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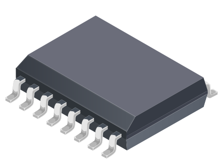
1 MHz Bandwidth, Galvanically Isolated Current Sensor IC in SOIC-16 Package

FEATURES AND BENEFITS

- AEC-Q100 automotive qualified
- High bandwidth, 1 MHz analog output
- Differential Hall sensing rejects common-mode fields
- High-isolation SOIC16 wide body package provides galvanic isolation for high-voltage applications
- Industry-leading noise performance with greatly improved bandwidth through proprietary amplifier and filter design
- UL60950-1 (ed. 2) certified
  - □ Dielectric Strength Voltage = 3.6 kV_{RMS}
  - □ Basic Isolation Working Voltage = 616 V_{RMS}
- Fast and externally configurable overcurrent fault detection
- 1 mΩ primary conductor resistance for low power loss and high inrush current withstand capability
- Options for 3.3 V and 5 V single supply operation
- Output voltage proportional to AC and DC current
- Factory-trimmed sensitivity and quiescent output voltage for improved accuracy
- Nearly zero magnetic hysteresis
- Ratiometric output from supply voltage

PACKAGE: 16-Pin SOICW (suffix LA)



Not to scale

CB Certificate Number:
US-23711-UL

DESCRIPTION

The ACS732 and ACS733 are a new generation of high bandwidth current sensor ICs from Allegro™. These devices provide a compact, fast, and accurate solution for measuring high-frequency currents in DC/DC converters and other switching power applications. The ACS732 and ACS733 offer high isolation, high bandwidth Hall-effect-based current sensing with user-configurable overcurrent fault detection. These features make them ideally suited for high-frequency transformer and current transformer replacement in applications running at high voltages.

The ACS732 and ACS733 are suitable for all markets, including automotive, industrial, commercial, and communications systems. They may be used in motor control, load detection and management, switch-mode power supplies, and overcurrent fault protection applications.

The wide body SOIC-16 package allows for easy implementation. 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. Device accuracy is optimized through the close proximity of the magnetic field to the Hall transducers. A precise, proportional voltage is provided by the Hall IC, which is factory-programmed after packaging for high accuracy. The fully integrated package has an internal copper conductive path with a typical resistance of 1 mΩ, providing low power loss.

The current-carrying pins (pins 1 through 8) are electrically isolated from the sensor leads (pins 9 through 16). This allows the devices to be used in high-side current sensing applications without the use of high-side differential amplifiers or other costly isolation techniques.

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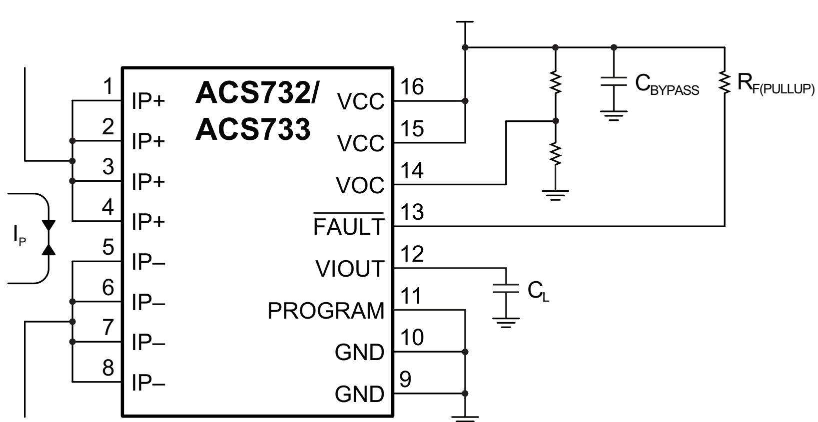


ACS732/ACS733 outputs an analog signal, V_{IOUT}, that changes proportionally with the bidirectional AC or DC primary sensed current, I_P, within the specified measurement range.

The overcurrent threshold may be set with a resistor divider tied to the V_{OC} pin.

Figure 1: Typical Application Circuit

DESCRIPTION (continued)

The ACS732 and ACS733 are provided in a small, low profile, surface-mount SOIC-16 wide-body package. 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 lead-free. These devices are fully calibrated prior to shipment from the Allegro factory.

SELECTION GUIDE

Part Number	Optimized Range, I_P (A)	Sensitivity [1], Sens(Typ) (mV/A)	Nominal Supply Voltage, V_{CC}, (V)	T_A (°C)	Packing [2]
ACS732KLATR-20AB-T	±20	100	5.0	–40 to 125	Tape and reel, 1000 pieces per reel
ACS732KLATR-40AB-T	±40	50			
ACS733KLATR-20AB-T	±20	66	3.3		
ACS733KLATR-40AB-T	±40	33			
ACS733KLATR-40AU-T	40	66			
ACS733KLATR-65AB-T	±65	20			

[1] Measured at Nominal Supply Voltage, V_{CC}.
[2] Contact Allegro for additional packing options.

ABSOLUTE MAXIMUM RATINGS

Characteristic	Symbol	Notes	Rating	Units
Supply Voltage	V_{CC}		6	V
Reverse Supply Voltage	V_{RCC}		–0.1	V
Output Voltage	V_{IOUT}		6	V
Reverse Output Voltage	V_{RIOUT}		–0.1	V
Fault Output Voltage	V_{FAULT}		6	V
Reverse Fault Output Voltage	V_{RFAULT}		–0.1	V
Forward V_{OC} Voltage	V_{VOC}		6	V
Reverse V_{OC} Voltage	V_{VOC}		0.1	V
Output Current	I_{OUT}	Maximum survivable sink or source current on the output	15	mA
Nominal Operating Ambient Temperature	T_A	Range K	–40 to 125	°C
Maximum Junction Temperature	T_J(max)		165	°C
Storage Temperature	T_{stg}		–65 to 170	°C

ISOLATION CHARACTERISTICS

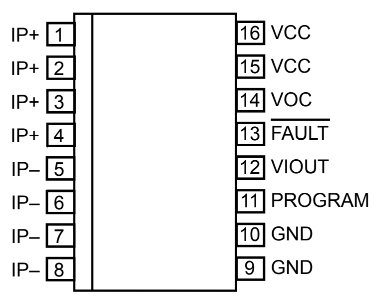
Characteristic	Symbol	Notes	Value	Units
Dielectric Strength Test Voltage	V_{ISO}	Agency type-tested for 60 seconds per UL 60950-1 (edition 2). Production Tested at 2250 V_{RMS} per UL 60950-1.	3600	V_{RMS}
Working Voltage for Basic Isolation	V_{WVBI}	Maximum approved working voltage for basic (single) isolation according to UL 60950-1 (edition 2).	870	V_{PK} or V_{DC}
			616	V_{RMS}
Clearance	D_{CL}	Minimum distance through air from IP leads to signal leads.	7.5	mm
Creepage	D_{CR}	Minimum distance along package body from IP leads to signal leads.	7.5	mm

THERMAL CHARACTERISTICS [1]

Characteristic	Symbol	Test Conditions	Value	Unit
Junction-to-Ambient Thermal Resistance	$R_{\theta JA}$	Mounted on the Allegro ASEK732/3 evaluation board. Performance values include the power consumed by the PCB. [2]	17	°C/W
Junction-to-Lead Thermal Resistance	$R_{\theta JL}$	Mounted on the Allegro ASEK732/3 evaluation board. [2]	5	°C/W

[1] Refer to the die temperature curves versus DC current plot (p. 29). Additional thermal information is available on the Allegro website.
[2] The Allegro evaluation board has 1500 mm^2 of 2 oz. copper on each side, connected to pins 1 through 4 and pins 5 through 8, with thermal vias connecting the layers. Performance values include the power consumed by the PCB. Further details on the board are available from the Frequently Asked Questions document on our website. Further information about board design and thermal performance also can be found in the Applications Information section of this datasheet.

PINOUT DIAGRAM AND TERMINAL LIST TABLE



Package LA, 16-Pin SOICW Pinout Diagram

Terminal List Table

Number	Name	Description
1,2,3,4	IP+	Positive terminals for current being sensed; fused internally.
5,6,7,8	IP–	Negative terminals for current being sensed; fused internally.
9,10	GND	Device ground terminal.
11	PROGRAM	Programming input pin for factory calibration. Connect to ground for best ESD performance.
12	VIOUT	Analog output signal.
13	$\overline{\text{FAULT}}$	Overcurrent Fault output. Open drain.
14	VOC	Set the overcurrent fault threshold via external resistor divider on this pin.
15,16	VCC	Device power supply terminal.

