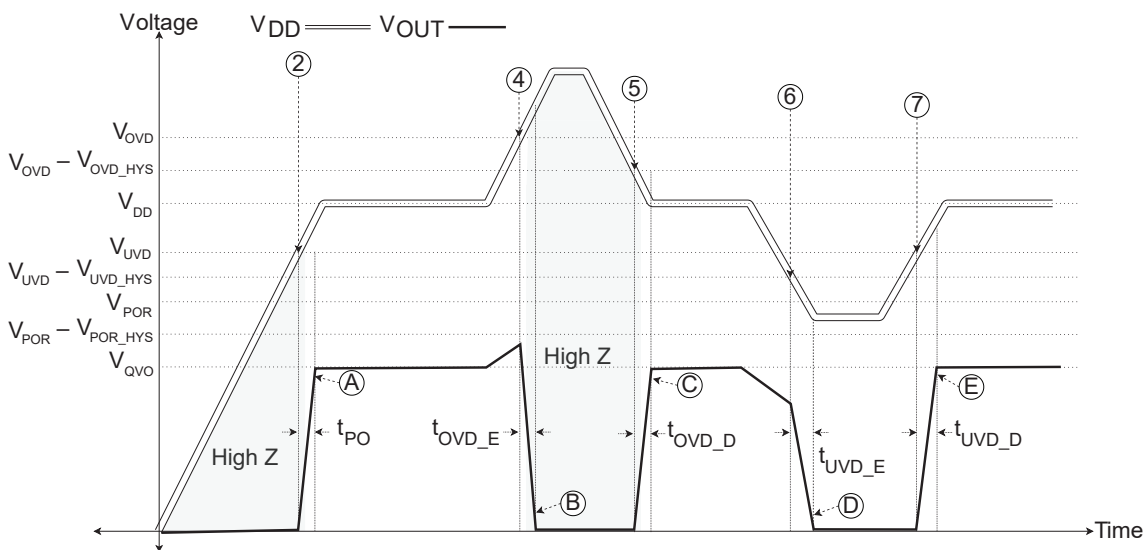


**Figure 11: $t_{PO}$, and $t_{OVD}/t_{OVD\_R}$, and $t_{UVD}/t_{UVD\_R}$ with $R_{L\_VOUT}$ = Pull-Down, 5 V**

## DEFINITIONS OF OPERATING AND PERFORMANCE CHARACTERISTICS

### Quiescent Voltage Output (V$_{QVO}$)

Quiescent Voltage Output, V$_{QVO}$, is defined as the voltage on the output, V$_{OUT}$, when no current is applied, I$_P$ = 0.

$$V_{QVO} = V_{OUT\_@0A} \ [mV]$$

### Quiescent Voltage Output Error (V$_{QVO\_E}$)

Quiescent Voltage Output Error, V$_{QVO\_E}$, is defined as the deviation of V$_{QVO}$ from the nominal target value in production testing.

$$V_{QVO\_E} = V_{QVO\_MEASURED} - V_{QVO\_IDEAL} \ [mV]$$

### Quiescent Voltage Output Ratiometry Error (V$_{OE\_RAT}$)

Ratiometric error for quiescent voltage output is calculated using the following equation:

$$V_{QVO\_RAT} = V_{QVO(VDD)} - V_{QVO(VDDN)} \ x \ \frac{V_{DD}}{V_{DD(N)}} \ [mV]$$

where $V_{DD(N)}$ is equal to the nominal V$_{DD}$ (3.3 V, or 5 V) and V$_{QVO(VCCN)}$ is the measured offset voltage at the nominal V$_{DD}$ for a particular device. The symbol $V_{DD}$ is the measured V$_{DD}$ value in application and $V_{QVO(VDD)}$ is the measured zero-current offset voltage for a particular device.

