BROADCOM®

Data Sheet

ACHS-719x

Fully Integrated, Hall-Effect Based Linear Current Sensor IC with 3 kV_{RMS} Isolation and a Low-Resistance Current Conductor

Description

The Broadcom® ACHS-719x (±10A to ±50A) fully integrated Hall-effect based isolated linear current sensors are designed for AC or DC current sensing in industrial, commercial, and communications systems. Inside each ACHS-719x IC is a precise, low-offset, linear Hall circuit with a copper conduction path located near the surface of the die. Applied current flowing through this copper conduction path generates a magnetic field that the differential Hall sensors convert into a proportional voltage. Device accuracy is optimized across the operating ambient temperature through the close proximity of the magnetic signal to the Hall sensors.

A precise, proportional voltage is provided by the low-offset, chopper-stabilized CMOS Hall IC, which is programmed for accuracy after packaging. The output of the device has a positive slope (>$V_{OUT(Q)}$) when an increasing current flows through the primary copper conduction path (from pins 1 and 2 to pins 3 and 4), which is the path used for current sampling.

The internal resistance of this conductive path is 0.7 mΩ typical, providing low power loss. The terminals of the conductive path are electrically isolated from the signal leads (pins 5 through 8).

This performance is delivered in a compact, surface mountable, SO-8 package that meets worldwide regulatory safety standards.

Features

- Wide operating temperature: –40ºC to +110ºC
- Internal conductor resistance: 0.7 mΩ typ.
- Sensing current range: ± 10A ~ ± 50A
- Output sensitivity: 40 mV/A to 185 mV/A
- Output voltage proportional to AC or DC currents
- Ratiometric output from supply voltage
- Single supply operation: 5.0V
- Low-noise analog signal path
- Device bandwidth is set via the new FILTER pin
  - 80 kHz typ. bandwidth with 1-nF filter capacitor
- Factory-trimmed for accuracy
- Extremely stable output offset voltage
- Near-zero magnetic hysteresis
- Maximum output error of ±6.0% across operating T_A
- >25 kV/µs common mode transient immunity
- Small footprint, low-profile SO-8 package
- Worldwide safety approval: UL/cUL, IEC/EN 62368-1 (V_{iorm} = 567 V_{peak})
  - Isolation voltage: 3 kVrms, 1 minute

Applications

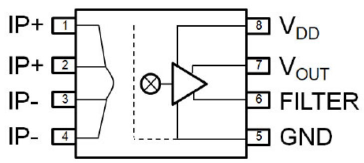
- Low-power inverter current sensing
- eBikes
- Motor phase and rail current sensing
- Solar inverters
- Chargers and converters
- Switching power supplies

CAUTION! Take normal static precautions in the handling and assembly of this component to prevent damage, degradation, or both, which may be induced by ESD. The components featured in this data sheet are not to be used in military or aerospace applications or environments. The component is not AEC-Q100 qualified and not recommended for automotive applications.

Part Number	Current Range	Sensitivity
ACHS-7191	±10A	185 mV/A
ACHS-7192	±20A	100 mV/A
ACHS-7193	±30A	66 mV/A
ACHS-7194	±40A	50 mV/A
ACHS-7195	±50A[a]	40 mV/A

a. Due to the package dissipation power limitations, the input power of ACHS-7195 must be derated at –25.2 mW/°C above 85°C on a 4-oz copper PCB.

Functional Diagram



NOTE: The connection of a 1-μF bypass capacitor between pins 8 and 5 is recommended.

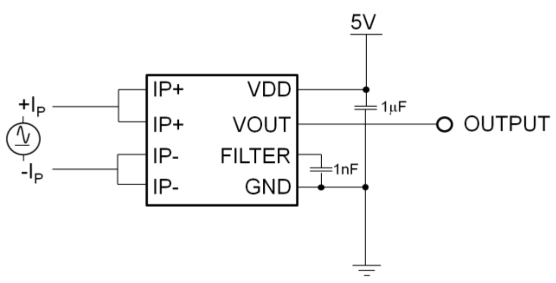
Pin Description

Pin	Pin Name	Description
1	IP+	Terminals for current being sampled; fused internally
2	IP+	
3	IP-	Terminals for current being sampled; fused internally
4	IP-	

Pin	Pin Name	Description
8	V_{DD}	Supply voltage relative to GND
7	V_{OUT}	Output voltage
6	FILTER	Filter pin to set bandwidth
5	GND	Output side ground

Typical Application Circuit

A typical application circuit of each ACHS-719x will have a 1-μF bypass capacitor and a filter capacitor as additional external components. The input side pin 1 and pin 2 are shorted together, and pin 3 and pin 4 are shorted together. The output voltage is directly measured from the V_{OUT} pin.



Ordering Information

Part Number	Current Rating	Option (RoHS) Compliant	Package	Surface Mount	Tape & Reel	UL 3 kV_{RMS} 1 min. Rating	Quantity
ACHS-7191	± 10A	-000E	SO-8	X		X	100 per tube
		-500E		X	X	X	1500 per reel
ACHS-7192	± 20A	-000E		X		X	100 per tube
		-500E		X	X	X	1500 per reel
ACHS-7193	± 30A	-000E		X		X	100 per tube
		-500E		X	X	X	1500 per reel
ACHS-7194	± 40A	-000E		X		X	100 per tube
		-500E		X	X	X	1500 per reel
ACHS-7195	± 50A	-000E		X		X	100 per tube
		-500E		X	X	X	1500 per reel

To form an order entry, choose a part number from the Part Number column and combine with the desired option from the Option column.

