

DC to 5 MHz Bandwidth, Galvanically Isolated, High-Accuracy Current Sensor IC with Reference Output (ACS37030) or Fault (ACS37032)

# FEATURES AND BENEFITS

- High operating bandwidth for fast control loops or where high-speed switching currents are monitored
   DC to 5 MHz bandwidth
  - $\Box$  40 ns typical response time
- High accuracy and low noise
   ±2% sensitivity error over temperature
   ±10 mV maximum offset voltage over temperature
   50 mA<sub>RMS</sub> input referred noise
  - $\square$  3.3 V non-ratiometric supply operation
  - Differential sensing immune to external magnetic fields
- VREF output voltage for differential routing in noisy application environments (ACS37030)
- FAULT output for fast open drain overcurrent detection (ACS37032)
- Highly isolated compact surface-mount package

   3500 V<sub>RMS</sub> rated isolation voltage
   840 V<sub>RMS</sub> / 1188 V<sub>DC</sub> basic isolation voltages
   420 V<sub>RMS</sub> / 594 V<sub>DC</sub> reinforced isolation voltages
- Wide operating temperature, -40°C to 150°C
- AEC-Q100 qualified

# PACKAGE:

6-pin SOIC (suffix LZ) Not to scale



# DESCRIPTION

The ACS37030/2 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 seen 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 out interfering common-mode magnetic fields. The IC has no physical connection to the integrated current conductor and provides a 3500 V<sub>RMS</sub> isolation voltage between the primary and secondary signal leads of the package. This high rating provides a basic working voltage of 840 V<sub>RMS</sub>.

Both zero current reference (ACS37030) and overcurrent fault with internal pull up (ACS37032) options are available.

The ACS37030/32 is provided in a six-lead custom SOIC surface mount package with the current conductor leads formed together for a reduced resistance of 0.6 m $\Omega$ . The leadframe is plated with 100% matte tin, which is compatible with standard lead (Pb) free printed circuit board assembly processes. Internally, the device is Pb-free.



#### Figure 1: Typical Application Circuit

The ACS37030/32 outputs an analog signal,  $V_{OUT}$ , that varies linearly with the bidirectional AC or DC primary current,  $I_{p}$ , within the range specified.

#### SELECTION GUIDE

Part Number	Current Sensing Range, I <sub>PR</sub> (A)	Sensitivity (mV/A)	V <sub>DD</sub> (V)	V <sub>QVO</sub> (V)	Optimized Temperature Range T <sub>A</sub> (°C)	Packing
ACS37030LLZATR-020B3	±20	66				
ACS37030LLZATR-040B3	±40	33			-40 to 150	
ACS37030LLZATR-065B3	±65	20.3		3.3 1.65 -40 to 1		Tape and reel, 3000
ACS37032LLZATR-020B3	±20	66	3.3			pieces per reel
ACS37032LLZATR-040B3	±40	33				
ACS37032LLZATR-065B3	±65	20.3				





#### ABSOLUTE MAXIMUM RATINGS<sup>[1]</sup>

Characteristic	Symbol	Notes	Rating	Unit
Supply Voltage	V <sub>DD</sub>		–0.5 to 4	V
Forward Output Voltage	Vo	Applies to $V_{OUT,} V_{REF}$ , and FAULT	–0.5 to V <sub>DD</sub> + 0.5 (< 3.8)	V
Operating Ambient Temperature	T <sub>A</sub>	L temperature range	-40 to 150	°C
Storage Temperature	T <sub>stg</sub>		–65 to 165	°C
Maximum Junction Temperature	T <sub>J(max)</sub>		165	°C

<sup>[1]</sup> 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	Value	Units
Withstand Strength <sup>[1][2]</sup>	V <sub>ISO</sub>	Agency rated for 60 seconds per UL 62368-1 (edition 3)	3500	V <sub>RMS</sub>
Impulse Withstand	VIMPULSE	Tested ±5 pulses at 2/minute in compliance to IEC 61000-4-5, 1.2 $\mu s$ (rise) / 50 $\mu s$ (width)	5000	V <sub>PK</sub>
Working Voltage for Resignation [2]	V	Maximum approved working voltage for basic (single) isolation	1188	$V_{PK  or}  V_{DC}$
	V WVBI	according to UL 62368-1 (edition 3)	840	V <sub>RMS</sub>
Working Voltage for Reinforced	V	Maximum approved working voltage for reinforced isolation according	594	V <sub>PK or</sub> V <sub>DC</sub>
Isolation <sup>[2]</sup>	VWVRI	to UL 62368-1 (edition 3)	420	V <sub>RMS</sub>
Clearance	D <sub>CL</sub>	Minimum distance through air from IP leads to signal leads	4.2	mm
Creepage	D <sub>CR</sub>	Minimum distance along package body from IP leads to signal leads	4.2	mm
Distance Through Insulation	DTI	Minimum internal distance through insulation	54	μm
Comparative Tracking Index	СТІ	Material Group I	>600	V

<sup>[1]</sup> Production tested for 1 second in accordance with UL 62368-1 (edition 3). <sup>[2]</sup> Certification pending.