### Sensitivity (Sens)

Sensitivity, or Sens, is defined as the ratio of the V$_{OUT}$ swing and the current through the primary conductor, I$_P$. The current causes a voltage change on V$_{OUT}$ away from V$_{QVO}$ until V$_{SAT}$. The magnitude and direction of the output voltage is proportional to the magnitude and direction of the current, I$_P$. The proportional relationship between output voltage and current is Sensitivity, defined as:

$$Sens = \frac{V_{OUT\_IP1} - V_{OUT\_IP2}}{I_{P1} - I_{P2}} \ [mV/A]$$

where I$_{P1}$ and I$_{P2}$ are two different currents, and V$_{OUT}$(I$_{P1}$) and V$_{OUT}$(I$_{P2}$) are the respective output voltages, at VOUT, at those currents.

### Sensitivity Error (E$_{SENS}$)

Sensitivity Error, E$_{SENS}$, is the deviation of Sensitivity from the nominal sensitivity target value in production testing.

$$E_{SENS} = \frac{SENS_{MEASURED} - SENS_{IDEAL}}{SENS_{IDEAL}} \ x \ 100 \ [\%]$$

### Sensitivity Ratiometry Error (V$_{SENS\_RAT}$)

Ideally, a 5% increase in V$_{DD}$ results in a 5% increase in sensitivity. However, the ratiometric response of any sensor is not ideal. Ratiometric sensitivity error, E$_{RAT(SENS)}$, is specified by the equation:

$$E_{SENS\_RAT} = \left[ 1 - \left( \frac{Sens_{VDD}}{Sens_{VDD(N)}} \ x \ \frac{V_{DD(N)}}{V_{DD}} \right) \right] x \ 100 \ [\%]$$

where $V_{DD(N)}$ is equal to the nominal V$_{DD}$ (3.3 V, or 5 V) and $Sens_{VDD(N)}$ is the measured sensitivity at nominal V$_{DD}$ for a particular device. The symbol $V_{DD}$ is the measured V$_{DD}$ value in application and $Sens_{VDD}$ is the measured sensitivity at that V$_{DD}$ level for a particular device.

### Output Saturation Voltage (V$_{SAT\_H}$ and V$_{SAT\_L}$)

Output Saturation Voltage, V$_{SAT}$, is defined as the minimum and maximum voltages the VOUT output budder can drive. V$_{SAT\_H}$ is the highest voltage the output can reach, while V$_{SAT\_L}$ is the lowest. In other states, the VOUT pin may be pulled outside of V$_{SAT\_L}$ and V$_{SAT\_H}$. Note that changing the sensitivity does not change the V$_{SAT}$ points.

### Lifetime Drift
(E$_{SENS\_LT}$ and V$_{QVO\_LT}$)

Lifetime drift characteristics are based on the mean drift of the worst-case distribution observed during AEC-Q100 qualification stresses. Solder reflow induces stress and lifetime drift limits apply immediately after solder reflow.

# DEFINITIONS OF OVERCURRENT FAULT (OCF) CHARACTERISTICS AND PERFORMANCE

## OVERCURRENT FAULT PIN (OCF)

As the output swings, if the sensed current exceeds its set threshold, the overcurrent fault pin triggers with an active low flag. This is internally compared with the VOC voltage.

The implementation for the OCF circuitry is accurate over temperature and does not require further temperature compensation because it is dependent on the Sens and $V_{QVO}$ parameters that are factory-programmed over temperature.

## VOLTAGE OVERCURRENT PIN (VOC)

The Voltage Overcurrent pin, or VOC, is a voltage input that is used to set the Overcurrent FAULT Threshold, $I_{OCR}$.

Connecting a resistor divider between VDD and GND sets the voltage at VOC. The voltage on the VOC pin may range from $0.1 \times V_{DD}$ to $0.4 \times V_{DD}$. Overcurrent fault threshold may be set anywhere from 50% to 200% IPR. $I_{OCR}$ is set as a percentage of the full-scale sensing range of the device, $I_{PR(MAX)}$, and can be between 50% $I_{PR(Max.)}$ and 200% $I_{PR(MAX)}$. Overcurrent fault threshold versus $V_{VOC}$ is shown in Figure 12.