FUNCTIONAL BLOCK DIAGRAM

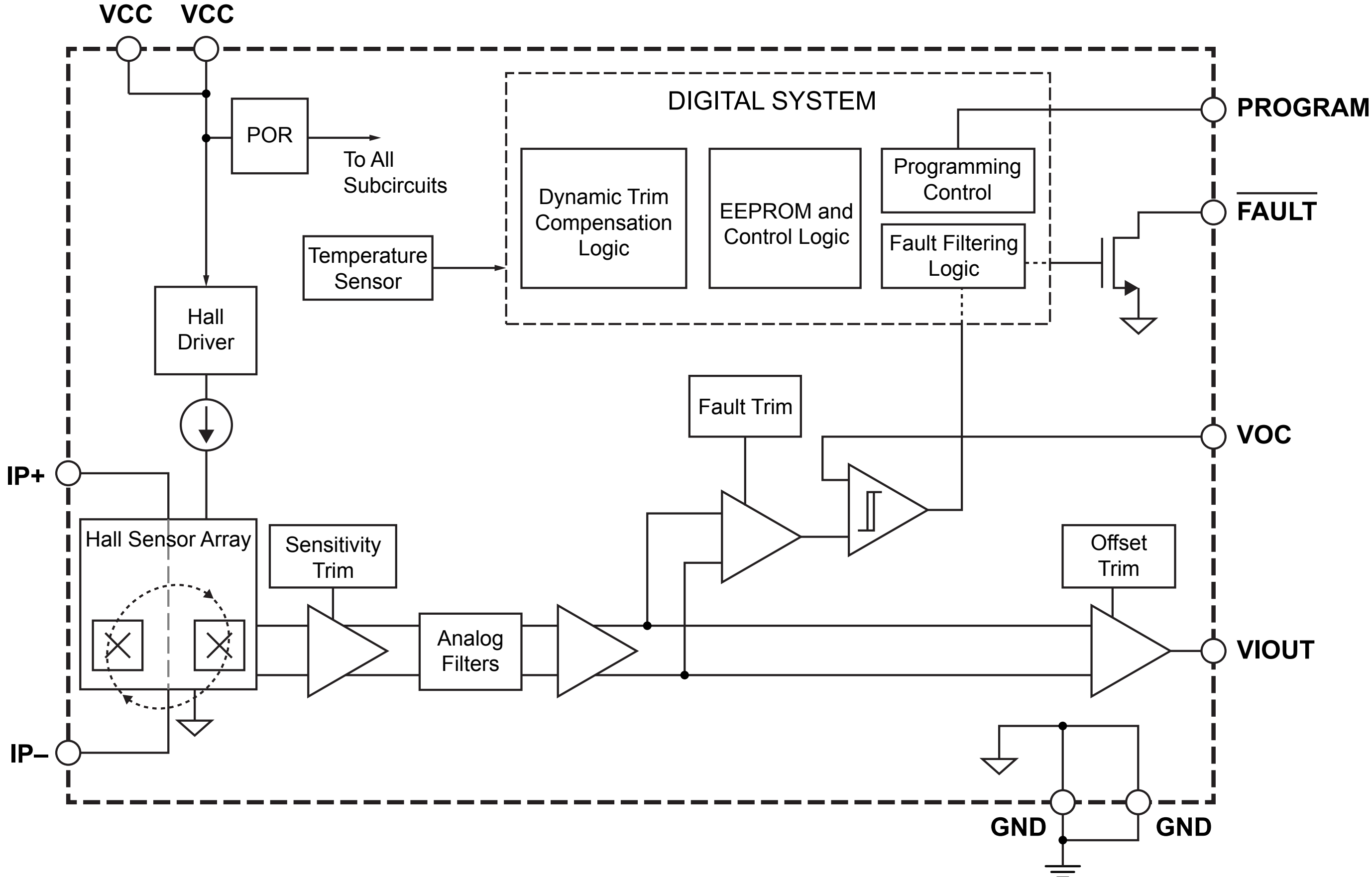


Figure 2: Functional Block Diagram

COMMON ELECTRICAL CHARACTERISTICS: Over full range of T_A, over supply voltage range $V_{CC(MIN)}$ through $V_{CC(MAX)}$ of a sensor variant, C_{BYPASS} = 0.1 µF, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ. [1]	Max.	Unit
Supply Voltage	V_{CC}	ACS732	4.75	5.0	5.25	V
		ACS733	3.14	3.3	3.46	V
Supply Current	I_{CC}	ACS732; V_{CC} = 5.0 V	–	24	35	mA
		ACS733; V_{CC} = 3.3 V	–	20	35	mA
Bypass Capacitor [2]	C_{BYPASS}	V_{CC} to GND	0.1	–	–	µF
Output Capacitance Load	C_L	V_{IOUT} to GND	–	–	220	pF
Output Resistive Load	R_L	V_{IOUT} to GND	50	–	–	kΩ
Output Saturation Voltage	$V_{SAT(HIGH)}$	V_{CC} = 5.0 V, T_A = 25°C, $R_{L(PULLDOWN)}$ = 50 kΩ to GND	V_{CC} – 0.3	–	–	V
		V_{CC} = 3.3 V, T_A = 25°C, $R_{L(PULLDOWN)}$ = 50 kΩ to GND	V_{CC} – 0.3	–	–	V
	$V_{SAT(LOW)}$	V_{CC} = 5.0 V, T_A = 25°C, $R_{L(PULLDOWN)}$ = 50 kΩ to VCC	–	–	0.5	V
		V_{CC} = 3.3 V, T_A = 25°C, $R_{L(PULLDOWN)}$ = 50 kΩ to VCC	–	–	0.3	V
Primary Conductor Resistance	R_{IP}	T_A = 25°C	–	1	–	mΩ
Primary Hall Coupling Factor	$C_{F(P)}$	T_A = 25°C	–	10.8	–	G/A
Secondary Hall Coupling Factor	$C_{F(s)}$	T_A = 25°C	–	4.3	–	G/A
Hall Plate Sensitivity Matching	$Sens_{match}$	T_A = 25°C	–	1	–	%
Power On Delay Time	t_{POD}	T_A = 25°C; when $V_{CC} \geq V_{CC(MIN)}$ until V_{IOUT} = 90% of steady state value	–	180	–	µs
Internal Bandwidth	BW	Small signal –3 dB; C_L = 220 pF	–	1	–	MHz
Rise Time [3]	t_r	T_A = 25°C, C_L = 220 pF, input step with 1 µs rise time, 1 V step on output	–	0.7	–	µs
Response Time [3]	$t_{RESPONSE}$		–	0.2	–	µs
Propagation Delay Time [3]	t_{pd}		–	0.14	–	µs
Zero Current Output Ratiometry Error	$E_{RAT(Q)}$	T_A = 25°C, V_{CC} = ±5 % variation of nominal supply voltage	–12	±10	12	mV
Sensitivity Ratiometry Error	$E_{RAT(SENS)}$	T_A = 25°C, V_{CC} = ±5 % variation of nominal supply voltage	–2	±1.72	2	%
Ratiometry Bandwidth	BW_{RAT}	±100 mV on V_{CC}	–	10	–	kHz
Linearity Error [4]	E_{LIN}	T_A = 25°C, up to full-scale I_P	–	±0.5	–	%
Noise Density	I_{ND}	V_{CC} = 5.0 V, T_A = 25°C, C_L = 220 pF; input referred	–	55	–	µA/√Hz
		V_{CC} = 3.3 V, T_A = 25°C, C_L = 220 pF; input referred	–	80	–	µA/√Hz

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COMMON ELECTRICAL CHARACTERISTICS (continued): Over full range of T_A, over supply voltage range $V_{CC(MIN)}$ through $V_{CC(MAX)}$ of a sensor variant, C_{BYPASS} = 0.1 µF, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ. [1]	Max.	Unit
OVERCURRENT FAULT CHARACTERISTICS						
$\overline{FAULT}$ Response Time [5]	$t_{RESPONSE(F)}$	Time from $I_P > I_{\overline{FAULT}}$ to when $\overline{FAULT}$ pin is pulled below $V_{\overline{FAULT}}$; input current step from 0 to 1.2 × $I_{\overline{FAULT}}$	0.2	0.5	0.75	µs
$\overline{FAULT}$ Release Time [5]	$t_{C(F)}$	Time from I_P falling below $I_{\overline{FAULT}} - I_{HYS}$ to when $V_{\overline{FAULT}}$ is pulled above $V_{\overline{FAULT}L}$; 100 pF from $\overline{FAULT}$ to ground	0.1	–	0.45	µs
$\overline{FAULT}$ Range	$I_{\overline{FAULT}}$	Relative to the full scale of I_{PR}; set via the VOC pin	0.5 × I_{PR}	–	2 × I_{PR}	A
$\overline{FAULT}$ Output Low Voltage	$V_{\overline{FAULT}}$	In fault condition; $R_{F(PULLUP)}$ = 10 kΩ	–	–	0.4	V
$\overline{FAULT}$ Pull-Up Resistance	$R_{F(PULLUP)}$		10	–	500	kΩ
$\overline{FAULT}$ Leakage Current	$I_{\overline{FAULT}(LEAKAGE)}$		–	±2	–	nA
$\overline{FAULT}$ Hysteresis [6]	I_{HYST}		–	0.05 × I_{PR}	–	A
$\overline{FAULT}$ Error [7]	$E_{\overline{FAULT}}$	Tested at V_{VOC} = 0.2 × V_{CC} ($I_{\overline{FAULT}}$ threshold = 100% × I_{PR})	–	±5	–	%
V_{OC} Input Range	V_{VOC}		0.1 × V_{CC}	–	0.4 × V_{CC}	V
V_{OC} Input Current	I_{VOC}		–	10	100	nA

[1] Typical values are mean ± 3 sigma values.
[2] Use of a bypass capacitor is required to increase output stability.
[3] See definitions of Dynamic Response Characteristics section of this datasheet.
[4] The sensor will continue to respond to current beyond the range of I_{PR} until the high or low output saturation voltage. However, the nonlinearity in this region may be worse than the nominal operating range.
[5] Guaranteed by design.
[6] After I_P goes above $I_{\overline{FAULT}}$, tripping the internal comparator, I_P must fall below $I_{\overline{FAULT}} - I_{HYST}$, before the internal comparator will reset.
[7] Fault error is defined as the value at which a fault is reported relative to the desired threshold for $I_{\overline{FAULT}}$.

ACS732KLATR-20AB PERFORMANCE CHARACTERISTICS: Valid at T_A = –40°C to 125°C, V_{CC} = 5 V, C_{BYPASS} = 0.1 µF, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ. [1]	Max.	Unit
NOMINAL PERFORMANCE						
Current Sensing Range	I_{PR}		–20	–	20	A
Sensitivity	Sens		–	100	–	mV/A
Zero Current Output Voltage	$V_{IOUT(Q)}$		–	0.5 × V_{CC}	–	V
TOTAL OUTPUT ERROR COMPONENTS [2] $E_{TOT} = E_{SENS} + 100 \times V_{OE} / (Sens \times I_P)$						
Total Output Error [3]	E_{TOT}	$I_P = I_{PR(max)}$, T_A = 25°C	–2.5	±1.6	2.5	%
		$I_P = I_{PR(max)}$, T_A = 125°C	–3	±2	3	%
		$I_P = I_{PR(max)}$, T_A = –40°C	–7.5	±4.5	7.5	%
Sensitivity Error	E_{SENS}	$I_P = I_{PR(max)}$, T_A = 25°C	–1.5	±0.75	1.5	%
		$I_P = I_{PR(max)}$, T_A = 125°C	–1.5	±1.25	1.5	%
		$I_P = I_{PR(max)}$, T_A = –40°C	–3	±2	3	%
Offset Voltage Error	V_{OE}	I_P = 0 A, T_A = 25°C	–55	±30	55	mV
		I_P = 0 A, T_A = 125°C	–25	±18	25	mV
		I_P = 0 A, T_A = –40°C	–120	±100	120	mV
LIFETIME DRIFT CHARACTERISTICS [4]						
Total Output Error Including Lifetime Drift	$E_{TOT(DRIFT)}$	$I_P = I_{PR(max)}$, T_A = 25°C to 125°C	–5.5	±2.8	5.5	%
		$I_P = I_{PR(max)}$, T_A = –40°C to 25°C	–10	±4.4	10	%
Sensitivity Error Including Lifetime Drift	$E_{SENS(DRIFT)}$	$I_P = I_{PR(max)}$, T_A = 25°C to 125°C	–2.7	±2.1	2.7	%
		$I_P = I_{PR(max)}$, T_A = –40°C to 25°C	–4	±3.7	4	%
Offset Voltage Error Including Lifetime Drift	$V_{OE(DRIFT)}$	T_A = 25°C to 125°C	–67	±42	67	mV
		T_A = –40°C to 25°C	–120	±93	120	mV

[1] Typical values with ± are mean ±3 sigma values, except for lifetime drift which are the average value including drift after AEC-Q100 qualification.
[2] A single part will not have both the maximum sensitivity error and the maximum offset voltage, as that would violate the maximum/minimum total output error specification. For total error, 3 sigma distribution values for offset and sensitivity may be combined by taking the square root of the sum of the squares. See characteristic performance data plots for temperature drift performance.
[3] Percentage of I_P, with $I_P = I_{PR(MAX)}$.
[4] Lifetime drift characteristics are based on AEC-Q100 qualification results.