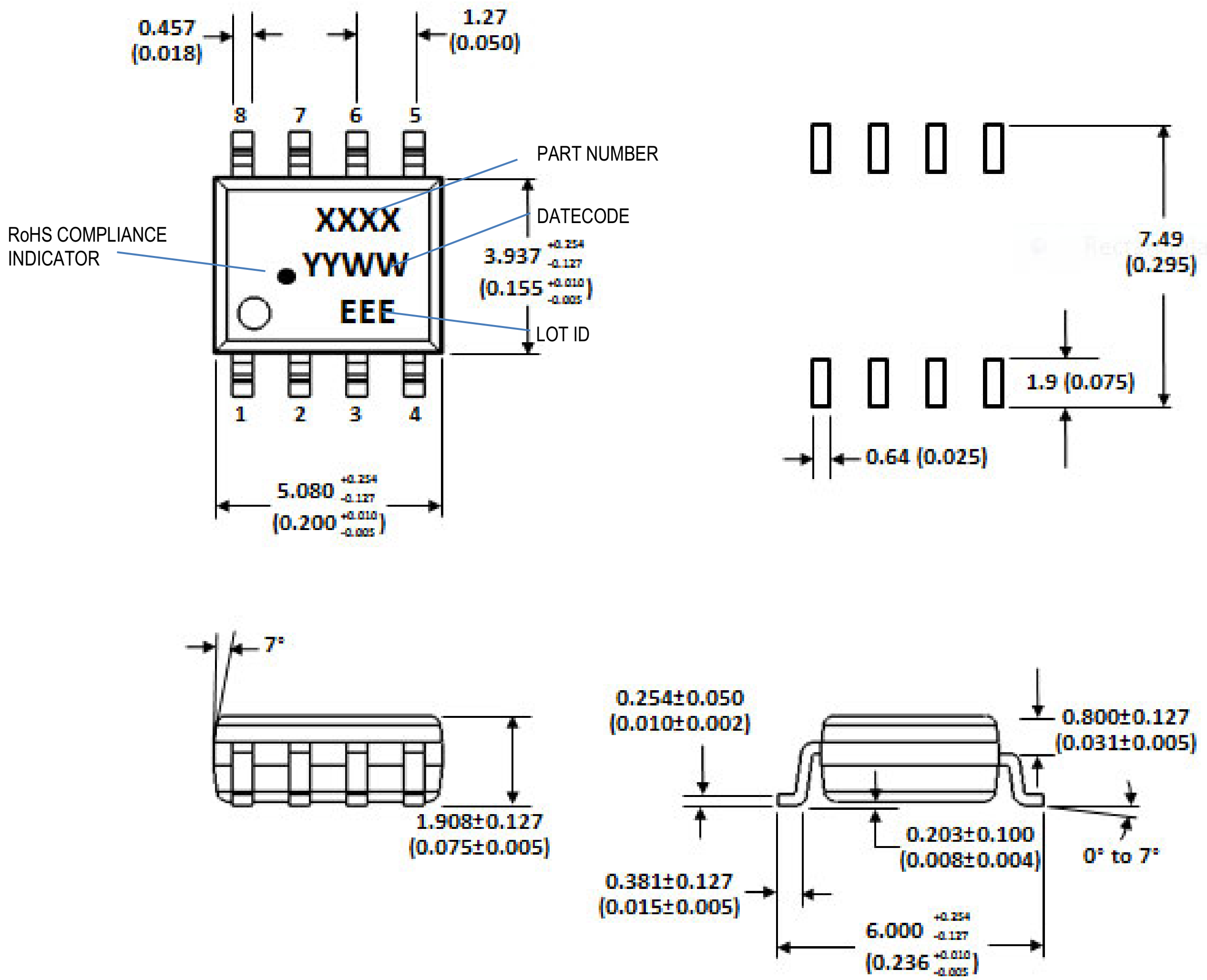
Example 1:

Select ACHS-7195-500E to order the product with ±50A, Surface Mount type in Tape-and-Reel packaging and RoHS compliance. Contact your Broadcom sales representative or authorized distributor for information.

Option data sheets are available. Contact your Broadcom sales representative or authorized distributor for information.

Package Outline Drawing

ACHS-719x SO-8 Package



NOTE:

1. Dimensions are in millimeters (inches).
2. Lead coplanarity = 0.100 mm (0.004 in.) maximum.
3. Floating lead protrusion = 0.254 mm (0.010 in.) maximum.
4. Mold flash on each side = 0.127 mm (0.005 in.) maximum.

Recommended Pb-Free IR Profile

Recommended reflow condition as per JEDEC Standard, J-STD-020 (latest revision). Non-halide flux should be used.

Regulatory Information

The ACHS-719x ICs are approved by the following organizations:

- UL/cUL approval: UL 1577, component recognition program up to V_{ISO} = 3000 V_{RMS}.
- Approved under IEC/EN 62368-1 (former IEC 60950-1), certified under TUV Rheinland at working voltage V_{iorm} = 567 V_{peak}.

Insulation and Safety Related Specifications

Parameter	Symbol	Value	Units	Conditions
Minimum External Air Gap (External Clearance)	L(101)	4.0	mm	Measured from input terminals to output terminals, shortest distance through air.
Minimum External Tracking (External Creepage)	L(102)	4.0	mm	Measured from input terminals to output terminals, shortest distance path along the body.
Minimum Internal Plastic Gap (Internal Clearance)	—	0.05	mm	Through insulation distance, conductor to conductor, usually the direct distance between the primary input conductor and the detector IC.
Tracking Resistance (Comparative Tracking Index)	CTI	>175	V	DIN IEC 112/VDE 0303 Part 1.
Isolation Group	—	IIIa	—	Material Group (DIN VDE 0110, 1/89, Table 1).