The equation for calculating the trip current is shown below. For bidirectional devices, the fault trips for both positive and negative currents.

$$I_{FAULT} = I_{PR(MAX)} \left\{ 5 \times \frac{V_{VOC}}{V_{CC}} \right\}$$

This may be rearranged to solve for the appropriate $V_{VOC}$ value based on a desired overcurrent fault threshold, shown by the equation:

$$V_{VOC} = \frac{V_{CC}}{5} \times \frac{I_{FAULT}}{I_{PR(MAX)}}$$

By setting $V_{VOC}$ with a resistor divider from $V_{DD}$, the ratio of $V_{VOC}/V_{DD}$ remains constant with changes to $V_{DD}$. In this regard, the fault trip point remains constant even as the supply voltage varies.

## OVERCURRENT FAULT OUTPUT ERROR ($E_{OC}$)

Overcurrent FAULT Error, $E_{OC}$, is defined as the difference between the set current threshold, and the measured current at which the OCF activates.

## OVERCURRENT FAULT HYSTERESIS ($I_{OC\_HYS}$)

Overcurrent Hysteresis, or $I_{OC\_HYST}$, is defined as the magnitude of current in percentage of the FS that must drop before a

fault assertion will be cleared. This can be seen as the separation between the voltages [9] to [10] in Figure 13 and Figure 14.

## VOC INPUT LINEAR OPERATING RANGE ($V_{OR\_VOC}$)

VOC Input Linear Operating Range, $V_{OR\_VOC}$, is the voltage range for $V_{VOC}$ in which the Overcurrent FAULT Threshold, $I_{OCR}$, varies linearly with $V_{VOC}$.

## OVERCURRENT FAULT RESPONSE TIME ($t_{OC\_RESP}$)

Overcurrent Response Time, or $t_{OC\_RESP}$, is defined as the time from when the input current reaches the operating point [9] until the OCF pin falls below $V_{FAULT\_L}$ [G].
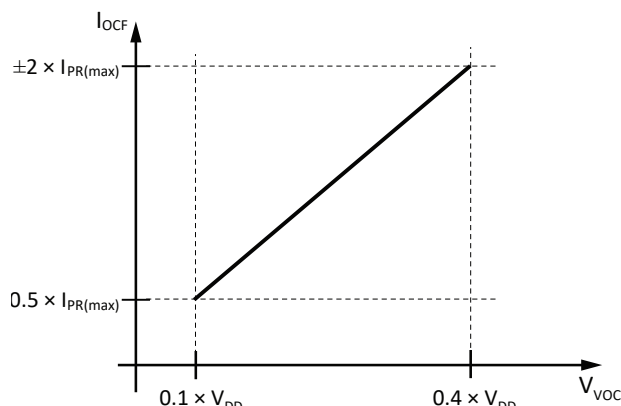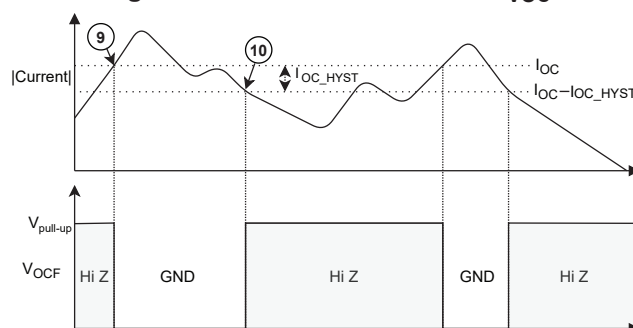


**Figure 12: Fault Threshold vs. $V_{VOC}$**



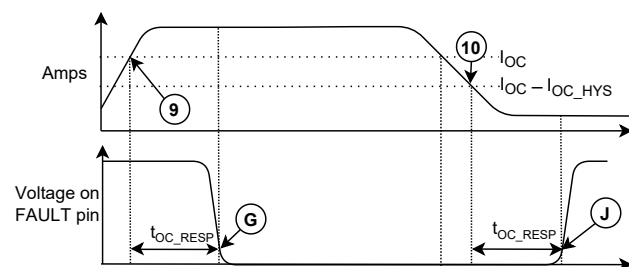**Figure 13: Fault Thresholds and OCF Functionality**



**Figure 14: Fault Timing Diagram**

## THERMAL PERFORMANCE

Resistive heating due to the flow of electrical current in the package should be considered during the thermal design of the application. The sensor, PCB, and PCB terminals generate heat and act as a heat sink.