ACS732KLATR-40AB PERFORMANCE CHARACTERISTICS: Valid at T_A = –40°C to 125°C, V_{CC}= 5 V, C_{BYPASS} = 0.1 µF, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ. [1]	Max.	Unit
NOMINAL PERFORMANCE						
Current Sensing Range	I_{PR}		–40	–	40	A
Sensitivity	Sens		–	50	–	mV/A
Zero Current Output Voltage	$V_{IOUT(Q)}$		–	0.5 × V_{CC}	–	V
TOTAL OUTPUT ERROR COMPONENTS [2] $E_{TOT} = E_{SENS} + 100 \times V_{OE} / (Sens \times I_P)$						
Total Output Error [3]	E_{TOT}	$I_P = I_{PR(max)}$, T_A = 25°C	–2.5	±1.6	2.5	%
		$I_P = I_{PR(max)}$, T_A = 125°C	–2.5	±1	2.5	%
		$I_P = I_{PR(max)}$, T_A = –40°C	–6.5	±3.4	6.5	%
Sensitivity Error	E_{SENS}	$I_P = I_{PR(max)}$, T_A = 25°C	–2	±1.5	2	%
		$I_P = I_{PR(max)}$, T_A = 125°C	–2	±0.9	2	%
		$I_P = I_{PR(max)}$, T_A = –40°C	–4	±2.7	4	%
Offset Voltage Error	V_{OE}	I_P = 0 A, T_A = 25°C	–45	±27	45	mV
		I_P = 0 A, T_A = 125°C	–25	±8	25	mV
		I_P = 0 A, T_A = –40°C	–95	±58	95	mV
LIFETIME DRIFT CHARACTERISTICS [4]						
Total Output Error Including Lifetime Drift	$E_{TOT(DRIFT)}$	$I_P = I_{PR(max)}$, T_A = 25°C to 125°C	–5.5	±2.8	5.5	%
		$I_P = I_{PR(max)}$, T_A = –40°C to 25°C	–6.5	±4.4	6.5	%
Sensitivity Error Including Lifetime Drift	$E_{SENS(DRIFT)}$	$I_P = I_{PR(max)}$, T_A = 25°C to 125°C	–2.7	±2.1	2.7	%
		$I_P = I_{PR(max)}$, T_A = –40°C to 25°C	–4	±3.7	4	%
Offset Voltage Error Including Lifetime Drift	$V_{OE(DRIFT)}$	T_A = 25°C to 125°C	–67	±42	67	mV
		T_A = –40°C to 25°C	–95	±93	95	mV

[1] Typical values with ± are mean ±3 sigma values, except for lifetime drift which are the average value including drift after AEC-Q100 qualification.
[2] A single part will not have both the maximum sensitivity error and the maximum offset voltage, as that would violate the maximum/minimum total output error specification. For total error, 3 sigma distribution values for offset and sensitivity may be combined by taking the square root of the sum of the squares. See characteristic performance data plots for temperature drift performance.
[3] Percentage of I_P, with $I_P = I_{PR(MAX)}$.
[4] Lifetime drift characteristics are based on AEC-Q100 qualification results.

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ACS733KLATR-20AB PERFORMANCE CHARACTERISTICS: Valid at T_A = –40°C to 125°C, V_{CC}= 3.3 V, C_{BYPASS} = 0.1 µF, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ. [1]	Max.	Unit
NOMINAL PERFORMANCE						
Current Sensing Range	I_{PR}		–20	–	20	A
Sensitivity	Sens		–	66	–	mV/A
Zero Current Output Voltage	$V_{IOUT(Q)}$		–	0.5 × V_{CC}	–	V
TOTAL OUTPUT ERROR COMPONENTS [2] $E_{TOT} = E_{SENS} + 100 \times V_{OE} / (Sens \times I_P)$						
Total Output Error [3]	E_{TOT}	$I_P = I_{PR(max)}$, T_A = 25°C	–4.5	±1.7	4.5	%
		$I_P = I_{PR(max)}$, T_A = 125°C	–3	±1.25	3	%
		$I_P = I_{PR(max)}$, T_A = –40°C	–10	±5	10	%
Sensitivity Error	E_{SENS}	$I_P = I_{PR(max)}$, T_A = 25°C	–1.5	±1	1.5	%
		$I_P = I_{PR(max)}$, T_A = 125°C	–1.5	±0.8	1.5	%
		$I_P = I_{PR(max)}$, T_A = –40°C	–3	±2	3	%
Offset Voltage Error	V_{OE}	I_P = 0 A, T_A = 25°C	–55	±21	55	mV
		I_P = 0 A, T_A = 125°C	–25	±10	25	mV
		I_P = 0 A, T_A = –40°C	–120	±80	120	mV
LIFETIME DRIFT CHARACTERISTICS [4]						
Total Output Error Including Lifetime Drift	$E_{TOT(DRIFT)}$	$I_P = I_{PR(max)}$, T_A = 25°C to 125°C	–5.5	±2.9	5.5	%
		$I_P = I_{PR(max)}$, T_A = –40°C to 25°C	–10	±6	10	%
Sensitivity Error Including Lifetime Drift	$E_{SENS(DRIFT)}$	$I_P = I_{PR(max)}$, T_A = 25°C to 125°C	–2.7	±1.2	2.7	%
		$I_P = I_{PR(max)}$, T_A = –40°C to 25°C	–3	±2.2	3	%
Offset Voltage Error Including Lifetime Drift	$V_{OE(DRIFT)}$	T_A = 25°C to 125°C	–67	±36	67	mV
		T_A = –40°C to 25°C	–120	±115	120	mV

[1] Typical values with ± are mean ±3 sigma values, except for lifetime drift which are the average value including drift after AEC-Q100 qualification.
[2] A single part will not have both the maximum sensitivity error and the maximum offset voltage, as that would violate the maximum/minimum total output error specification. For total error, 3 sigma distribution values for offset and sensitivity may be combined by taking the square root of the sum of the squares. See characteristic performance data plots for temperature drift performance.
[3] Percentage of I_P, with $I_P = I_{PR(MAX)}$.
[4] Lifetime drift characteristics are based on AEC-Q100 qualification results.

ACS733KLATR-40AB PERFORMANCE CHARACTERISTICS: Valid at T_A = –40°C to 125°C, V_{CC} = 3.3 V, C_{BYPASS} = 0.1 µF, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ. [1]	Max.	Unit
NOMINAL PERFORMANCE						
Current Sensing Range	I_{PR}		–40	–	40	A
Sensitivity	Sens		–	33	–	mV/A
Zero Current Output Voltage	$V_{IOUT(Q)}$		–	0.5 × V_{CC}	–	V
TOTAL OUTPUT ERROR COMPONENTS [2] $E_{TOT} = E_{SENS} + 100 \times V_{OE} / (Sens \times I_P)$						
Total Output Error [3]	E_{TOT}	$I_P = I_{PR(max)}$, T_A = 25°C	–3	±1.4	3	%
		$I_P = I_{PR(max)}$, T_A = 125°C	–2	±1.25	2	%
		$I_P = I_{PR(max)}$, T_A = –40°C	–6.5	±3	6.5	%
Sensitivity Error	E_{SENS}	$I_P = I_{PR(max)}$, T_A = 25°C	–1.5	±1.3	1.5	%
		$I_P = I_{PR(max)}$, T_A = 125°C	–2	±1	2	%
		$I_P = I_{PR(max)}$, T_A = –40°C	–4.5	±2.2	4.5	%
Offset Voltage Error	V_{OE}	I_P = 0 A, T_A = 25°C	–40	±9	40	mV
		I_P = 0 A, T_A = 125°C	–40	±7	40	mV
		I_P = 0 A, T_A = –40°C	–75	±35	75	mV
LIFETIME DRIFT CHARACTERISTICS [4]						
Total Output Error Including Lifetime Drift	$E_{TOT(DRIFT)}$	$I_P = I_{PR(max)}$, T_A = 25°C to 125°C	–5.5	±2.6	5.5	%
		$I_P = I_{PR(max)}$, T_A = –40°C to 25°C	–6.5	±4	6.5	%
Sensitivity Error Including Lifetime Drift	$E_{SENS(DRIFT)}$	$I_P = I_{PR(max)}$, T_A = 25°C to 125°C	–2.7	±1.5	2.7	%
		$I_P = I_{PR(max)}$, T_A = –40°C to 25°C	–4.5	±2.4	4.5	%
Offset Voltage Error Including Lifetime Drift	$V_{OE(DRIFT)}$	T_A = 25°C to 125°C	–67	±24	67	mV
		T_A = –40°C to 25°C	–75	±70	75	mV

[1] Typical values with ± are mean ±3 sigma values, except for lifetime drift which are the average value including drift after AEC-Q100 qualification.
[2] A single part will not have both the maximum sensitivity error and the maximum offset voltage, as that would violate the maximum/minimum total output error specification. For total error, 3 sigma distribution values for offset and sensitivity may be combined by taking the square root of the sum of the squares. See characteristic performance data plots for temperature drift performance.
[3] Percentage of I_P, with $I_P = I_{PR(MAX)}$.
[4] Lifetime drift characteristics are based on AEC-Q100 qualification results.

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ACS733KLATR-40AU PERFORMANCE CHARACTERISTICS: Valid at T_A = –40°C to 125°C, V_{CC} = 3.3 V, C_{BYPASS} = 0.1 µF, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ. [1]	Max.	Unit
NOMINAL PERFORMANCE						
Current Sensing Range	I_{PR}		0	–	40	A
Sensitivity	Sens		–	66	–	mV/A
Zero Current Output Voltage	$V_{IOUT(Q)}$		–	0.1 × V_{CC}	–	V
TOTAL OUTPUT ERROR COMPONENTS [2] $E_{TOT} = E_{SENS} + 100 \times V_{OE} / (Sens \times I_P)$						
Total Output Error [3]	E_{TOT}	$I_P = I_{PR(max)}$, T_A = 25°C	–2.5	±1	2.5	%
		$I_P = I_{PR(max)}$, T_A = 125°C	– 2.5	±1	2.5	%
		$I_P = I_{PR(max)}$, T_A = –40°C	–6.5	±3.3	6.5	%
Sensitivity Error	E_{SENS}	$I_P = I_{PR(max)}$, T_A = 25°C	–1.5	±0.9	1.5	%
		$I_P = I_{PR(max)}$, T_A = 125°C	–1.5	±0.9	1.5	%
		$I_P = I_{PR(max)}$, T_A = –40°C	–4	±2.7	4	%
Offset Voltage Error	V_{OE}	I_P = 0 A, T_A = 25°C	–30	±17	30	mV
		I_P = 0 A, T_A = 125°C	–25	±12	25	mV
		I_P = 0 A, T_A = –40°C	–110	±70	110	mV
LIFETIME DRIFT CHARACTERISTICS [4]						
Total Output Error Including Lifetime Drift	$E_{TOT(DRIFT)}$	$I_P = I_{PR(max)}$, T_A = 25°C to 125°C	–5.5	±2.2	5.5	%
		$I_P = I_{PR(max)}$, T_A = –40°C to 25°C	–6.5	±4.3	6.5	%
Sensitivity Error Including Lifetime Drift	$E_{SENS(DRIFT)}$	$I_P = I_{PR(max)}$, T_A = 25°C to 125°C	–2.7	±1.1	2.7	%
		$I_P = I_{PR(max)}$, T_A = –40°C to 25°C	–4	±2.9	4	%
Offset Voltage Error Including Lifetime Drift	$V_{OE(DRIFT)}$	T_A = 25°C to 125°C	–67	±32	67	mV
		T_A = –40°C to 25°C	–110	±105	110	mV

[1] Typical values with ± are mean ±3 sigma values, except for lifetime drift which are the average value including drift after AEC-Q100 qualification.
[2] A single part will not have both the maximum sensitivity error and the maximum offset voltage, as that would violate the maximum/minimum total output error specification. For total error, 3 sigma distribution values for offset and sensitivity may be combined by taking the square root of the sum of the squares. See characteristic performance data plots for temperature drift performance.
[3] Percentage of I_P, with $I_P = I_{PR(MAX)}$.
[4] Lifetime drift characteristics are based on AEC-Q100 qualification results.