#### PACKAGE CHARACTERISTICS

Characteristic	Symbol	Notes	Min.	Тур.	Max.	Unit
Internal Conductor Resistance	R <sub>IC</sub>	$T_A = 25^{\circ}C$	_	0.68	_	mΩ
Internal Conductor Inductance	L <sub>IC</sub>	T <sub>A</sub> = 25°C	_	2.4	_	nH
Moisture Sensitivity Level	MSL	Per IPC/JEDEC J-STD-020	_	2	_	_



Figure 2: LZ 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





Figure 3: Functional Block Diagram



# DC to 5 MHz Bandwidth, Galvanically Isolated, High-Accuracy Current Sensor IC with Reference Output (ACS37030) or Fault (ACS37032)

# **COMMON ELECTRICAL CHARACTERISTICS:** Valid through full operating temperature range, $T_A = -40^{\circ}$ C to 150°C, $C_{BYPASS} = 0.1 \mu$ F, and $V_{DD} = 3.3 \text{ V}$ , unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Тур.	Max.	Units		
Supply Voltage	V <sub>DD</sub>		3	3.3	3.6	V		
Supply Current	I <sub>DD</sub>	$V_{DD}$ = 3.3 V, no load on $V_{OUT}$ or $V_{REF}$	_	20	30	mA		
Supply Bypass Capacitor	CBYPASS	VDD to GND	0.1	-	-	μF		
Output Capacitive Load	C <sub>L_VOUT</sub>	VOUT to GND	-	-	100	pF		
Power-On Reset Voltage	V <sub>POR</sub>	V <sub>DD</sub> rising 1 V/ms	2.6	2.9	3	V		
POR Hysteresis	V <sub>POR_HYS</sub>		200	250	-	mV		
Power-On Time	t <sub>PO</sub>		_	2	4	ms		
OUTPUT SIGNAL CHARACTERISTICS (VOUT)								
Saturation Voltage	V <sub>SAT_H</sub>	$R_L = 50 \text{ k}\Omega \text{ to GND}$	3	-	-	V		
Saturation voltage	V <sub>SAT_L</sub>	$R_L = 50 \text{ k}\Omega \text{ to } V_{DD}$	-	-	0.15	V		
VOLIT Short Circuit Current	т	$T_A = 25^{\circ}C$ , shorted to GND	-	25	-	mA		
VOOT Short Circuit Current	ISC_VOUT	$T_A = 25^{\circ}C$ , shorted to VDD	-	-25	-	mA		
Bandwidth	BW	Small signal –3 dB, C <sub>L</sub> = 100 pF	-	5	-	MHz		
Rise Time	t <sub>R</sub>	T <sub>A</sub> = 25°C, C <sub>L</sub> = 100 pF	_	40	_	ns		
Response Time	t <sub>RESP</sub>	$T_A = 25^{\circ}C, C_L = 100 \text{ pF}$	_	40	_	ns		
Propagation Delay	t <sub>PD</sub>	T <sub>A</sub> = 25°C, C <sub>L</sub> = 100 pF	_	30	_	ns		
Noise	I <sub>N</sub>	BW = 5 MHz, T <sub>A</sub> = 25°C, C <sub>L</sub> = 100 pF	_	50	-	mA <sub>RMS</sub>		
Common-Mode Field Rejection	CMFR	Input-referred error due to a common-mode field	_	0.9	_	mA/G		
REFERENCE OUTPUT CHARACTE	RISTICS (VRE	F)						
VREF Resistive Load	R <sub>L_VREF</sub>	VREF to GND or VREF to VDD	50	-	-	kΩ		
VREF Capacitive Load	C <sub>L_VREF</sub>	VREF to GND	_	-	100	pF		
Reference Source Current Limit	I <sub>SC_VREF</sub>	VREF shorted to GND	-	25	-	mA		
Reference Source Current Limit	I <sub>SK_VREF</sub>	VREF shorted to VDD	_	-25	_	mA		
FAULT OUTPUT CHARACTERISTIC	cs							
Overcurrent Operating Range	I <sub>OCR</sub>		90	100	110	%		
Internal Overcurrent Pull-Up Resistance	R <sub>L_IFAULT</sub>		_	10	_	kΩ		
Overcurrent Error	E <sub>OC</sub>		-10	-	10	%I <sub>OCR</sub> [1]		
FAULT Output Low Voltage	V <sub>FAULT_L</sub>	$R_{L_{FAULT}}$ = 10 k $\Omega$ , fault condition present	_	0.1	0.4	V		
FAULT Leakage Current	I <sub>FAULT_OFF</sub>	$R_{L_{FAULT}}$ = 10 k $\Omega$ , no fault condition present	_	100	500	nA		
Overcurrent Hysteresis	I <sub>OC_HYS</sub>		_	6	10	%I <sub>PR</sub>		
Overcurrent Response Time [2]	t <sub>OC_RESP</sub>		_	50	_	ns		
Overcurrent Release Time [2]	t <sub>OC_REL</sub>		_	100	_	ns		
Overcurrent Hold Time [2]	t <sub>OC_HLD</sub>		_	0.1	_	ms		

 $^{[1]}$  Where  ${\rm I}_{\rm OCR}$  is the specific point at which the OCF trigger will occur.  $^{[2]}$  Guaranteed by design and bench validated.



