ACS37029 and ACS37031

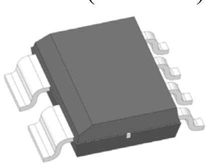
DC to 5 MHz Bandwidth, Galvanically Isolated, High-Accuracy Current Sensor IC with Reference Output (ACS37031) or Fault (ACS37029)

FEATURES AND BENEFITS

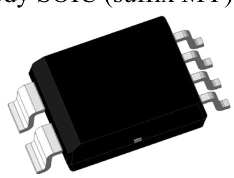
- High operating bandwidth for fast control loops or where high-speed switching currents are monitored
  - DC to 5 MHz bandwidth
  - 40 ns typical response time
- High accuracy and low noise
  - ±2% sensitivity error over temperature
  - ±10 mV maximum offset voltage over temperature
  - 50 mA_{RMS} input-referred noise
  - 3.3 V non-ratiometric supply operation
  - Differential sensing immune to external magnetic fields
- Zero-current voltage reference output, VREF, for differential routing in noisy application environments (ACS37031)
- Overcurrent FAULT output with adjustable threshold (ACS37029)
- UL-certified, isolated, compact surface-mount package
- Available in two packages: LZ (4.1 mm creepage) and MY (8.5 mm creepage)
- Wide operating temperature, –40°C to 150°C
- Grade 0, AEC-Q100 automotive qualified

PACKAGES

6-pin Fused-Lead SOIC (suffix LZ)



6-pin Fused-Lead Wide Body SOIC (suffix MY)



Not to scale

DESCRIPTION

The ACS37029/31 is a fully integrated current sensor IC that senses current flowing through the primary conductor. Two signal paths are used: a Hall-effect element path to capture DC and low-frequency current information, and an inductive coil path to capture high-frequency current information. These two paths are summed to allow for sensing of a wide frequency band with a single device. The properties of the coil increase SNR as frequency increases, minimizing noise at the output.

The internal construction provides high isolation by magnetically coupling the field generated by current flow in the conductor to the fully monolithic Hall and coil IC. The current is sensed differentially by two Hall plates and two coils that subtract interfering common-mode magnetic fields. The IC is not physically connected to the integrated current conductor, and it provides a 3500 V_{RMS} (LZ package) and a 4242 V_{RMS} (MY package) isolation voltage between the primary signal leads. These high ratings provide a basic working voltage of 905 V_{RMS} (LZ package) and 1000 V_{RMS} (MY package) isolation voltage between the primary and secondary signal leads of the package.

Both zero-current reference (ACS37031) and overcurrent fault with internal pull-up (ACS37029) options are available.

The ACS37029/31 is provided in two six-lead custom SOIC surface mount packages; these packages are low resistance, <1 mΩ with fuse-lead current conductors. The LZ package has a resistance of 0.6 mΩ with a creepage/clearance of 4.1 mm, while the MY package has a resistance of 0.9 mΩ with a creepage/clearance of 8.5 mm. The leadframe is plated with 100% matte tin, which is compatible with standard lead (Pb) free printed circuit board (PCB) assembly processes. Internally, the device is Pb-free.

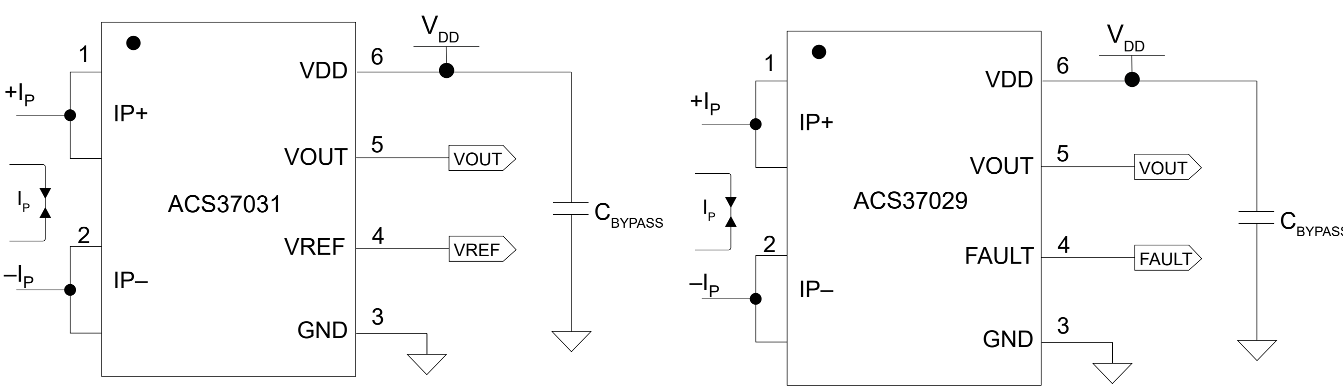


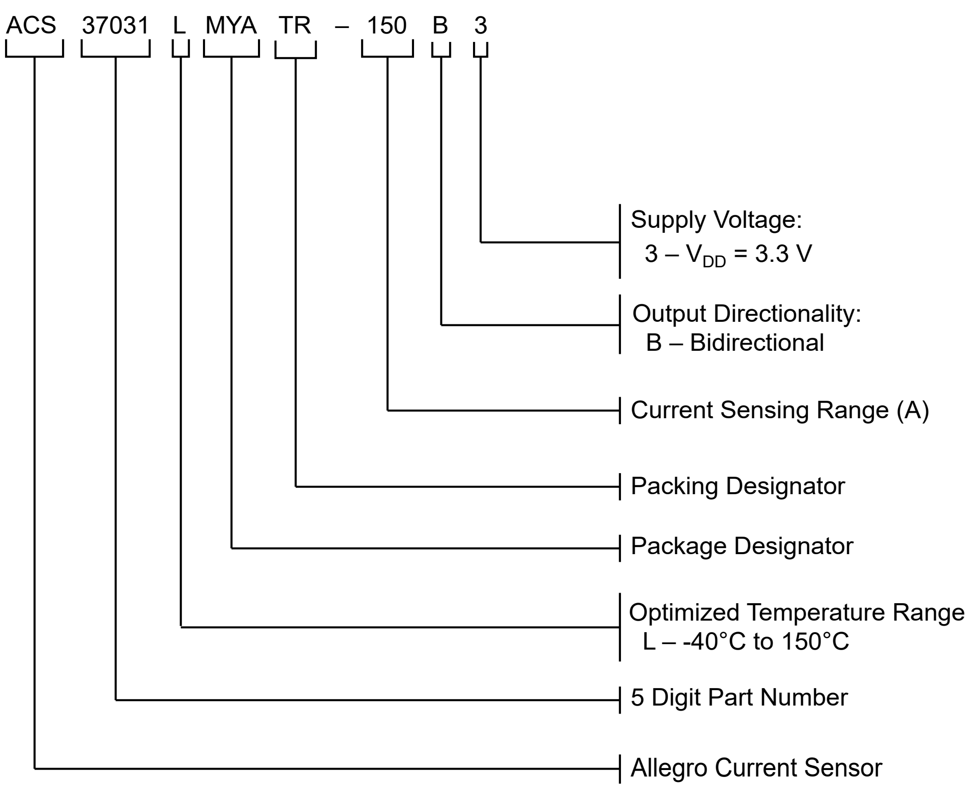
Figure 1: Typical Application Circuit

The device outputs an analog signal, V_{OUT}, that varies linearly with the bidirectional AC or DC primary current, I_P, within the ranges specified.

SELECTION GUIDE

Part Number	Current Sensing Range, I_{PR} (A)	Sensitivity (mV/A)	V_{DD} (V)	V_{QVO} (V)	Feature	Optimized Temperature Range T_A (°C)	Packing
LZ Package							
ACS37031LLZATR-090B3	±90	14.6	3.3	1.65	VREF	–40 to 150	Tape and reel, 3000 pieces per reel
ACS37031LLZATR-150B3	±150	8.8		1.60			
ACS37029LLZATR-090B3	±90	14.6		1.65	FAULT		
ACS37029LLZATR-150B3	±150	8.8		1.65			
MY Package (Wide Body, Material Group 2)							
ACS37031LMYATR-090B3	±90	14.6	3.3	1.65	VREF	–40 to 150	Tape and reel, 1000 pieces per reel
ACS37031LMYATR-150B3	±150	8.8					
ACS37029LMYATR-090B3 [1]	±90	14.6			FAULT		
ACS37029LMYATR-150B3 [1]	±150	8.8					

[1] Pending release.



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ABSOLUTE MAXIMUM RATINGS [1]

Characteristic	Symbol	Notes	Rating	Unit
Supply Voltage	V_{DD}		–0.5 to 4	V
Forward Output Voltage	V_O	Applies to V_{OUT}, V_{REF}, and FAULT	–0.5 to V_{DD} + 0.5 (< 3.8)	V
Operating Ambient Temperature	T_A	L temperature range	–40 to 150	°C
Storage Temperature	T_{stg}		–65 to 165	°C
Maximum Junction Temperature	$T_{J(max)}$	Sensing range of sensor is limited by $T_{J(max)}$ = 165°C	165	°C

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

LZ PACKAGE ISOLATION CHARACTERISTICS

Characteristic	Symbol	Notes	Value	Units
Withstand Voltage [1][2]	V_{ISO}	Agency rated for 60 seconds per UL 62368-1 (edition 3)	3500	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)	1188	V_{PK} or V_{DC}
			840	V_{RMS}
Working Voltage for Reinforced Isolation [2]	V_{WVRI}	Maximum approved working voltage for reinforced isolation according to UL 62368-1 (edition 3)	594	V_{PK} or V_{DC}
			420	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	13000	V_{PK}
Impulse Withstand Voltage	$V_{IMPULSE}$	1.2/50 µs waveform, tested in air	5000	V_{RMS}
Clearance	D_{CL}	Minimum distance through air from IP leads to signal leads	4.1	mm
Creepage	D_{CR}	Minimum distance along package body from IP leads to signal leads	4.1	mm
Distance Through Insulation	DTI	Minimum internal distance through insulation	54	µm
Comparative Tracking Index	CTI	Material Group I	>600	V

[1] Production tested in accordance with UL 62368-1 (edition 3).
[2] Certification pending.