The thermal response is highly dependent on the PCB layout, copper thickness, cooling method, and the profile of the injected current (including peak current, current on-time, and duty cycle).

In-pad vias help improve thermal performance. Placing vias under the copper pads of the board reduces electrical resistance and improves heat conduction to the PCB (Figure 15 and Figure 16). The ACSEVB-MA16-LA16 includes in-pad vias and is recommended to improve thermal performance.
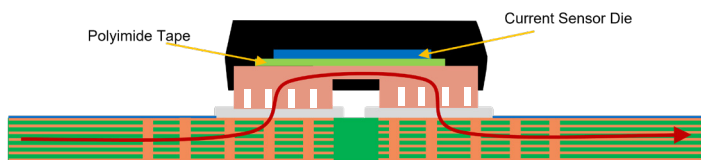


**Figure 15: Vias Under Copper Pads (not to scale)**



**Figure 16: No Vias Under Copper Pads (not to scale)**

Figure 17 shows the measured rise in steady-state die temperature of sensor versus DC continuous current at an ambient temperature $T_A = 25°C$ for two board designs: with filled in-pad vias and without in-pad vias.

Figure 18 shows the measured rise in steady-state die temperature of sensor versus DC continuous current at ambient temperatures of 25°C and 125°C.

The thermal performance of sensor must always be verified in the specific conditions of the application. The maximum junction temperature of the sensor, $T_{J(MAX)} = 165°C$, must not be exceeded.
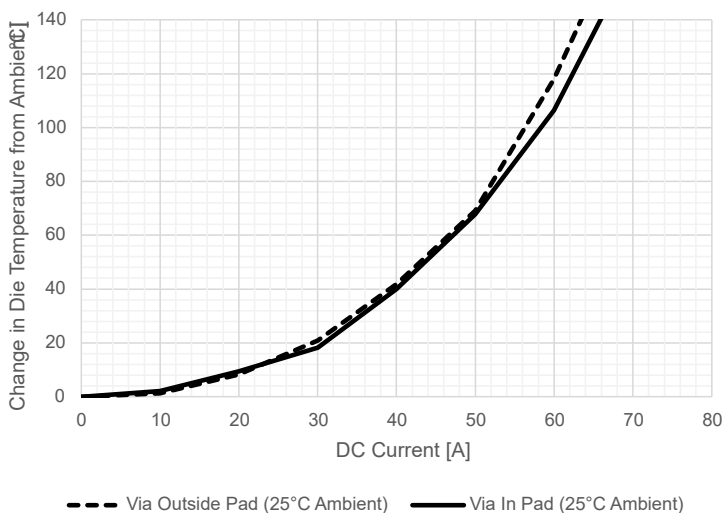