# DC to 5 MHz Bandwidth, Galvanically Isolated, High-Accuracy Current Sensor IC with Reference Output (ACS37030) or Fault (ACS37032)

**ACS37030LLZATR-020B3 PERFORMANCE CHARACTERISTICS:** Valid through full operating temperature range,  $T_A = -40^{\circ}$ C to 150°C. C<sub>BVDASS</sub> = 0.1 µF, and V<sub>DD</sub> = 3.3 V, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ. <sup>[1]</sup>	Max.	Units
NOMINAL PERFORMANCE						
Current Sensing Range	I <sub>PR</sub>		-20	-	20	А
Sensitivity	Sens	$I_{PR(min)} < I_P < I_{PR(max)}$	-	66	-	mV/A
Quiescent Voltage Output	V <sub>QVO</sub>	I <sub>P</sub> = 0 A	-	1.65	-	V
Reference Voltage Output	V <sub>REF</sub>		-	1.65	-	V
ERROR COMPONENTS						
Sonoitivity Error	E	$I_P = I_{PR(max)}$ , $T_A = -40^{\circ}C$ to 150°C, DC	-2	±1	2	%
	E <sub>SENS</sub>	$I_{P}=I_{PR(max)}$ , $T_{A} = -40^{\circ}$ C to 150°C, 500 kHz	-	±2	-	%
Offset Error	V <sub>OE</sub>	$I_{P} = 0 \text{ A}, T_{A} = -40^{\circ}\text{C} \text{ to } 150^{\circ}\text{C}$	-10	±5	10	mV
Reference Voltage Output Error	V <sub>REF_E</sub>	I <sub>P</sub> = 0 A, T <sub>A</sub> =–40°C to 150°C	-10	±5	10	mV
Quiescent Voltage Output Error	V <sub>QVO_E</sub>	$I_{P} = 0 \text{ A}, T_{A} = -40^{\circ}\text{C} \text{ to } 150^{\circ}\text{C}$	-10	±5	10	mV
Power Supply Offset Error	V <sub>OE_PS</sub>	3.15 to 3.45 V, T <sub>A</sub> = 25°C	-5	±3	5	mV
Power Supply Sensitivity Error	E <sub>SENS_PS</sub>	3.15 to 3.45 V, T <sub>A</sub> = 25°C	-1.5	±1	1.5	%
ERROR INCLUDING LIFETIME D	RIFT <sup>[2]</sup>					
Hall Path Sensitivity Error Including Lifetime Drift	E <sub>SENS_H_LT</sub>	I <sub>P</sub> = I <sub>PR(max)</sub> , DC	-3.5	-	3.5	%
Coil Path Sensitivity Error Including Lifetime Drift	E <sub>SENS_C_LT</sub>	I <sub>P</sub> = I <sub>PR(max)</sub> , AC	-3.75	-	3.75	%
Offset Error Including Lifetime Drift	V <sub>OE_LT</sub>	$I_{P} = 0 \text{ A}, T_{A} = -40^{\circ}\text{C} \text{ to } 150^{\circ}\text{C}$	-10	_	10	mV
Reference Voltage Error Including Lifetime Drift	V <sub>REF_LT</sub>	$T_A = -40^{\circ}C$ to 150°C	-10	_	10	mV
Quiescent Voltage Error Including Lifetime Drift	V <sub>QVO_LT</sub>	$I_{P} = 0 \text{ A}, T_{A} = -40^{\circ}\text{C} \text{ to } 150^{\circ}\text{C}$	-10	_	10	mV

<sup>[1]</sup> Typical values are the mean ±3 sigma of production distributions.



# DC to 5 MHz Bandwidth, Galvanically Isolated, High-Accuracy Current Sensor IC with Reference Output (ACS37030) or Fault (ACS37032)