Absolute Maximum Rating

Parameter	Symbol	Min.	Max.	Units	Test Conditions
Storage Temperature	T_S	–55	+125	°C	
Ambient Operating Temperature	T_A	–40	+110	°C	
Junction Temperature	$T_{J(max)}$	—	+150	°C	
Primary Conductor Lead Temperature	$T_{L(MAX)}$	—	+150	°C	Pins 1, 2, 3, or 4
Supply Voltage	V_{DD}	–0.5	8.0	V	
Output Voltage	V_{OUT}	–0.5	V_{DD} + 0.5	V	
Output Current Source	$I_{OUT(source)}$	—	10	mA	T_A = 25°C
Output Current Sink	$I_{OUT(sink)}$	—	10	mA	T_A = 25°C
Overcurrent Transient Tolerance	I_P	—	100	A	1 pulse, 100 ms; T_A = 25°C
Input Power Dissipation[a]	P_{IN}	—	1750	mW	
Output Power Dissipation	P_{OUT}	—	90	mW	

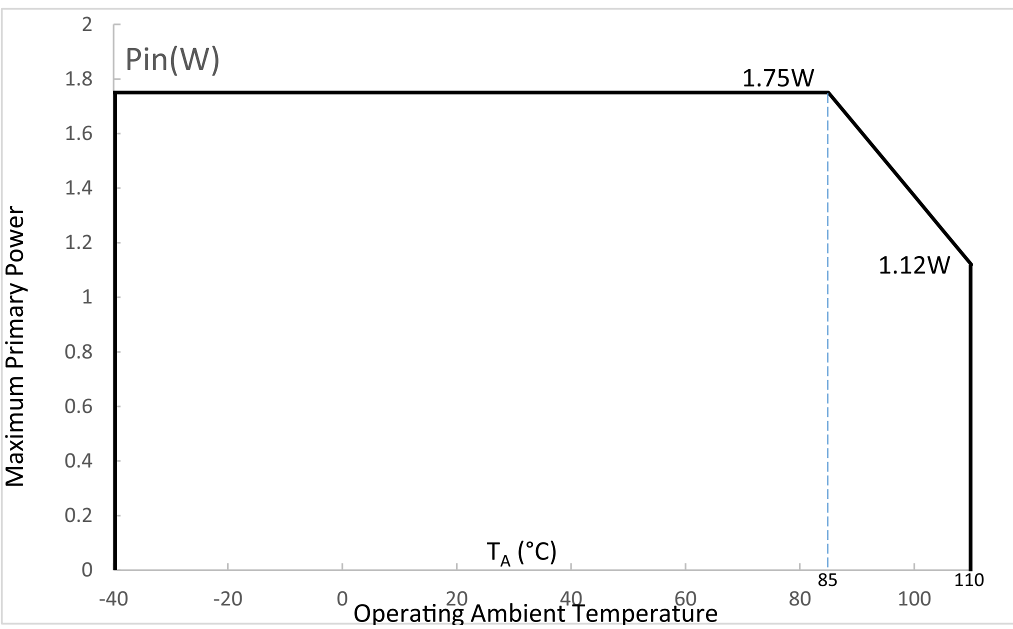
a. Absolute maximum input power dissipation is only valid if a 4-oz copper PCB is used. This power is valid up to 85°C ambient temperature. For >85°C ambient, a derating factor of –25.2 mW/°C is required.

Recommended Operating Conditions

Parameter		Symbol	Min.	Max.	Units
Ambient Operating Temperature		T_A	–40	+110	°C
VDD Supply Voltage		V_{DD}	4.5	5.5	V
Output Capacitance Load		C_{LOAD}	—	10	nF
Output Resistive Load		R_{LOAD}	4.7	—	kΩ
Input Current Range	ACHS-7191	I_P	–10	+10	A
	ACHS-7192		–20	+20	A
	ACHS-7193		–30	+30	A
	ACHS-7194		–40	+40	A
	ACHS-7195[a]		–50	+50	A

a. Due to the SO-8 package power dissipation limitations, the input peak current is valid up to 85°C ambient temperature only on a 4-oz copper PCB. For >85°C ambient, derating is required. For details, see Footnote a at Absolute Maximum Rating. For the input power derating curve, see Primary Power Derating Curve for ACHS-7195.

Primary Power Derating Curve for ACHS-7195



NOTE: Mounted on Broadcom's evaluation board as shown in Figure 16 and Figure 17.

Common Electrical Specifications

Unless otherwise noted, all minimum/maximum specifications are over-recommended operating conditions, C_F = 1 nF. Typical values are at T_A = +25°C, V_{DD} = 5.0V, C_F = 1 nF.

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Condition	Figure	Note
Supply Current	I_{DD}	—	13	15	mA	V_{DD} = 5V, output open	5, 6	
Primary Conductance Resistance	$R_{PRIMARY}$	—	0.7	—	mΩ			
Zero Current Output Voltage	$V_{OUT(Q)}$	—	V_{DD} / 2	—	V	Bidirectional, I_P = 0A	2	
Input Filter Resistance	$R_{F(INT)}$	—	1.6	—	kΩ			
Bandwidth	BW	—	80	—	kHz	–3 dB		
Rise Time	t_r	—	4	—	µs		10	
Power-on Time	t_{PO}	—	21	—	µs		8	
Common Mode Transient Immunity	CMTI	25	—	—	kV/µs	V_{CM} = 1000V		a

a. Common Mode Transient Immunity is tested by applying a fast rising/falling voltage pulse across pin 4 and GND (pin 5). The output glitch observed is less than 0.2V from the average output voltage for less than 1 µs.

Electrical Specifications

ACHS-7191

Unless otherwise noted, all minimum and maximum specifications are over-recommended operating conditions, C_F = 1 nF. Typical values are at T_A = +25°C, V_{DD} = 5.0V, C_F = 1 nF.