MY PACKAGE ISOLATION CHARACTERISTICS

Characteristic	Symbol	Notes	Value	Units
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 Withstand Voltage	$V_{IMPULSE}$	1.2/50 µs waveform, tested in air	6000	V_{RMS}
Clearance	D_{CL}	Minimum distance through air from IP leads to signal leads	8.5	mm
Creepage	D_{CR}	Minimum distance along package body from IP leads to signal leads	8.5	mm
Distance Through Insulation	DTI	Minimum internal distance through insulation	54	µm
Comparative Tracking Index	CTI	Material Group II (MYA only)	400 to 599	V

[1] Production tested in accordance with UL 62368-1 (edition 3).
[2] Certification pending.

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THERMAL CHARACTERISTICS

Characteristic	Symbol	Notes	Value	Unit
Package Thermal Resistance (Junction to Ambient)	$R_{\theta JA}$	LZ package; mounted on the standard LZ current sensor evaluation board (ACSEVB-LC8-LZ6)	16	°C/W
		MY package; mounted on the standard MY current sensor evaluation board (ACSEVB-MZ6-MY6)	17	°C/W
Package Thermal Metric (Junction to Top)	Ψ_{JT}	LZ package; mounted on the standard LZ current sensor evaluation board (ACSEVB-LC8-LZ6)	0	°C/W
		MY package; mounted on the standard MY current sensor evaluation board (ACSEVB-MZ6-MY6)	–3	°C/W
Package Thermal Resistance (Junction to Case)	$R_{\theta JC}$	LZ package; simulated per the methods in JESD51-1	23	°C/W
		MY package; simulated per the methods in JESD51-1	26	°C/W
Package Thermal Resistance (Junction to Board)	$R_{\theta JB}$	LZ package; simulated per the methods in JESD51-8	12	°C/W
		MY package; simulated per the methods in JESD51-8	7	°C/W

PACKAGE CHARACTERISTICS

Characteristic	Symbol	Notes	Min.	Typ.	Max.	Unit
Internal Conductor Resistance	R_{IC}	LZ package, T_A = 25°C	–	0.68	–	mΩ
		MY package, T_A = 25°C	–	0.9	–	mΩ
Internal Conductor Inductance	L_{IC}	LZ package, T_A = 25°C	–	2.2	–	nH
		MY package, T_A = 25°C	–	4.4	–	nH
Moisture Sensitivity Level	MSL	Per IPC/JEDEC J-STD-020	–	2	–	–

PINOUT DIAGRAM AND TERMINAL LIST TABLE

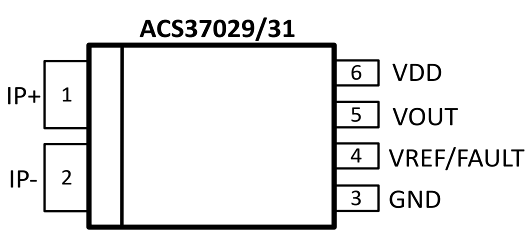

Figure 2: LZ/MY Package Pinout Diagram

Terminal List

Number	Name	Description
1	IP+	Positive terminal for current being sensed
2	IP–	Negative terminal for current being sensed
3	GND	Device ground terminal
4	VREF/FAULT	Reference or overcurrent fault output
5	VOUT	Analog output signal
6	VDD	Device power supply terminal