**ACS37030LLZATR-040B3 PERFORMANCE CHARACTERISTICS:** Valid through full operating temperature range,  $T_A = -40^{\circ}$ C to 150°C,  $C_{BYPASS} = 0.1 \,\mu$ F, and  $V_{DD} = 3.3 \,$ V, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ. <sup>[1]</sup>	Max.	Units
NOMINAL PERFORMANCE						
Current Sensing Range	I <sub>PR</sub>		-40	-	40	А
Sensitivity	Sens	$I_{PR(min)} < I_P < I_{PR(max)}$	-	33	_	mV/A
Quiescent Voltage Output	V <sub>QVO</sub>	I <sub>P</sub> = 0 A	-	1.65	-	V
Reference Voltage Output	V <sub>REF</sub>		-	1.65	—	V
ERROR COMPONENTS						
Sonsitivity Error	E	$I_P = I_{PR(max)}$ , $T_A = -40^{\circ}C$ to 150°C, DC	-2	±1	2	%
Sensitivity Error	ESENS	$I_{P}=I_{PR(max)}$ , $T_{A}=-40^{\circ}C$ to 150°C, 500 kHz	-	±2	-	%
Offset Error	V <sub>OE</sub>	$I_P = 0 A, T_A = -40^{\circ}C \text{ to } 150^{\circ}C$	-10	±5	10	mV
Reference Voltage Output Error	V <sub>REF_E</sub>	$I_P = 0 A, T_A = -40^{\circ}C \text{ to } 150^{\circ}C$	-10	±5	10	mV
Quiescent Voltage Output Error	V <sub>QVO_E</sub>	$I_P = 0 A, T_A = -40^{\circ}C \text{ to } 150^{\circ}C$	-10	±5	10	mV
Power Supply Offset Error	V <sub>OE_PS</sub>	3.15 to 3.45 V, T <sub>A</sub> = 25°C	-5	±3	5	mV
Power Supply Sensitivity Error	E <sub>SENS_PS</sub>	3.15 to 3.45 V, T <sub>A</sub> = 25°C	-1.5	±1	1.5	%
ERROR INCLUDING LIFETIME D	RIFT <sup>[2]</sup>					
Hall Path Sensitivity Error Including Lifetime Drift	E <sub>SENS_H_LT</sub>	I <sub>P</sub> = I <sub>PR(max)</sub> , DC	-3.5	_	3.5	%
Coil Path Sensitivity Error Including Lifetime Drift	E <sub>SENS_C_LT</sub>	I <sub>P</sub> = I <sub>PR(max)</sub> , AC	-3.75	_	3.75	%
Offset Error Including Lifetime Drift	V <sub>OE_LT</sub>	$I_P = 0 A, T_A = -40^{\circ}C \text{ to } 150^{\circ}C$	-10	-	10	mV
Reference Voltage Error Including Lifetime Drift	V <sub>REF_LT</sub>	$T_A = -40^{\circ}C$ to $150^{\circ}C$	-10	_	10	mV
Quiescent Voltage Error Including Lifetime Drift	V <sub>QVO_LT</sub>	$I_{P} = 0 \text{ A}, T_{A} = -40^{\circ}\text{C} \text{ to } 150^{\circ}\text{C}$	-10	_	10	mV

 $^{[1]}$  Typical values are the mean ±3 sigma of production distributions.



# DC to 5 MHz Bandwidth, Galvanically Isolated, High-Accuracy Current Sensor IC with Reference Output (ACS37030) or Fault (ACS37032)

**ACS37030LLZATR-065B3 PERFORMANCE CHARACTERISTICS:** Valid through full operating temperature range,  $T_A = -40^{\circ}$ C to 150°C. C<sub>EVENCES</sub> = 0.1 µF, and V<sub>DD</sub> = 3.3 V, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ. <sup>[1]</sup>	Max.	Units
NOMINAL PERFORMANCE				·		
Current Sensing Range	I <sub>PR</sub>		-65	-	65	A
Sensitivity	Sens	$I_{PR(min)} < I_P < I_{PR(max)}$	-	20.3	_	mV/A
Quiescent Voltage Output	V <sub>QVO</sub>	I <sub>P</sub> = 0 A	-	1.65	_	V
Reference Voltage Output	V <sub>REF</sub>		_	1.65	_	V
ERROR COMPONENTS						
Sonoitivity Error	E	$I_P$ = 60 A, $T_A$ = -40°C to 150°C, DC	-2	±1	2	%
	E <sub>SENS</sub>	$I_{P}=I_{PR(max)}$ , $T_{A}=-40^{\circ}C$ to 150°C, 500 kHz	-	±2	_	%
Offset Error	V <sub>OE</sub>	$I_P = 0 A, T_A = -40^{\circ}C \text{ to } 150^{\circ}C$	-10	±5	10	mV
Reference Voltage Output Error	V <sub>REF_E</sub>	$I_P = 0 A, T_A = -40^{\circ}C \text{ to } 150^{\circ}C$	-10	±5	10	mV
Quiescent Voltage Output Error	V <sub>QVO_E</sub>	$I_P = 0 A, T_A = -40^{\circ}C \text{ to } 150^{\circ}C$	-10	±5	10	mV
Power Supply Offset Error	V <sub>OE_PS</sub>	3.15 to 3.45 V, T <sub>A</sub> = 25°C	-5	±3	5	mV
Power Supply Sensitivity Error	E <sub>SENS_PS</sub>	3.15 to 3.45 V, T <sub>A</sub> = 25°C	-1.5	±1	1.5	%
ERROR INCLUDING LIFETIME D	RIFT <sup>[2]</sup>					
Hall Path Sensitivity Error Including Lifetime Drift	E <sub>SENS_H_LT</sub>	I <sub>P</sub> = I <sub>PR(MAX)</sub> , DC	-3.5	_	3.5	%
Coil Path Sensitivity Error Including Lifetime Drift	E <sub>SENS_C_LT</sub>	I <sub>P</sub> = I <sub>PR(MAX)</sub> , AC	-3.75	_	3.75	%
Offset Error Including Lifetime Drift	V <sub>OE_LT</sub>	$I_P = 0 A, T_A = -40^{\circ}C \text{ to } 150^{\circ}C$	-10	-	10	mV
Reference Voltage Error Including Lifetime Drift	V <sub>REF_LT</sub>	$T_A = -40^{\circ}C$ to $150^{\circ}C$	-10	_	10	mV
Quiescent Voltage Error Including Lifetime Drift	V <sub>QVO_LT</sub>	$I_{P} = 0 \text{ A}, T_{A} = -40^{\circ}\text{C} \text{ to } 150^{\circ}\text{C}$	-10	_	10	mV

