ACS773

High Accuracy, Hall-Effect-Based, 200 kHz Bandwidth, Galvanically Isolated Current Sensor IC with 100 µΩ Current Conductor

FEATURES AND BENEFITS

- AEC-Q100 Grade 1 qualified
- Typical of 2.5 µs output response time
- 3.3 V supply operation
- Ultra-low power loss: 100 µΩ internal conductor resistance
- Reinforced galvanic isolation allows use in economical, high-side current sensing in high-voltage systems
- 4800 Vrms dielectric strength certified under UL60950-1
- Industry-leading noise performance with greatly improved bandwidth through proprietary amplifier and filter design techniques
- Integrated shield greatly reduces capacitive coupling from current conductor to die due to high dV/dt signals, and prevents offset drift in high-side, high-voltage applications
- Greatly improved total output error through digitally programmed and compensated gain and offset over the full operating temperature range
- Small package size, with easy mounting capability
- Monolithic Hall IC for high reliability
- Output voltage proportional to AC or DC currents
- Factory-trimmed for accuracy
- Extremely stable output offset voltage

CB Certificate Number:
US-29755-UL

DESCRIPTION

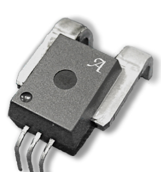
The Allegro™ ACS773 family of current sensor ICs provide economical and precise solutions for AC or DC current sensing, ideal for motor control, load detection and management, power supply and DC-to-DC converter control, and inverter control. The 2.5 µs response time enables overcurrent fault detection in safety-critical applications.

The device consists of a precision, low-offset linear Hall circuit with a copper conduction path located near the die. Applied current flowing through this copper conduction path generates a magnetic field which the Hall IC converts into a proportional voltage. Device accuracy is optimized through the close proximity of the magnetic signal to the Hall transducer. A precise, proportional output voltage is provided by the low-offset, chopper-stabilized BiCMOS Hall IC, which is programmed for accuracy at the factory. Proprietary digital temperature compensation technology greatly improves the IC accuracy and temperature stability.

High-level immunity to current conductor dV/dt and stray electric fields is offered by Allegro proprietary integrated shield technology for low output voltage ripple and low offset drift in high-side, high-voltage applications.

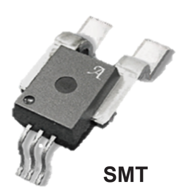
Continued on the next page…

PACKAGE: 5-pin package (suffix CB)



PFF Leadform

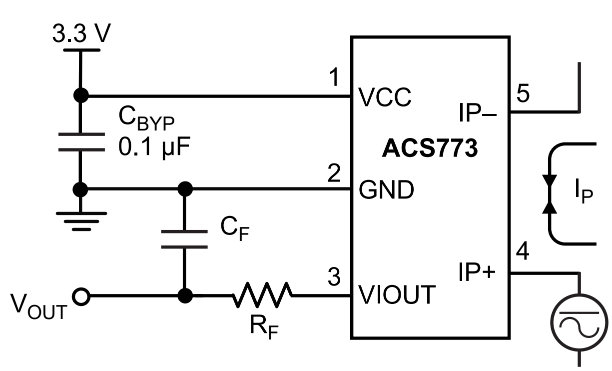
PSF Leadform



SMT Leadform

Not to scale

Application 1: the ACS773 outputs an analog signal, V_{OUT}, that varies linearly with the bidirectional AC or DC primary sensed current, I_P, within the range specified. R_F and C_F are for optimal noise management, with values that depend on the application.



Typical Application

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DESCRIPTION (continued)

The output of the device increases when an increasing current flows through the primary copper conduction path (from terminal 4 to terminal 5), which is the path used for current sampling. The internal resistance of this conductive path is 100 µΩ typical, providing low power loss.

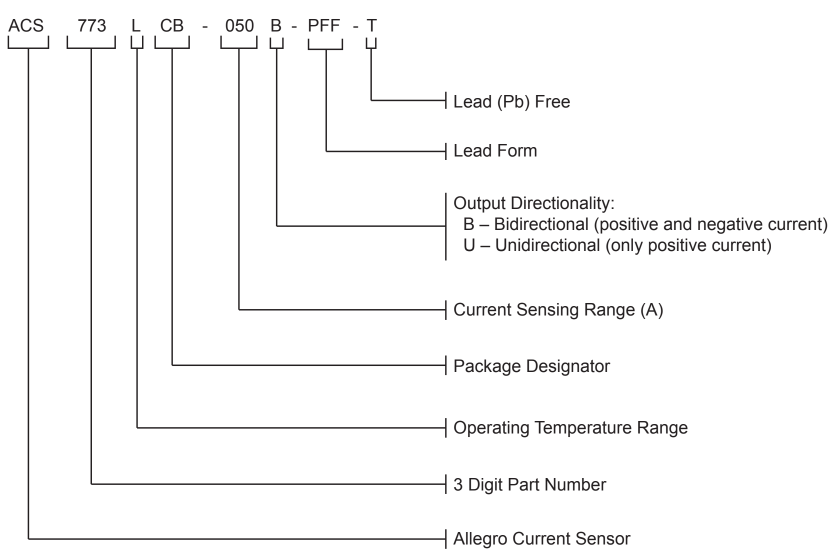
The thickness of the copper conductor allows survival of the device at high overcurrent conditions. The terminals of the conductive path are electrically isolated from the signal leads (pins 1 through 3). This allows the ACS773 family of sensor ICs to be used in applications requiring electrical isolation without the use of opto-isolators or other costly isolation techniques.

The device is fully calibrated prior to shipment from the factory. The ACS773 family is lead (Pb) free. All leads are plated with 100% matte tin, and there is no Pb inside the package. The heavy gauge leadframe is made of oxygen-free copper.

SELECTION GUIDE

Part Number [1]	Package		Primary Sampled Current , I_P (A)	Sensitivity Sens (Typ.) (mV/A) [2]	Nominal T_A [3] (°C)	Packing [4]
	Terminals	Signal Pins				
ACS773LCB-050B-PFF-T	Formed	Formed	±50	26.4	–40 to 150	34 pieces per tube
ACS773LCB-050B-SMT-T	Formed	Formed				
ACS773LCB-100B-PFF-T	Formed	Formed	±100	13.2		
ACS773LCB-100B-SMT-T	Formed	Formed				
ACS773KCB-150B-PFF-T	Formed	Formed	±150	8.8	–40 to 125	
ACS773KCB-150B-SMT-T	Formed	Formed				
ACS773ECB-200B-PFF-T	Formed	Formed	±200	6.6	–40 to 85	
ACS773ECB-200B-PSF-T	Straight	Formed				
ACS773ECB-250U-PSF-T	Straight	Formed	250	10.56		

[1] Additional leadform options available for qualified volumes.
[2] Measured at V_{CC} = 3.3 V.
[3] All ACS773 devices are production tested and guaranteed to T_A = 150°C, provided the Maximum Junction Temperature, $T_{J(MAX)}$, is not exceeded. See Absolute Maximum Ratings and Thermal Application section of this datasheet for more information.
[4] Contact Allegro for additional packing options.



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ABSOLUTE MAXIMUM RATINGS

Characteristic	Symbol	Notes	Rating	Unit
Supply Voltage	V_{CC}		6.5	V
Reverse Supply Voltage	V_{RCC}		–0.5	V
Output Voltage	V_{IOUT}		6.5	V
Reverse Output Voltage	V_{RIOUT}		–0.5	V
Output Source Current	$I_{OUT(Source)}$	VIOUT to GND	3	mA
Output Sink Current	$I_{OUT(Sink)}$	Minimum pull-up resistor of 500 Ω from VCC to VIOUT	10	mA
Maximum Continuous Current	I_{CMAX}	T_A = 25°C	250	A
Operating Ambient Temperature [1]	T_A	Range E, K, and L	–40 to 150	°C
Maximum Junction Temperature	$T_{J(max)}$		165	°C
Storage Temperature	T_{stg}		–65 to 165	°C

[1] All ACS773 devices are production tested and guaranteed to T_A = 150°C, provided the Maximum Junction Temperature, $T_{J(MAX)}$, is not exceeded. See Thermal Application section of this datasheet for more information.

ESD RATINGS

Characteristic	Symbol	Test Conditions	Value	Unit
Human Body Model	V_{HBM}	Per AEC-Q100	±6	kV
Charged Device Model	V_{CDM}	Per AEC-Q100	±1	kV

ISOLATION CHARACTERISTICS

Characteristic	Symbol	Notes	Rating	Unit
Dielectric Surge Strength Test Voltage	V_{SURGE}	Tested ±5 pulses at 2/minute in compliance to IEC 61000-4-5 1.2 µs (rise) / 50 µs (width)	8000	V
Dielectric Strength Test Voltage [2]	V_{ISO}	Agency type-tested for 60 seconds per UL standard 60950-1, 2nd Edition. Tested at 3000 V_{RMS} for 1 second in production.	4800	V_{RMS}
Working Voltage for Basic Isolation	V_{WVBI}	For basic (single) isolation per UL standard 60950-1, 2nd Edition	1358	V_{PK} or V_{DC}
			960	V_{RMS}
Working Voltage for Reinforced Isolation	V_{WFRI}	For reinforced (double) isolation per UL standard 60950-1, 2nd Edition	672	V_{PK} or V_{DC}
			475	V_{RMS}

[2] Allegro does not conduct 60-second testing. It is done only during the UL certification process.

TYPICAL OVERCURRENT CAPABILITIES [4][5]

Characteristic	Symbol	Notes	Rating	Unit
Overcurrent	I_{POC}	T_A = 25°C, current is on for 1 second and off for 99 seconds, 100 pulses applied	1200	A
		T_A = 85°C, current is on for 1 second and off for 99 seconds, 100 pulses applied	900	A
		T_A = 150°C, current is on for 1 second and off for 99 seconds, 100 pulses applied	600	A

[4] Test was done with Allegro evaluation board. The maximum allowed current is limited by $T_{J(max)}$ only.
[5] For more overcurrent profiles, please see FAQ on the Allegro website, www.allegromicro.com.