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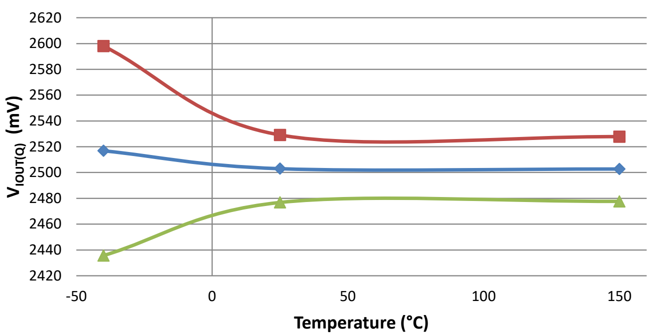
ACS733KLATR-65AB PERFORMANCE CHARACTERISTICS: Valid at T_A = –40°C to 125°C, V_{CC} = 3.3 V, C_{BYPASS} = 0.1 µF, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ. [1]	Max.	Unit
NOMINAL PERFORMANCE						
Current Sensing Range	I_{PR}		–65	–	65	A
Sensitivity	Sens		–	20	–	mV/A
Zero Current Output Voltage	$V_{IOUT(Q)}$		–	0.5 × V_{CC}	–	V
TOTAL OUTPUT ERROR COMPONENTS [2] $E_{TOT} = E_{SENS} + 100 \times V_{OE} / (Sens \times I_P)$						
Total Output Error [3]	E_{TOT}	$I_P = I_{PR(max)}$, T_A = 25°C	–3.5	±1.8	3.5	%
		$I_P = I_{PR(max)}$, T_A = 125°C	–3	±1.4	3	%
		$I_P = I_{PR(max)}$, T_A = –40°C	–6	±4	6	%
Sensitivity Error	E_{SENS}	$I_P = I_{PR(max)}$, T_A = 25°C	–2.5	±1.6	2.5	%
		$I_P = I_{PR(max)}$, T_A = 125°C	–2.5	±1.6	2.5	%
		$I_P = I_{PR(max)}$, T_A = –40°C	–4.5	±3.1	4.5	%
Offset Voltage Error	V_{OE}	I_P = 0 A, T_A = 25°C	–30	±17	30	mV
		I_P = 0 A, T_A = 125°C	–25	±7	25	mV
		I_P = 0 A, T_A = –40°C	–70	±31	70	mV
LIFETIME DRIFT CHARACTERISTICS [4]						
Total Output Error Including Lifetime Drift	$E_{TOT(DRIFT)}$	$I_P = I_{PR(max)}$, T_A = 25°C to 125°C	–5.5	±3	5.5	%
		$I_P = I_{PR(max)}$, T_A = –40°C to 25°C	–6	±5	6	%
Sensitivity Error Including Lifetime Drift	$E_{SENS(DRIFT)}$	$I_P = I_{PR(max)}$, T_A = 25°C to 125°C	–2.7	±1.8	2.7	%
		$I_P = I_{PR(max)}$, T_A = –40°C to 25°C	–4.5	±3.3	4.5	%
Offset Voltage Error Including Lifetime Drift	$V_{OE(DRIFT)}$	T_A = 25°C to 125°C	–67	±32	67	mV
		T_A = –40°C to 25°C	–70	±66	70	mV

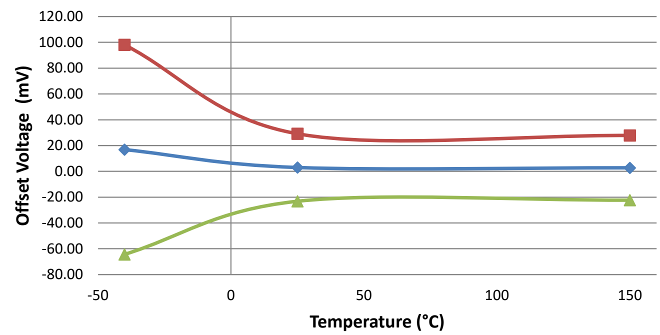
[1] Typical values with ± are mean ±3 sigma values, except for lifetime drift which are the average value including drift after AEC-Q100 qualification.
[2] A single part will not have both the maximum sensitivity error and the maximum offset voltage, as that would violate the maximum/minimum total output error specification. For total error, 3 sigma distribution values for offset and sensitivity may be combined by taking the square root of the sum of the squares. See characteristic performance data plots for temperature drift performance.
[3] Percentage of I_P, with $I_P = I_{PR(MAX)}$.
[4] Lifetime drift characteristics are based on AEC-Q100 qualification results.

CHARACTERISTIC PERFORMANCE
ACS732-KLATR-20AB

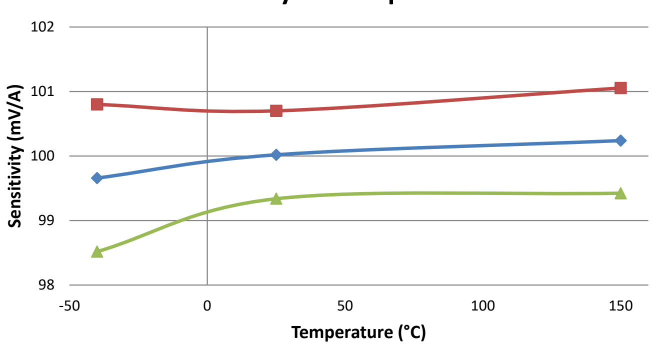
Zero Current Output Voltage vs. Temperature