 $^{[1]}$  Typical values are the mean  $\pm 3$  sigma of production distributions.



# DC to 5 MHz Bandwidth, Galvanically Isolated, High-Accuracy Current Sensor IC with Reference Output (ACS37030) or Fault (ACS37032)

**ACS37032LLZATR-020B3 PERFORMANCE CHARACTERISTICS:** Valid through full operating temperature range,  $T_A = -40^{\circ}$ C to 150°C. C<sub>EVENCE</sub> = 0.1 µF, and V<sub>DD</sub> = 3.3 V, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ. <sup>[1]</sup>	Max.	Units
NOMINAL PERFORMANCE						
Current Sensing Range	I <sub>PR</sub>		-20	-	20	А
Sensitivity	Sens	$I_{PR(min)} < I_P < I_{PR(max)}$	_	66	_	mV/A
Quiescent Voltage Output	V <sub>QVO</sub>	I <sub>P</sub> = 0 A	-	1.65	-	V
Overcurrent Threshold	I <sub>OC</sub>		-	100	-	%I <sub>PR</sub>
Overcurrent Hysteresis	I <sub>OC_HYS</sub>		_	1.2	-	Α
FAULT ERROR						
Overcurrent Error	I <sub>OC_E</sub>		-2	-	2	Α
ERROR COMPONENTS						
Sanaitivity Error	F	$I_P = I_{PR(max)}$ , $T_A = -40^{\circ}C$ to 150°C, DC	-2	±1	2	%
	⊏SENS	$I_{P}=I_{PR(max)}$ , $T_{A}=-40^{\circ}C$ to 150°C, 500 kHz	-	±2	-	%
Quiescent Voltage Output Error	V <sub>QVO_E</sub>	$I_P = 0 A, T_A = -40^{\circ}C \text{ to } 150^{\circ}C$	-10	±5	10	mV
Power Supply Offset Error	V <sub>OE_PS</sub>	3.15 to 3.45 V, T <sub>A</sub> = 25°C	-5	±3	5	mV
Power Supply Sensitivity Error	E <sub>SENS_PS</sub>	3.15 to 3.45 V, T <sub>A</sub> = 25°C	-1.5	±1	1.5	%
ERROR INCLUDING LIFETIME D	RIFT <sup>[2]</sup>					
Hall Path Sensitivity Error Including Lifetime Drift	E <sub>SENS_H_LT</sub>	I <sub>P</sub> = I <sub>PR(MAX)</sub> , DC	-3.5	_	3.5	%
Coil Path Sensitivity Error Including Lifetime Drift	E <sub>SENS_C_LT</sub>	I <sub>P</sub> = I <sub>PR(MAX)</sub> , AC	-3.75	_	3.75	%
Quiescent Voltage Error Including Lifetime Drift	V <sub>QVO_LT</sub>	$I_{P} = 0 \text{ A}, T_{A} = -40^{\circ}\text{C} \text{ to } 150^{\circ}\text{C}$	-10	_	10	mV

 $\ensuremath{^{[1]}}$  Typical values are the mean ±3 sigma of production distributions.



# DC to 5 MHz Bandwidth, Galvanically Isolated, High-Accuracy Current Sensor IC with Reference Output (ACS37030) or Fault (ACS37032)