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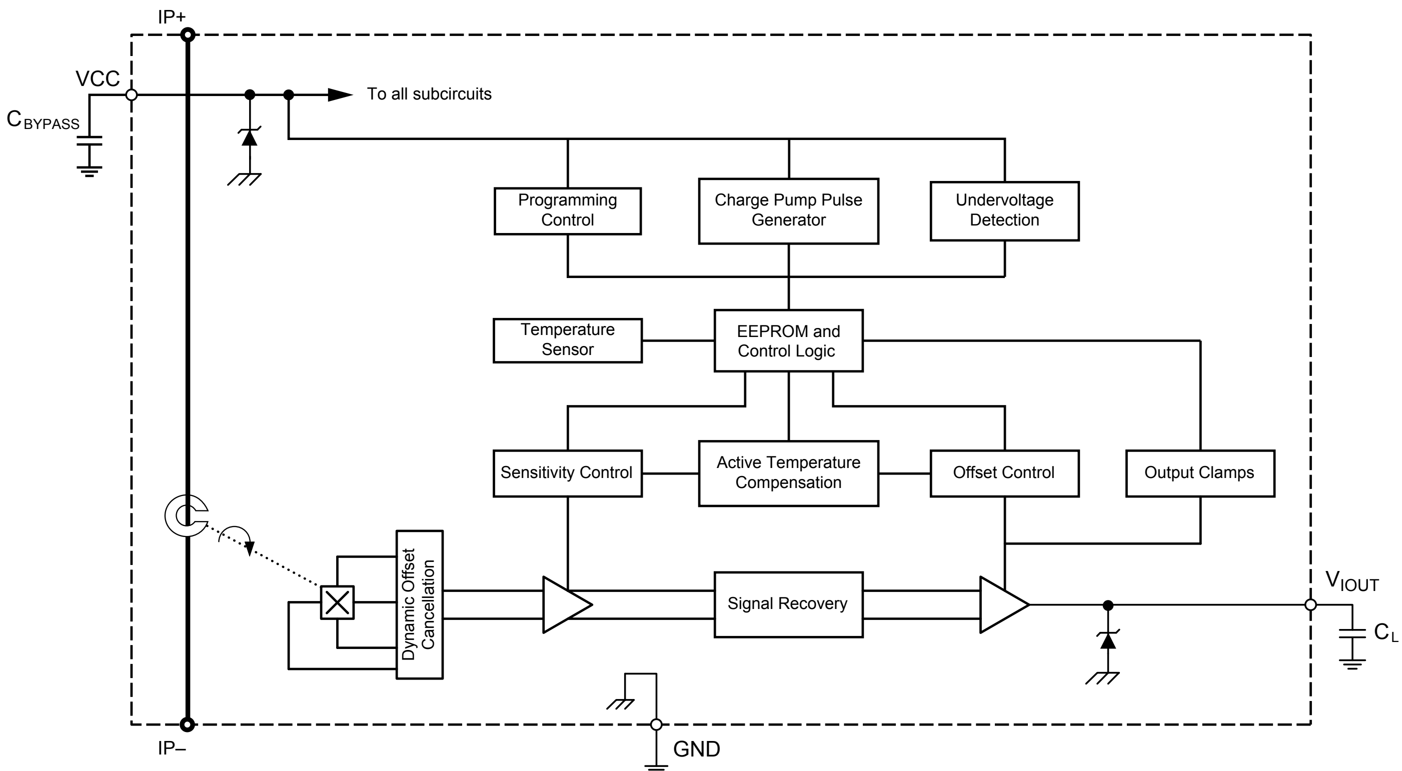
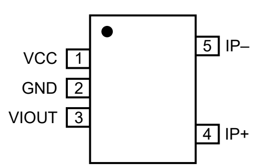


Functional Block Diagram

THERMAL CHARACTERISTICS: May require derating at maximum conditions

Characteristic	Symbol	Test Conditions [3]	Value	Unit
Package Thermal Resistance	$R_{\theta JA}$	Mounted on the Allegro evaluation board with 2800 mm^2 (1400 mm^2 on component side and 1400 mm^2 on opposite side) of 4 oz. copper connected to the primary leadframe and with thermal vias connecting the copper layers. Performance is based on current flowing through the primary leadframe and includes the power consumed by the PCB.	7	°C/W

[3] Additional thermal information available on the Allegro website



Pinout Diagram

Terminal List Table

Number	Name	Description
1	VCC	Device power supply terminal
2	GND	Signal ground terminal
3	VIOUT	Analog output signal
4	IP+	Terminal for current being sampled
5	IP–	Terminal for current being sampled

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COMMON OPERATING CHARACTERISTICS: Valid at T_A = –40°C to 150°C, C_{BYP} = 0.1 µF, and V_{CC} = 3.3 V, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
ELECTRICAL CHARACTERISTICS						
Supply Voltage	V_{CC}		3	3.3	3.6	V
Supply Current	I_{CC}	V_{CC} ≤ 5 V, no load on output	–	10	15	mA
Power-On Delay	t_{POD}	T_A = 25°C	–	64	–	µs
Power-On Reset Voltage	V_{PORH}	V_{CC} rising at 1 V/ms	–	2.9	–	V
	V_{PORL}	V_{CC} falling at 1 V/ms	–	2.5	–	V
POR Hysteresis	$V_{HYS(POR)}$		250	–	–	mV
Rise Time	t_r	T_A = 25°C, C_L = 0.47 nF	–	2.4	–	µs
Propagation Delay Time	t_{PROP}	T_A = 25°C, C_L = 0.47 nF	–	1.2	–	µs
Response Time	$t_{RESPONSE}$	T_A = 25°C, C_L = 0.47 nF	–	2.5	–	µs
Output Slew Rate	SR	T_A = 25°C, C_L = 0.47 nF	–	0.44	–	V/µs
Internal Bandwidth	BW_i	Small signal –3 dB, C_L = 4.7 nF	–	200	–	kHz
DC Output Impedance	R_{OUT}	T_A = 25°C	–	3.3	–	Ω
Output Load Resistance	$R_{LOAD(MIN)}$	VIOUT to GND, VIOUT to VCC	4.7	–	–	kΩ
Output Load Capacitance	$C_{LOAD(MAX)}$	VIOUT to GND	–	1	10	nF
Primary Conductor Resistance	$R_{PRIMARY}$	T_A = 25°C	–	100	–	µΩ
Output Saturation Voltage	$V_{SAT(HIGH)}$	T_A = 25°C, $R_{L(PULLDWN)}$ = 10 kΩ to GND	V_{CC} – 0.2	–	–	V
	$V_{SAT(LOW)}$	T_A = 25°C, $R_{L(PULLUP)}$ = 10 kΩ to VCC	–	–	200	mV
ERROR COMPONENTS						
QVO Ratiometry Error [1]	Rat_{ERRQVO}	V_{CC} = 3.15 to 3.45 V	–	±0.15	–	%
Sens Ratiometry Error [1]	$Rat_{ERRSens}$	V_{CC} = 3.15 to 3.45 V	–	±0.3	–	%
Noise	I_N	Input referenced noise density; T_A = 25°C, C_L = 1 nF	–	0.2	–	$mA/\sqrt{(Hz)}$
		Input referenced noise at 200 kHz; T_A = 25°C, C_L = 1 nF	–	120	–	mA_{RMS}
Nonlinearity [1]	E_{LIN}	Up to full scale of I_P	–0.9	±0.5	0.9	%
Symmetry [1]	E_{SYM}	Over half-scale I_P	–0.8	±0.4	0.8	%

[1] See Characteristic Definitions section of this datasheet.

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X050B PERFORMANCE CHARACTERISTICS: T_A = –40°C to 150°C [1], V_{CC} = 3.3 V, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ.[2]	Max.	Unit
NOMINAL PERFORMANCE						
Current Sensing Range	I_{PR}		–50	–	50	A
Sensitivity	Sens	$I_{PR(min)} < I_P < I_{PR(max)}$	–	26.4 × V_{CC} / 3.3	–	mV/A
Zero Current Output Voltage	$V_{IOUT(Q)}$	Bidirection; I_P = 0 A	–	V_{CC}/2	–	V
ACCURACY PERFORMANCE						
Noise	V_N	T_A = 25°C, C_L = 1 nF	–	19.2	–	mV_{p-p}
		T_A = 25°C, C_L = 1 nF	–	3.2	–	mV_{RMS}
Sensitivity Error	E_{Sens}	Full scale of I_P, T_A = 25°C	–1	±0.5	1	%
		Full scale of I_P, T_A = 25°C to 150°C	–1.25	±1	1.25	%
		Full scale of I_P, T_A = –40°C to 25°C	–3.5	±1.5	3.5	%
Electrical Offset Error	$V_{OE(TA)}$	I_P = 0 A, T_A = 25°C	–8	±4	8	mV
	$V_{OE(TA)HT}$	I_P = 0 A, T_A = 25°C to 150°C	–8	±4	8	mV
	$V_{OE(TA)LT}$	I_P = 0 A, T_A = –40°C to 25°C	–20	±6	20	mV
Magnetic Offset Error	I_{ERROM}	I_P = 0 A, T_A = 25°C, after excursion of $I_{PR(max)}$	–	210	250	mA
Total Output Error	$E_{TOT(HT)}$	Full scale of I_P, T_A = 25°C to 150°C	–1.5	±1	1.5	%
	$E_{TOT(LT)}$	Full scale of I_P, T_A = –40°C to 25°C	–3.5	±1.5	3.5	%
LIFETIME ACCURACY CHARACTERISTICS [3]						
Sensitivity Error Including Lifetime	$E_{Sens(LIFE)(HT)}$	T_A = 25°C to 150°C	–2.1	±1.6	2.1	%
	$E_{Sens(LIFE)(LT)}$	T_A = –40°C to 25°C	–3.5	±2.5	3.5	%
Total Output Error Including Lifetime	$E_{TOT(LIFE)(HT)}$	T_A = 25°C to 150°C	–2.1	±1.7	2.1	%
	$E_{TOT(LIFE)(LT)}$	T_A = –40°C to 25°C	–3.5	±2.6	3.5	%
Electric Offset Error Including Lifetime	$E_{OFF(LIFE)(HT)}$	T_A = 25°C to 150°C	–10	±7	10	mV
	$E_{OFF(LIFE)(LT)}$	T_A = –40°C to 25°C	–20	±8.9	20	mV

[1] All ACS773 devices are production tested and guaranteed to T_A = 150°C, provided the Maximum Junction Temperature, $T_{J(MAX)}$, is not exceeded. See Absolute Maximum Ratings and Thermal Application section of this datasheet for more information.
[2] Typical values are ±3 sigma values.
[3] Min/max limits are derived from AEC-Q100 Grade 1 testing.

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Characteristic	Symbol	Test Conditions	Min.	Typ.[2]	Max.	Unit
NOMINAL PERFORMANCE						
Current Sensing Range	I_{PR}		–100	–	100	A
Sensitivity	Sens	$I_{PR(min)} < I_P < I_{PR(max)}$	–	13.2 × V_{CC} / 3.3	–	mV/A
Zero Current Output Voltage	$V_{IOUT(Q)}$	Bidirection; I_P = 0 A	–	V_{CC}/2	–	V
ACCURACY PERFORMANCE						
Noise	V_N	T_A = 25°C, C_L = 1 nF	–	9.6	–	mV_{p-p}
		T_A = 25°C, C_L = 1 nF	–	1.6	–	mV_{RMS}
Sensitivity Error	E_{Sens}	Full scale of I_P, T_A = 25°C	–1	±0.5	1	%
		Full scale of I_P, T_A = 25°C to 150°C	–1.25	±1	1.25	%
		Full scale of I_P, T_A = –40°C to 25°C	–3.5	±1.5	3.5	%
Electrical Offset Error	$V_{OE(TA)}$	I_P = 0 A, T_A = 25°C	–8	±4	8	mV
	$V_{OE(TA)HT}$	I_P = 0 A, T_A = 25°C to 150°C	–8	±4	8	mV
	$V_{OE(TA)LT}$	I_P = 0 A, T_A = –40°C to 25°C	–20	±6	20	mV
Magnetic Offset Error	I_{ERROM}	I_P = 0 A, T_A = 25°C, after excursion of $I_{PR(max)}$	–	280	400	mA
Total Output Error	$E_{TOT(HT)}$	Full scale of I_P, T_A = 25°C to 150°C	–1.5	±1	1.5	%
	$E_{TOT(LT)}$	Full scale of I_P, T_A = –40°C to 25°C	–3.5	±1.5	3.5	%
LIFETIME ACCURACY CHARACTERISTICS [3]						
Sensitivity Error Including Lifetime	$E_{Sens(LIFE)(HT)}$	T_A = 25°C to 150°C	–2.1	±1.6	2.1	%
	$E_{Sens(LIFE)(LT)}$	T_A = –40°C to 25°C	–3.5	±2.5	3.5	%
Total Output Error Including Lifetime	$E_{TOT(LIFE)(HT)}$	T_A = 25°C to 150°C	–2.1	±1.7	2.1	%
	$E_{TOT(LIFE)(LT)}$	T_A = –40°C to 25°C	–3.5	±2.6	3.5	%
Electric Offset Error Including Lifetime	$E_{OFF(LIFE)(HT)}$	T_A = 25°C to 150°C	–10	±7	10	mV
	$E_{OFF(LIFE)(LT)}$	T_A = –40°C to 25°C	–20	±8.9	20	mV

[1] All ACS773 devices are production tested and guaranteed to T_A = 150°C, provided the Maximum Junction Temperature, $T_{J(MAX)}$, is not exceeded. See Absolute Maximum Ratings and Thermal Application section of this datasheet for more information.
[2] Typical values are ±3 sigma values.
[3] Min/max limits are derived from AEC-Q100 Grade 1 testing.