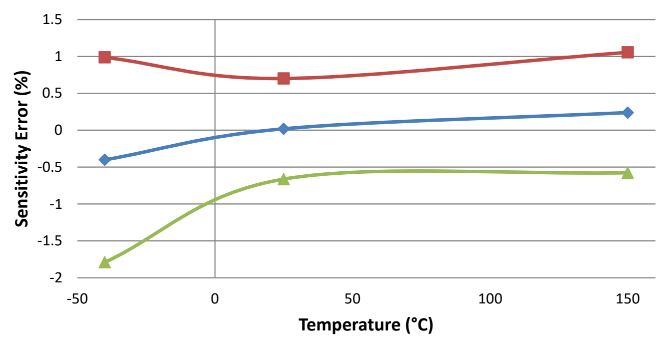
Offset Voltage vs. Temperature



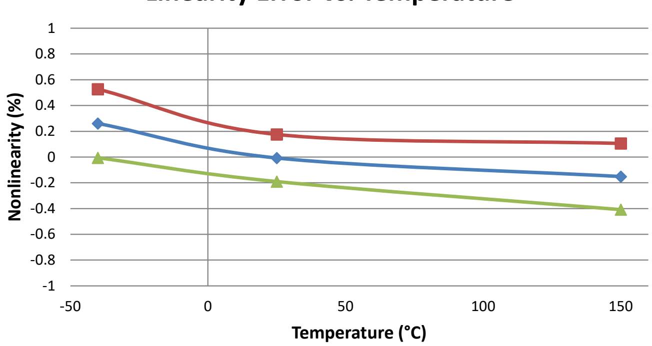
Sensitivity vs. Temperature



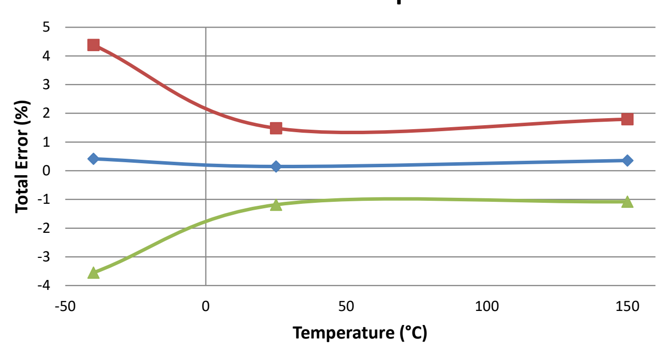
Sensitivity Error vs. Temperature



Linearity Error vs. Temperature



Total Error vs. Temperature



Average +3 Sigma -3 Sigma

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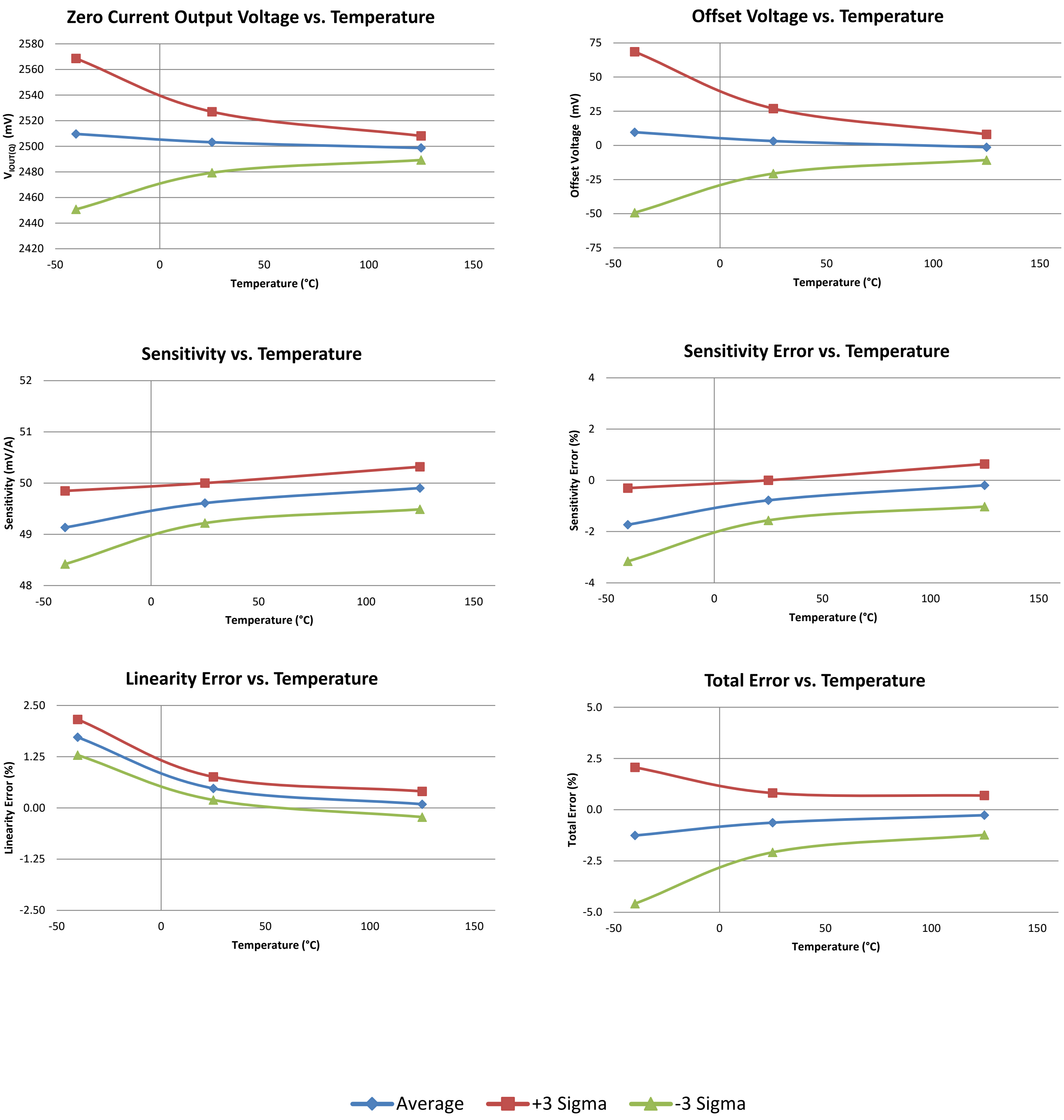
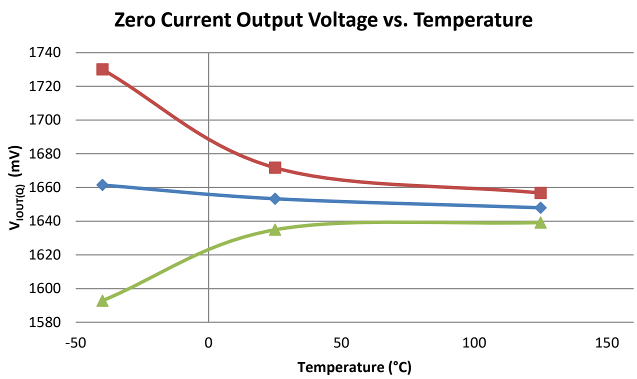
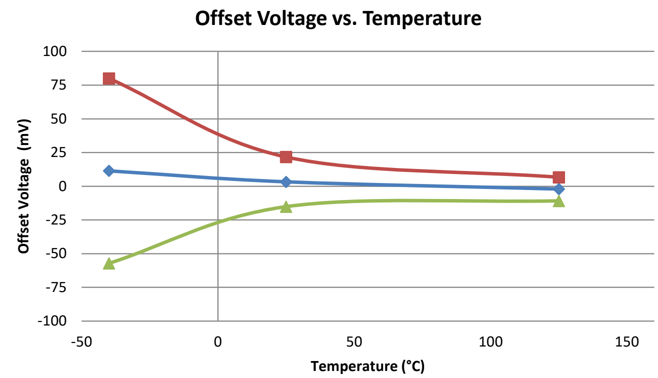
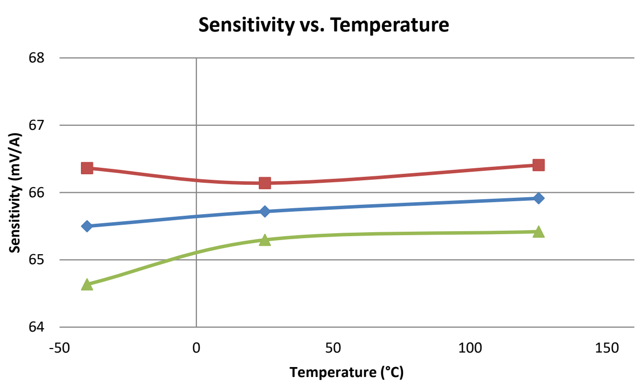
CHARACTERISTIC PERFORMANCE
ACS732-KLATR-40AB

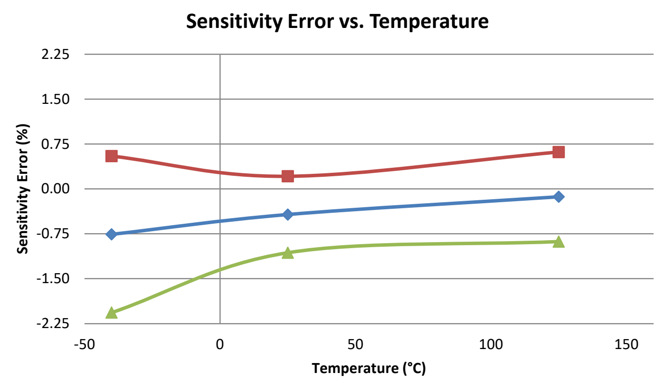


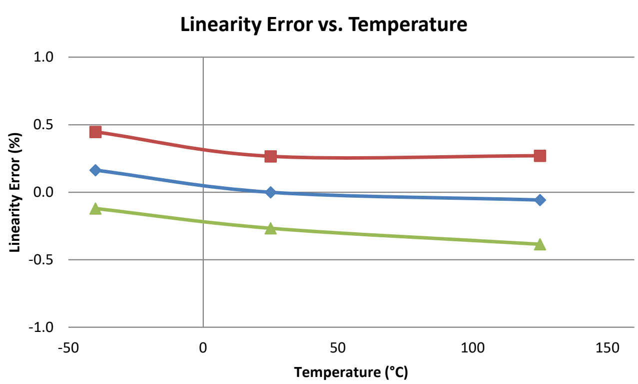
CHARACTERISTIC PERFORMANCE
ACS733-KLATR-20AB

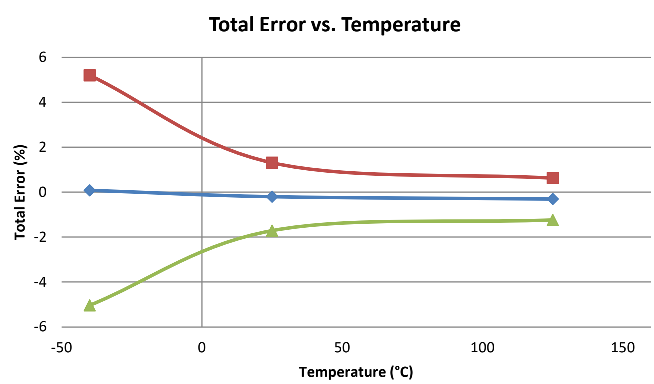






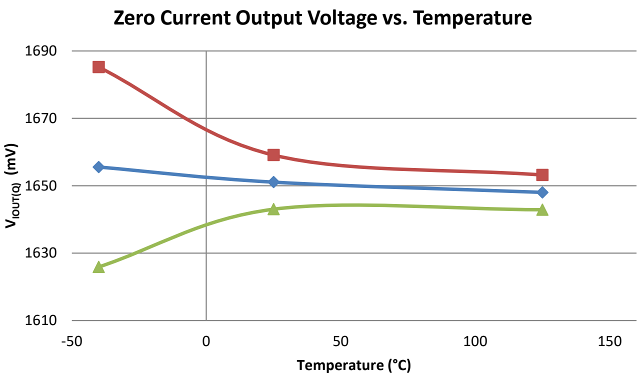


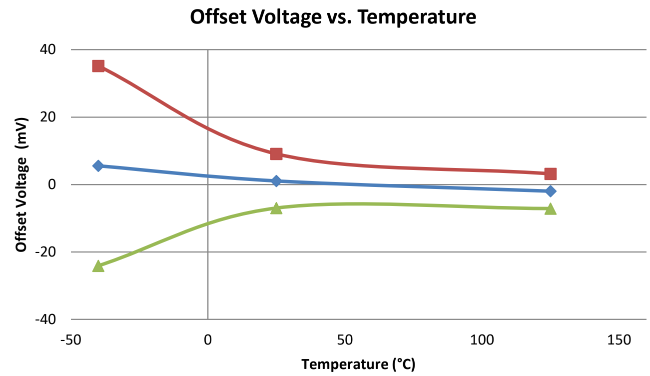


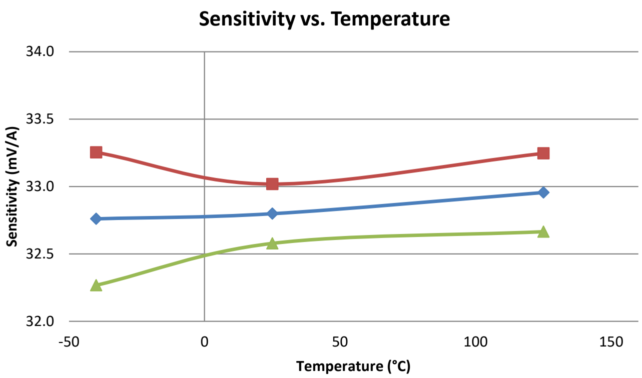


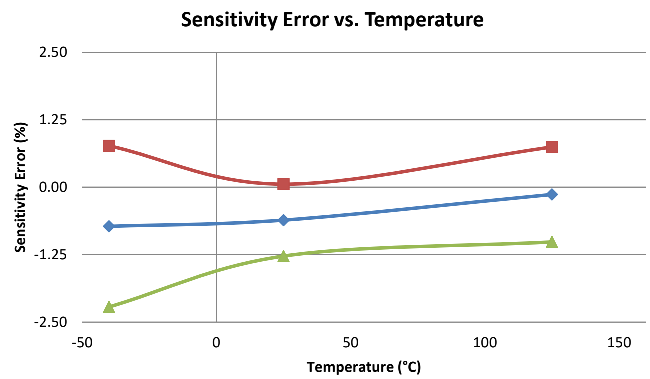
Average +3 Sigma -3 Sigma

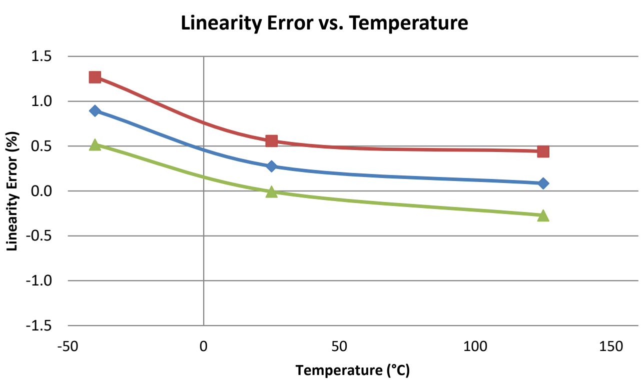
CHARACTERISTIC PERFORMANCE
ACS733-KLATR-40AB

