ACS750xCA-075

Fully Integrated, Hall Effect-Based Linear Current Sensor with High Voltage Isolation and a Low-Resistance Current Conductor

Last Time Buy

These parts are in production but have been determined to be LAST TIME BUY. This classification indicates that the product is obsolete and notice has been given. Sale of this device is currently restricted to existing customer applications. The device should not be purchased for new design applications because of obsolescence in the near future. Samples are no longer available.

Date of status change: April 28, 2008

Deadline for receipt of LAST TIME BUY orders: October 31, 2008.

Recommended Substitutions:

For existing customer transition, and for new customers or new applications, refer to the ACS756.

NOTE: For detailed information on purchasing options, contact your local Allegro field applications engineer or sales representative.

ACS750xCA-75

Fully Integrated, Hall Effect-Based Linear Current Sensor with High Voltage Isolation and a Low-Resistance Current Conductor

Features and Benefits

- Monolithic Hall IC for high reliability
- Single +5 V supply
- 3 kV_{RMS} isolation voltage between terminals 4/5 and pins 1/2/3 for up to 1 minute
- 13 kHz bandwidth
- Automotive temperature range
- End-of-line factory-trimmed for gain and offset
- Ultra-low power loss: 130 µΩ internal conductor resistance
- Ratiometric output from supply voltage
- Extremely stable output offset voltage
- Small package size, with easy mounting capability
- Output proportional to AC and DC currents

Package: 5 pin module (leadform PFF)

Description

The Allegro ACS75x family of current sensors provides economical and precise solutions for current sensing in industrial, automotive, commercial, and communications systems. The device package allows for easy implementation by the customer. Typical applications include motor control, load detection and management, power supplies, and overcurrent fault protection.

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

The output of the device has a positive slope ($>V_{CC}/2$) when an increasing current flows through the primary copper conduction path (from terminal 4 to terminal 5), which is the path used for current sensing. The internal resistance of this conductive path is typically 130 µΩ, providing low power loss. The thickness of the copper conductor allows survival of the device at up to

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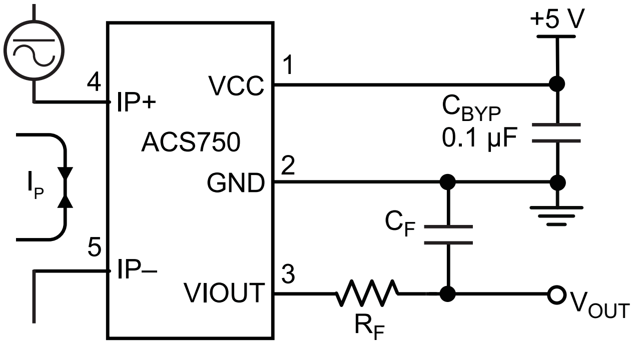
Typical Application



Application 1. The ACS750 outputs an analog signal, V_{OUT}. that varies linearly with the uni- or bi-directional AC or DC primary sensed current, I_P, within the range specified. C_F is recommended for noise management, with values that depend on the application.

Description (continued)

5× overcurrent conditions. The terminals of the conductive path are electrically isolated from the sensor leads (pins 1 through 3). This allows the ACS75x family of sensors 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 ACS75x family is lead (Pb) free. All pins are coated with 100% matte tin, and there is no lead inside the package. The heavy gauge leadframe is made of oxygen-free copper.

Selection Guide

Part Number	T_{OP} (°C)	Primary Sensed Current, I_P (A)	Sensitivity Sens (Typ.) (mV/A)	Packing[1]
~~ACS750LCA-075~~[2]	–40 to 150	±75	19.75	170 pieces per bulk bag
~~ACS750SCA-075~~[2]	–20 to 85	±75	19.75	170 pieces per bulk bag

[1] Contact Allegro for additional packing options.