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***X*150B PERFORMANCE CHARACTERISTICS: T_A = –40°C to 150°C [1], V_{CC} = 3.3 V, unless otherwise specified**

Characteristic	Symbol	Test Conditions	Min.	Typ.[2]	Max.	Unit
NOMINAL PERFORMANCE						
Current Sensing Range	I_{PR}		–150	–	150	A
Sensitivity	Sens	$I_{PR(min)} < I_P < I_{PR(max)}$	–	8.8 × V_{CC} / 3.3	–	mV/A
Zero Current Output Voltage	$V_{IOUT(Q)}$	Bidirection; I_P = 0 A	–	$V_{CC}/2$	–	V
ACCURACY PERFORMANCE						
Noise	V_N	T_A = 25°C, C_L = 1 nF	–	9.6	–	mV_{p-p}
		T_A = 25°C, C_L = 1 nF	–	1.6	–	mV_{RMS}
Sensitivity Error	E_{Sens}	Full scale of I_P, T_A = 25°C	–1	±0.7	1	%
		Full scale of I_P, T_A = 25°C to 150°C	–1.25	±0.8	1.25	%
		Full scale of I_P, T_A = –40°C to 25°C	–3.5	±1.7	3.5	%
Electrical Offset Error	$V_{OE(TA)}$	I_P = 0 A, T_A = 25°C	–8	±4	8	mV
	$V_{OE(TA)HT}$	I_P = 0 A, T_A = 25°C to 150°C	–8	±4	8	mV
	$V_{OE(TA)LT}$	I_P = 0 A, T_A = –40°C to 25°C	–20	±6	20	mV
Magnetic Offset Error	I_{ERROM}	I_P = 0 A, T_A = 25°C, after excursion of $I_{PR(max)}$	–	280	450	mA
Total Output Error	$E_{TOT(HT)}$	Full scale of I_P, T_A = 25°C to 150°C	–1.5	±0.9	1.5	%
	$E_{TOT(LT)}$	Full scale of I_P, T_A = –40°C to 25°C	–3.5	±1.7	3.5	%
LIFETIME ACCURACY CHARACTERISTICS [3]						
Sensitivity Error Including Lifetime	$E_{Sens(LIFE)(HT)}$	T_A = 25°C to 150°C	–2.1	±1.6	2.1	%
	$E_{Sens(LIFE)(LT)}$	T_A = –40°C to 25°C	–3.5	±2.5	3.5	%
Total Output Error Including Lifetime	$E_{TOT(LIFE)(HT)}$	T_A = 25°C to 150°C	–2.1	±1.7	2.1	%
	$E_{TOT(LIFE)(LT)}$	T_A = –40°C to 25°C	–3.5	±2.6	3.5	%
Electric Offset Error Including Lifetime	$E_{OFF(LIFE)(HT)}$	T_A = 25°C to 150°C	–10	±7	10	mV
	$E_{OFF(LIFE)(LT)}$	T_A = –40°C to 25°C	–20	±8.9	20	mV

[1] All ACS773 devices are production tested and guaranteed to T_A = 150°C, provided the Maximum Junction Temperature, $T_{J(MAX)}$, is not exceeded. See Absolute Maximum Ratings and Thermal Application section of this datasheet for more information.
[2] Typical values are ±3 sigma values.
[3] Min/max limits are derived from AEC-Q100 Grade 1 testing.

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Characteristic	Symbol	Test Conditions	Min.	Typ.[2]	Max.	Unit
NOMINAL PERFORMANCE						
Current Sensing Range	I_{PR}		–200	–	200	A
Sensitivity	Sens	$I_{PR(min)} < I_P < I_{PR(max)}$	–	6.6 × V_{CC} / 3.3	–	mV/A
Zero Current Output Voltage	$V_{IOUT(Q)}$	Bidirection; I_P = 0 A	–	V_{CC}/2	–	V
ACCURACY PERFORMANCE						
Noise	V_N	T_A = 25°C, C_L = 1 nF	–	4.8	–	mV_{p-p}
		T_A = 25°C, C_L = 1 nF	–	0.8	–	mV_{RMS}
Sensitivity Error	E_{Sens}	Full scale of I_P, T_A = 25°C	–1	±0.5	1	%
		Full scale of I_P, T_A = 25°C to 150°C	–1.25	±1	1.25	%
		Full scale of I_P, T_A = –40°C to 25°C	–3.5	±1.5	3.5	%
Electrical Offset Error	$V_{OE(TA)}$	I_P = 0 A, T_A = 25°C	–8	±4	8	mV
	$V_{OE(TA)HT}$	I_P = 0 A, T_A = 25°C to 150°C	–8	±4	8	mV
	$V_{OE(TA)LT}$	I_P = 0 A, T_A = –40°C to 25°C	–20	±6	20	mV
Magnetic Offset Error	I_{ERROM}	I_P = 0 A, T_A = 25°C, after excursion of $I_{PR(max)}$	–	380	450	mA
Total Output Error	$E_{TOT(HT)}$	Full scale of I_P, T_A = 25°C to 150°C	–1.5	±1	1.5	%
	$E_{TOT(LT)}$	Full scale of I_P, T_A = –40°C to 25°C	–3.5	±1.5	3.5	%
LIFETIME ACCURACY CHARACTERISTICS [3]						
Sensitivity Error Including Lifetime	$E_{Sens(LIFE)(HT)}$	T_A = 25°C to 150°C	–2.1	±1.6	2.1	%
	$E_{Sens(LIFE)(LT)}$	T_A = –40°C to 25°C	–3.5	±2.5	3.5	%
Total Output Error Including Lifetime	$E_{TOT(LIFE)(HT)}$	T_A = 25°C to 150°C	–2.1	±1.7	2.1	%
	$E_{TOT(LIFE)(LT)}$	T_A = –40°C to 25°C	–3.5	±2.6	3.5	%
Electric Offset Error Including Lifetime	$E_{OFF(LIFE)(HT)}$	T_A = 25°C to 150°C	–10	±7	10	mV
	$E_{OFF(LIFE)(LT)}$	T_A = –40°C to 25°C	–20	±8.9	20	mV

[1] All ACS773 devices are production tested and guaranteed to T_A = 150°C, provided the Maximum Junction Temperature, $T_{J(MAX)}$, is not exceeded. See Absolute Maximum Ratings and Thermal Application section of this datasheet for more information.
[2] Typical values are ±3 sigma values.
[3] Min/max limits are derived from AEC-Q100 Grade 1 testing.

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X250U PERFORMANCE CHARACTERISTICS: T_A = –40°C to 150°C [1], V_{CC} = 3.3 V, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ.[2]	Max.	Unit
NOMINAL PERFORMANCE						
Current Sensing Range	I_{PR}		0	–	250	A
Sensitivity	Sens	$I_{PR(min)} < I_P < I_{PR(max)}$	–	10.56 × V_{CC} / 3.3	–	mV/A
Zero Current Output Voltage	$V_{IOUT(Q)}$	Bidirection; I_P = 0 A	–	V_{CC}/10	–	V
ACCURACY PERFORMANCE						
Noise	V_N	T_A = 25°C, C_L = 1 nF	–	11.52	–	mV_{p-p}
		T_A = 25°C, C_L = 1 nF	–	1.28	–	mV_{RMS}
Sensitivity Error	E_{Sens}	Full scale of I_P, T_A = 25°C	–1	±0.5	1	%
		Full scale of I_P, T_A = 25°C to 150°C	–1.25	±1	1.25	%
		Full scale of I_P, T_A = –40°C to 25°C	–3.5	±1.5	3.5	%
Electrical Offset Error	$V_{OE(TA)}$	I_P = 0 A, T_A = 25°C	–8	±4	8	mV
	$V_{OE(TA)HT}$	I_P = 0 A, T_A = 25°C to 150°C	–8	±4	8	mV
	$V_{OE(TA)LT}$	I_P = 0 A, T_A = –40°C to 25°C	–20	±6	20	mV
Magnetic Offset Error	I_{ERROM}	I_P = 0 A, T_A = 25°C, after excursion of $I_{PR(max)}$	–	380	450	mA
Total Output Error	$E_{TOT(HT)}$	Full scale of I_P, T_A = 25°C to 150°C	–1.5	±1	1.5	%
	$E_{TOT(LT)}$	Full scale of I_P, T_A = –40°C to 25°C	–3.5	±1.5	3.5	%
LIFETIME ACCURACY CHARACTERISTICS [3]						
Sensitivity Error Including Lifetime	$E_{Sens(LIFE)(HT)}$	T_A = 25°C to 150°C	–2.1	±1.6	2.1	%
	$E_{Sens(LIFE)(LT)}$	T_A = –40°C to 25°C	–3.5	±2.5	3.5	%
Total Output Error Including Lifetime	$E_{TOT(LIFE)(HT)}$	T_A = 25°C to 150°C	–2.1	±1.7	2.1	%
	$E_{TOT(LIFE)(LT)}$	T_A = –40°C to 25°C	–3.5	±2.6	3.5	%
Electric Offset Error Including Lifetime	$E_{OFF(LIFE)(HT)}$	T_A = 25°C to 150°C	–10	±7	10	mV
	$E_{OFF(LIFE)(LT)}$	T_A = –40°C to 25°C	–20	±8.9	20	mV

[1] All ACS773 devices are production tested and guaranteed to T_A = 150°C, provided the Maximum Junction Temperature, $T_{J(MAX)}$, is not exceeded. See Absolute Maximum Ratings and Thermal Application section of this datasheet for more information.
[2] Typical values are ±3 sigma values.
[3] Min/max limits are derived from AEC-Q100 Grade 1 testing.