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions	Figure	Note
Optimized Accuracy Range	I_P	–10	—	+10	A		7	a
Sensitivity	Sens	—	185	—	mV/A	–10A ≤ I_P ≤ +10A	1	b
Sensitivity Error	E_{SENS}	–5	±3	+5	%	T_A = –40°C to 110°C, V_{DD} = 5V	1	b
Sensitivity Slope	∆Sens	—	0.04	—	mV/A/°C	T_A = –40°C to 25°C	1	b
		—	0.01	—		T_A = 25°C to 110°C	1	b
Zero Current Output Error	V_{OE}	–30	—	+30	mV	T_A = 25°C	2	b
Zero Current Output Error Slope	ΔV_{OE}	—	0.03	—	mV/°C	T_A = –40°C to 25°C	2	b
		—	0.06	—		T_A = 25°C to 110°C	2	b
Output Noise	$V_{N(RMS)}$	—	7.8	—	mV	BW = 2 kHz	9	c
Nonlinearity	NL	—	0.27	—	%		3	d
Total Output Error	E_{TOT}	–6	±1.5	+6	%	T_A = –40°C to 110°C	4	e
Sensitivity Error Lifetime Drift	E_{SENS_DRIFT}	—	±2	—	%			
Total Output Error Lifetime Drift	E_{TOT_DRIFT}	—	±2	—	%			

a. The device may be operated at higher primary current levels, I_P, provided that the Maximum Junction Temperature, $T_{J(MAX)}$, is not exceeded.

b. See Definition of Electrical Characteristics.

c. Output Noise is the noise level of ACHS-7191 expressed in root mean square (RMS) voltage.

d. Nonlinearity is defined as half of the peak-to-peak output deviation from the best-fit line, expressed as a percentage of the full-scale output voltage. See Definition of Electrical Characteristics for the complete definition and formula.

e. Total Output Error in percentage is the difference between the measured output voltage at maximum input current (I_{PMAX}) and the ideal output voltage at I_{PMAX} divided by the ideal output voltage at I_{PMAX}. The Total Output Error's typical value is based on the total output error measured at the point of product release.

ACHS-7192

Unless otherwise noted, all minimum/maximum specifications are over-recommended operating conditions, C_F = 1 nF. Typical values are at T_A = +25°C, V_{DD} = 5.0V, C_F = 1 nF.

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions	Figure	Note
Optimized Accuracy Range	I_P	–20	—	+20	A		7	a
Sensitivity	Sens	—	100	—	mV/A	–20A ≤ I_P ≤ +20A	1	b
Sensitivity Error	E_{SENS}	–4.5	±3	+4.5	%	T_A = –40°C to 110°C, V_{DD} = 5V	1	b
Sensitivity Slope	∆Sens	—	0.01	—	mV/A/°C	T_A = –40°C to 25°C	1	b
		—	0.01	—	%	T_A = 25°C to 110°C	1	b
Zero Current Output Error	V_{OE}	–25	—	+25	mV	T_A = 25°C	2	b
Zero Current Output Error Slope	ΔV_{OE}	—	–0.01	—	mV/°C	T_A = –40°C to 25°C	2	b
		—	0.02	—	mV/°C	T_A = 25°C to 110°C	2	b
Output Noise	$V_{N(RMS)}$	—	4.1	—	mV	BW = 2 kHz	9	c
Nonlinearity	NL	—	0.18	—	%		3	d
Total Output Error	E_{TOT}	–5.5	±1.5	+5.5	%	T_A = –40°C to 110°C	4	e
Sensitivity Error Lifetime Drift	E_{SENS_DRIFT}	—	±2	—	%			
Total Output Error Lifetime Drift	E_{TOT_DRIFT}	—	±2	—	%			

a. The device may be operated at higher primary current levels, I_P, provided that the Maximum Junction Temperature, $T_{J(MAX)}$, is not exceeded.

b. See Definition of Electrical Characteristics.

c. Output Noise is the noise level of ACHS-7192 expressed in root mean square (RMS) voltage.

d. Nonlinearity is defined as half of the peak-to-peak output deviation from the best-fit line, expressed as a percentage of the full-scale output voltage. See Definition of Electrical Characteristics for the complete definition and formula.

e. Total Output Error in percentage is the difference between the measured output voltage at maximum input current (I_{PMAX}) and the ideal output voltage at I_{PMAX} divided by the ideal output voltage at I_{PMAX}. The Total Output Error's typical value is based on the total output error measured at the point of product release.

ACHS-7193

Unless otherwise noted, all minimum/maximum specifications are over-recommended operating conditions, C_F = 1 nF. Typical values are at T_A = +25°C, V_{DD} = 5.0V, C_F = 1 nF.

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions	Figure	Note
Optimized Accuracy Range	I_P	–30	—	+30	A		7	a
Sensitivity	Sens	—	66	—	mV/A	–30A ≤ I_P ≤ +30A	1	b
Sensitivity Error	E_{SENS}	–4.5	±3	+4.5	%	T_A = –40°C to 110°C, V_{DD} = 5V	1	b
Sensitivity Slope	ΔSens	—	0.01	—	mV/A/°C	T_A = –40°C to 25°C	1	b
		—	0.01	—	%	T_A = 25°C to 110°C	1	b
Zero Current Output Error	V_{OE}	–20	—	+20	mV	T_A = 25°C	2	b
Zero Current Output Error Slope	ΔV_{OE}	—	0.01	—	mV/°C	T_A = –40°C to 25°C	2	b
		—	0.02	—	mV/°C	T_A = 25°C to 110°C	2	b
Output Noise	$V_{N(RMS)}$	—	2.7	—	mV	BW = 2 kHz	9	c
Nonlinearity	NL	—	0.11	—	%		3	d
Total Output Error	E_{TOT}	–5.5	±1.5	+5.5	%	T_A = –40°C to 110°C	4	e
Sensitivity Error Lifetime Drift	E_{SENS_DRIFT}	—	±2	—	%			
Total Output Error Lifetime Drift	E_{TOT_DRIFT}	—	±2	—	%			

a. The device may be operated at higher primary current levels, I_P, provided that the Maximum Junction Temperature, $T_{J(MAX)}$, is not exceeded.

b. See Definition of Electrical Characteristics.

c. Output Noise is the noise level of ACHS-7193 expressed in root mean square (RMS) voltage.

d. Nonlinearity is defined as half of the peak-to-peak output deviation from the best-fit line, expressed as a percentage of the full-scale output voltage. See Definition of Electrical Characteristics for the complete definition and formula.

e. Total Output Error in percentage is the difference between the measured output voltage at maximum input current (I_{PMAX}) and the ideal output voltage at I_{PMAX} divided by the ideal output voltage at I_{PMAX}. The Total Output Error's typical value is based on the total output error measured at the point of product release.