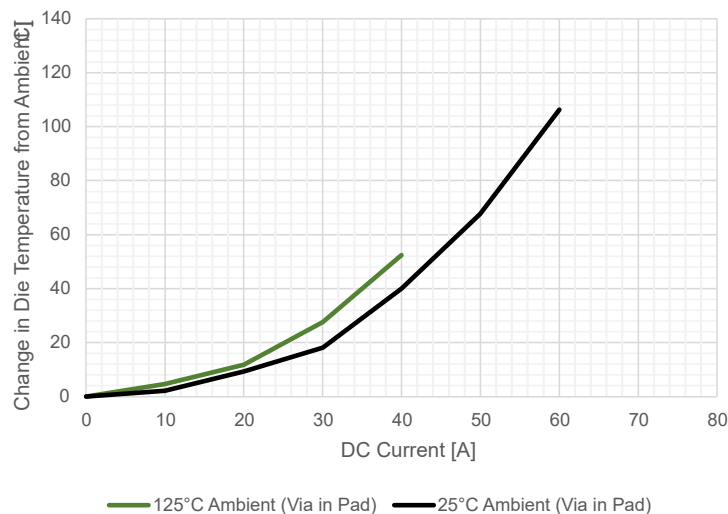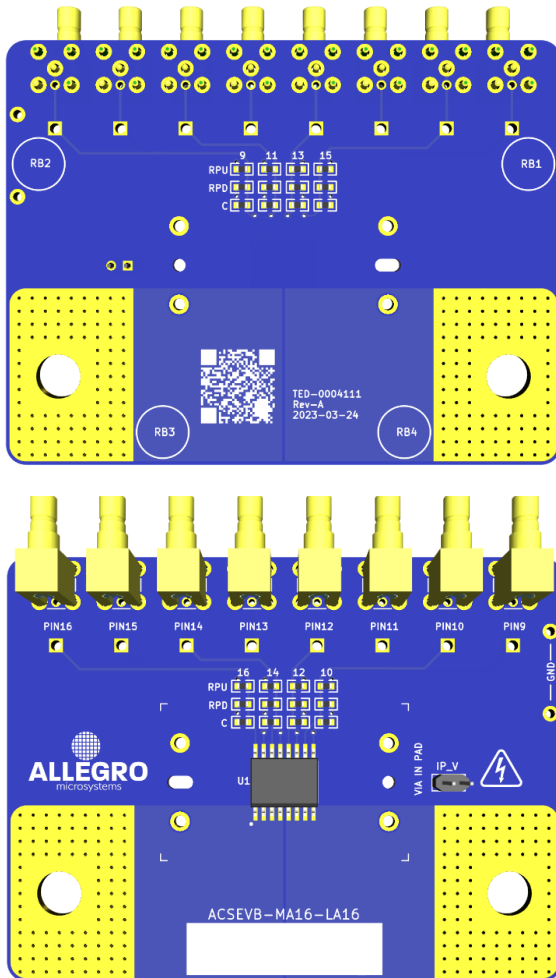**Figure 17: LA Package Performance with/without Vias**



**Figure 18: LA Package Performance at 25°C and 125°C**

## Evaluation Board Layout

Thermal data shown was collected using the ACSEVB-MA16-LA16 Allegro evaluation board (TED-0004111). This board includes six layers of 2 oz. copper weight on all layers. The top and bottom layers of the PCB are shown in Figure 19.