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FUNCTIONAL BLOCK DIAGRAM

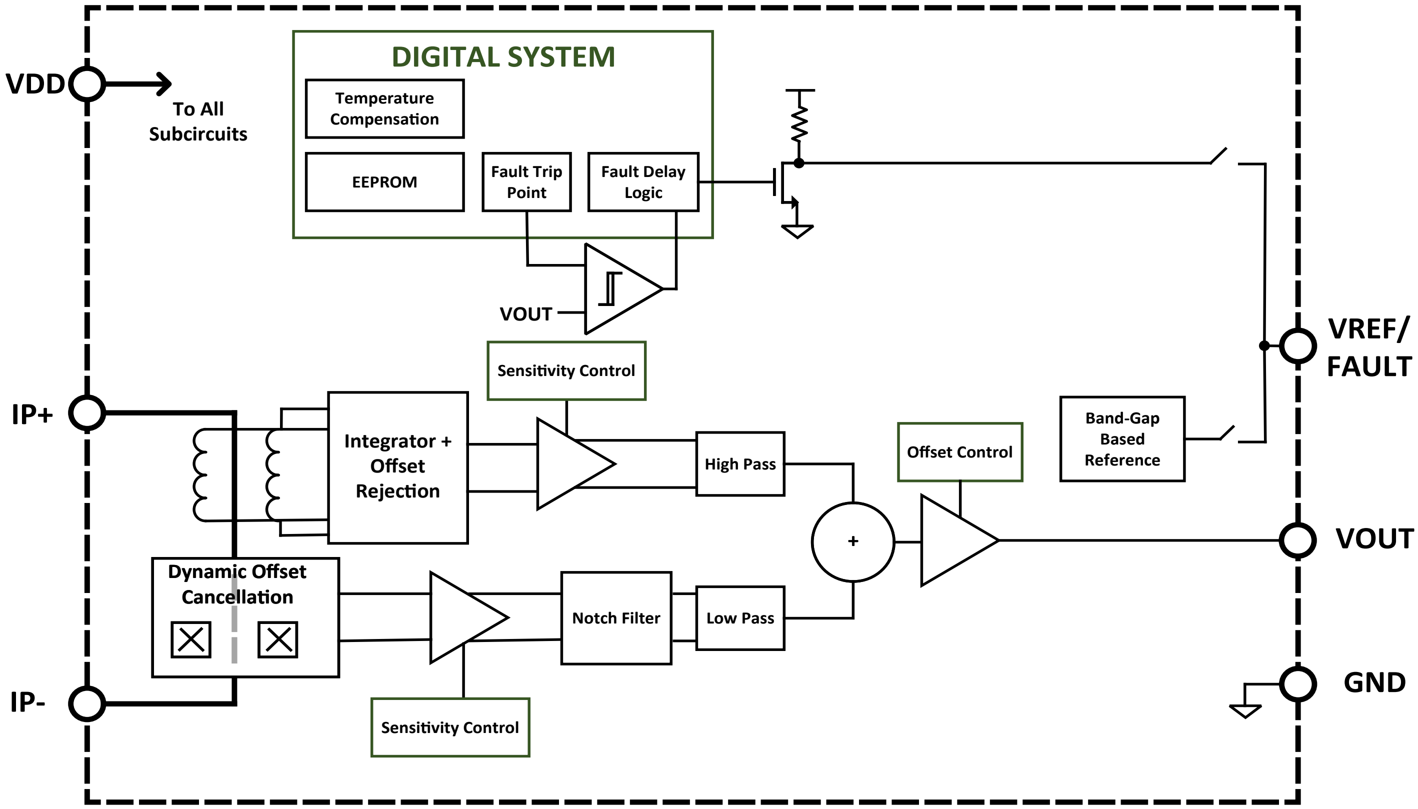

Figure 3: Functional Block Diagram

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COMMON ELECTRICAL CHARACTERISTICS [1]: Valid through full operating temperature range, T_A = –40°C to 150°C, C_{BYPASS} = 0.1 µF, and V_{DD} = 3.3 V, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ.	Max.	Units
Supply Voltage	V_{DD}		3	3.3	3.6	V
Supply Current	I_{DD}	Load not present on V_{OUT} or V_{REF}	–	20	30	mA
Supply Bypass Capacitor	C_{BYPASS}		0.1	–	–	µF
Output Resistive Load	R_{L_VOUT}		50	–	–	kΩ
Output Capacitive Load	C_{L_VOUT}		–	–	100	pF
Power-On Reset Voltage	V_{POR}	T_A = 25°C, V_{DD} rising 1 V/ms	2.6	2.9	3	V
POR Hysteresis	V_{POR_HYS}		200	250	–	mV
Power-On Time	t_{PO}		–	2	4	ms
OUTPUT SIGNAL CHARACTERISTICS (VOUT)						
Saturation Voltage	V_{SAT_H}	R_{L_VOUT} = 50 kΩ to GND	3	–	–	V
	V_{SAT_L}	R_{L_VOUT} = 50 kΩ to V_{DD}	–	–	0.15	V
VOUT Short Circuit Current	I_{SC_VOUT}	T_A = 25°C, shorted to GND	–	25	–	mA
		T_A = 25°C, shorted to VDD	–	–25	–	mA
Bandwidth	BW	Small signal –3 dB, C_{L_VOUT} = 100 pF	–	5	–	MHz
Rise Time	t_R	T_A = 25°C, C_{L_VOUT} = 100 pF	–	40	–	ns
Response Time	t_{RESP}	T_A = 25°C, C_{L_VOUT} = 100 pF	–	40	–	ns
Propagation Delay	t_{PD}	T_A = 25°C, C_{L_VOUT} = 100 pF	–	30	–	ns
Noise	I_N	BW = 5 MHz, T_A = 25°C, C_{L_VOUT} = 100 pF	–	50	–	mA_{RMS}
Common-Mode Field Rejection	CMFR	Input-referred error due to a common-mode field	–	1.6	–	mA/G
REFERENCE OUTPUT CHARACTERISTICS (VREF, ACS37031 only)						
Reference Resistive Load	R_{L_VREF}		50	–	–	kΩ
Reference Capacitive Load	C_{L_VREF}		–	–	100	pF
Reference Source/Sink Current Limit	I_{SC_VREF}	VREF shorted to GND	–	25	–	mA
	I_{SK_VREF}	VREF shorted to VDD	–	–25	–	mA
FAULT OUTPUT CHARACTERISTICS (FAULT, ACS37029 only)						
Overcurrent FAULT Operating Range [3]	I_{OCR}		90	100	110	%
Internal Overcurrent Pull-Up Resistance	R_{L_IFAULT}		–	10	–	kΩ
Overcurrent FAULT Error	E_{OC}		–10	–	10	$\%I_{OCR}$
Overcurrent FAULT Output Low Voltage	V_{FAULT_L}	R_{L_FAULT} = 10 kΩ, fault condition present	–	0.1	0.4	V
Overcurrent FAULT Leakage Current	I_{FAULT_OFF}	R_{L_FAULT} = 10 kΩ, fault condition not present	–	100	500	nA
Overcurrent FAULT Hysteresis	I_{OC_HYS}		–	6	10	$\%I_{PR}$
Overcurrent Response Time [2]	t_{OC_RESP}		–	150	–	ns

[1] Minimum and maximum values are tested in production or 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 performance beyond the specified current sensing range are not validated.
[3] Where I_{OCR} is the specific point at which the overcurrent FAULT trigger occurs.

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Characteristic	Symbol	Test Conditions	Min. [2]	Typ.	Max. [2]	Units
NOMINAL PERFORMANCE						
Current Sensing Range [3]	I_{PR}	Limited by $T_{J(max)}$ = 165°C	–90	–	90	A
Sensitivity	Sens	$I_{PR(min)} < I_P < I_{PR(max)}$	–	14.6	–	mV/A
Quiescent Voltage Output	V_{QVO}	I_P = 0 A	–	1.65	–	V
Reference Voltage Output	V_{REF}		–	1.65	–	V
ERROR COMPONENTS						
Sensitivity Error	E_{SENS}	I_P = 40 A, T_A = –40°C to 150°C, DC	–2	±1	2	%
		I_P = 7 A, T_A = –40°C to 150°C, 500 kHz	–	±2	–	%
Offset Error	V_{OE}	I_P = 0 A, T_A = –40°C to 150°C	–10	±5	10	mV
Reference Voltage Output Error	V_{REF_E}	I_P = 0 A, T_A = –40°C to 150°C	–10	±5	10	mV
Quiescent Voltage Output Error	V_{QVO_E}	I_P = 0 A, T_A = –40°C to 150°C	–10	±5	10	mV
Power Supply Offset Error	V_{OE_PS}	$V_{DD(min)}$ to $V_{DD(max)}$	–5	±3	5	mV
Power Supply Sensitivity Error	E_{SENS_PS}	$V_{DD(min)}$ to $V_{DD(max)}$	–1.5	±1	1.5	%
ERROR INCLUDING LIFETIME DRIFT [4]						
Hall Path Sensitivity Error Including Lifetime Drift	$E_{SENS\_H\_LT}$	I_P = 40 A, DC	–3.5	–	3.5	%
Coil Path Sensitivity Error Including Lifetime Drift	$E_{SENS\_C\_LT}$	I_P = 7 A, AC	–3.75	–	3.75	%
Offset Error Including Lifetime Drift	V_{OE_LT}	I_P = 0 A, T_A = –40°C to 150°C	–10	–	10	mV
Reference Voltage Error Including Lifetime Drift	V_{REF_LT}	T_A = –40°C to 150°C	–10	–	10	mV
Quiescent Voltage Error Including Lifetime Drift	V_{QVO_LT}	I_P = 0 A, T_A = –40°C to 150°C	–10	–	10	mV

[1] Minimum and maximum values are tested in production or validated by design and characterization.
[2] Absolute minimum (Min. or min) and absolute maximum (Max. or max) are the production limits that the device must not exceed.
[3] Validated by design and characterization.
[4] Lifetime drift minimum/maximum values are mean ±3 sigma, and are based on a statistical combination of production distributions and worst-case drift distributions observed after AEC-Q100 qualification stresses.

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Characteristic	Symbol	Test Conditions	Min. [2]	Typ.	Max. [2]	Units
NOMINAL PERFORMANCE						
Current Sensing Range [3]	I_{PR}	Limited by $T_{J(max)}$ = 165°C	–150	–	150	A
Sensitivity	Sens	$I_{PR(min)} < I_P < I_{PR(max)}$	–	8.8	–	mV/A
Quiescent Voltage Output	V_{QVO}	I_P = 0 A	–	1.60	–	V
Reference Voltage Output	V_{REF}		–	1.60	–	V
ERROR COMPONENTS						
Sensitivity Error	E_{SENS}	I_P = 40 A, T_A = –40°C to 150°C, DC	–2	±1	2	%
		I_P = 7 A, T_A = –40°C to 150°C, 500 kHz	–	±2	–	%
Offset Error	V_{OE}	I_P = 0 A, T_A = –40°C to 150°C	–10	±5	10	mV
Reference Voltage Output Error	V_{REF_E}	I_P = 0 A, T_A = –40°C to 150°C	–10	±5	10	mV
Quiescent Voltage Output Error	V_{QVO_E}	I_P = 0 A, T_A = –40°C to 150°C	–10	±5	10	mV
Power Supply Offset Error	V_{OE_PS}	$V_{DD(min)}$ to $V_{DD(max)}$	–5	±3	5	mV
Power Supply Sensitivity Error	E_{SENS_PS}	$V_{DD(min)}$ to $V_{DD(max)}$	–1.5	±1	1.5	%
ERROR INCLUDING LIFETIME DRIFT [4]						
Hall Path Sensitivity Error Including Lifetime Drift	$E_{SENS\_H\_LT}$	I_P = 40 A, DC	–3.5	–	3.5	%
Coil Path Sensitivity Error Including Lifetime Drift	$E_{SENS\_C\_LT}$	I_P = 7 A, AC	–3.75	–	3.75	%
Offset Error Including Lifetime Drift	V_{OE_LT}	I_P = 0 A, T_A = –40°C to 150°C	–10	–	10	mV
Reference Voltage Error Including Lifetime Drift	V_{REF_LT}	T_A = –40°C to 150°C	–10	–	10	mV
Quiescent Voltage Error Including Lifetime Drift	V_{QVO_LT}	I_P = 0 A, T_A = –40°C to 150°C	–10	–	10	mV

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Characteristic	Symbol	Test Conditions	Min. [2]	Typ.	Max. [2]	Units
NOMINAL PERFORMANCE						
Current Sensing Range [3]	I_{PR}	Limited by $T_{J(max)}$ = 165°C	–90	–	90	A
Sensitivity	Sens	$I_{PR(min)} < I_P < I_{PR(max)}$	–	14.6	–	mV/A
Quiescent Voltage Output	V_{QVO}	I_P = 0 A	–	1.65	–	V
Overcurrent Threshold	I_{OC}		–	100	–	$\%I_{PR}$
Overcurrent Hysteresis	I_{OC_HYS}		–	5.4	–	A
FAULT ERROR						
Overcurrent Error	I_{OC_E}		–9	–	9	A
ERROR COMPONENTS						
Sensitivity Error	E_{SENS}	I_P = 40 A, T_A = –40°C to 150°C, DC	–2	±1	2	%
		I_P = 7 A, T_A = –40°C to 150°C, 500 kHz	–	±2	–	%
Quiescent Voltage Output Error	V_{QVO_E}	I_P = 0 A, T_A = –40°C to 150°C	–10	±5	10	mV
Power Supply Offset Error	V_{OE_PS}	$V_{DD(min)}$ to $V_{DD(max)}$	–5	±3	5	mV
Power Supply Sensitivity Error	E_{SENS_PS}	$V_{DD(min)}$ to $V_{DD(max)}$	–1.5	±1	1.5	%
ERROR INCLUDING LIFETIME DRIFT [4]						
Hall Path Sensitivity Error Including Lifetime Drift	$E_{SENS\_H\_LT}$	I_P = 40 A, DC	–3.5	–	3.5	%
Coil Path Sensitivity Error Including Lifetime Drift	$E_{SENS\_C\_LT}$	I_P = 7 A, AC	–3.75	–	3.75	%
Quiescent Voltage Error Including Lifetime Drift	V_{QVO_LT}	I_P = 0 A, T_A = –40°C to 150°C	–10	–	10	mV

[1] Minimum and maximum values are tested in production or validated by design and characterization.
[2] Absolute minimum (Min. or min) and absolute maximum (Max. or max) are the production limits that the device must not exceed.
[3] Validated by design and characterization.
[4] Lifetime drift minimum/maximum values are mean ±3 sigma, and are based on a statistical combination of production distributions and worst-case drift distributions observed after AEC-Q100 qualification stresses.