ACHS-7194

Unless otherwise noted, all minimum/maximum specifications are over-recommended operating conditions, C_F = 1 nF. Typical values are at T_A = +25°C, V_{DD} = 5.0V, C_F = 1 nF.

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions	Figure	Note
Optimized Accuracy Range	I_P	–40	—	+40	A		7	a
Sensitivity	Sens	—	50	—	mV/A	–40A ≤ I_P ≤ 40A	1	b
Sensitivity Error	E_{SENS}	–4.5	±3	+4.5	%	T_A = –40°C to 110°C, V_{DD} = 5V	1	b
Sensitivity Slope	∆Sens	—	0.01	—	mV/A/°C	T_A = –40°C to 25°C	1	b
		—	0.01	—	%	T_A = 25°C to 110°C	1	b
Zero Current Output Error	V_{OE}	–20	—	+20	mV	T_A = 25°C	2	b
Zero Current Output Error Slope	ΔV_{OE}	—	–0.01	—	mV/°C	T_A = –40°C to 25°C	2	b
		—	0.02	—	mV/°C	T_A = 25°C to 110°C	2	b
Output Noise	$V_{N(RMS)}$	—	2	—	mV	BW = 2 kHz	9	c
Nonlinearity	NL	—	0.1	—	%		3	d
Total Output Error	E_{TOT}	–5.5	±1.5	+5.5	%	T_A = –40°C to 110°C	4	e
Sensitivity Error Lifetime Drift	E_{SENS_DRIFT}	—	±2	—	%			
Total Output Error Lifetime Drift	E_{TOT_DRIFT}	—	±2	—	%			

a. The device may be operated at higher primary current levels, I_P, provided that the Maximum Junction Temperature, ($T_{J(MAX)}$), is not exceeded.

b. See Definition of Electrical Characteristics.

c. Output Noise is the noise level of ACHS-7194 expressed in root mean square (RMS) voltage.

d. Nonlinearity is defined as half of the peak-to-peak output deviation from the best-fit line, expressed as a percentage of the full-scale output voltage. See Definition of Electrical Characteristics for the complete definition and formula.

e. Total Output Error in percentage is the difference between the measured output voltage at maximum input current (I_{PMAX}) and the ideal output voltage at I_{PMAX} divided by the ideal output voltage at I_{PMAX}. The Total Output Error's typical value is based on the total output error measured at the point of product release.

ACHS-7195

Unless otherwise noted, all minimum/maximum specifications are over-recommended operating conditions, C_F = 1 nF. Typical values are at T_A = +25°C, V_{DD} = 5.0V, C_F = 1 nF.

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions	Figure	Note
Optimized Accuracy Range[a]	I_P	–50	—	+50	A		7	b
Sensitivity	Sens	—	40	—	mV/A	–50A ≤ I_P ≤ 50A	1	c
Sensitivity Error	E_{SENS}	–4.5	±3	+4.5	%	T_A = –40°C to 110°C, V_{DD} = 5V	1	c
Sensitivity Slope	∆Sens	—	+0.01	—	mV/A/°C	T_A = –40°C to 25°C	1	c
		—	0	—	%	T_A = 25°C to 110°C	1	c
Zero Current Output Error	V_{OE}	–30	—	+30	mV	T_A = 25°C	2	c
Zero Current Output Error Slope	ΔV_{OE}	—	–0.01	—	mV/°C	T_A = –40°C to 25°C	2	c
		—	0.01	—	mV/°C	T_A = 25°C to 110°C	2	c
Output Noise	$V_{N(RMS)}$	—	1.7	—	mV	BW = 2 kHz	9	d
Nonlinearity	NL	—	0.08	—	%		3	e
Total Output Error	E_{TOT}	–5.5	±1.5	+5.5	%	T_A = –40°C to 110°C	4	f
Sensitivity Error Lifetime Drift	E_{SENS_DRIFT}	—	±2	—	%			
Total Output Error Lifetime Drift	E_{TOT_DRIFT}	—	±2	—	%			

a. Due to the SO-8 package power dissipation limitations, the input RMS or DC current of the 50A product must be derated above 85°C ambient at –25.2 mW/°C on a 4-oz copper PCB.

b. The device may be operated at higher primary current levels, I_P, provided that the Maximum Junction Temperature, $T_{J(MAX)}$, is not exceeded.

c. See Definition of Electrical Characteristics.

d. Output Noise is the noise level of ACHS-7195 expressed in root mean square (RMS) voltage.

e. Nonlinearity is defined as half of the peak-to-peak output deviation from the best-fit line, expressed as a percentage of the full-scale output voltage. See Definition of Electrical Characteristics for the complete definition and formula.

f. Total Output Error in percentage is the difference between the measured output voltage at maximum input current (I_{PMAX}) and the ideal output voltage at I_{PMAX} divided by the ideal output voltage at I_{PMAX}. The Total Output Error's typical value is based on the total output error measured at the point of product release.

Package Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Condition	Note
Input-Output Momentary Withstand Voltage	V_{ISO}	3000	—	—	V_{RMS}	RH < 50%, t = 1 minute, T_A = 25°C	a, b, c
Resistance (Input-Output)	R_{I-O}	—	10^{14}	—	Ω	V_{I-O} = 500 V_{DC}	c
Capacitance (Input-Output)	C_{I-O}	—	1.3	—	pF	f = 1 MHz	c
Junction-to-Ambient Thermal Resistance (Due to Primary Conductor)	$R_{\theta 12}$	—	35	—	°C/W	Based on the Broadcom evaluation board	d
Junction-to-Ambient Thermal Resistance (Due to IC)	$R_{\theta 22}$	—	22	—	°C/W	Based on the Broadcom evaluation board	d

a. In accordance with UL 1577, each device is proof-tested by applying an insulation test voltage ≤ 3600 V_{RMS} for 1 second.

b. The Input-Output Momentary Withstand Voltage is a dielectric voltage rating that should not be interpreted as an input-output continuous voltage rating.

c. This is a two-terminal measurement: pins 1 through 4 are shorted together, and pins 5 through 8 are shorted together.

d. The Broadcom evaluation board has 650 mm^2 (total area including the top and bottom copper minus the mounting holes) of 4-oz copper connected to pins 1 and 2 and pins 3 and 4. See Thermal Consideration for additional information on thermal characterization.