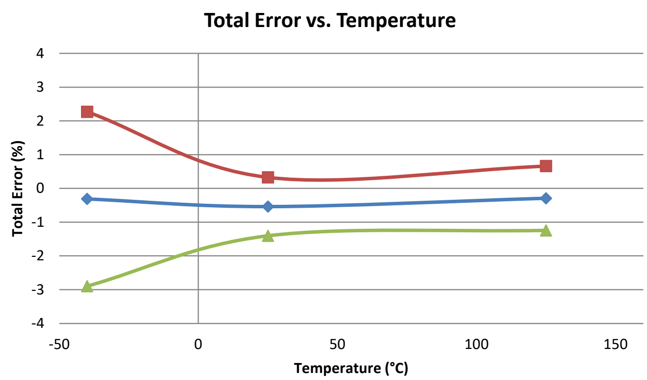












Average +3 Sigma -3 Sigma

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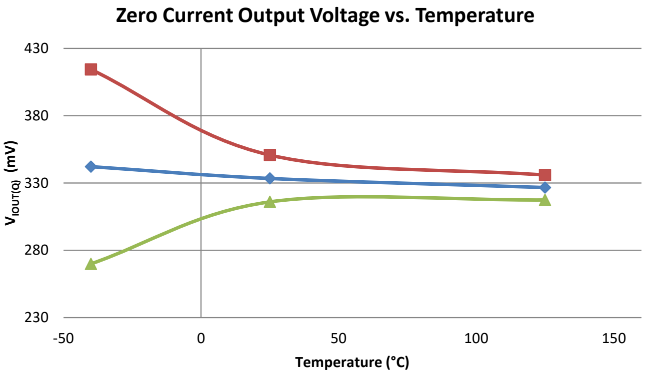
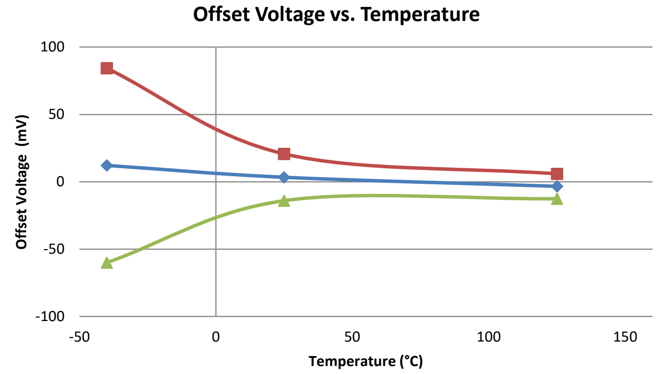
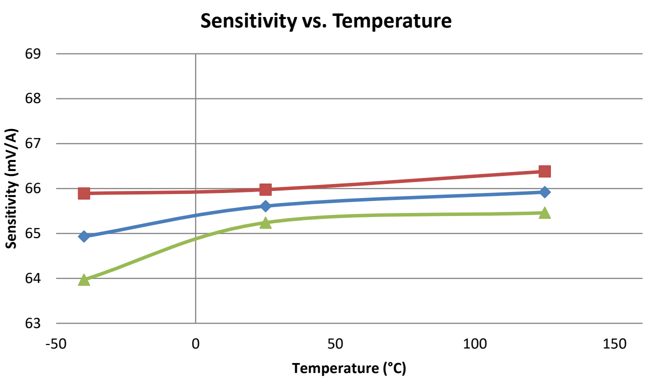
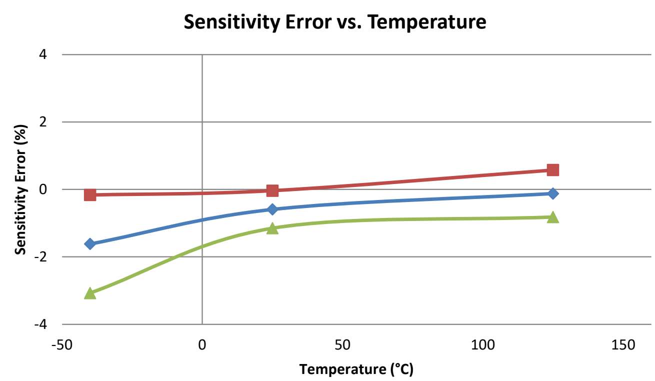
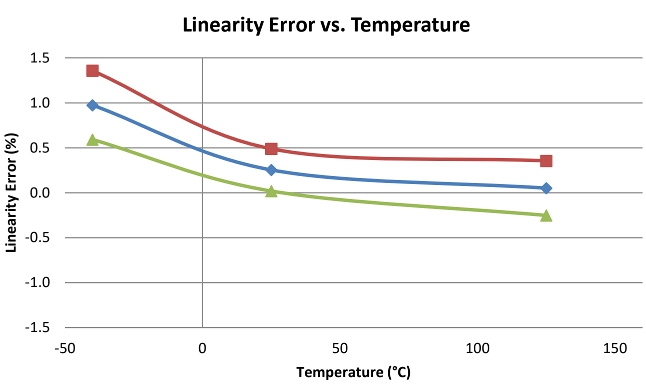
CHARACTERISTIC PERFORMANCE
ACS733-KLATR-40AU

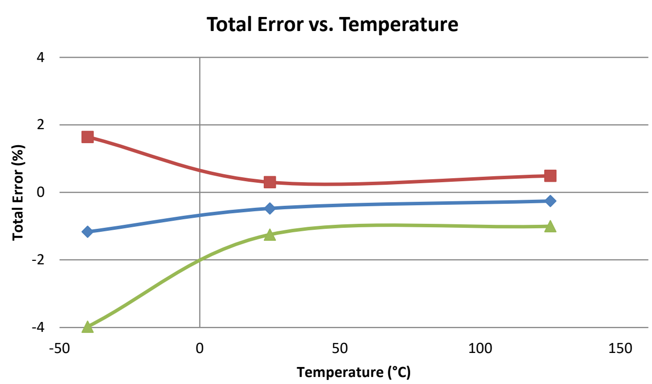












Average +3 Sigma -3 Sigma

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CHARACTERISTIC PERFORMANCE
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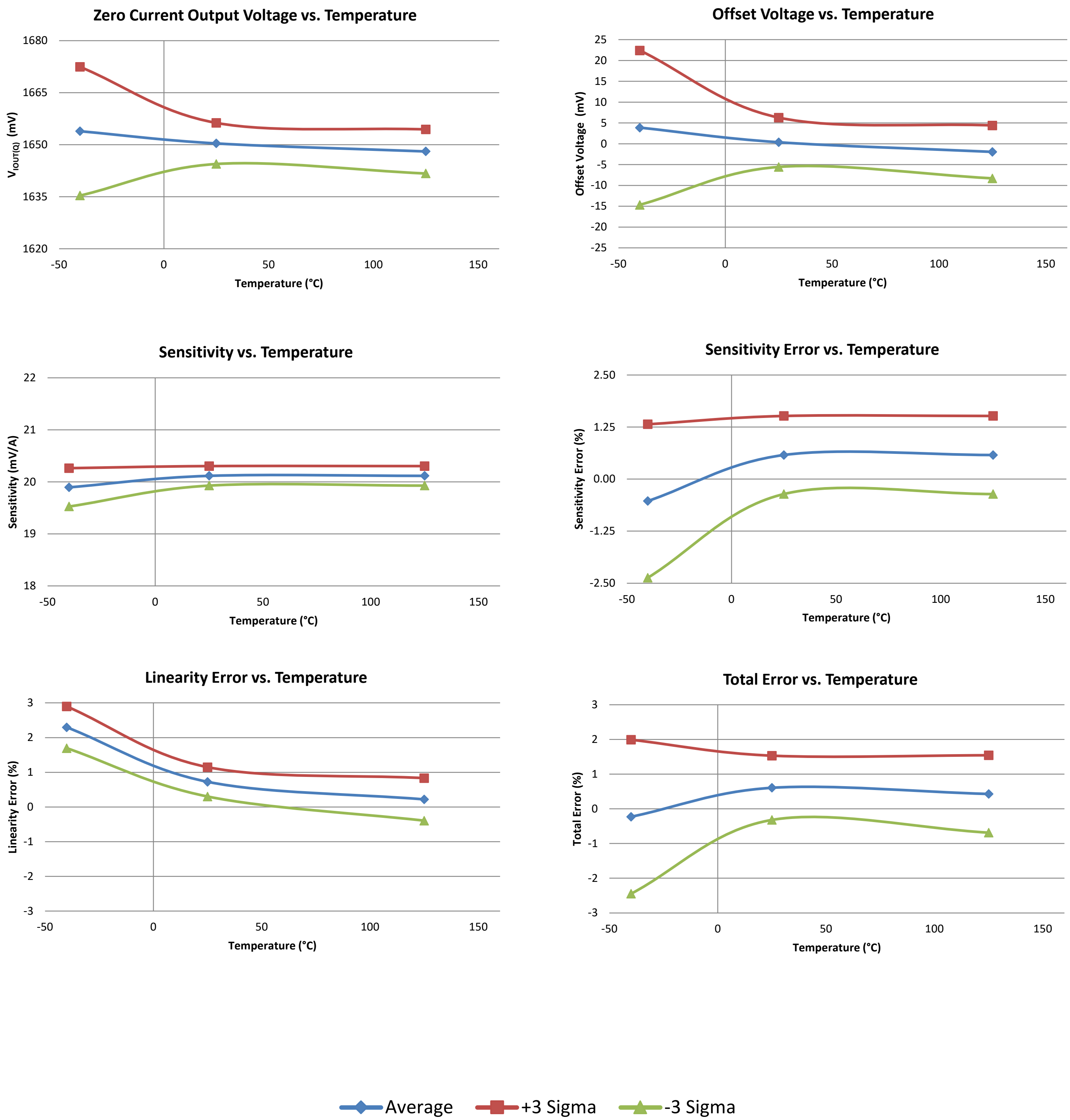
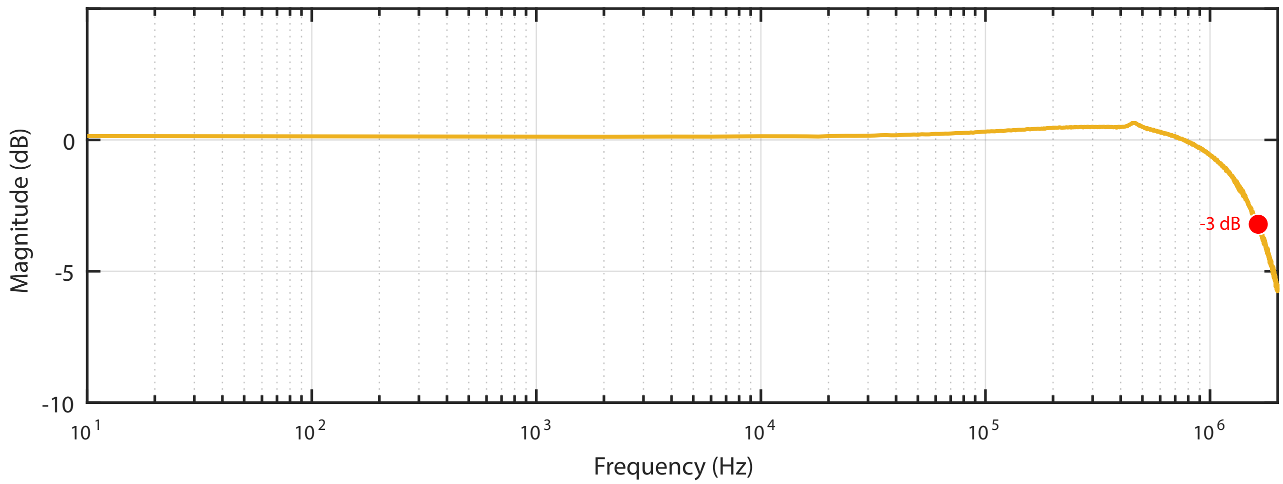
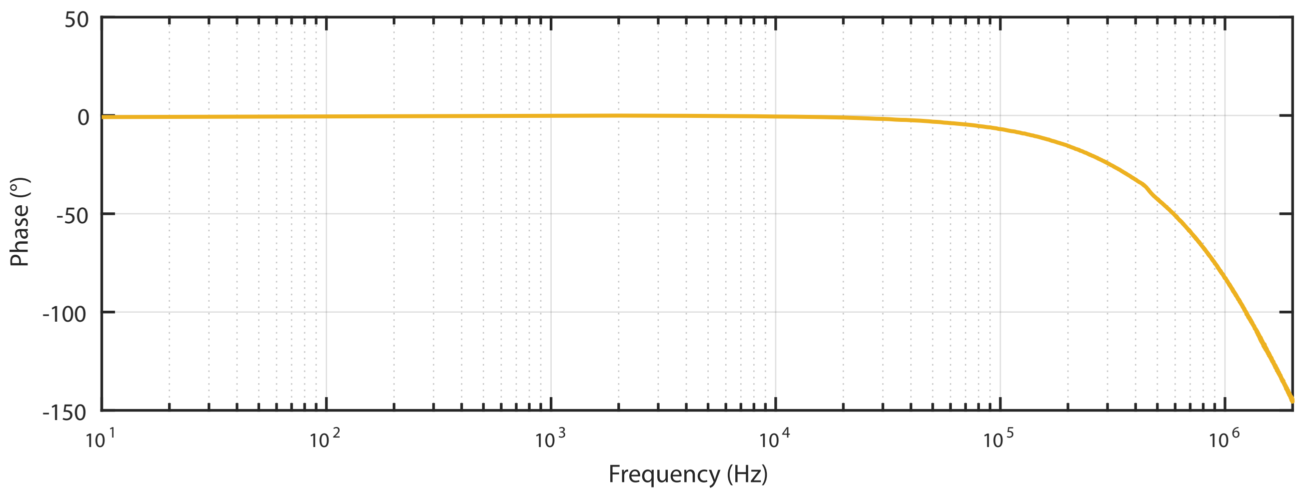