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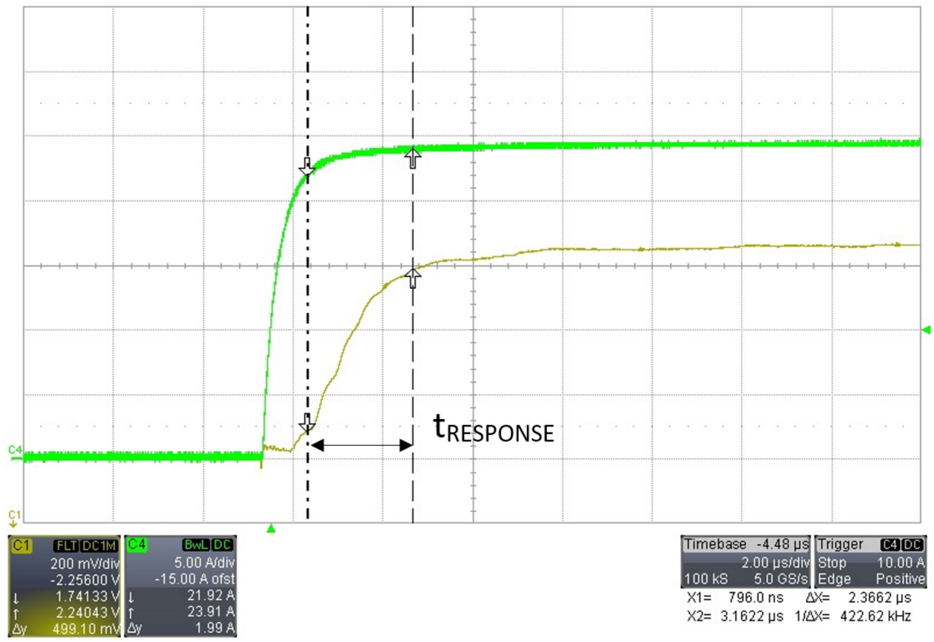
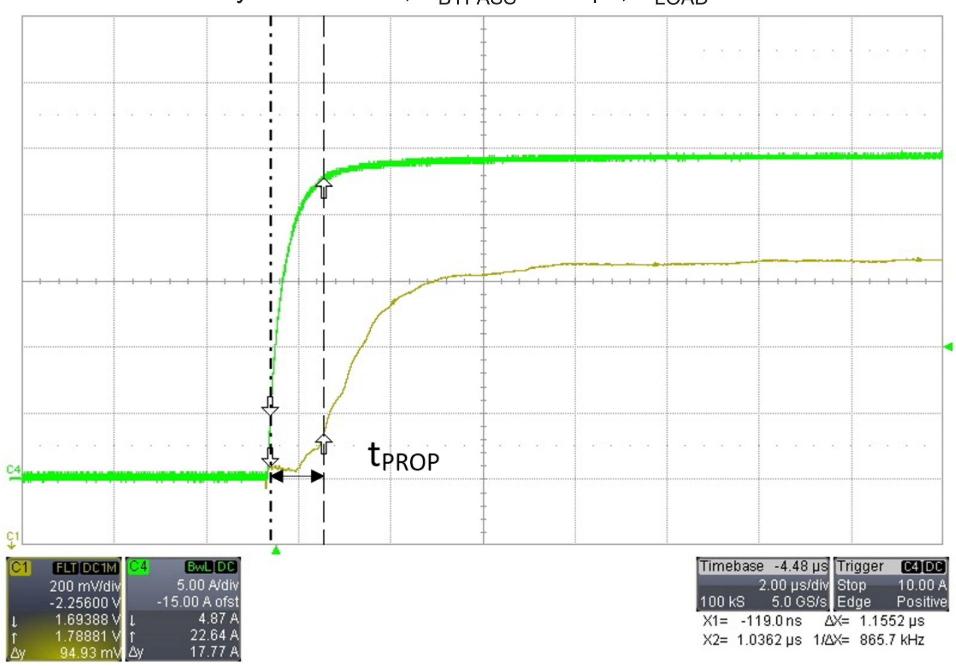
CHARACTERISTIC PERFORMANCE DATA

Response Time ($t_{RESPONSE}$)
25 A excitation signal with 10%-90% rise time = 1 µs
Sensitivity = 26.4 mV/A, C_{BYPASS} = 0.1 µF, C_{LOAD} = 1 nF



Propagation Delay (t_{PROP})
25 A excitation signal with 10%-90% rise time = 1 µs
Sensitivity = 26.4 mV/A, C_{BYPASS} = 0.1 µF, C_{LOAD} = 1 nF



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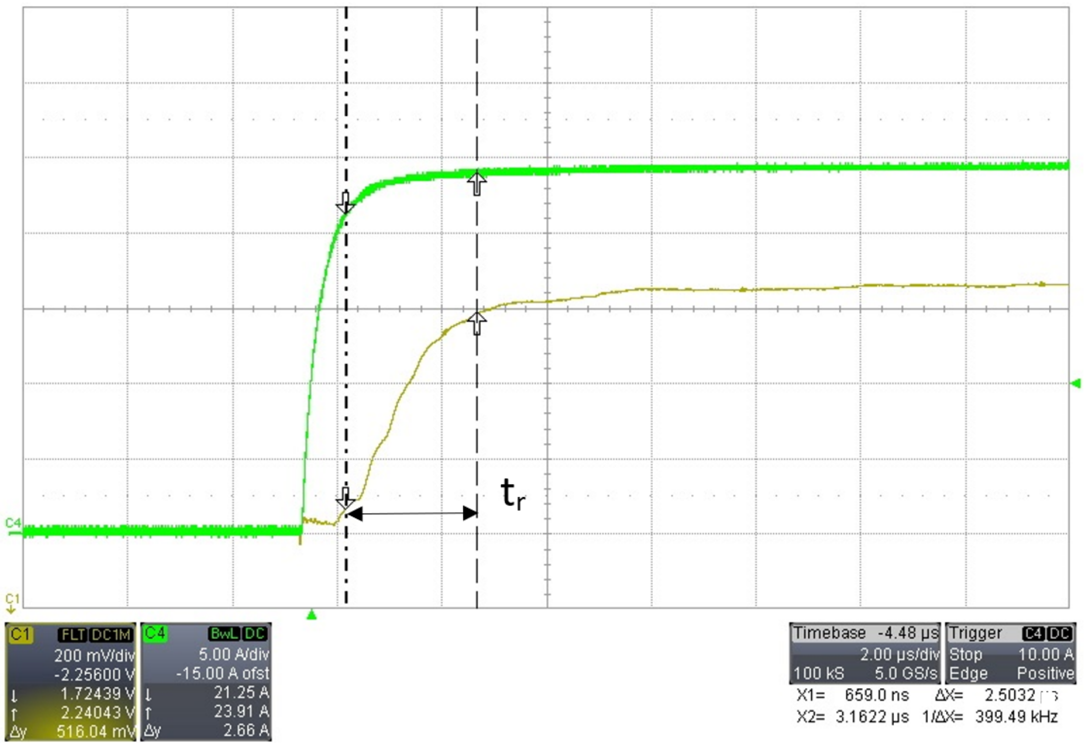
Rise Time (t_r)
25 A excitation signal with 10%-90% rise time = 1 µs
Sensitivity = 26.4 mV/A, C_{BYPASS} = 0.1 µF, C_{LOAD} = 1 nF



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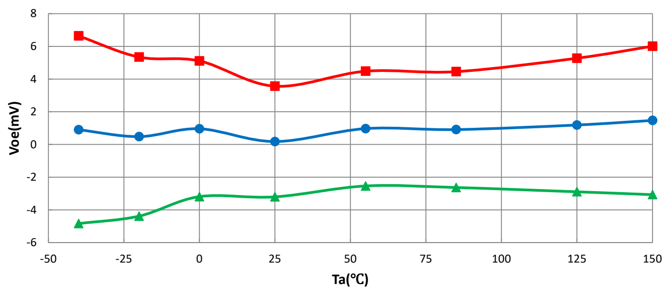
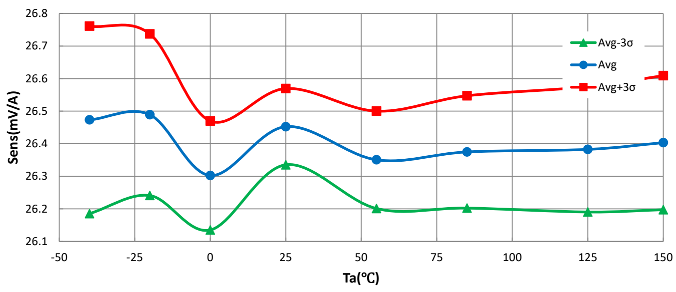
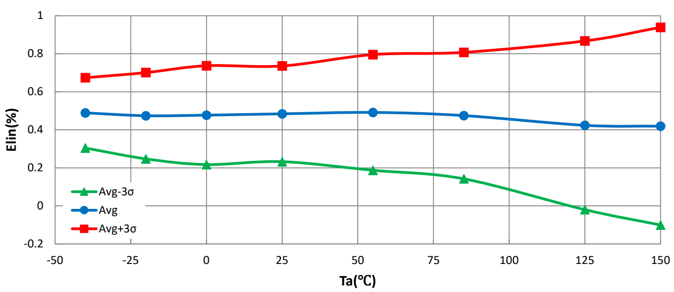
Electrical Offset Voltage versus Ambient Temperature



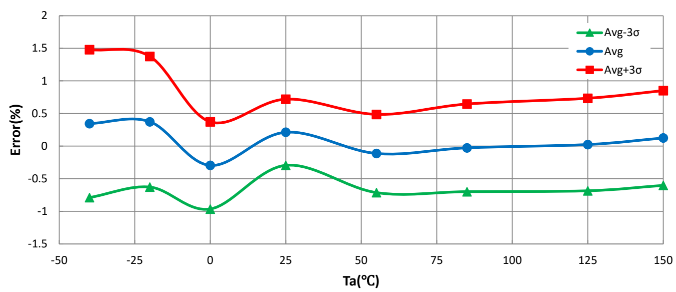
Sensitivity versus Ambient Temperature



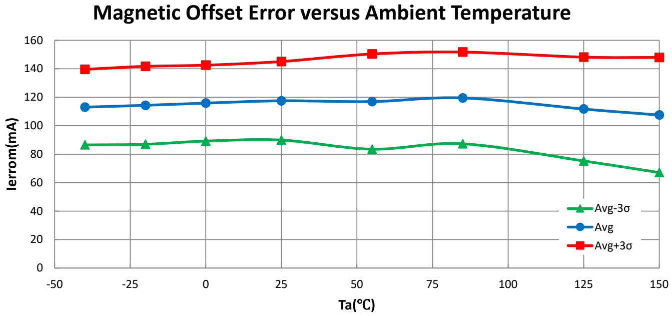
Nonlinearity versus Ambient Temperature



Total Output Error versus Ambient Temperature



Magnetic Offset Error versus Ambient Temperature



Mean + 3 sigma   Mean   Mean – 3 sigma

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CHARACTERISTIC PERFORMANCE
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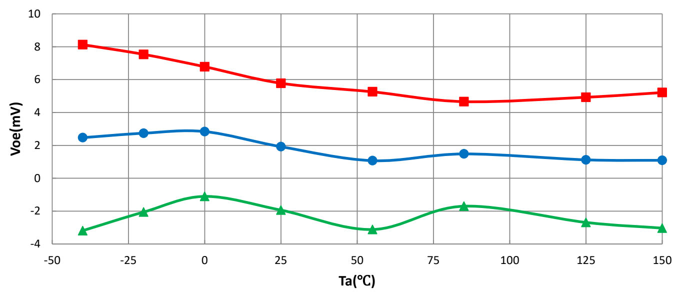
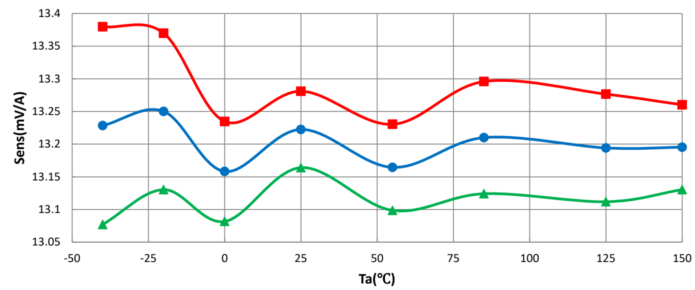
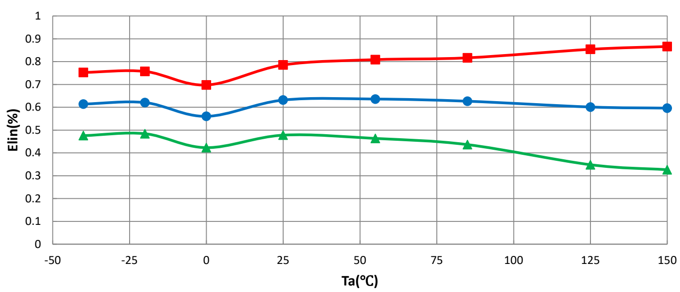
Electrical Offset Voltage versus Ambient Temperature