Typical Performance Plots

All typical plots are based on T_A = 25°C, V_{DD} = 5V, C_F = 1 nF, unless otherwise stated.

Figure 1: Sensitivity vs. Temperature

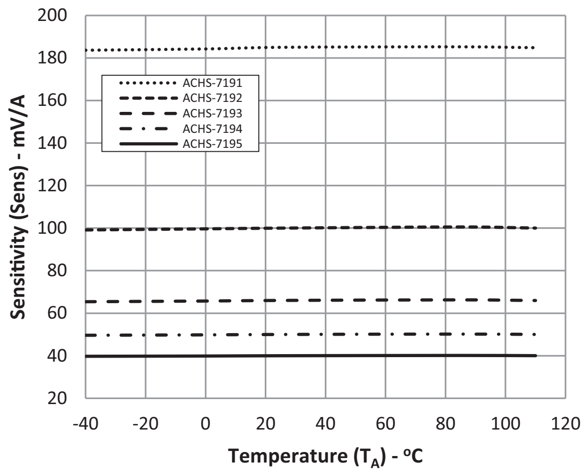


Figure 2: Zero Current Output Voltage vs. Temperature

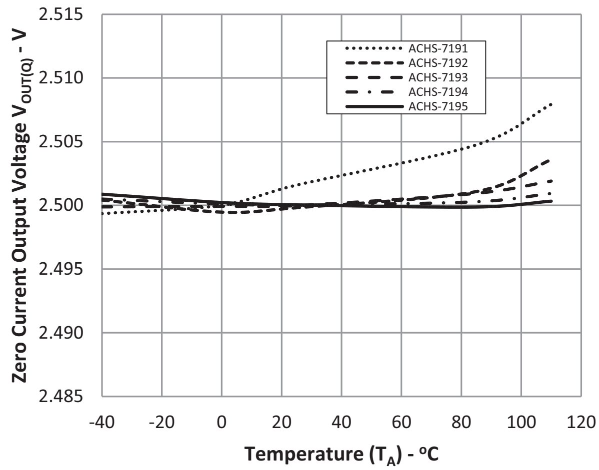


Figure 3: Nonlinearity vs. Temperature

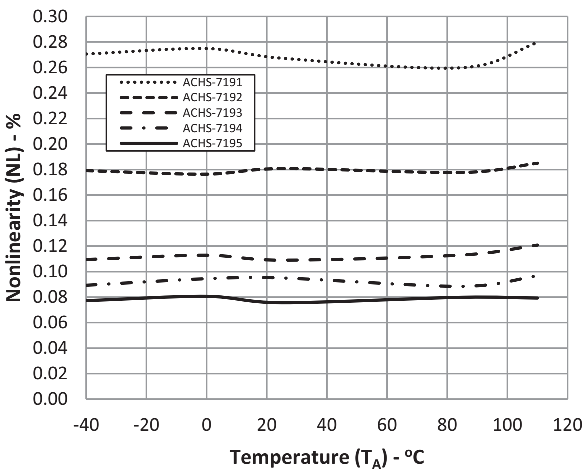


Figure 4: Total Output Error @ $I_{P(MAX)}$ vs. Temperature

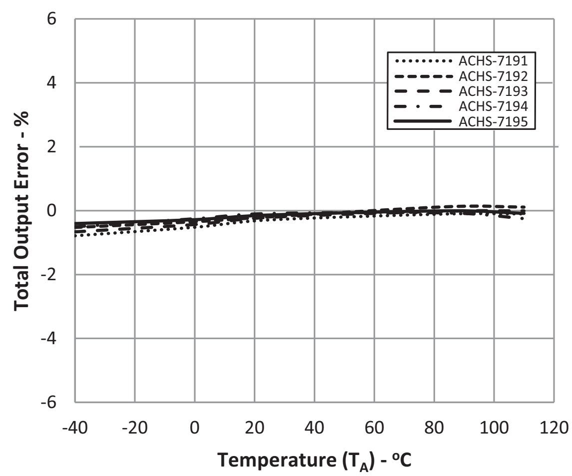


Figure 5: Supply Current vs. Temperature

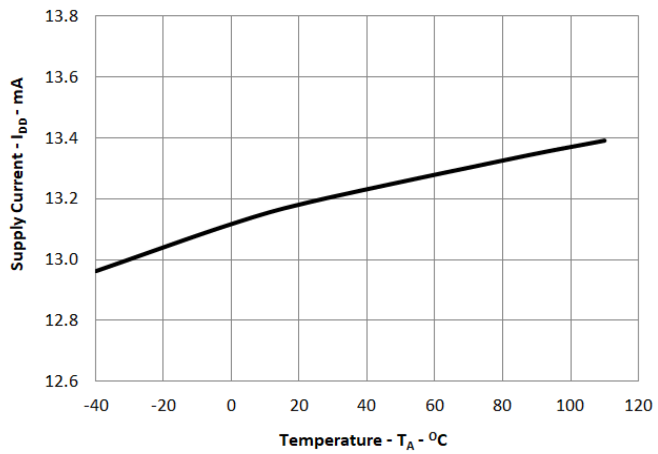


Figure 6: Supply Current vs. Supply Voltage

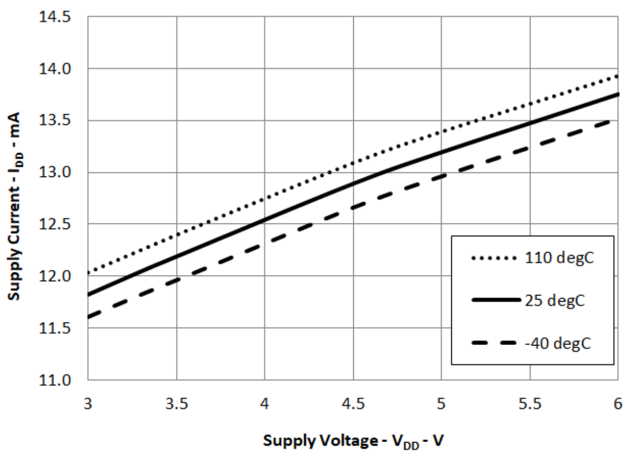


Figure 7: Output Voltage vs. Sensed Current

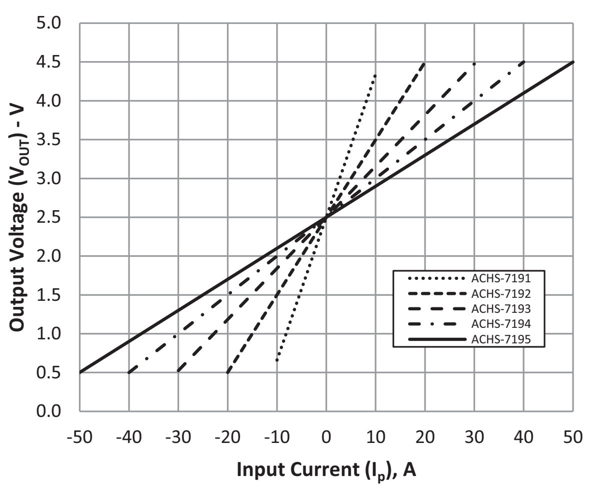


Figure 8: Power-On Time vs. External Filter

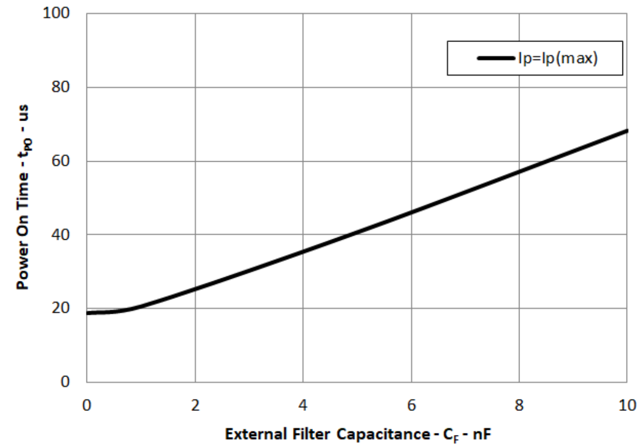


Figure 9: Noise vs. External Filter

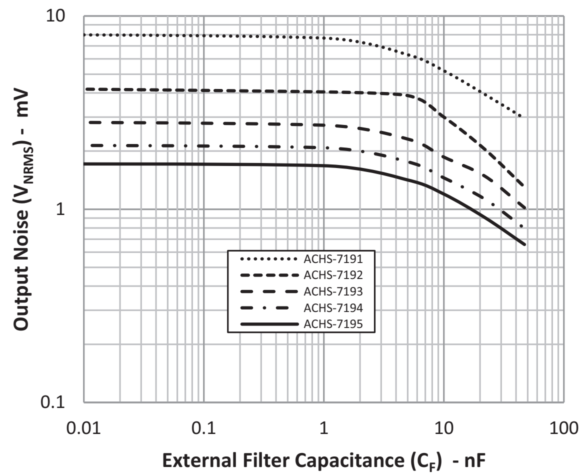
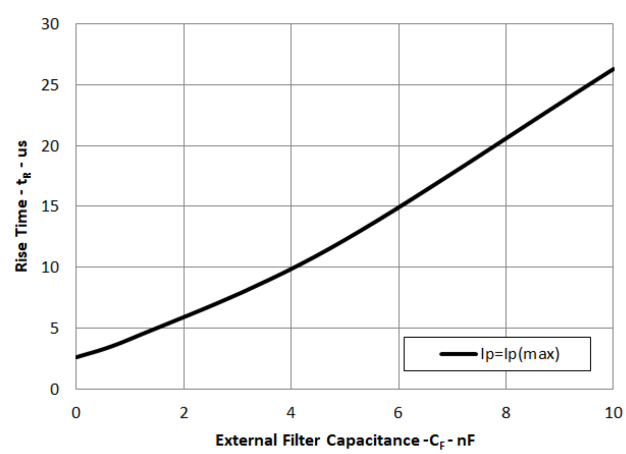


Figure 10: Rise Time vs. External Filter



Definition of Electrical Characteristics

The ACHS-719x product series is a Hall-effect current sensor that sends an analog voltage proportional to the magnetic field intensity caused by the current flowing through the input primary conductor. Without a magnetic field, the output voltage is half of the supply voltage. It can detect both DC and AC current.