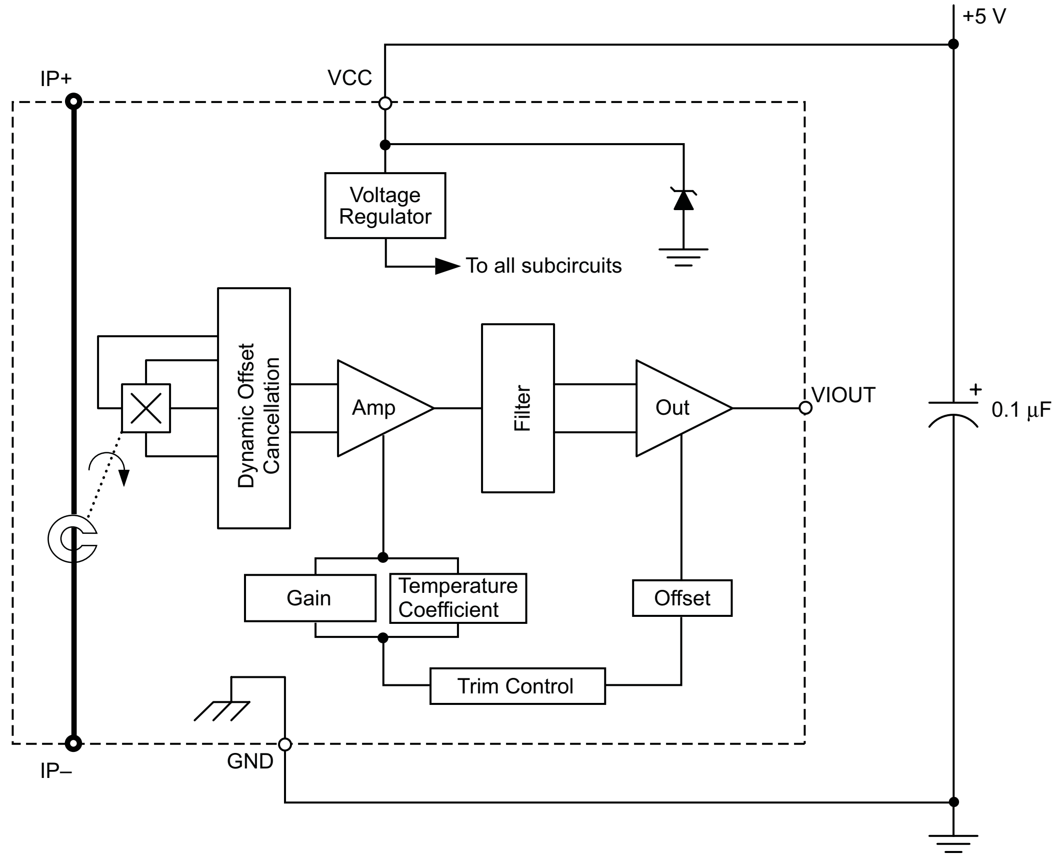
[2] Variant is in production but has been determined to be LAST TIME BUY. This classification indicates that the variant is obsolete and notice has been given. Sale of the variant is currently restricted to existing customer applications. The variant should not be purchased for new design applications because of obsolescence in the near future. Samples are no longer available. Status date change: April 28, 2008. Deadline for receipt of LAST TIME BUY orders is October 31, 2008.

Absolute Maximum Ratings

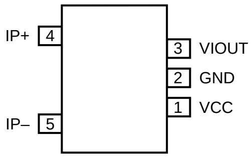
Characteristic	Symbol	Notes	Rating	Units
Supply Voltage	V_{CC}		16	V
Reverse Supply Voltage	V_{RCC}		–16	V
Output Voltage	V_{IOUT}		16	V
Reverse Output Voltage	V_{RIOUT}		–0.1	V
Maximum Basic Isolation Voltage	V_{ISO}		353 VAC, 500 VDC, or V_{pk}	V
Maximum Rated Input Current	I_{IN}		100	A
Output Current Source	$I_{OUT(Source)}$		3	mA
Output Current Sink	$I_{OUT(Sink)}$		10	mA
Nominal Operating Ambient Temperature	T_A	Range L	–40 to 150	ºC
		Range S	–20 to 85	ºC
Maximum Junction	T_J(max)		165	ºC
Storage Temperature	T_{stg}		–65 to 170	ºC

TÜV America Certificate Number: U8V 04 11 54214 001	Fire and Electric Shock EN60950-1:2001