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Characteristic	Symbol	Test Conditions	Min. [2]	Typ.	Max. [2]	Units
NOMINAL PERFORMANCE						
Current Sensing Range [3]	I_{PR}	Limited by $T_{J(max)}$ = 165°C	–150	–	150	A
Sensitivity	Sens	$I_{PR(min)} < I_P < I_{PR(max)}$	–	8.8	–	mV/A
Quiescent Voltage Output	V_{QVO}	I_P = 0 A	–	1.65	–	V
Overcurrent Threshold	I_{OC}		–	100	–	%I_{PR}
Overcurrent Hysteresis	I_{OC_HYS}		–	9	–	A
FAULT ERROR						
Overcurrent Error	I_{OC_E}		–15	–	15	A
ERROR COMPONENTS						
Sensitivity Error	E_{SENS}	I_P = 40 A, T_A = –40°C to 150°C, DC	–2	±1	2	%
		I_P = 7 A, T_A = –40°C to 150°C, 500 kHz	–	±2	–	%
Quiescent Voltage Output Error	V_{QVO_E}	I_P = 0 A, T_A = –40°C to 150°C	–10	±5	10	mV
Power Supply Offset Error	V_{OE_PS}	$V_{DD(min)}$ to $V_{DD(max)}$	–5	±3	5	mV
Power Supply Sensitivity Error	E_{SENS_PS}	$V_{DD(min)}$ to $V_{DD(max)}$	–1.5	±1	1.5	%
ERROR INCLUDING LIFETIME DRIFT [4]						
Hall Path Sensitivity Error Including Lifetime Drift	$E_{SENS\_H\_LT}$	I_P = 40 A, DC	–3.5	–	3.5	%
Coil Path Sensitivity Error Including Lifetime Drift	$E_{SENS\_C\_LT}$	I_P = 7 A, AC	–3.75	–	3.75	%
Quiescent Voltage Error Including Lifetime Drift	V_{QVO_LT}	I_P = 0 A, T_A = –40°C to 150°C	–10	–	10	mV

[1] Minimum and maximum values are tested in production or validated by design and characterization.
[2] Absolute minimum (Min. or min) and absolute maximum (Max. or max) are the production limits that the device must not exceed.
[3] Validated by design and characterization.
[4] Lifetime drift minimum/maximum values are mean ±3 sigma, and are based on a statistical combination of production distributions and worst-case drift distributions observed after AEC-Q100 qualification stresses.

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ACS37031LMYATR-090B3 PERFORMANCE CHARACTERISTICS [1]: Valid through full operating temperature range, T_A = – 40°C to 150°C, C_{BYPASS} = 0.1 µF, and V_{DD} = 3.3 V unless otherwise specified

Characteristic	Symbol	Test Conditions	Min. [2]	Typ.	Max. [2]	Units
NOMINAL PERFORMANCE						
Current Sensing Range [3]	I_{PR}	Limited by $T_{J(max)}$ = 165°C	–90	–	90	A
Sensitivity	Sens	$I_{PR(min)} < I_P < I_{PR(max)}$	–	14.6	–	mV/A
Quiescent Voltage Output	V_{QVO}	I_P = 0 A	–	1.65	–	V
Reference Voltage Output	V_{REF}		–	1.65	–	V
ERROR COMPONENTS						
Sensitivity Error	E_{SENS}	I_P= 40 A, T_A = –40°C to 150°C, DC	–2	±1	2	%
		I_P= 7 A, T_A = –40°C to 150°C, 500 kHz	–	±2	–	%
Offset Error	V_{OE}	I_P = 0 A, T_A = –40°C to 150°C	–10	±5	10	mV
Reference Voltage Output Error	V_{REF_E}	I_P = 0 A, T_A = –40°C to 150°C	–10	±5	10	mV
Quiescent Voltage Output Error	V_{QVO_E}	I_P = 0 A, T_A = –40°C to 150°C	–10	±5	10	mV
Power Supply Offset Error	V_{OE_PS}	$V_{DD(min)}$ to $V_{DD(max)}$	–5	±3	5	mV
Power Supply Sensitivity Error	E_{SENS_PS}	$V_{DD(min)}$ to $V_{DD(max)}$	–1.5	±1	1.5	%
ERROR INCLUDING LIFETIME DRIFT [4]						
Hall Path Sensitivity Error Including Lifetime Drift	$E_{SENS\_H\_LT}$	I_P = 40 A, DC	–3.5	–	3.5	%
Coil Path Sensitivity Error Including Lifetime Drift	$E_{SENS\_C\_LT}$	I_P = 7 A, AC	–3.75	–	3.75	%
Offset Error Including Lifetime Drift	V_{OE_LT}	I_P = 0 A, T_A = –40°C to 150°C	–10	–	10	mV
Reference Voltage Error Including Lifetime Drift	V_{REF_LT}	T_A = –40°C to 150°C	–10	–	10	mV
Quiescent Voltage Error Including Lifetime Drift	V_{QVO_LT}	I_P = 0 A, T_A = –40°C to 150°C	–10	–	10	mV

[1] Minimum and maximum values are tested in production or validated by design and characterization.
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ACS37031LMYATR-150B3 PERFORMANCE CHARACTERISTICS [1]: Valid through full operating temperature range, T_A = – 40°C to 150°C, C_{BYPASS} = 0.1 µF, and V_{DD} = 3.3 V unless otherwise specified

Characteristic	Symbol	Test Conditions	Min. [2]	Typ.	Max. [2]	Units
NOMINAL PERFORMANCE						
Current Sensing Range [3]	I_{PR}	Limited by $T_{J(max)}$ = 165°C	–150	–	150	A
Sensitivity	Sens	$I_{PR(min)} < I_P < I_{PR(max)}$	–	8.8	–	mV/A
Quiescent Voltage Output	V_{QVO}	I_P = 0 A	–	1.65	–	V
Reference Voltage Output	V_{REF}		–	1.65	–	V
ERROR COMPONENTS						
Sensitivity Error	E_{SENS}	I_P= 40 A, T_A = –40°C to 150°C, DC	–2	±1	2	%
		I_P= 7 A, T_A = –40°C to 150°C, 500 kHz	–	±2	–	%
Offset Error	V_{OE}	I_P = 0 A, T_A = –40°C to 150°C	–10	±5	10	mV
Reference Voltage Output Error	V_{REF_E}	I_P = 0 A, T_A = –40°C to 150°C	–10	±5	10	mV
Quiescent Voltage Output Error	V_{QVO_E}	I_P = 0 A, T_A = –40°C to 150°C	–10	±5	10	mV
Power Supply Offset Error	V_{OE_PS}	$V_{DD(min)}$ to $V_{DD(max)}$	–5	±3	5	mV
Power Supply Sensitivity Error	E_{SENS_PS}	$V_{DD(min)}$ to $V_{DD(max)}$	–1.5	±1	1.5	%
ERROR INCLUDING LIFETIME DRIFT [4]						
Hall Path Sensitivity Error Including Lifetime Drift	$E_{SENS\_H\_LT}$	I_P = 40 A, DC	–3.5	–	3.5	%
Coil Path Sensitivity Error Including Lifetime Drift	$E_{SENS\_C\_LT}$	I_P = 7 A, AC	–3.75	–	3.75	%
Offset Error Including Lifetime Drift	V_{OE_LT}	I_P = 0 A, T_A = –40°C to 150°C	–10	–	10	mV
Reference Voltage Error Including Lifetime Drift	V_{REF_LT}	T_A = –40°C to 150°C	–10	–	10	mV
Quiescent Voltage Error Including Lifetime Drift	V_{QVO_LT}	I_P = 0 A, T_A = –40°C to 150°C	–10	–	10	mV

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Characteristic	Symbol	Test Conditions	Min. [2]	Typ.	Max. [2]	Units
NOMINAL PERFORMANCE						
Current Sensing Range [3]	I_{PR}	Limited by $T_{J(max)}$ = 165°C	–90	–	90	A
Sensitivity	Sens	$I_{PR(min)} < I_P < I_{PR(max)}$	–	14.6	–	mV/A
Quiescent Voltage Output	V_{QVO}	I_P = 0 A	–	1.65	–	V
Overcurrent Threshold	I_{OC}		–	100	–	$\%I_{PR}$
Overcurrent Hysteresis	I_{OC_HYS}		–	5.4	–	A
FAULT ERROR						
Overcurrent Error	I_{OC_E}		–9	–	9	A
ERROR COMPONENTS						
Sensitivity Error	E_{SENS}	I_P = 40 A, T_A = –40°C to 150°C, DC	–2	±1	2	%
		I_P = 7 A, T_A = –40°C to 150°C, 500 kHz	–	±2	–	%
Quiescent Voltage Output Error	V_{QVO_E}	I_P = 0 A, T_A = –40°C to 150°C	–10	±5	10	mV
Power Supply Offset Error	V_{OE_PS}	3.15 to 3.45 V, T_A = 25°C	–5	±3	5	mV
Power Supply Sensitivity Error	E_{SENS_PS}	3.15 to 3.45 V, T_A = 25°C	–1.5	±1	1.5	%
ERROR INCLUDING LIFETIME DRIFT [4]						
Hall Path Sensitivity Error Including Lifetime Drift	$E_{SENS\_H\_LT}$	I_P = 40 A, DC	–3.5	–	3.5	%
Coil Path Sensitivity Error Including Lifetime Drift	$E_{SENS\_C\_LT}$	I_P = 7 A, AC	–3.75	–	3.75	%
Quiescent Voltage Error Including Lifetime Drift	V_{QVO_LT}	I_P = 0 A, T_A = –40°C to 150°C	–10	–	10	mV