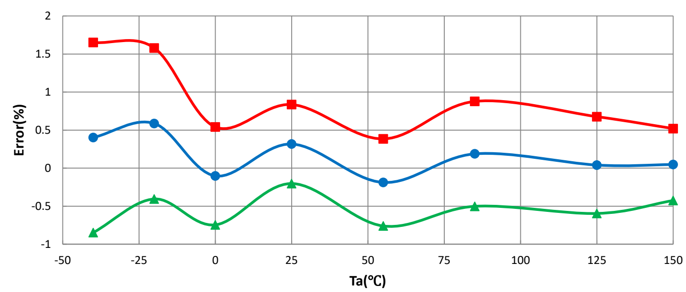
Sensitivity versus Ambient Temperature



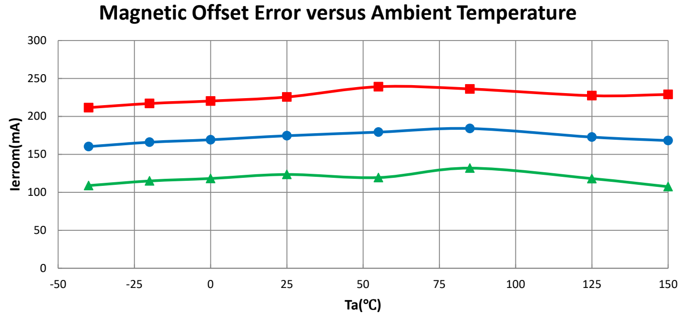
Nonlinearity versus Ambient Temperature

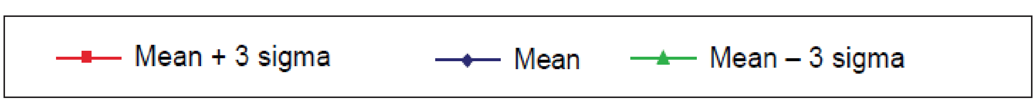


Total Output Error versus Ambient Temperature



Magnetic Offset Error versus Ambient Temperature





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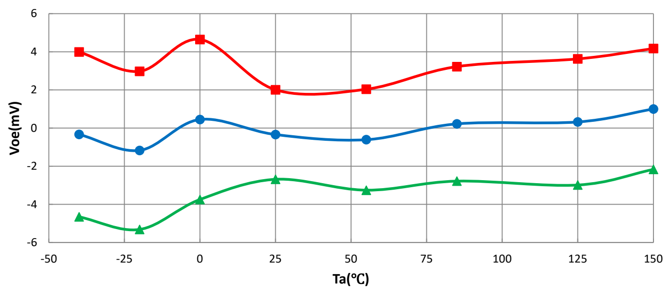
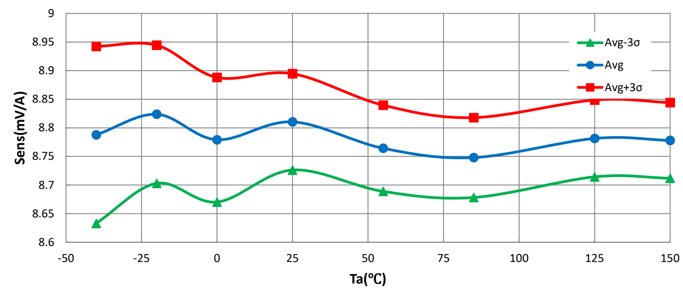
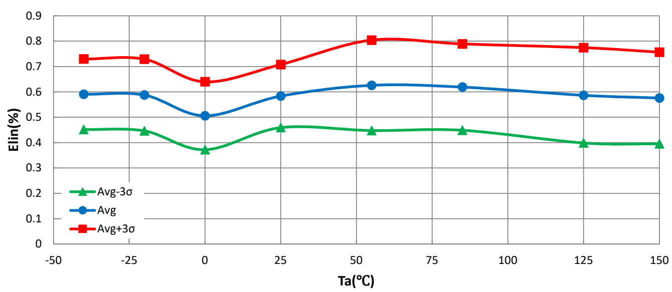
Electrical Offset Voltage versus Ambient Temperature



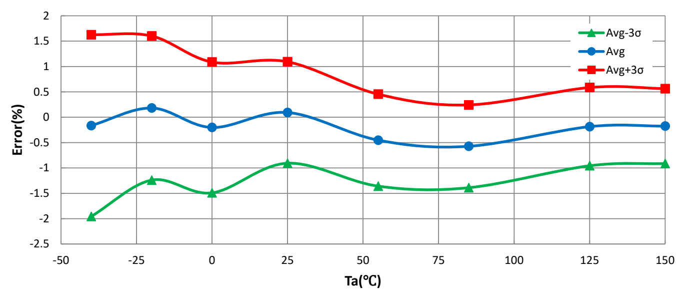
Sensitivity versus Ambient Temperature



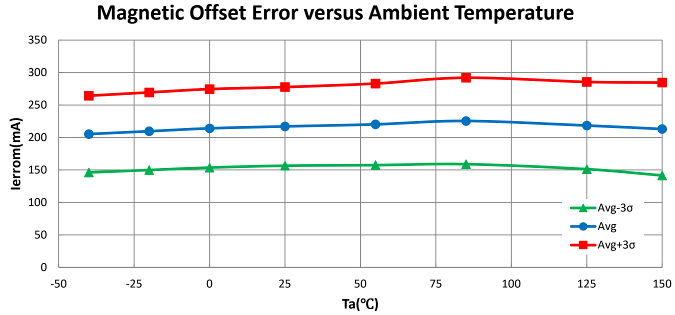
Nonlinearity versus Ambient Temperature

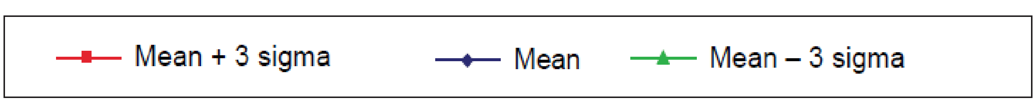


Total Output Error versus Ambient Temperature



Magnetic Offset Error versus Ambient Temperature





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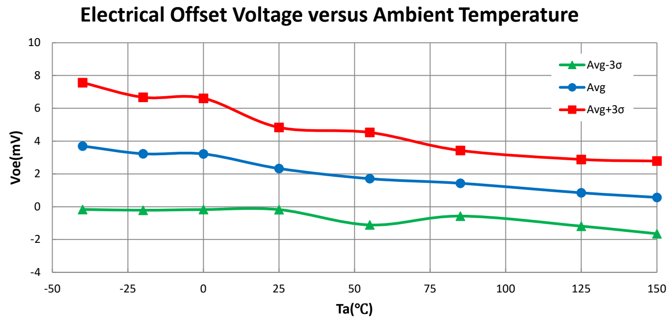

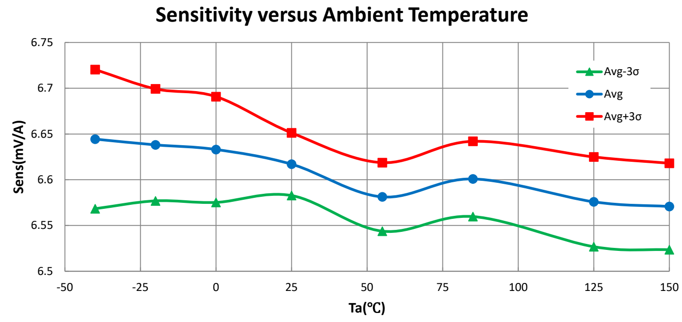

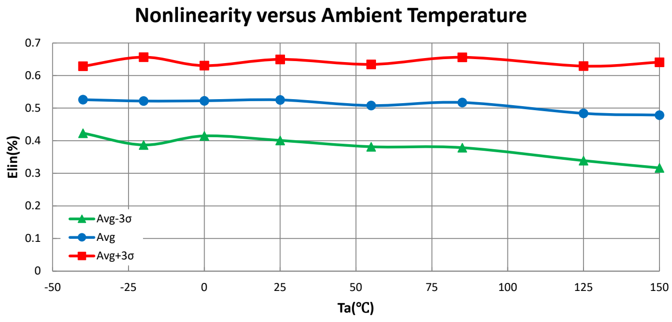

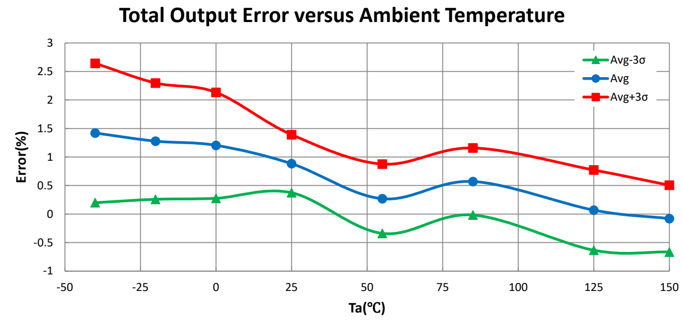

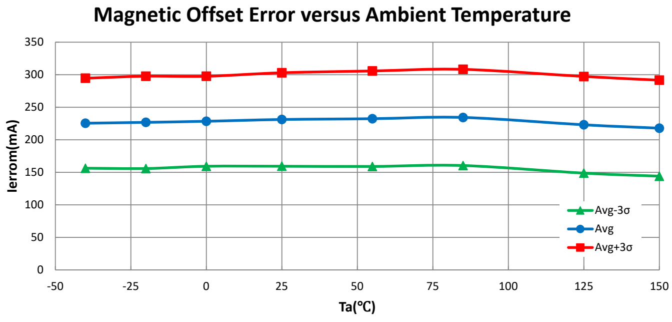

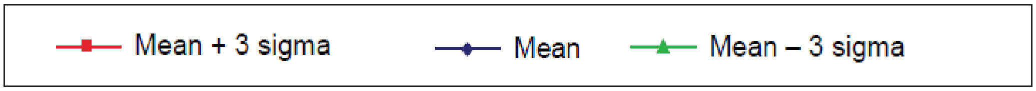

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CHARACTERISTIC DEFINITIONS

Definitions of Accuracy Characteristics

SENSITIVITY (Sens)

The change in sensor IC output in response to a 1 A change through the primary conductor. The sensitivity is the product of the magnetic circuit sensitivity (G/A; 1 G = 0.1 mT) and the linear IC amplifier gain (mV/G). The linear IC amplifier gain is programmed at the factory to optimize the sensitivity (mV/A) for the full-scale current of the device.

SENSITIVITY ERROR (E_{Sens})

The sensitivity error is the percent difference between the measured sensitivity and the ideal sensitivity. For example, in the case of V_{CC} = 3.3 V:

$$E_{Sens} = \frac{Sens_{Meas(3.3V)} - Sens_{Ideal(3.3V)}}{Sens_{IDEAL(3.3V)}} \times 100\ (\%)$$

NOISE (V_N)

The noise floor is derived from the thermal and shot noise observed in Hall elements. Dividing the noise (mV) by the sensitivity (mV/A) provides the smallest current that the device is able to resolve.

NONLINEARITY (E_{LIN})

The ACS773 is designed to provide a linear output in response to a ramping current. Consider two current levels: I1 and I2. Ideally, the sensitivity of a device is the same for both currents, for a given supply voltage and temperature. Nonlinearity is present when there is a difference between the sensitivities measured at I1 and I2. Nonlinearity is calculated separately for the positive (E_{LINpos}) and negative (E_{LINneg}) applied currents as follows:

$$E_{LINpos} = 100\ (\%) \times \{1 - (Sens_{IPOS2} / Sens_{IPOS1})\}$$

$$E_{LINneg} = 100\ (\%) \times \{1 - (Sens_{INEG2} / Sens_{INEG1})\}$$

where:

$$Sens_{Ix} = (V_{IOUT(Ix)} - V_{IOUT(Q)}) / Ix$$

and I_{POSx} and I_{NEGx} are positive and negative currents.