**ACS37032LLZATR-040B3 PERFORMANCE CHARACTERISTICS:** Valid through full operating temperature range,  $T_A = -40^{\circ}$ C to 150°C,  $C_{BYPASS} = 0.1 \mu$ F, and  $V_{DD} = 3.3$  V, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ. <sup>[1]</sup>	Max.	Units
NOMINAL PERFORMANCE			·	·		
Current Sensing Range	I <sub>PR</sub>		-40	-	40	A
Sensitivity	Sens	$I_{PR(min)} < I_P < I_{PR(max)}$	-	33	-	mV/A
Quiescent Voltage Output	V <sub>QVO</sub>	I <sub>P</sub> = 0 A	-	1.65	-	V
Overcurrent Threshold	I <sub>OC</sub>		-	100	-	%I <sub>PR</sub>
Overcurrent Hysteresis	I <sub>OC_HYS</sub>		-	2.4	-	A
FAULT ERROR						
Overcurrent Error	I <sub>OC_E</sub>		-4	-	4	A
ERROR COMPONENTS						
Separitivity	E	$I_P = I_{PR(max)}$ , $T_A = -40$ °C to 150°C, DC	-2	±1	2	%
	⊏sens	$I_{P}=I_{PR(max)}$ , $T_{A}=-40^{\circ}$ C to 150°C, 500 kHz	-	±2	-	%
Quiescent Voltage Output Error	V <sub>QVO_E</sub>	$I_P = 0 A, T_A = -40^{\circ}C \text{ to } 150^{\circ}C$	-10	±5	10	mV
Power Supply Offset Error	V <sub>OE_PS</sub>	3.15 to 3.45 V, T <sub>A</sub> = 25°C	-5	±3	5	mV
Power Supply Sensitivity Error	E <sub>SENS_PS</sub>	3.15 to 3.45 V, T <sub>A</sub> = 25°C	-1.5	±1	1.5	%
ERROR INCLUDING LIFETIME	DRIFT <sup>[2]</sup>					
Hall Path Sensitivity Error Including Lifetime Drift	E <sub>SENS_H_LT</sub>	I <sub>P</sub> = I <sub>PR(MAX)</sub> , DC	-3.5	_	3.5	%
Coil Path Sensitivity Error Including Lifetime Drift	E <sub>SENS_C_LT</sub>	I <sub>P</sub> = I <sub>PR(MAX)</sub> , AC	-3.75	_	3.75	%
Quiescent Voltage Error Including Lifetime Drift	V <sub>QVO_LT</sub>	$I_{P} = 0 \text{ A}, T_{A} = 25^{\circ}\text{C} \text{ to } 150^{\circ}\text{C}$	-10	_	10	mV

 $^{[1]}$  Typical values are the mean ±3 sigma of production distributions.



# DC to 5 MHz Bandwidth, Galvanically Isolated, High-Accuracy Current Sensor IC with Reference Output (ACS37030) or Fault (ACS37032)

**ACS37032LLZATR-065B3 PERFORMANCE CHARACTERISTICS:** Valid through full operating temperature range,  $T_A = -40^{\circ}$ C to 150°C,  $C_{RVDASS} = 0.1 \ \mu$ F, and  $V_{DD} = 3.3 \ V$ , unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ. <sup>[1]</sup>	Max.	Units
NOMINAL PERFORMANCE			• •			
Current Sensing Range	I <sub>PR</sub>		-65	-	65	A
Sensitivity	Sens	$I_{PR(min)} < I_P < I_{PR(max)}$	-	20.3	_	mV/A
Quiescent Voltage Output	V <sub>QVO</sub>	I <sub>P</sub> = 0 A	-	1.65	_	V
Overcurrent Threshold	I <sub>OC</sub>		-	100	_	%I <sub>PR</sub>
Overcurrent Hysteresis	I <sub>OC_HYS</sub>		-	3.9	_	A
FAULT ERROR						
Overcurrent Error	I <sub>OC_E</sub>		-6.5	-	6.5	A
ERROR COMPONENTS						
Separitivity	F	$I_{P}$ = 60 A, $T_{A}$ = -40°C to 150°C, DC	-2	±1	2	%
	⊂ SENS	$I_{P}=I_{PR(max)}$ , $T_{A}=-40^{\circ}C$ to 150°C, 500 kHz	-	±2	_	%
Quiescent Voltage Output Error	V <sub>QVO_E</sub>	$I_P = 0 A, T_A = -40^{\circ}C \text{ to } 150^{\circ}C$	-10	±5	10	mV
Power Supply Offset Error	V <sub>OE_PS</sub>	3.15 to 3.45 V, T <sub>A</sub> = 25°C	-5	±3	5	mV
Power Supply Sensitivity Error	E <sub>SENS_PS</sub>	3.15 to 3.45 V, T <sub>A</sub> = 25°C	-1.5	±1	1.5	%
ERROR INCLUDING LIFETIME	DRIFT <sup>[2]</sup>					
Hall Path Sensitivity Error Including Lifetime Drift	E <sub>SENS_H_LT</sub>	I <sub>P</sub> = I <sub>PR(max)</sub> , DC	-3.5	_	3.5	%
Coil Path Sensitivity Error Including Lifetime Drift	E <sub>SENS_C_LT</sub>	I <sub>P</sub> = I <sub>PR(max)</sub> , AC	-3.75	_	3.75	%
Quiescent Voltage Error Including Lifetime Drift	V <sub>QVO_LT</sub>	$I_{P} = 0 \text{ A}, T_{A} = 25^{\circ}\text{C} \text{ to } 150^{\circ}\text{C}$	-10	_	10	mV

<sup>[1]</sup> Typical values are the mean ±3 sigma of production distributions.





ACS37030/2 TYPICAL FREQUENCY RESPONSE



# **RESPONSE CHARACTERISTICS DEFINITIONS AND PERFORMANCE DATA**

# Response Time (t<sub>RESP</sub>)

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

# Propagation Delay (t<sub>PD</sub>)

The time interval between a) when the sensed input current reaches 10% of its full-scale value, and b) when the sensor output reaches 10% of its full-scale value.