Ratiometric Output

The output voltage of the ACHS-719x series is ratiometric or proportional to the supply voltage. The sensitivity (Sens) of the device and the quiescent output voltage change when there is a change in the supply voltage (V_{DD}). For example, for ACHS-7195 when the V_{DD} is increased by +10% from 5V to 5.5V, the quiescent output voltage will change from 2.5V to 2.75V and the sensitivity will also change from 40 mV/A to 44 mV/A.

Sensitivity

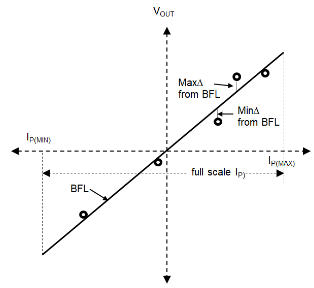
The output sensitivity (Sens) is the ratio of the output voltage (V_{OUT}) over the input current (I_P) flowing through the primary conductor. It is expressed in mV/A. When an applied current flows through the input primary conductor, it generates a magnetic field that the Hall IC converts into a voltage. The proportional voltage is provided by the Hall IC, which is programmed at the factory for accuracy after packaging. The output voltage has a positive slope when an increasing current flows through pins 1 and 2 to pins 3 and 4. Sensitivity Error (E_{SENS}) is the difference between the measured sensitivity and the ideal sensitivity expressed in percentage (%).