Then:

$$E_{LIN} = max(E_{LINpos}, E_{LINneg})$$

SYMMETRY (E_{SYM})

The degree to which the absolute voltage output from the IC varies in proportion to either a positive or negative half-scale primary current. The following equation is used to derive symmetry:

$$100 \times \left(\frac{V_{IOUT\_+half\text{-}scale\ amperes} - V_{IOUT(Q)}}{V_{IOUT(Q)} - V_{IOUT\_-half\text{-}scale\ amperes}} \right)$$

RATIOMETRY ERROR

The device features a ratiometric output. This means that the quiescent voltage output, V_{IOUTQ}, and the magnetic sensitivity, Sens, are proportional to the supply voltage, V_{CC}.The ratiometric change (%) in the quiescent voltage output is defined as:

$$Rat_{ErrQVO} = \left[1 - \frac{(V_{IOUTQ(VCC)} / V_{IOUTQ(3.3V)})}{V_{CC} / 3.3\ V} \right] \times 100\%$$

and the ratiometric change (%) in sensitivity is defined as:

$$Rat_{ErrSens} = \left[1 - \frac{(Sens_{(VCC)} / Sense_{(3.3V)})}{V_{CC} / 3.3\ V} \right] \times 100\%$$

ZERO CURRENT OUTPUT VOLTAGE ($V_{IOUT(Q)}$)

The output of the sensor when the primary current is zero. It nominally remains at 0.5 × V_{CC} for a bidirectional device and 0.1 × V_{CC} for a unidirectional device. For example, in the case of a bidirectional output device, V_{CC} = 3.3 V translates into $V_{IOUT(Q)}$ = 1.65 V. Variation in $V_{IOUT(Q)}$ can be attributed to the resolution of the Allegro linear IC quiescent voltage trim and thermal drift.

ELECTRICAL OFFSET VOLTAGE (V_{OE})

The deviation of the device output from its ideal quiescent value of 0.5 × V_{CC} (bidirectional) or 0.1 × V_{CC} (unidirectional) due to nonmagnetic causes. To convert this voltage to amperes, divide by the device sensitivity, Sens.

MAGNETIC OFFSET ERROR (I_{ERROM})

The magnetic offset is due to the residual magnetism (remnant field) of the core material. The magnetic offset error is highest when the magnetic circuit has been saturated, usually when the device has been subjected to a full-scale or high-current overload condition. The magnetic offset is largely dependent on the material used as a flux concentrator. The larger magnetic offsets are observed at the lower operating temperatures.

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TOTAL OUTPUT ERROR (E_{TOT})

The difference between the current measurement from the sensor IC and the actual current (IP), relative to the actual current. This is equivalent to the difference between the ideal output voltage and the actual output voltage, divided by the ideal sensitivity, relative to the current flowing through the primary conduction path:

$$E_{TOT}(I_P) = \frac{V_{IOUT(IP)} - V_{IOUT(ideal)(IP)}}{Sens_{ideal} \times I_P} \times 100(\%)$$

where

$$V_{IOUT(ideal)(IP)} = V_{IOUT(Q)} + (Sens_{IDEAL} \times I_P)$$

The Total Output Error incorporates all sources of error and is a function of IP.

At relatively high currents, E_{TOT} will be mostly due to sensitivity error, and at relatively low currents, E_{TOT} will be mostly due to Offset Voltage (V_{OE}). In fact, as I_P approaches zero, E_{TOT} approaches infinity due to the offset voltage. This is illustrated in Figure 1 and Figure 2. Figure 1 shows a distribution of output voltages versus I_P at 25°C and across temperature. Figure 2 shows the corresponding E_{TOT} versus I_P.

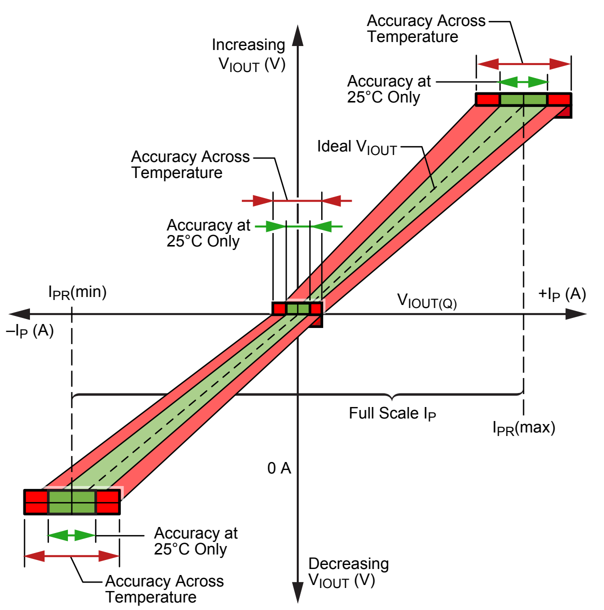

Figure 1: Output Voltage versus Sensed Current

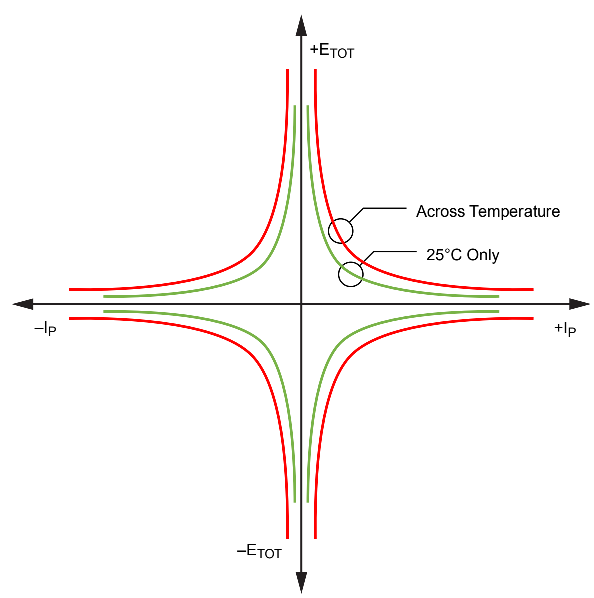

Figure 2: Total Output Error versus Sensed Current

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DEFINITIONS OF DYNAMIC RESPONSE CHARACTERISTICS

POWER-ON DELAY (t_{POD})

When the supply is ramped to its operating voltage, the device requires a finite time to power its internal components before responding to an input magnetic field. Power-On Delay, t_{POD}, 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, after the power supply has reached its minimum specified operating voltage, V_{CC}(min), as shown in the chart at right.

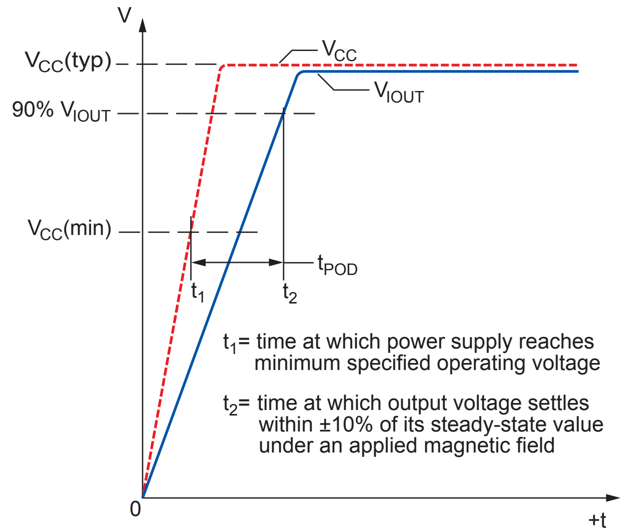

Figure 3: Power-On Delay (t_{POD})

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_{PROP})

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

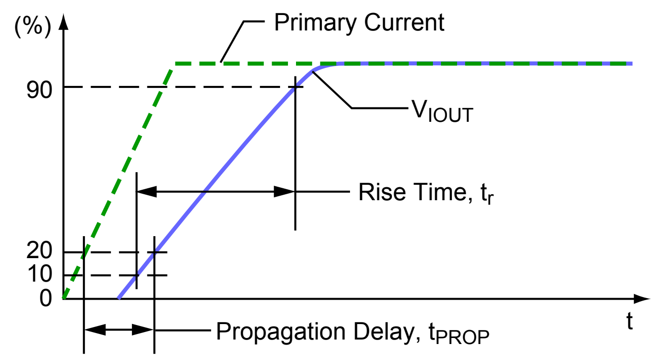

Figure 4: Rise Time (t_r) and Propagation Delay (t_{PROP})

RESPONSE TIME ($t_{RESPONSE}$)

The time interval between a) when the applied current reaches 90% of its final value, and b) when the sensor reaches 90% of its output corresponding to the applied current.

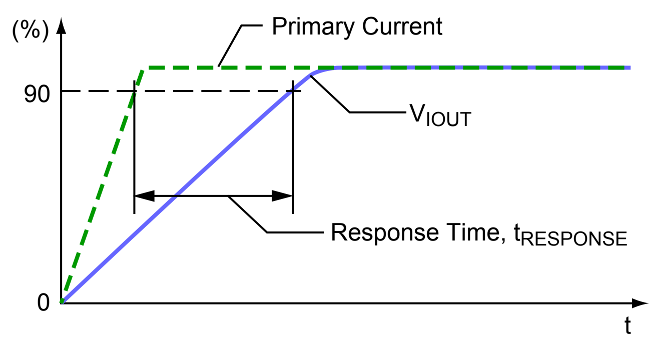

Figure 5: Response Time ($t_{RESPONSE}$)

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FUNCTIONAL DESCRIPTION

Power-On Reset (POR)

The descriptions in this section assume: temperature = 25°C, no output load (R_L, C_L), and I_P = 0 A.

Power-Up

At power-up, as V_{CC} ramps up, the output is in a high-impedance state. When V_{CC} crosses V_{PORH} (location [1] in Figure 6 and [1′] in Figure 7), the POR Release counter starts counting for t_{PO} [2, 2′]. At this point, the output will go to V_{CC}/2.

V_{CC} drops below V_{CC}(min) = 3 V

If V_{CC} drops below V_{PORH} [3′] but remains higher than V_{PORL} [4′], the output will continue to be V_{CC}/2.

Power-Down

As V_{CC} ramps down below V_{PORL} [3, 5’], the output will enter a high-impedance state.