Functional Block Diagram



Pin-out Diagram



Terminal List Table

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

ELECTRICAL CHARACTERISTICS, over temperature range unless otherwise indicated

Characteristic	Symbol	Test Conditions	Min.	Typ.	Max.	Units
Primary Sensed Current	I_P		–75	–	75	A
Supply Voltage	V_{CC}		4.5	5.0	5.5	V
Supply Current	I_{CC}	V_{CC} = 5.0 V, output open	–	7	10	mA
Output Resistance	R_{OUT}	I_{OUT} = 1.2 mA	–	1	2	Ω
Output Capacitance Load	C_{LOAD}	VOUT to GND	–	–	10	nF
Output Resistive Load	R_{LOAD}	VOUT to GND	4.7	–	–	kΩ
Primary Conductor Resistance	$R_{PRIMARY}$	I_P = ±100A, T_A = +25°C	–	130	–	μΩ
Isolation Voltage	V_{ISO}	Pins 1-3 and 4-5, 60 Hz, 1 minute	3.0	–	–	kV
PERFORMANCE CHARACTERISTICS, –20°C to +85°C, V_{CC} = 5 V unless otherwise specified						
Propagation time	t_{PROP}	I_P = ±50 A, T_A = +25°C	–	4	–	μs
Response time	$t_{RESPONSE}$	I_P = ±50 A, T_A = +25°C	–	27	–	μs
Rise time	t_r	I_P = ±50 A, T_A = +25°C	–	26	–	μs
Frequency Bandwidth	f	–3 dB, T_A = +25°C	–	13	–	kHz
Sensitivity	Sens	Over full range of I_P, T_A = +25°C	18.75	19.75	20.75	mV/A
		Over full range of I_P	17.5	–	21.5	mV/A
Noise	V_{NOISE}	Peak-to-peak, T_A = +25°C External filter BW = 24 kHz	–	7	–	mV
Linearity	E_{LIN}	Over full range of I_P	–	–	±5	%
Symmetry	E_{SYM}	Over full range of I_P	97	100	103	%
Zero Current Output Voltage	$V_{OUT(Q)}$	I = 0 A, T_A = +25°C	–	$V_{CC}/2$	–	V
Electrical Offset Voltage (Magnetic error not included)	V_{OE}	I = 0 A, T_A = +25°C	–40	–	40	mV
		I = 0 A	–50	–	50	mV
Magnetic Offset Error	I_{ERROM}	I = 0 A, after excursion of 100 A	–	±0.3	±0.8	A
Total Output Error (Including all offsets)	E_{TOT}	Over full range of I_P, T_A = +25°C	–	±1	–	%
		Over full range of I_P	–	–	±13	%
PERFORMANCE CHARACTERISTICS, –40°C to +85°C, V_{CC} = 5 V unless otherwise specified						
Propagation time	t_{PROP}	I_P = ±50 A, T_A = +25°C	–	4	–	μs
Response time	$t_{RESPONSE}$	I_P = ±50 A, T_A = +25°C	–	27	–	μs
Rise time	t_r	I_P = ±50 A, T_A = +25°C	–	26	–	μs
Frequency Bandwidth	f	–3 dB , T_A = +25°C	–	13	–	kHz
Sensitivity	Sens	Over full range of I_P, T_A = +25°C	18.75	19.75	20.75	mV/A
		Over full range of I_P	16.5	–	23	mV/A
Noise	V_{NOISE}	Peak-to-peak; T_A = +25°C External filter BW = 40 kHz	–	7	–	mV
Linearity	E_{LIN}	Over full range of I_P	–	–	±5	%
Symmetry	E_{SYM}	Over full range of I_P	97	100	103	%
Zero Current Output Voltage	$V_{OUT(Q)}$	I = 0 A, T_A = +25°C	–	$V_{CC}/2$	–	V
Electrical Offset Voltage (Magnetic error not included)	V_{OE}	I = 0 A, T_A = +25°C	–40	–	40	mV
		I = 0 A	–60	–	60	mV
Magnetic Offset Error	I_{ERROM}	I = 0 A, after excursion of 100 A	–	0.3	±0.8	A
Total Output Error (Including all offsets)	E_{TOT}	Over full range of I_P, T_A = +25°C	–	±1	–	%
		Over full range of I_P	–	–	±15	%

Definitions of Accuracy Characteristics

Sensitivity (Sens). The change in sensor output in response to a 1 A change through the primary conductor. The sensitivity is the product of the magnetic circuit sensitivity (G / A) 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.

Noise (V_{NOISE}). The product of the linear IC amplifier gain (mV/G) and the noise floor for the Allegro Hall effect linear IC (≈1 G). 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.