# Rise Time (t<sub>R</sub>)

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







# FUNCTIONAL DESCRIPTION OF POWER ON/OFF OPERATION

### Introduction

The voltage of  $V_{OUT}$  during a high-impedance state will be most consistent with a known load ( $R_{L VOUT}$ ,  $C_{L VOUT}$ ). Figure 5 and Figure 6 use the same labeling scheme for different power thresholds. References in brackets "[]" are valid for each of these plots.

#### **POWER-ON OPERATION**

As  $V_{DD}$  ramps up, the  $V_{OUT}$  and  $V_{REF}$  pins are high-Z until  $V_{DD}$  reaches and passes  $V_{POR}$  [1]. Once  $V_{DD}$  has passed  $V_{POR}$  [1],  $V_{OUT}$  enters normal operation.

#### **POWER-OFF OPERATION**

As  $V_{DD}$  drops below  $V_{POR} - V_{POR_HYS}$  (power-on voltage minus the hysteresis level for the power-on voltage), the outputs will enter a high-Z state. The hysteresis on the power-on voltage prevents noise on the supply line from causing the ACS37030 from entering/exiting POR around the  $V_{POR}$  level.

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.

### Voltage Thresholds

#### POWER-ON RESET RELEASE VOLTAGE (VPOR)

If  $V_{DD}$  falls below  $V_{POR} - V_{POR_HYS}$  [2] while in operation, the digital circuitry turns off and the output will re-enter a high-Z state. After  $V_{DD}$  recovers and exceeds  $V_{POR}$  [1], the output will begin reporting again after the delay of  $t_{PO}$ .



Figure 5: Power States Thresholds with V<sub>OUT</sub> Behavior for a 3.3 V Device, R<sub>L</sub> = Pull-Down



# **Timing Thresholds**

### POWER-ON DELAY (t<sub>PO</sub>)

When the supply is ramped to  $V_{POR}$  [1], 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 [1] to [A]. After this delay, the output will quickly approach  $V_{OUT(IP)} = Sens \times I_P + V_{REF}$ .





# DEFINITIONS OF OPERATING AND PERFORMANCE CHARACTERISTICS

### Quiescent Voltage Output (V<sub>QVO</sub>)

Quiescent Voltage Output, or  $V_{QVO}$ , is defined as the voltage on the output,  $V_{OUT}$ , when zero amps are applied through I<sub>P</sub>.

## Quiescent Voltage Output Error(V<sub>QVO\_E</sub>)

Quiescent Voltage Output Error, or  $V_{QVO\_E}$ , is defined as the error of the VOUT voltage to the  $V_{QVO}$  target over all temperatures, with 0 A applied. To improve over temperature performance, the temperature drift is compensated with Allegro factory trim to remain within the limits across temperature.

# Reference Voltage Output (V<sub>REF</sub>)

The Reference Voltage Output, or  $V_{REF}$ , reports the quiescent voltage output for the output channel,  $V_{OUT}$ . The internally generated  $V_{REF}$  is used in a pseudo-differential mode to remove errors due to the reference shifts or noise on the ground line. ACS37030 only.

# Reference Voltage Output Error (V<sub>REF\_E</sub>)

Reference Voltage Output Error, or  $V_{REF_E}$ , is defined as the error of the VREF output voltage to the target Reference Voltage Output,  $V_{REF}$ . ACS37030 only.

### Offset Error (V<sub>OE</sub>)

Offset Error, or  $V_{OE}$ , is defined as the difference between  $V_{QVO}$  and  $V_{REF}$ ,  $V_{OE}$  includes  $V_{QVO\_E}-V_{REF}$  drift over temperature. ACS37030 only.

# Output Saturation Voltage (V<sub>SAT\_H</sub>/V<sub>SAT\_L</sub>)

Output Saturation Voltage, or  $V_{SAT}$ , is defined as the voltage that the  $V_{OUT}$  does not pass as a result of an increasing magnitude of current.  $V_{SAT\_H}$  is the highest voltage the output can drive to, while  $V_{SAT\_L}$  is the lowest. Note that changing the sensitivity does not change the  $V_{SAT}$  points.

# Sensitivity (Sens)

Sensitivity, or Sens, is the ratio of the output swing versus the applied current through the primary conductor, I<sub>P</sub>. This current causes a voltage deviation away from V<sub>QVO</sub> on the V<sub>OUT</sub> output until V<sub>SAT</sub>. The magnitude and direction of the output voltage swing is proportional to the magnitude and direction of the applied current. This proportional relationship between output and input is Sensitivity and is defined as:

$$Sens = \frac{V_{\text{OUT}(\text{IP}_1)} - V_{\text{OUT}(\text{IP}_2)}}{IP_1 - IP_2}$$

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

### Sensitivity Error (E<sub>SENS</sub>)

Sensitivity Error, or  $E_{SENS}$ , is the error of Sensitivity from the sensitivity target including drift over temperature. Sensitivity error is compensated with Allegro factory trim.