[1] Minimum and maximum values are tested in production or validated by design and characterization.
[2] Absolute minimum (Min. or min) and absolute maximum (Max. or max) are the production limits that the device must not exceed.
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ACS37029LMYATR-150B3 PERFORMANCE CHARACTERISTICS [1]: Valid through full operating temperature range, T_A = – 40°C to 150°C, C_{BYPASS} = 0.1 µF, and V_{DD} = 3.3 V unless otherwise specified

Characteristic	Symbol	Test Conditions	Min. [2]	Typ.	Max. [2]	Units
NOMINAL PERFORMANCE						
Current Sensing Range [3]	I_{PR}	Limited by $T_{J(max)}$ = 165°C	–150	–	150	A
Sensitivity	Sens	$I_{PR(min)} < I_P < I_{PR(max)}$	–	8.8	–	mV/A
Quiescent Voltage Output	V_{QVO}	I_P = 0 A	–	1.65	–	V
Overcurrent Threshold	I_{OC}		–	100	–	%I_{PR}
Overcurrent Hysteresis	I_{OC_HYS}		–	9	–	A
FAULT ERROR						
Overcurrent Error	I_{OC_E}		–15	–	15	A
ERROR COMPONENTS						
Sensitivity Error	E_{SENS}	I_P= 40 A, T_A = –40°C to 150°C, DC	–2	±1	2	%
		I_P= 7 A, T_A = –40°C to 150°C, 500 kHz	–	±2	–	%
Quiescent Voltage Output Error	V_{QVO_E}	I_P = 0 A, T_A = –40°C to 150°C	–10	±5	10	mV
Power Supply Offset Error	V_{OE_PS}	3.15 to 3.45 V, T_A = 25°C	–5	±3	5	mV
Power Supply Sensitivity Error	E_{SENS_PS}	3.15 to 3.45 V, T_A = 25°C	–1.5	±1	1.5	%
ERROR INCLUDING LIFETIME DRIFT [4]						
Hall Path Sensitivity Error Including Lifetime Drift	$E_{SENS\_H\_LT}$	I_P = 40 A, DC	–3.5	–	3.5	%
Coil Path Sensitivity Error Including Lifetime Drift	$E_{SENS\_C\_LT}$	I_P = 7 A, AC	–3.75	–	3.75	%
Quiescent Voltage Error Including Lifetime Drift	V_{QVO_LT}	I_P = 0 A, T_A = –40°C to 150°C	–10	–	10	mV

[1] Minimum and maximum values are tested in production or validated by design and characterization.
[2] Absolute minimum (Min. or min) and absolute maximum (Max. or max) are the production limits that the device must not exceed.
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ACS37029/31 TYPICAL FREQUENCY RESPONSE

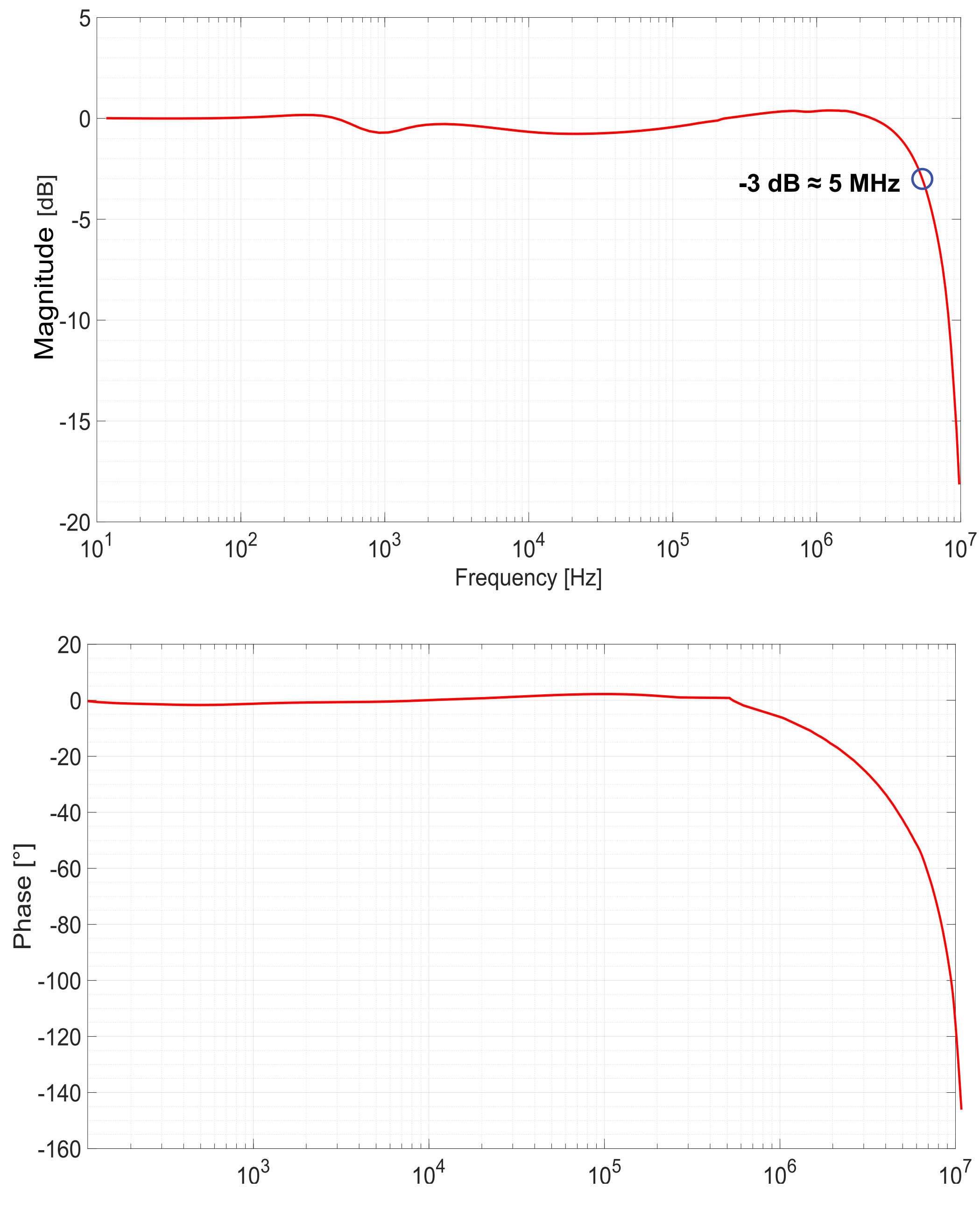

Figure 4: Typical Frequency Response

RESPONSE CHARACTERISTICS DEFINITIONS AND PERFORMANCE DATA

Response Time (t_{RESP})

The time interval between a) when the sensed input current reaches 90% of its full-scale value, and b) when the sensor output, V_{OUT}, reaches 90% of its full-scale output value.

Propagation Delay (t_{PD})

The time interval between a) when the sensed input current reaches 20% of its full-scale value, and b) when the sensor output, V_{OUT}, reaches 20% of its full-scale output value.

Rise Time (t_R)

The time interval between a) when the sensor output, V_{OUT}, reaches 10% of its full-scale value, and b) when the sensor output, V_{OUT}, reaches 90% of its full-scale value.

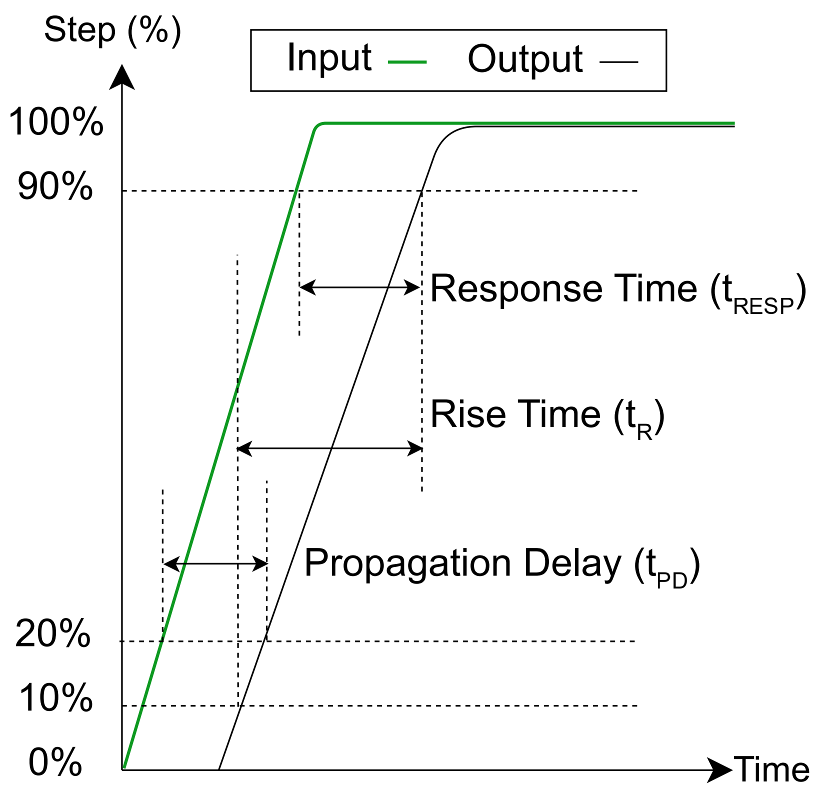

Figure 5: Step Response Characteristics

FUNCTIONAL DESCRIPTION OF POWER ON/OFF OPERATION

Introduction

The graphs in this section show the behavior of V_{OUT} as V_{DD} reaches or falls below the required power-on voltage. Figure 6 and Figure 7 use the same labeling convention for different voltage thresholds. References in brackets "[ ]" are valid for each of these graphs.