**Figure 19: MA/LA Evaluation Board
Top and Bottom Layers**

## PACKAGE OUTLINE DRAWING

**For Reference Only – Not for Tooling Use**
(Reference Allegro DWG-0000388, Rev. 1 and JEDEC MS-013AA)
NOT TO SCALE
Dimensions in millimeters
Dimensions exclusive of mold flash, gate burrs, and dambar protrusions
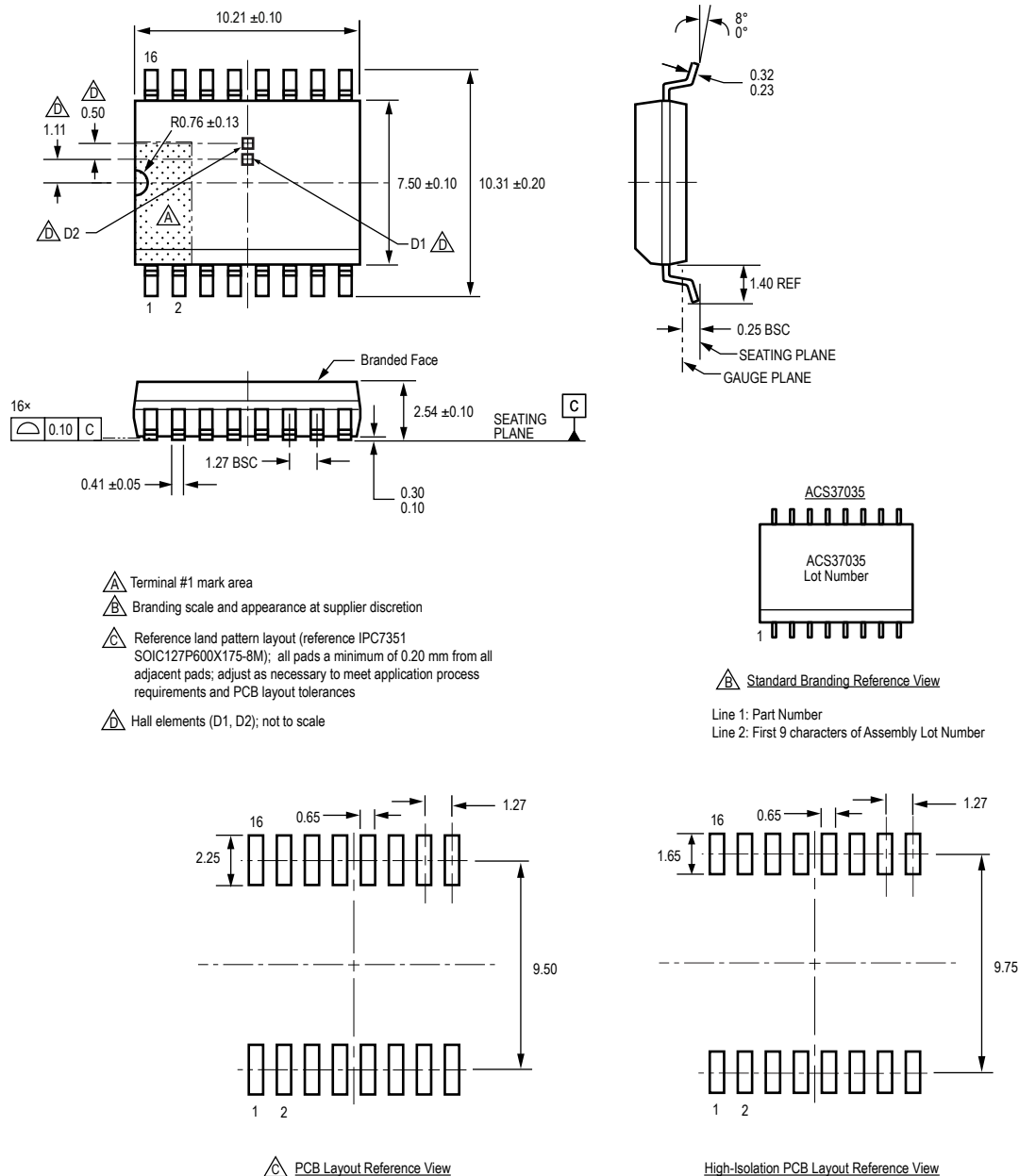Exact case and lead configuration at supplier discretion within limits shown

A. Terminal #1 mark area

B. Branding scale and appearance at supplier discretion

C. Reference land pattern layout (reference IPC7351 SOIC127P600X175-8M); all pads a minimum of 0.20 mm from all adjacent pads; adjust as necessary to meet application process requirements and PCB layout tolerances

D. Hall elements (D1, D2); not to scale

B. Standard Branding Reference View

Line 1: Part Number
Line 2: First 9 characters of Assembly Lot Number

C. PCB Layout Reference View

High-Isolation PCB Layout Reference View

**Figure 20: Package LA, 16-PIN SOICW**

## Revision History

| Number | Date | Description |
|---|---|---|
| – | March 7, 2025 | Initial release |
| 1 | March 18, 2025 | Updated Sensitivity Drift Over Lifetime value and footnote 1 (pages 8-10); fixed Part Naming Specification diagram (page 2) |
| 2 | May 15, 2025 | Added ACS37035KLACTR-065B5 variant (page 2, 11); updated performance characteristics tables (page 8, 9, 10); updated application information for a ratiometric device (12-16); minor editorial updates |
| 3 | June 9, 2025 | Updated Distance Through Insulation value (page 3) and Figures 4 through 7 (pages 12 and 13) |