## Error Components Including Lifetime Drift (E<sub>SENS\_LTD</sub>/V<sub>QVO\_LTD</sub>/V<sub>REF\_LTD</sub>/V<sub>OE\_LTD</sub>)

Lifetime drift characteristics are based on a statistical combination of production distributions and worst-case distribution of parametric drift of individuals observed during AEC-Q100 qualification. Solder reflow induces stress on the ACS37030/32 device causing parametric shifts, and lifetime drift limits apply immediately after solder reflow as well as long term use.

# Power Supply Sensitivity Error (E<sub>SENS\_PS</sub>)

Power Supply Sensitivity Error, or  $E_{SENS_PS}$ , is defined as the difference in  $E_{SENS}$  measurements when  $V_{DD}$  is at the nominal value and  $V_{DD}$  is ±5%. For a 3.3 V device, this is 3.15 V to 3.45 V.

# Power Supply Offset Error (VOE PS)

Power Supply Offset Error, or V<sub>OE\_PS</sub>, is defined as the difference in V<sub>OE</sub> measurements when  $V_{DD}$  is at the nominal value and and V<sub>DD</sub> is ±5%. For a 3.3 V device, this is 3.15 V to 3.45 V.



# ACS37030 and<br/>ACS37032DC to 5 MHz Bandwidth, Galvanically Isolated, High-Accuracy<br/>Current Sensor IC with Reference Output (ACS37030) or Fault (ACS37032)

# **OVERCURRENT FAULT (OCF) BEHAVIOR**

The overcurrent fault (OCF) function (ACS37032 only) pulls the open-drain FAULT pin low when the applied current exceeds a preset threshold ( $I_{OCR}$ ). On the ACS37032, this threshold is internally set to 100% of the full-scale rated current. This flag trips symmetrically for positive and negative applied currents.

The implementation for the OCF circuitry is accurate over temperature and does not require further temperature compensation.

### OVERCURRENT ERROR (IOC\_E)

Overcurrent Error, or  $I_{OC\_E}\text{,}$  is the error between the ideal  $I_{OC}$  and the measured  $I_{OC.}$ 

### OVERCURRENT HYSTERESIS (I<sub>OC\_HYS</sub>)

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 7.

# OVERCURRENT FAULT RESPONSE TIME (toc\_RESP)

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

# OVERCURRENT FAULT HOLD TIME (t<sub>OC\_HLD</sub>)

Overcurrent Hold Time, or  $t_{OC\_HLD}$ , is defined as the minimum time the OCF flag will be asserted after an OCF event. After the hold time has been reached, the OCF will release if the OCF condition has ended ([G] until [J] in Figure 8) or persist if the OCF condition is still present. Factory default is 0.1 ms.



Figure 7: Fault Thresholds and OCF Pin Functionality



Figure 8: Fault Hold with Clear Fault After Hold Time



# ACS37030 and<br/>ACS37032DC to 5 MHz Bandwidth, Galvanically Isolated, High-Accuracy<br/>Current Sensor IC with Reference Output (ACS37030) or Fault (ACS37032)

# THERMAL PERFORMANCE

# Thermal Rise vs. Primary Current

Self-heating due to the flow of current in the package IP conductor should be considered during the design of any current sensing system. The sensor, printed circuit board (PCB), and contacts to the PCB will generate heat and act as a heat sink as current moves through the system. No external pull-up resistor is required, as the ACS37032 has an internal 10 k $\Omega$  pull-up resistor. The Fault output can be routed directly to a digital IO pin on the system microcontroller.

The thermal response is highly dependent on PCB layout, copper thickness, cooling techniques, and the profile of the injected current. The current profile includes peak current value, current on-time, and duty cycle.

Placing vias under the copper pads of the Allegro current sensor evaluation board minimizes the current path resistance and improves heatsinking to the PCB, while vias outside of the pads limit the current path to the top of the PCB trace and have worse heatsinking under the part (see Figure 9 and Figure 10).



Figure 9: Vias Under Copper Pads, LZ Package



#### Figure 10: No Vias Under Copper Pads, LZ Package

The plot in Figure 11 shows the measured rise in steady-state die temperature of the ACS37030/2 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. 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.



#### Figure 11: LZ Package Comparison with and without In-Pad Vias

The thermal capacity of the ACS37030/2 should be verified by the end user in the application's specific conditions. The maximum junction temperature,  $T_{J(max)}$  (165°C), should not be exceeded. Measuring the temperature of the top of the package is a close approximation of the die temperature.

# **Evaluation Board Layout**

Thermal data shown in Figure 11 was collected using the LC/LZ Current Sensor Evaluation Board (TED-0004110). This board includes six layers. The evaluation board is shown in Figure 12.



Figure 12: LZ Package Allegro Evaluation Board

Gerber files for the evaluation board used are available for download from the Allegro website. See the technical documents section of the ACS37030/2 webpage.



### PACKAGE OUTLINE DRAWING





Figure 14: LZ Package Branding



#### **Revision History**

Number	Date	Description
-	November 29, 2023	Initial release

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