POWER-ON OPERATION

As V_{DD} ramps up, the VOUT pin is in a high-impedance (high-Z) state until V_{DD} reaches and exceeds V_{POR} [1]. Once V_{DD} exceeds V_{POR} [1], V_{OUT} enters normal operation and starts responding to applied current, I_P.

POWER-OFF OPERATION

As V_{DD} reduces to less than $V_{POR} - V_{POR\_HYS}$, the outputs enter a high-Z state. The hysteresis on the power-on voltage prevents noise on the supply line from causing V_{OUT} to repeatedly enter and exit the high-Z state at approximately the V_{POR} level.

NOTE: Because the device is entering a high-Z state and not driving the output, the time required for the output to reach a steady state depends on the external circuitry.

Voltage Thresholds

POWER-ON RESET RELEASE VOLTAGE (V_{POR})

If V_{DD} reduces to less than $V_{POR} - V_{POR\_HYS}$ [2] while the sensor is in operation, the digital circuitry turns off and the output re-enters a high-Z state. After V_{DD} recovers and exceeds V_{POR} [1], the output enters normal operation after a delay of t_{PO}.

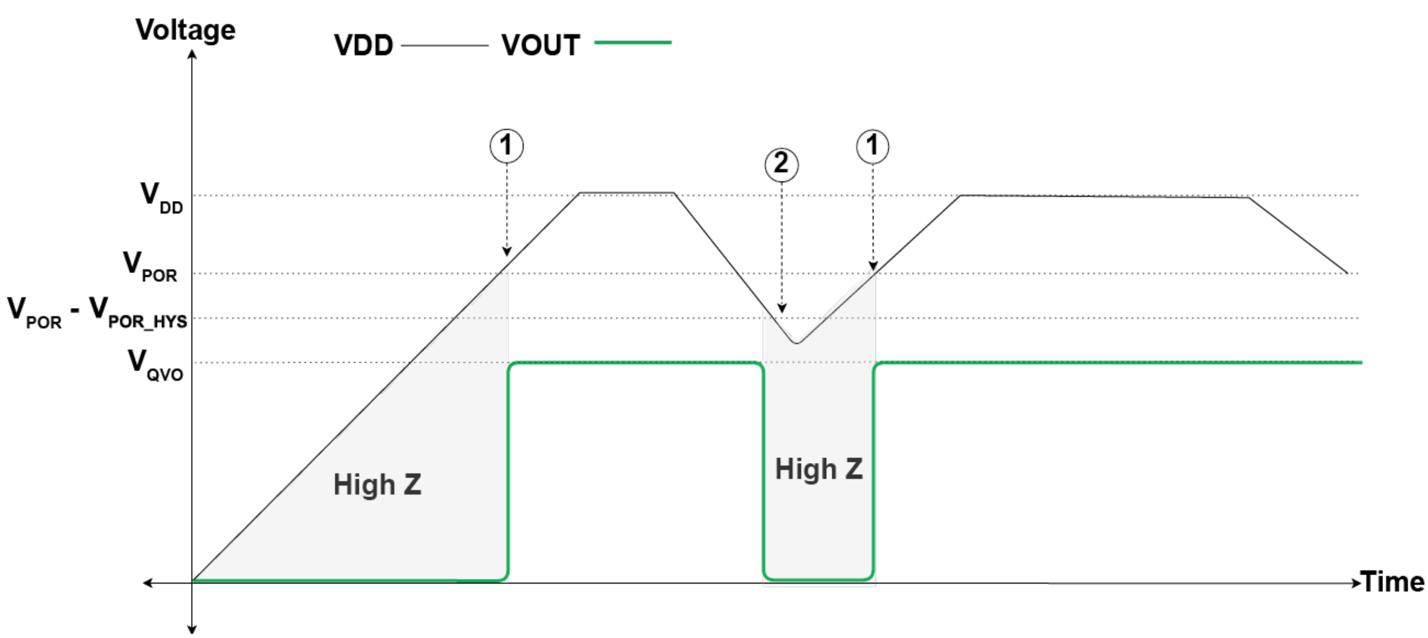

Figure 6: Power-On and Power-Off Operation

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Timing Thresholds

POWER-ON DELAY (t_{PO})

When the supply voltage reaches V_{POR} [1], the device requires a finite time to power its internal components before the outputs are released from the high-impedance state and start responding to the measured current, I_P. Power-on time, t_{PO}, is defined as the time required for the output voltage to settle within ±10% of its steady-state value when current, I_P, is applied, which can be observed as the time from [1] to [A] in Figure 7.

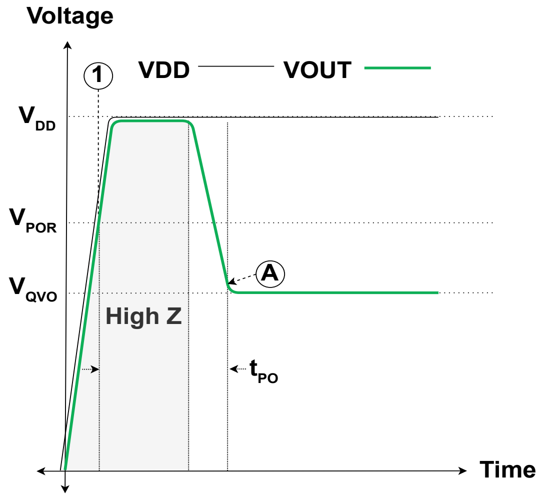

Figure 7: Power-On Delay, t_{PO}

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 A).

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

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.

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

Power Supply Offset Error (V_{OE_PS})

Power supply offset error, V_{OE_PS}, is defined as the change in V_{QVO} due to variations in the power supply voltage at a specific temperature. The power supply offset error is defined as the change in offset measured between the nominal supply voltage (V_{DD}) and V_{DD} ±E%, where E is the difference between V_{DD} and $V_{DD(MAX)}$ in percent. The error is expressed in millivolts to indicate how much the offset deviates from its ideal value due to changes in the supply voltage.

$$V_{OE\_PS} = V_{QVO_{@VDD}\pm E\%,T_A} - V_{QVO_{@VDD},T_A}\ [mV]$$

Sensitivity (Sens)

Sensitivity, Sens, is the ratio of the output swing versus the applied current through the primary conductor, I_P. This current causes a voltage change away from V_{QVO} on the V_{OUT} output until V_{SAT}. The magnitude and direction of the output voltage swing is proportional to the magnitude and direction of the applied current, I_P. This proportional relationship between output and input is sensitivity and is defined as:

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

where IP_1 and IP_2 are two different currents, and $V_{OUT(IP1)}$ and $V_{OUT(IP2)}$ are the respective output voltages of the device at those applied currents.

Sensitivity Error (E_{SENS})

Sensitivity error, E_{SENS}, is the error of sensitivity from the nominal sensitivity target value in production testing.

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

Power Supply Sensitivity Error (E_{SENS_PS})

Power supply sensitivity error, E_{SENS_PS}, is a measure of the change in sensitivity due to variations in the power supply voltage at a specific temperature. The power supply sensitivity error is defined as the percentage change in sensitivity measured between the nominal supply voltage (V_{DD}) and V_{DD} ±E%, where E is the difference between V_{DD} and $V_{DD(MAX)}$ in percent. The error is expressed as a percentage to indicate how much the sensitivity deviates from its ideal value due to changes in the supply voltage.

$$E_{SENS\_PS} = \frac{SEN_{@VDD\pm E\%,T_A} - SENS_{@VDD,T_A}}{SENS_{@VDD,T_A}}\ x\ 100\ [\%]$$

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 buffer 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.

Error Including 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.

OVERCURRENT FAULT (OCF) BEHAVIOR

The overcurrent fault (OCF) function (ACS37029 only) pulls the open-drain FAULT pin low when the applied current exceeds a preset threshold (I_{OCR}). This threshold is internally set to 100% of the full-scale (FS) rated current. This flag trips symmetrically for positive and negative applied currents.

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 FAULT activates.

OVERCURRENT FAULT HYSTERESIS (I_{OC_HYS})

Overcurrent hysteresis, I_{OC_HYS}, is defined as the magnitude of current in percentage of the FS that must drop before a fault assertion is cleared. This can be seen as the separation between the voltages [9] to [10] in Figure 8 and Figure 9.

OVERCURRENT FAULT RESPONSE TIME (t_{OC_RESP})

Overcurrent response time, t_{OC_RESP}, is defined as the time from when the input reaches the operating point [9] until the OCF pin falls below V_{FAULT_L} [G].