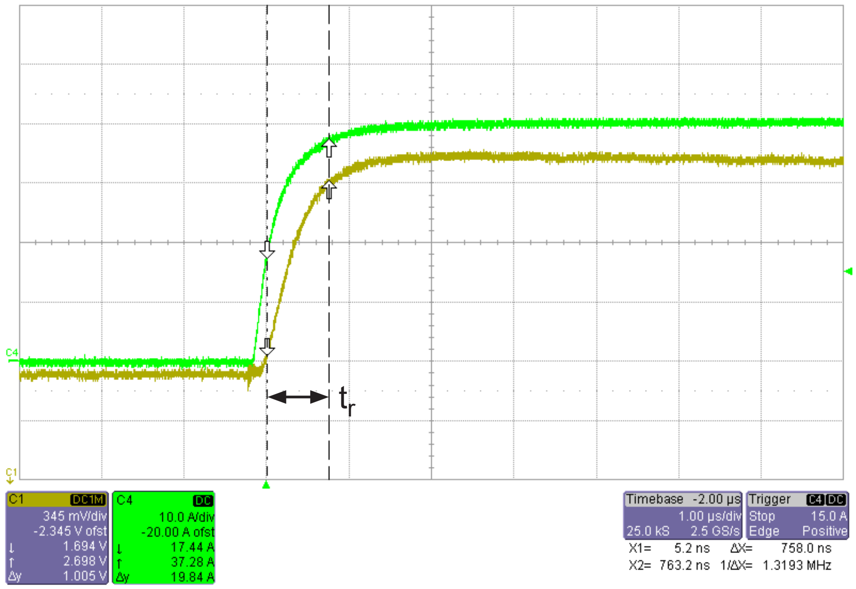
CHARACTERISTIC PERFORMANCE
ACS732 AND ACS733 TYPICAL FREQUENCY RESPONSE





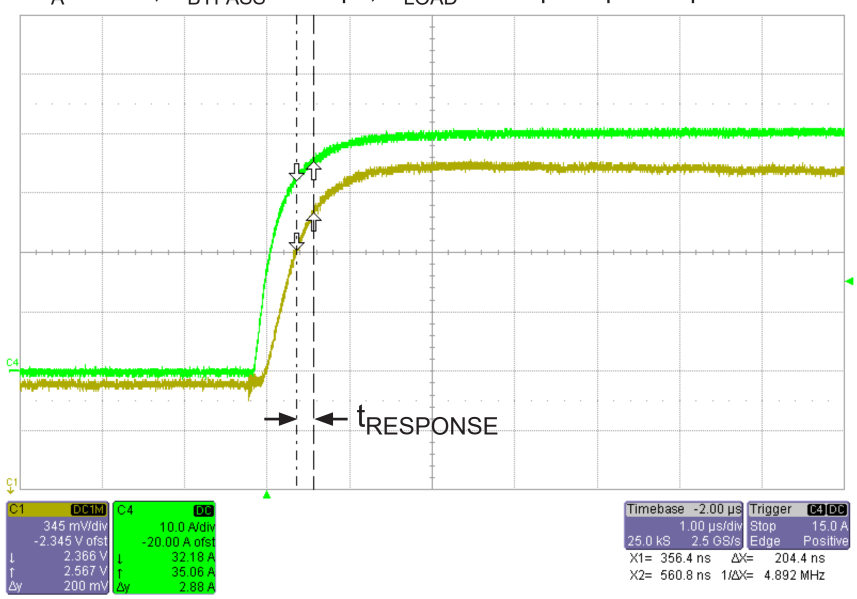
CHARACTERISTIC PERFORMANCE: ACS733 (3.3 V), Rise Time

Test Conditions: T_A = 25°C, C_{BYPASS} = 0.1 µF, C_{LOAD} = 220 pF. Input Step = 40 A with 1 µs rise time.



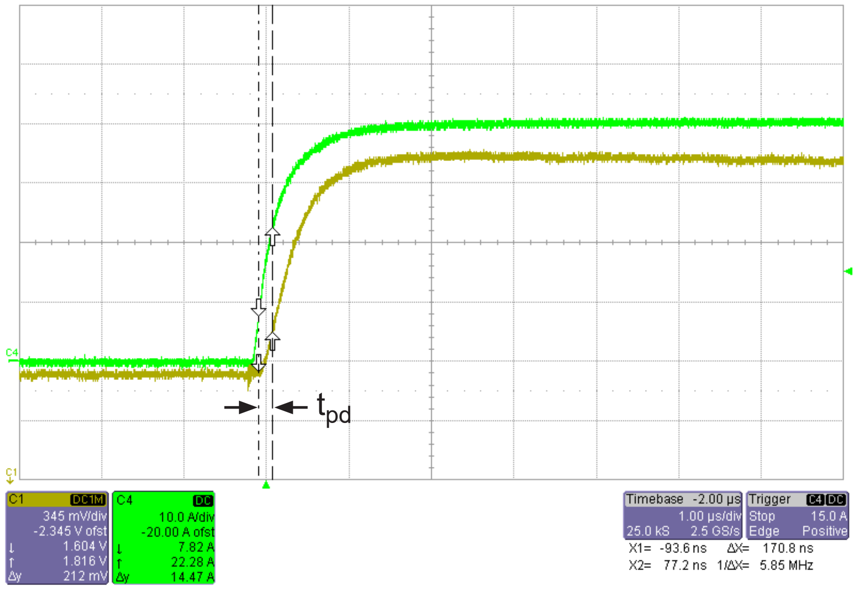
Response Time

Test Conditions: T_A = 25°C, C_{BYPASS} = 0.1 µF, C_{LOAD} = 220 pF. Input Step = 40 A with 1 µs rise time.



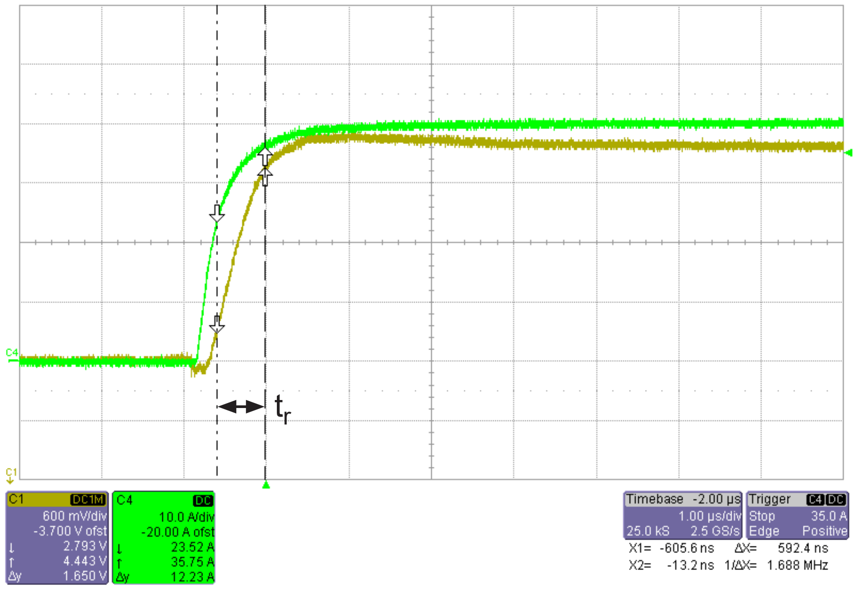
Propagation Delay Time

Test Conditions: T_A = 25°C, C_{BYPASS} = 0.1 µF, C_{LOAD} = 220 pF. Input Step = 40 A with 1 µs rise time.



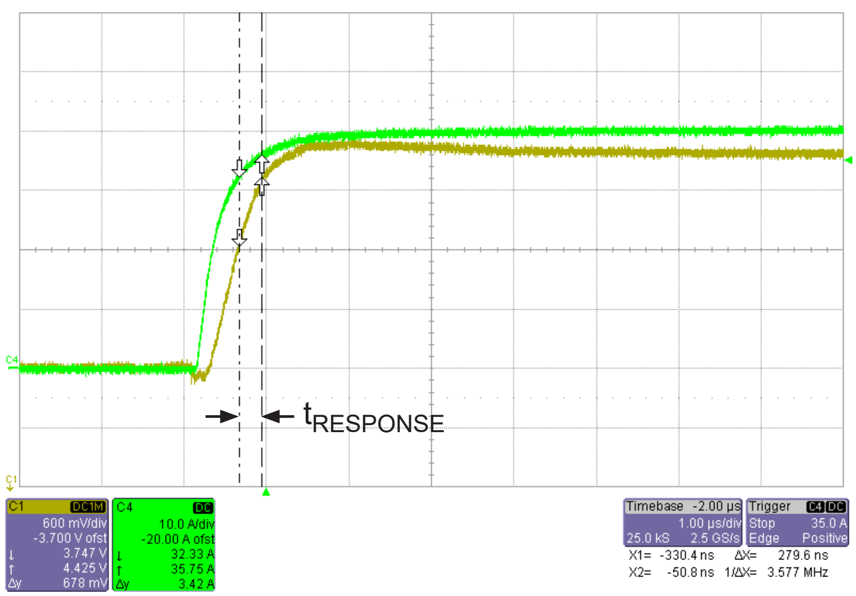
CHARACTERISTIC PERFORMANCE: ACS732 (5 V), Rise Time

Test Conditions: T_A = 25°C, C_{BYPASS} = 0.1 µF, C_{LOAD} = 220 pF. Input Step = 40 A with 1 µs rise time.