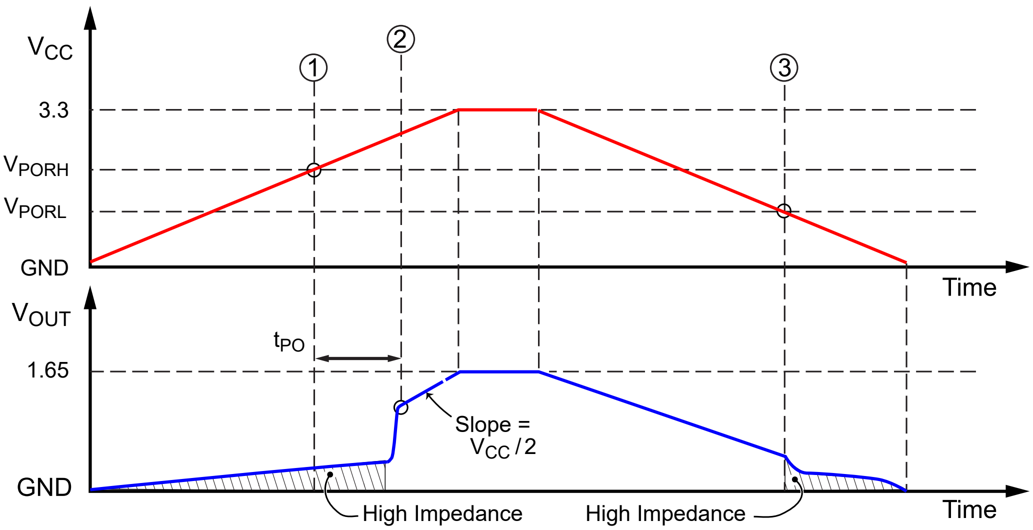

Figure 6: POR: Slow Rise Time Case

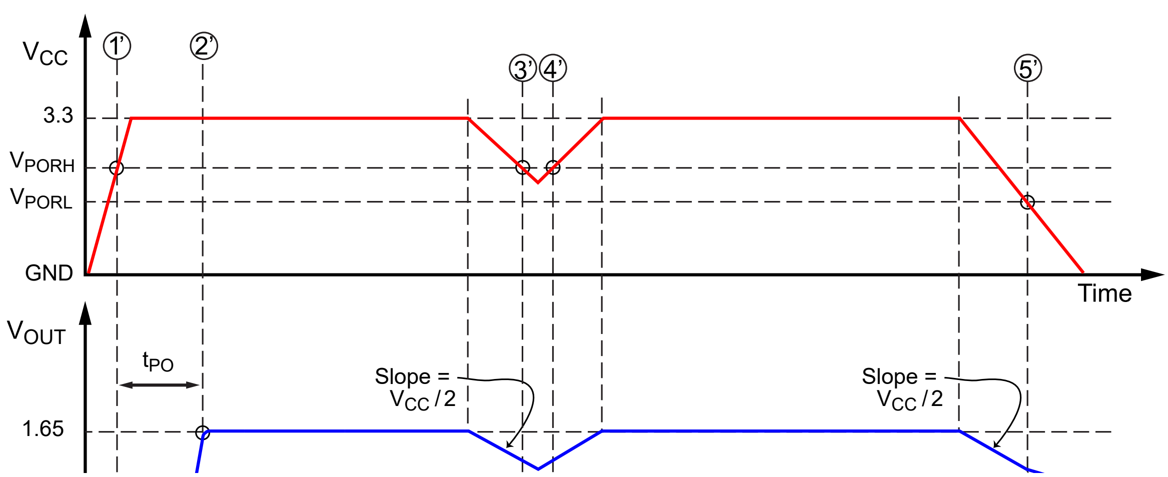

Figure 7: POR: Fast Rise Time Case

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EEPROM Error Checking And Correction

Hamming code methodology is implemented for EEPROM checking and correction. The device has ECC enabled after power-up. If an uncorrectable error has occurred, the VOUT pin will go to high impedance and the device will not respond to applied magnetic field.

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Chopper Stabilization Technique

When using Hall-effect technology, a limiting factor for switchpoint accuracy is the small signal voltage developed across the Hall element. This voltage is disproportionally small relative to the offset that can be produced at the output of the Hall sensor IC. This makes it difficult to process the signal while maintaining an accurate, reliable output over the specified operating temperature and voltage ranges.

Chopper stabilization is a unique approach used to minimize Hall offset on the chip. Allegro employs a technique to remove key sources of the output drift induced by thermal and mechanical stresses. This offset reduction technique is based on a signal modulation-demodulation process. The undesired offset signal is separated from the magnetic field-induced signal in the frequency domain, through modulation. The subsequent demodulation acts as a modulation process for the offset, causing the magnetic field-induced signal to recover its original spectrum at baseband, while the DC offset becomes a high-frequency signal. The magnetic-sourced signal then can pass through a low-pass filter, while the modulated DC offset is suppressed.

In addition to the removal of the thermal and stress related offset, this novel technique also reduces the amount of thermal noise in the Hall sensor IC while completely removing the modulated residue resulting from the chopper operation. The chopper stabilization technique uses a high-frequency sampling clock. For demodulation process, a sample-and-hold technique is used. This high-frequency operation allows a greater sampling rate, which results in higher accuracy and faster signal-processing capability. This approach desensitizes the chip to the effects of thermal and mechanical stresses, and produces devices that have extremely stable quiescent Hall output voltages and precise recoverability after temperature cycling. This technique is made possible through the use of a BiCMOS process, which allows the use of low-offset, low-noise amplifiers in combination with high-density logic integration and sample-and-hold circuits.

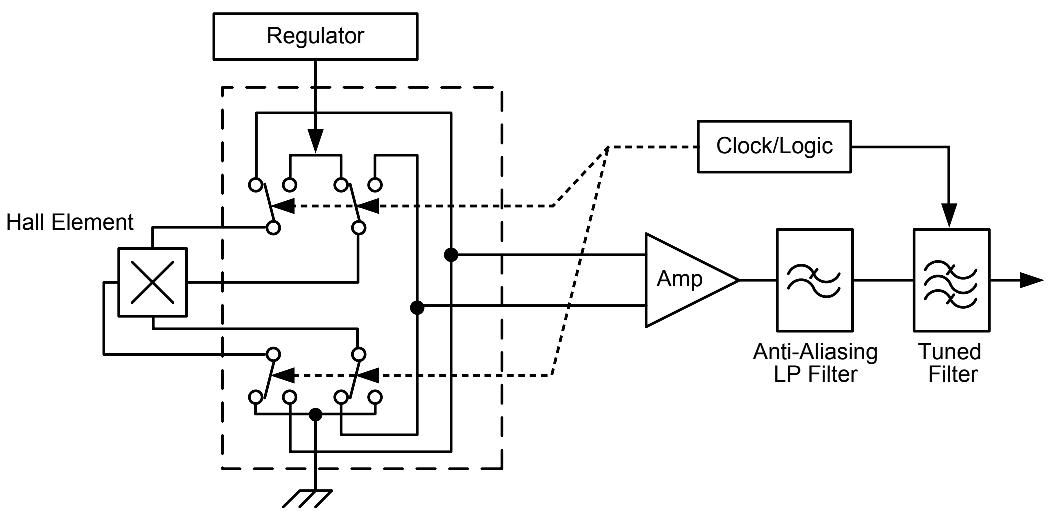

Figure 8: Concept of Chopper Stabilization Technique

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APPLICATION INFORMATION

Thermal Rise vs. Primary Current

Self-heating due to the flow of current 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 as current moves through the system.

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, current "on-time", and duty cycle. While the data presented in this section was collected with direct current (DC), these numbers may be used to approximate thermal response for both AC signals and current pulses.

The plot in Figure 9 shows the measured rise in steady-state die temperature of the ACS773 versus continuous current at an ambient temperature, T_A, of 25°C. The thermal offset curves may be directly applied to other values of T_A. Conversely, Figure 10 shows the maximum continuous current at a given T_A. Surges beyond the maximum current listed in Figure 10 are allowed given the maximum junction temperature, $T_{J(MAX)}$ (165°C), is not exceeded.

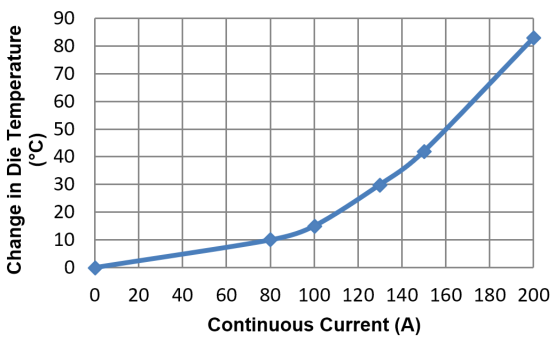

Figure 9: Self-Heating in the CB Package Due to Current Flow

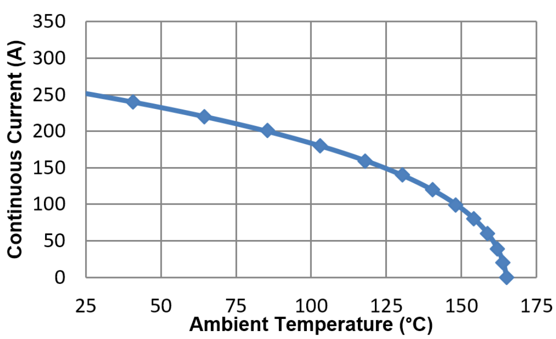

Figure 10: Maximum Continuous Current at a Given T_A

The thermal capacity of the ACS773 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. Further information on this application testing is available in the DC and Transient Current Capability application note on the Allegro website.

ASEK773 Evaluation Board Layout

Thermal data shown in Figure 9 was collected using the ASEK773 Evaluation Board (TED-85-0385-001). This board includes 2664 mm^2 of 4 oz. copper (0.1388 mm) connected to pins 4 and 5 with thermal vias connecting the layers. Top and Bottom layers of the PCB are shown below in Figure 11.

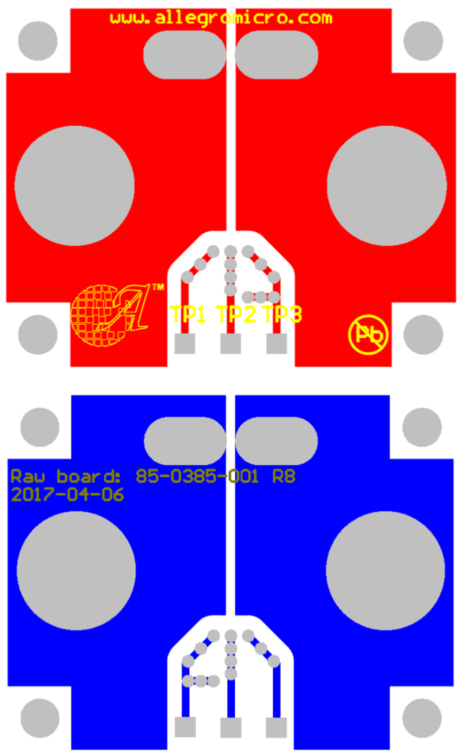

Figure 11: Top and Bottom Layers for ASEK773 Evaluation Board

Gerber files for the ASEK773 evaluation board are available for download from the Allegro website. See the technical documents section of the ACS773 device webpage.

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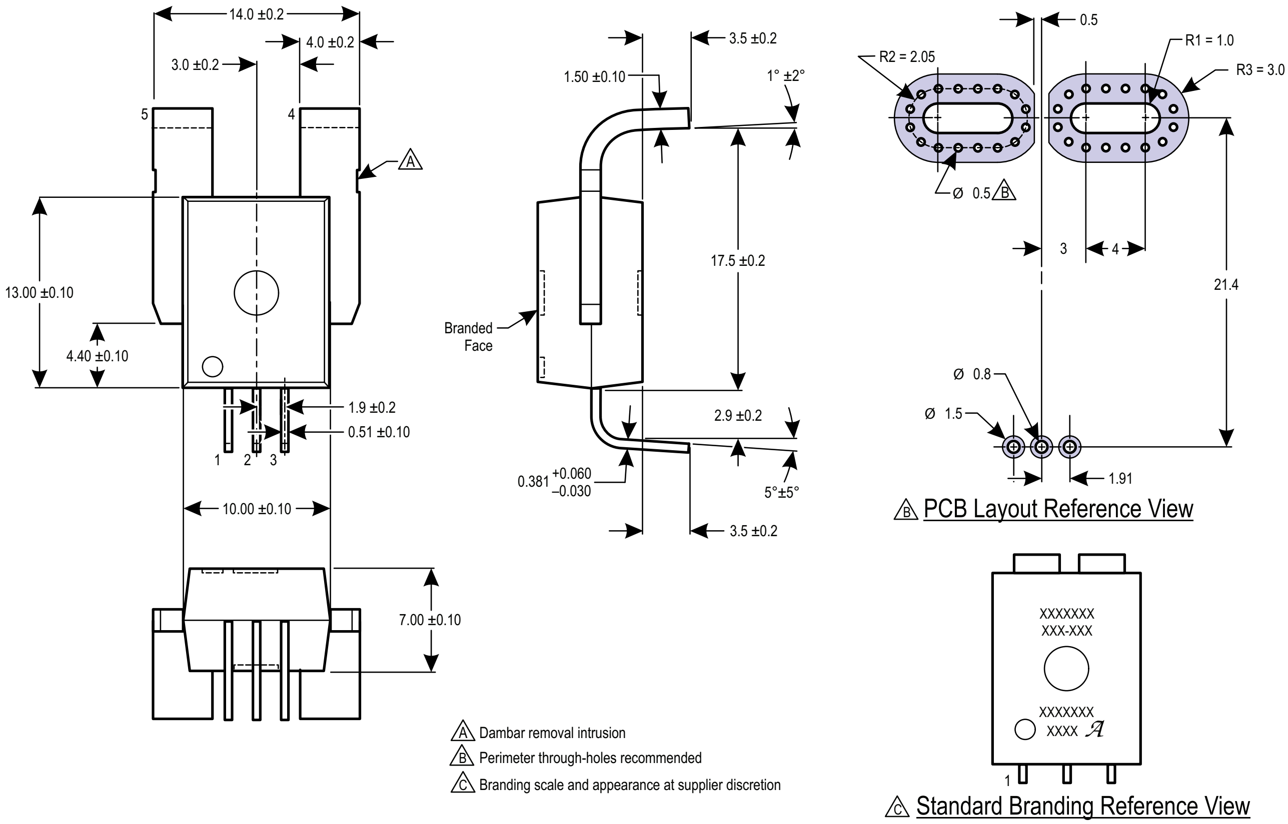
PACKAGE OUTLINE DRAWINGS