Nonlinearity

Nonlinearity is defined as half of the peak-to-peak output deviation from the best-fit line (BFL), expressed as a percentage of the full-scale output voltage. The full-scale output voltage is the product of the sensitivity (Sens) and full scale input current (I_P).

$$NL\ (\%) = \frac{[(\text{Max}\,\Delta\,\text{from BFL} - \text{Min}\,\Delta\,\text{from BFL}) / 2]}{\text{Sens} \times \text{Full Scale } I_P} \times 100\%$$

Figure 11: Nonlinearity Calculation



Zero Current Output Voltage

This is the output voltage of ACHS-719x when the primary current is zero. Zero current output voltage is half of the supply voltage ($V_{DD}/2$).

Zero Current Output Error

This the voltage difference between the measured output voltage and the ideal output voltage ($V_{DD}/2$) when there is no input current to the device.

Total Output Error

Total output error in percentage is the difference between the measured output voltage at maximum input current (I_{PMAX}) and the ideal output voltage at I_{PMAX} divided by the ideal output voltage at I_{PMAX}.

$$E_{TOT}(\%) = \frac{\text{Measured } V_{OUT} @ I_{PMAX} - \text{Ideal } V_{OUT} @ I_{PMAX}}{\text{Ideal } V_{OUT} @ I_{PMAX}} \times 100\%$$

Power-On Time

This is the time required for the internal circuitry of the device to be ready during the ramping of the supply voltage. Power-on time is defined as the finite time required for the output voltage to settle after the supply voltage reaches its recommended operating voltage.

FILTER Pin

The ACHS-719x has a FILTER pin for improving the signal-to-noise ratio of the device. This eliminates the need for an external RC filter to the V_{OUT} pin of the device, which can cause attenuation of the output signal. A ceramic capacitor, C_F, can be connected between the FILTER pin to GND.

Application Information

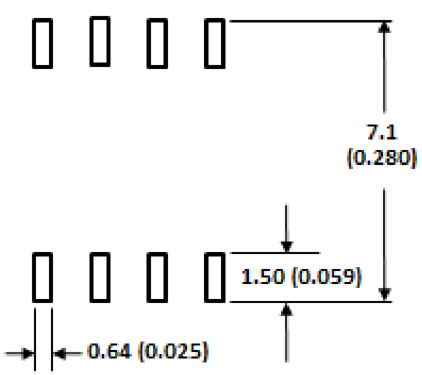
PCB Layout

The design of the printed circuit board (PCB) should follow good layout practices, such as keeping bypass capacitors close to the supply pin and the use of ground and power planes. A bypass capacitor must be connected between pins 5 and 8 of the device. The layout of the PCB can also affect the common mode transient immunity of the device due to stray capacitive coupling between the input and output circuits. To obtain maximum common mode transient immunity performance, the layout of the PCB should minimize any stray coupling by maintaining the maximum possible distance between the input and output sides of the circuit and ensuring that any ground or power plane on the PCB does not pass directly below or extend much wider than the body of the device.

Land Pattern for 4-mm Board Creepage

For applications that require PCB creepage of 4 mm between input and output sides, the land pattern in Figure 12 can be used.

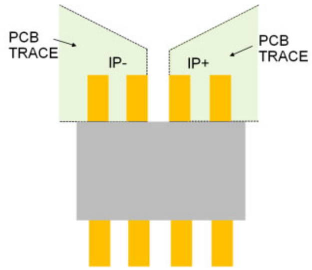
Figure 12: Land Pattern for 4-mm Creepage



Effect of PCB Layout on Sensitivity

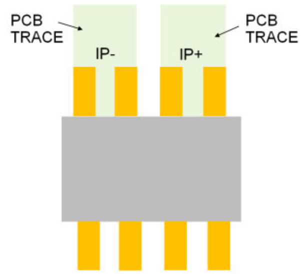
The trace layout on the input pins of ACHS-719x affects the sensitivity. Ensure that the PCB trace connection to the input pins covers the pins fully as shown in Figure 13.

Figure 13: Recommended Trace Layout on the Input Pins



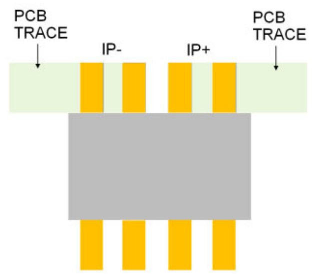
When the connection to the input pin covers only the vertical portion of the input pin, there is a sensitivity variation of about –0.6% versus the recommended PCB trace layout as shown in Figure 14.

Figure 14: Vertical Portion Connection



When the connection to the input pin covers only the horizontal portion of the input pin, there is a sensitivity variation of about +1.2% versus the recommended PCB trace layout (as shown in Figure 15).

Figure 15: Horizontal Portion Connection



Thermal Consideration

The evaluation board used in the thermal characterization is shown in Figure 16 and Figure 17. The inputs IP+ and IP- are each connected to the input plane of 4-oz copper with at least 650 mm^2 of total area (including top and bottom planes, minus the screw mounting holes). The output side GND is connected to a ground plane of 4-oz copper with 460 mm^2 of total area (including top and bottom planes). The 4-oz copper enables the board to conduct higher current and achieve good thermal distribution in a limited space.

Figure 16: Broadcom Evaluation Board – Top Layer

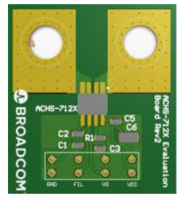


Figure 17: Broadcom Evaluation Board – Bottom Layer