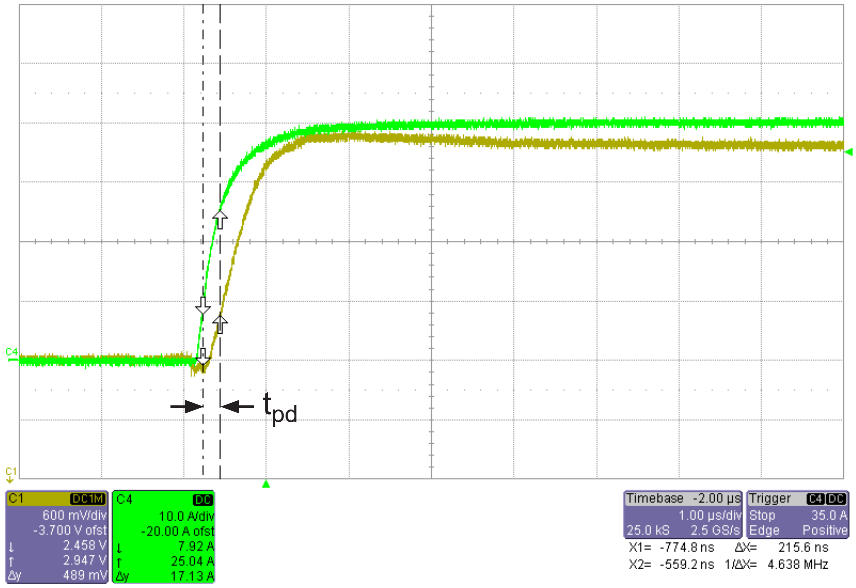
Response Time

Test Conditions: T_A = 25°C, C_{BYPASS} = 0.1 µF, C_{LOAD} = 220 pF. Input Step = 40 A with 1 µs rise time.



Propagation Delay Time

Test Conditions: T_A = 25°C, C_{BYPASS} = 0.1 µF, C_{LOAD} = 220 pF. Input Step = 40 A with 1 µs rise time.



OVERCURRENT FAULT

Overcurrent Fault

The ACS732 and ACS733 have fast and accurate overcurrent fault detection circuitry. The overcurrent fault threshold ($I_{\overline{FAULT}}$) is user-configurable via an external resistor divider and supports a range of 50% to 200% of the full-scale primary input ($I_{PR(MAX)}$). Fault response and the overcurrent fault thresholds are described in the following sections.

Fault Response

The high bandwidth of the ACS732 and ACS733 devices allow for extremely fast and accurate overcurrent fault detection. An overcurrent event occurs when the magnitude of the input current (I_P) exceeds the user-set threshold ($I_{\overline{FAULT}}$). Fault response time ($t_{RESPONSE(F)}$) is defined from the time I_P goes above $I_{\overline{FAULT}}$ to the time the $\overline{FAULT}$ pin goes below $V_{\overline{FAULT}}$. Overcurrent fault response is illustrated in Figure 3. When I_P goes below $I_{\overline{FAULT}} – I_{HYST}$, the $\overline{FAULT}$ pin will be released. The rise time of $V_{\overline{FAULT}}$ will depend on the value of the resistor $R_{F(PULLUP)}$ and the capacitance on the pin.

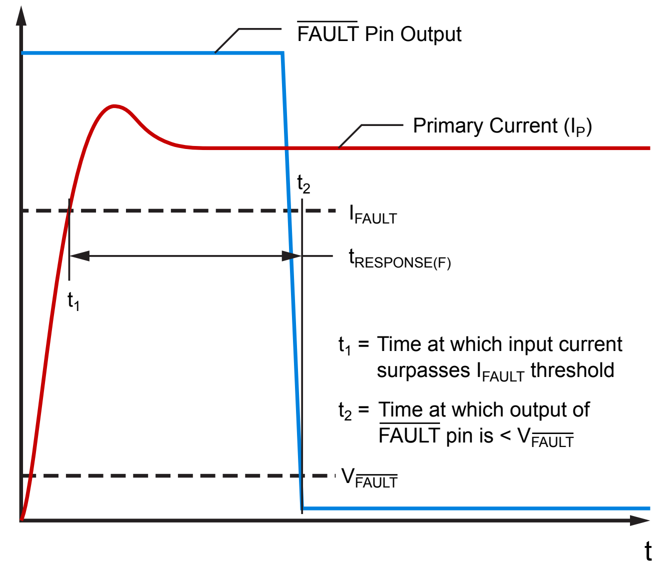


Figure 3: Overcurrent Fault Response

Setting the Overcurrent Fault Threshold

The overcurrent fault threshold (I_{FAULT}) is set via a resistor divider from V_{CC} to ground on the VOC pin. The voltage on the VOC pin, V_{VOC}, may range from 0.1 × V_{CC} to 0.4 × V_{CC}. I_{FAULT} may be set anywhere from 50% to 200% $I_{PR(MAX)}$.

Overcurrent fault threshold versus V_{VOC} is shown in Figure 4.

The equation for calculating the trip current is shown below. For bidirectional devices, the fault will trip 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 over current 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_{CC}, the ratio of V_{VOC} / V_{CC} will remain constant with changes to V_{CC}. In this regard, the fault trip point will remain constant even as the supply voltage varies.

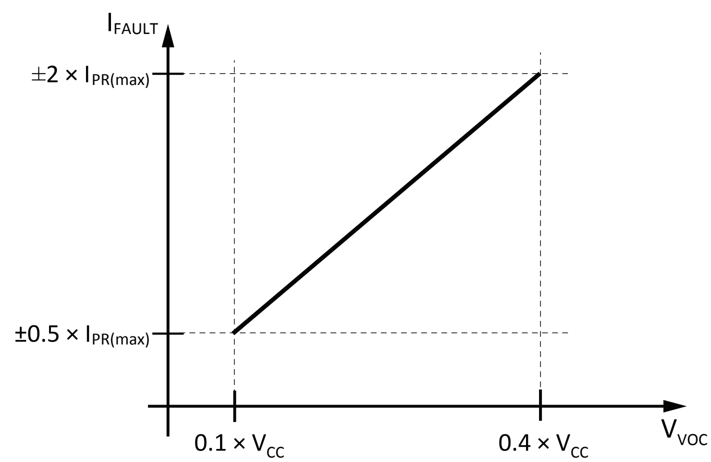


Figure 4: Fault Threshold vs. V_{VOC}

It is best practice to use resistor values < 10 kΩ for setting V_{VOC}. With larger resistor values, the leakage current on VOC may result in errors in the trip point.

DEFINITIONS OF DYNAMIC RESPONSE CHARACTERISTICS

Power-On Delay Time (t_{POD})

When the supply is ramped to its operating voltage, the device requires a finite amount of time to power its internal components before responding to an input magnetic field. Power-On Delay Time (t_{POD}) is defined as the time interval between a) the power supply has reached its minimum specified operating voltage ($V_{CC(MIN)}$), and b) when the sensor output has settled within ±10% of its steady-state value under an applied magnetic field. Power-On Delay Time is illustrated in Figure 5.

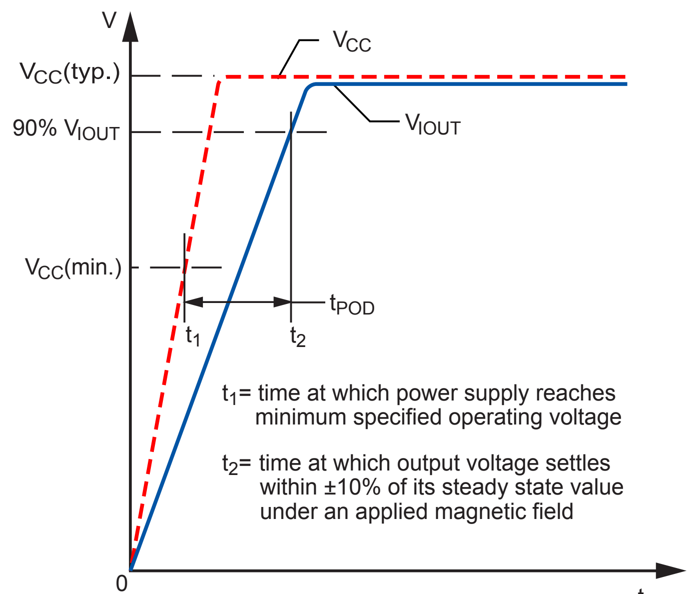


Figure 5: Power-On Delay Time (t_{POD})

Rise Time (t_r)

The time interval between a) when the sensor reaches 10% of its full-scale value, and b) when it reaches 90% of its full-scale 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 reaches 20% of its full-scale value.

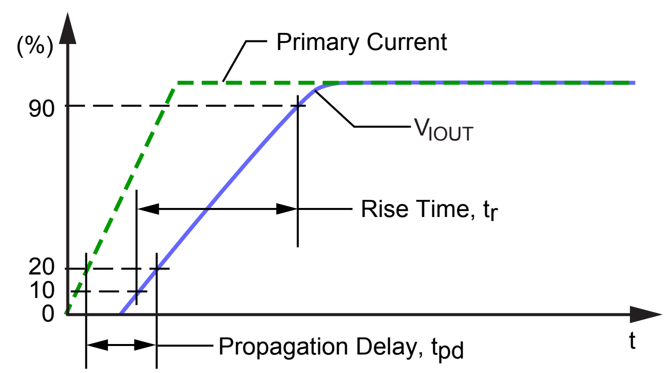


Figure 6: Rise Time (t_r) and Propagation Delay (t_{pd})

Response Time ($t_{RESPONSE}$)

The time interval between a) when the sensed input current reaches 80% of its final value, and b) when the sensor output reaches 80% of its full-scale value.

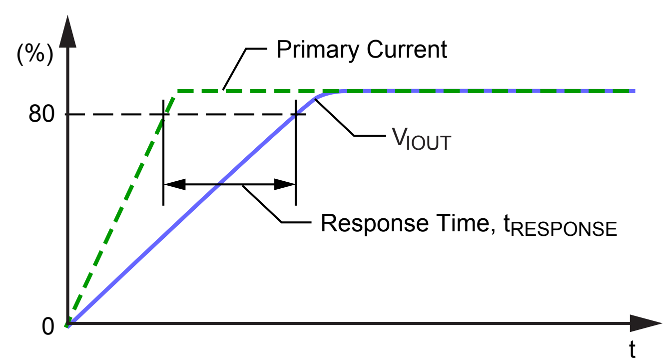


Figure 7: Response Time ($t_{RESPONSE}$)

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