For Reference Only – Not for Tooling Use

(Reference DWG-9111 & DWG-9110)
Dimensions in millimeters – NOT TO SCALE
Dimensions exclusive of mold flash, gate burs, and dambar protrusions
Exact case and lead configuration at supplier discretion within limits shown



Lines 1, 2, 3, 4 = 7 characters.

Line 1: Part Number
Line 2: Package Temperature - Amperes
Line 3: Lot Number
Line 4: Date Code, Logo A

Creepage distance, current terminals to signal pins: 7.25 mm
Clearance distance, current terminals to signal pins: 7.25 mm
Package mass: 4.63 g typical

Figure 12: Package CB, 5-Pin, Leadform PFF

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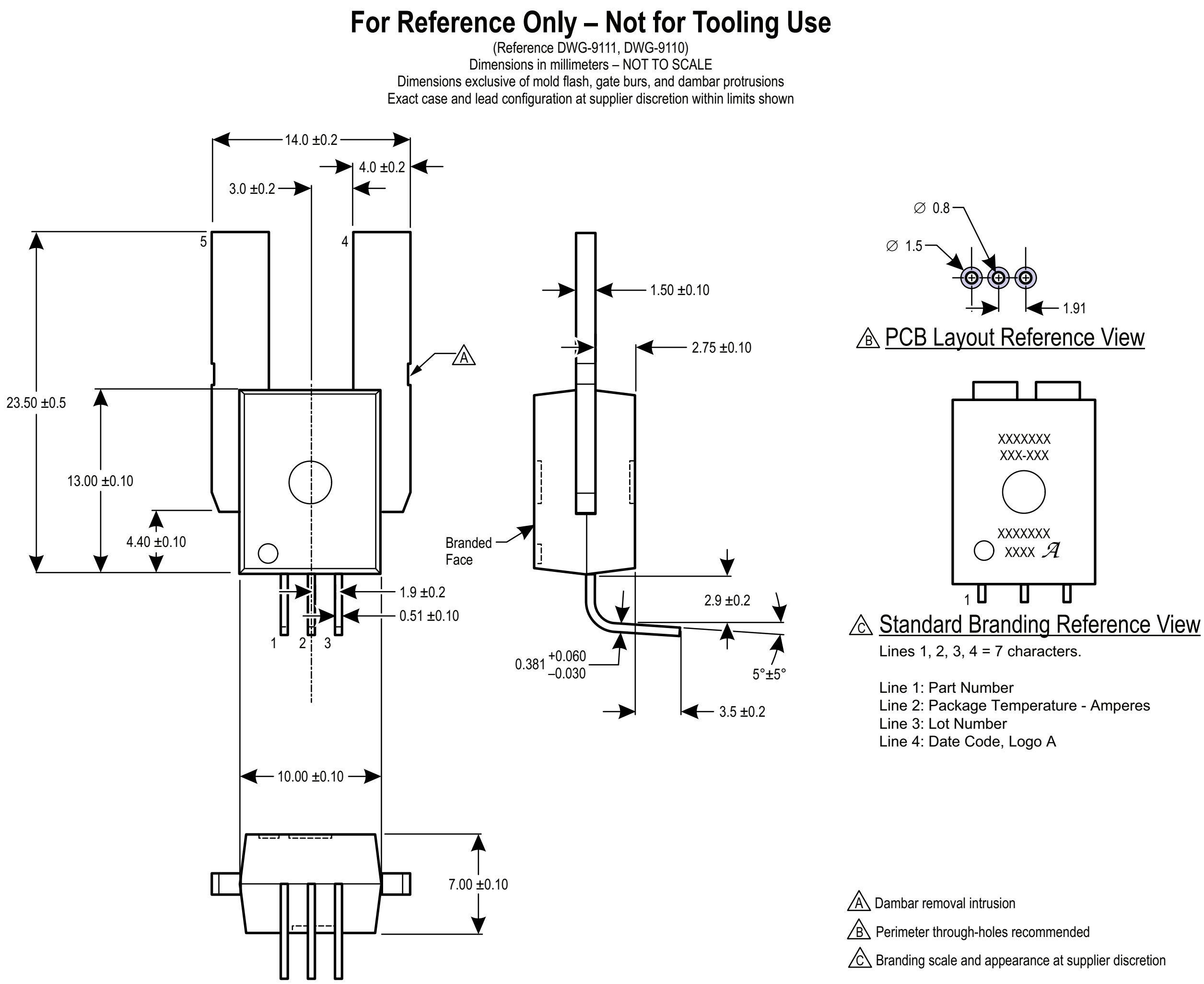

Figure 13: Package CB, 5-Pin, Leadform PSF

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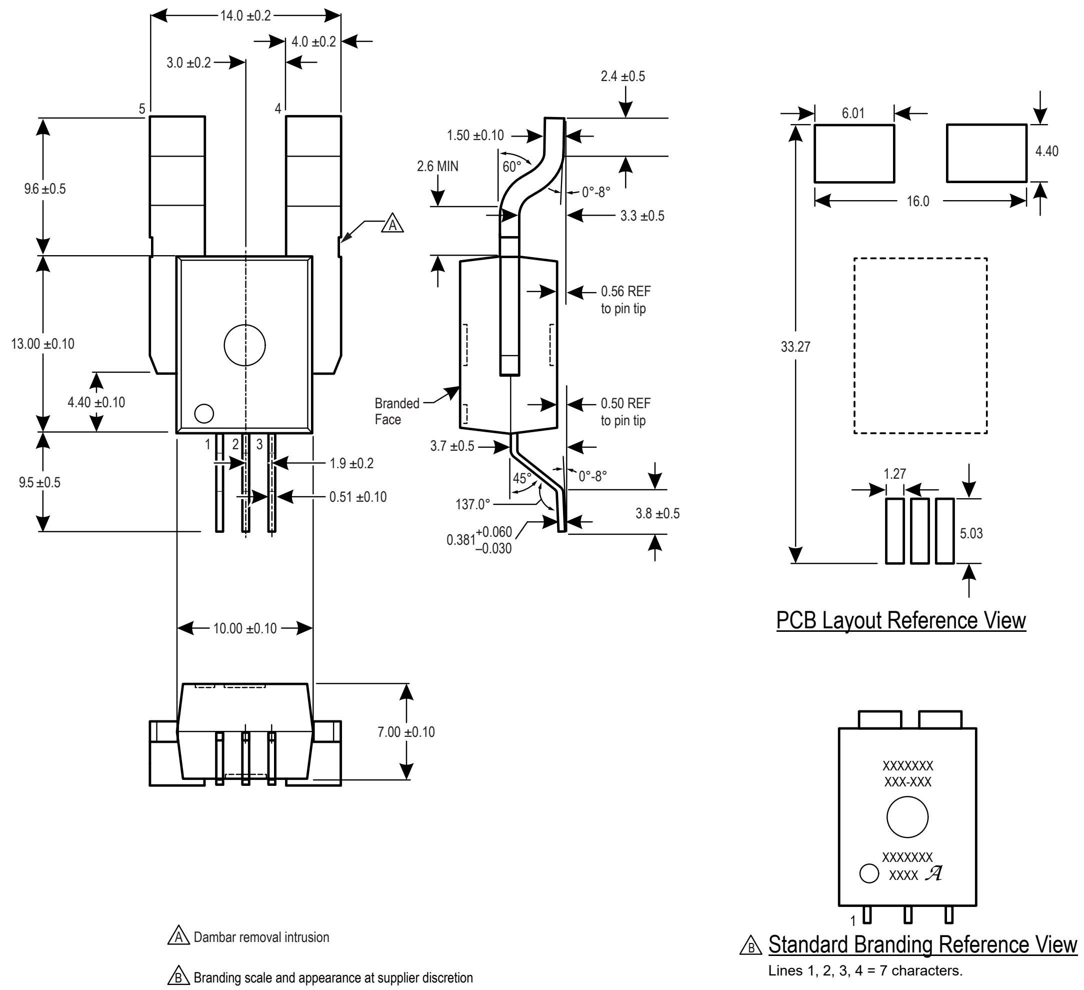
(Reference DWG-9111, DWG-9110)
Dimensions in millimeters – NOT TO SCALE
Dimensions exclusive of mold flash, gate burs, and dambar protrusions
Exact case and lead configuration at supplier discretion within limits shown



Lines 1, 2, 3, 4 = 7 characters.

Line 1: Part Number
Line 2: Package Temperature - Amperes
Line 3: Lot Number
Line 4: Date Code, Logo A

Figure 14: Package CB, 5-Pin, Leadform SMT

Note: The SMT leadform package variant is considered
Advance Information, and is subject to change without notice.

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Revision History

Number	Date	Description
–	December 12, 2017	Initial release
1	February 9, 2018	Added Dielectric Surge Strength Test Voltage characteristic (page 3) and EEPROM Error Checking and Correction section (page 15). Updated Power-On Reset (POR) section (page 14).
2	May 29, 2018	Added Characteristic Performance plots and -150B part variant.
3	November 2, 2018	Added -PSF leadform option and Applications Information section (page 22); updated Typical Application (page 1), pinout diagram (page 4), T_{OP} to T_A (pages 2 and 5-9), and Character Performance plots (page 11-12).
4	December 12, 2018	Added UL certificate; updated package outline drawing PCB layouts and branding (pages 24-25)
5	March 14, 2019	Updated package branding (pages 24-25) and Temperature ratings (pages 2-3, 6-10)
6	June 27, 2019	Corrected EVB copper thickness (page 23)
7	August 28, 2019	Added Maximum Continuous Current to Absolute Maximum Ratings table (page 3), ESD ratings table (page 3), and updated thermal data section (page 23)
8	November 6, 2019	Added SMT leadform package variant (pages 1, 2, 26) and Isolation Characteristics Pending Certification (page 3).
9	December 10, 2019	Added PCB Layout Reference View to SMT Leadform package drawings (page 26)
10	December 20, 2019	Removed Advance Information status from SMT leadform package variant (pages 1-2); updated Working Voltage for Basic Isolation and Working Voltage for Reinforced Isolation (page 3), Rise Time, Response Time, Propagation Delay, and Output Slew Rate test conditions, and Output Slew Rate value (page 5).
11	January 20, 2021	Added ACS773ECB-200B-PSF-T part option to Selection Guide (page 2).

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