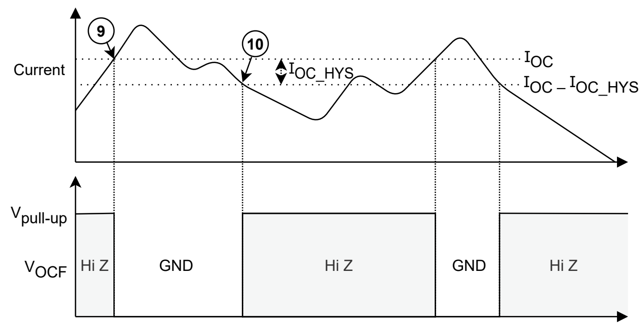

Figure 8: Fault Thresholds and OCF Pin Functionality

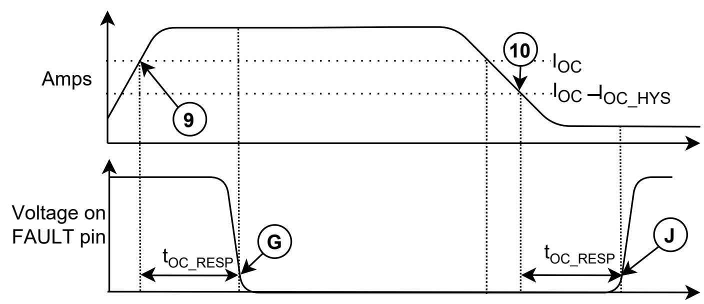

Figure 9: Fault Timing Diagram

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THERMAL PERFORMANCE

Thermal Rise vs. Primary Current

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

The thermal response is highly dependent on PCB layout, copper thickness, cooling techniques, and 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 10 and Figure 11). The ACSEVB-LZ8-LZ6 and ACSEVB-MZ8-MY6 evaluation boards include in-pad vias and are recommended to improve thermal performance. Figure 12 demonstrates the improved performance of vias.

The plot in Figure 13 shows the measured rise in steady-state die temperature of the LZ package versus DC continuous current at an ambient temperature, T_A, of 25°C for two board designs: filled vias under copper pads and no vias under copper pads (vias outside pad). Note the thermal offset curves may be directly applied to other values of T_A. Using in-pad vias has better thermal performance than no in-pad vias; this is true for both the LZ and MY packages.

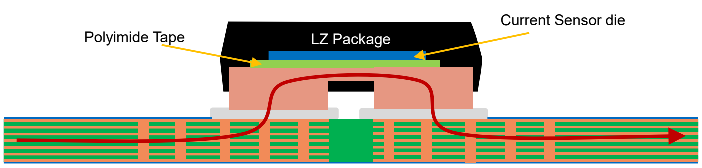

Figure 10: Vias Under Copper Pads, LZ Package

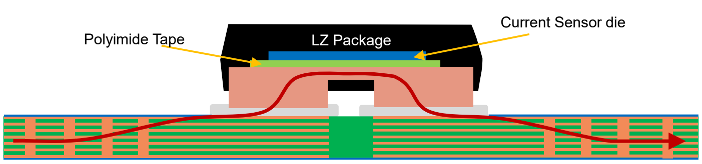

Figure 11: No Vias Under Copper Pads, LZ Package

The plot in Figure 14 shows the measured rise in steady-state die temperature of the MY package versus DC continuous current at an ambient temperature of 25°C and an ambient temperature of 125°C. These evaluation boards used filled vias under the copper pads. The thermal capacity of the ACS37029-31 in the LZ package should be verified by the end user in the application-specific conditions. Do not exceed the maximum junction temperature, $T_{J(max)}$ (165°C). Measuring the temperature of the top of the package is a close approximation of the die temperature.

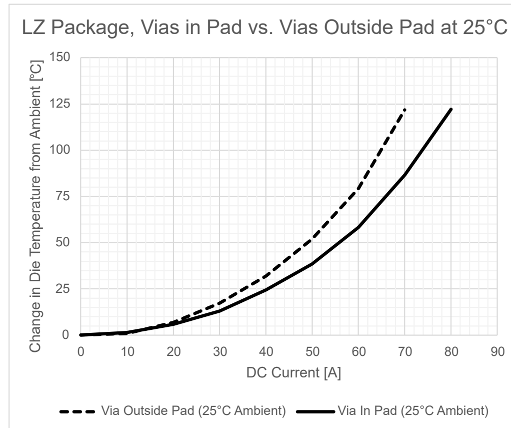

Figure 12: LZ Package Comparison with and without In-Pad Vias at Ambient Temperature

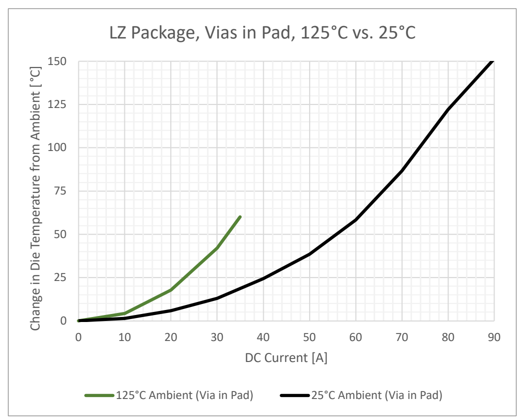

Figure 13: LZ Package Comparison at 125°C and 25°C, In-Pad Vias

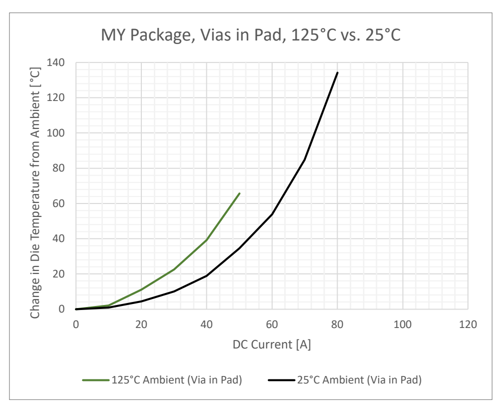

Figure 14: MY Package Comparison at 125°C and 25°C, Vias in-Pad

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Safe Operating Region

Current applied to the IP pins of the ACS37029-31 in the LZ package heats the package. The amount of heating depends on the current applied and the duration of current application. The range of applied current and duration of current that does not detrimentally affect the part is shown in Figure 15.

If sufficient energy is applied, the copper IP lead melts and fuses open. This is indicated by the blue line labeled “Time to Fuse.”

The maximum junction temperature is 165°C. If this limit is exceeded for an extended period of time, the PN junctions on the die could become damaged. This could affect product performance or create long-term reliability risks. The region in which this occurs is indicated by the green line labeled “Time to 165°C.”

The LZ package has a polyimide insulation barrier to enable high working voltages. Extended heating of the polyimide film causes deterioration of the material, reducing the insulation effectiveness of the package. This is indicated by the red line labeled “Time to Insulation Degradation.”

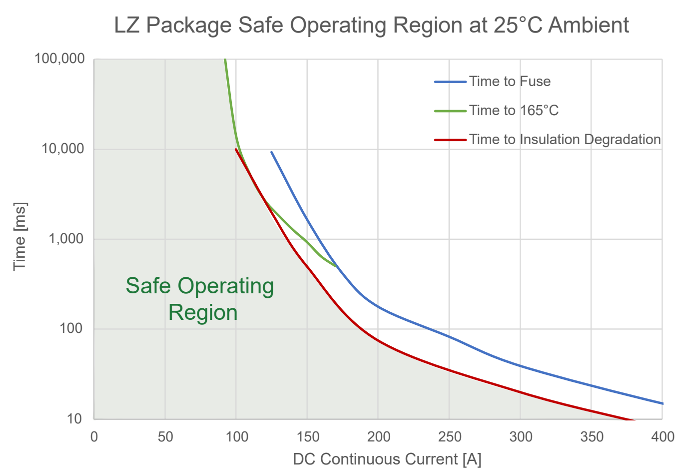

Figure 15: LZ Package Safe Operating Region

Evaluation Board Layout

The thermal data shown in Figure 12 and Figure 13 were collected using the LC/LZ current sensor evaluation board (ACSEVB-LC8-LZ6, TED-0004110). This board includes six layers. The evaluation board is shown in Figure 16.

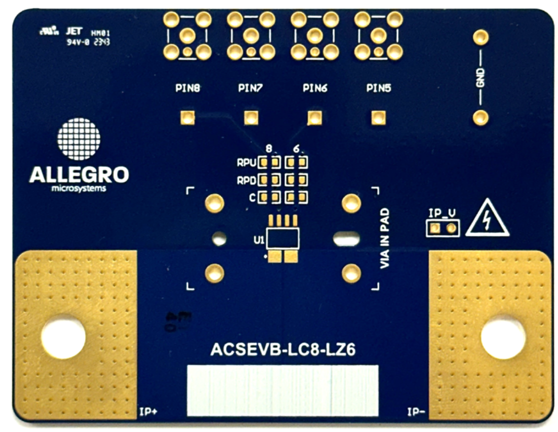

Figure 16: LZ Package Allegro Evaluation Board

The thermal data shown in Figure 14 were collected using the MZ/MY current sensor evaluation board (ACSEVB-MZ6-MY6, TED-0004281). This board includes six layers. The evaluation board is shown in Figure 17.

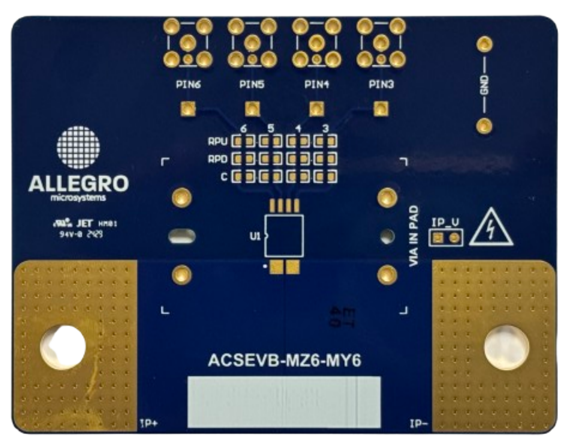

Figure 17: MY Package Allegro Evaluation Board

Design support files for the ACSEVB-LC8-LZ6 and ACSEVB-MZ6-MY6 evaluation boards are available for download from the Allegro website. See the technical documents section of the device webpage for more information.

PACKAGE OUTLINE DRAWINGS

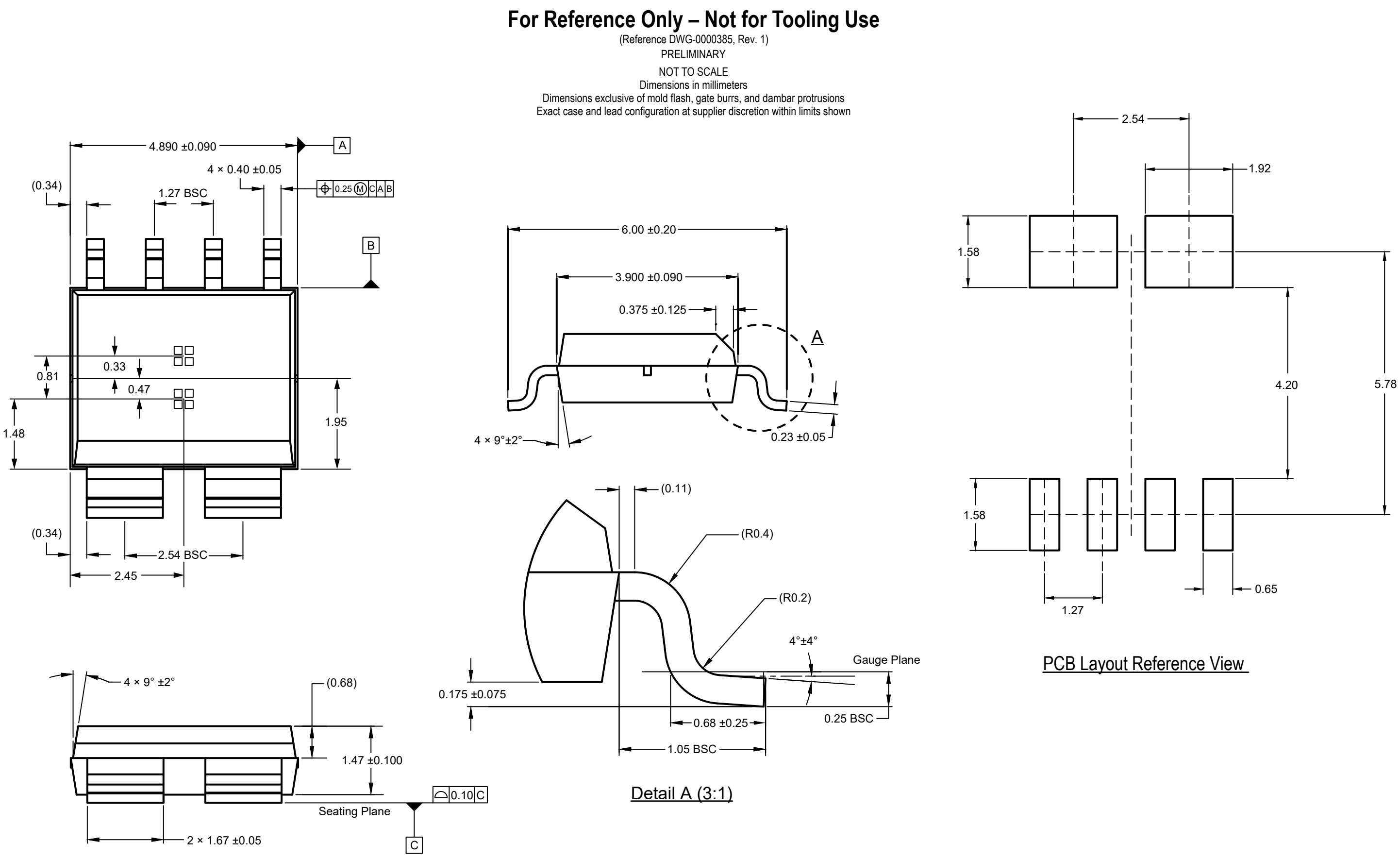

Figure 18: Custom 6-Pin SOIC (Suffix LZ)

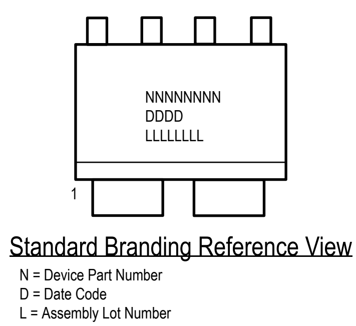

Figure 19: LZ Package Branding

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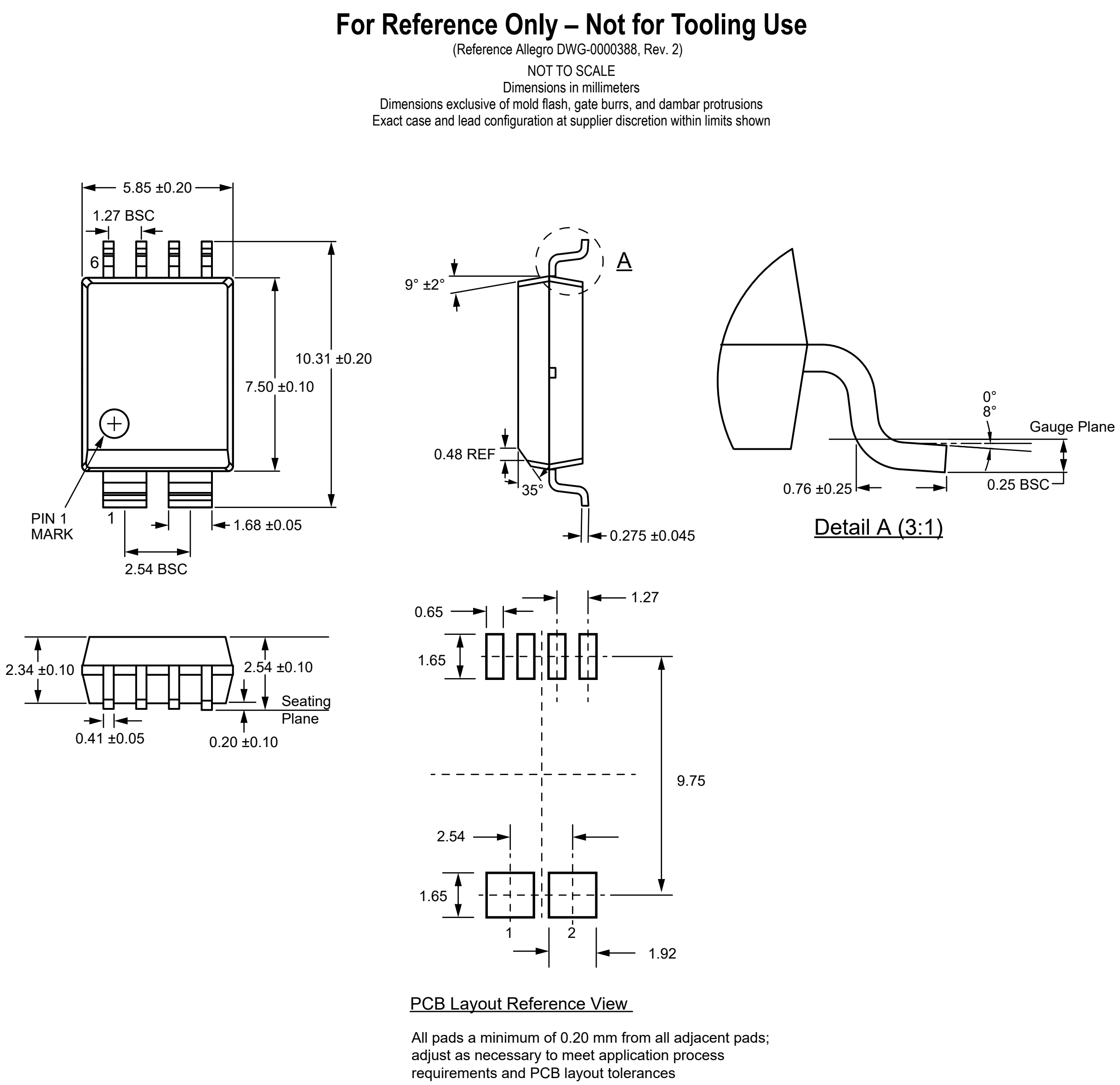

Figure 20: Custom 6-Pin SOIC (Suffix MY)

Revision History

Number	Date	Description
–	January 29, 2024	Initial release
1	June 12, 2024	Added output resistive load characteristic (page 5)
2	March 23, 2026	Added MYA package option. Removed overcurrent fault hold time characteristic, removed overcurrent release time characteristic, and updated overcurrent response time (page 6); modified application information for the fault section (page 16); and made minor formatting and editing modifications throughout
3	March 26, 2026	Minor editorial update

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