Linearity (E_{LIN}). The degree to which the voltage output from the sensor varies in direct proportion to the primary current through its full-scale amplitude. Nonlinearity in the output can be attributed to the saturation of the flux concentrator approaching the full-scale current. The following equation is used to derive the linearity:

$$100 \left\{ 1 - \left[\frac{\Delta \text{ gain} \times \% \text{ sat} \,(\, V_{\text{IOUT\_full-scale amperes}} - V_{\text{IOUT(Q)}})}{2 \,(V_{\text{IOUT\_half-scale amperes}} - V_{\text{IOUT(Q)}})} \right] \right\}$$

where

Δ gain = the gain variation as a function of temperature changes from 25ºC,

% sat = the percentage of saturation of the flux concentrator, which becomes significant as the current being sensed approaches full-scale $\pm I_P$, and

$V_{\text{IOUT\_full-scale amperes}}$ = the output voltage (V) when the sensed current approximates full-scale $\pm I_P$.

Symmetry (E_{SYM}). The degree to which the absolute voltage output from the sensor varies in proportion to either a positive or negative full-scale primary current. The following equation is used to derive symmetry:

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

Quiescent output voltage ($V_{IOUT(Q)}$). The output of the sensor when the primary current is zero. For a unipolar supply voltage, it nominally remains at $V_{CC} / 2$. Thus, V_{CC} = 5 V translates into $V_{IOUT(Q)}$ = 2.5 V. Variation in $V_{OUT(Q)}$ can be attributed to the resolution of the Allegro linear IC quiescent voltage trim, magnetic hysteresis, and thermal drift.

Electrical offset voltage (V_{OE}). The deviation of the device output from its ideal quiescent value of $V_{CC} / 2$ due to nonmagnetic causes.

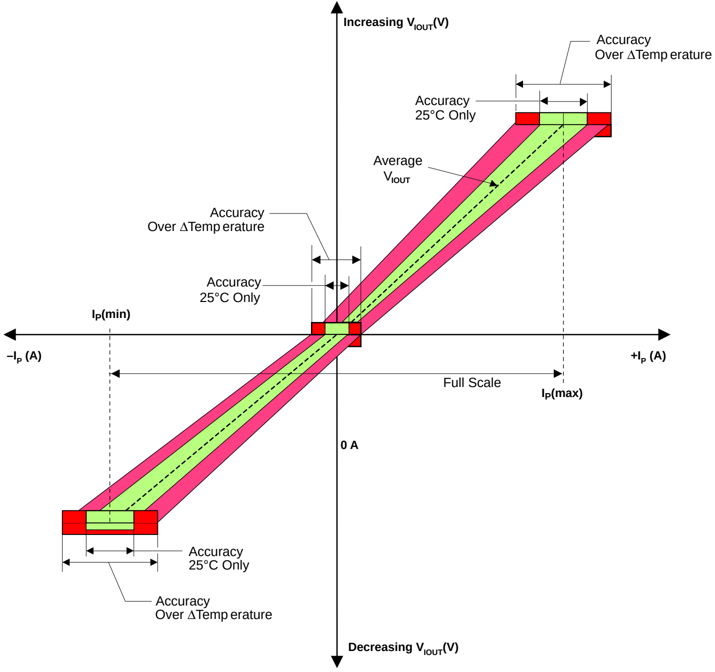
Magnetic offset error (I_{ERROM}). The magnetic offset is due to the residual magnetism (remnant field) of the core material. The magnetic offset error is highest when the magnetic circuit has been saturated, usually when the device has been subjected to a full-scale or high-current overload condition. 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.

Accuracy (E_{TOT}). The accuracy represents the maximum deviation of the actual output from its ideal value. This is also known as the total ouput error. The accuracy is illustrated graphically in the output voltage versus current chart on the following page.

Accuracy is divided into four areas:

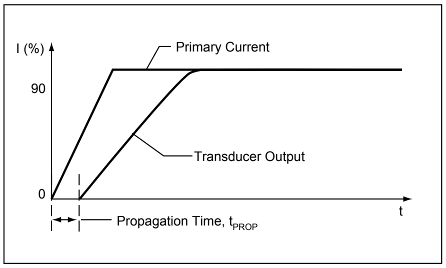
- **0 A at 25°C.** Accuracy of sensing zero current flow at 25°C, without the effects of temperature.
- **0 A over Δ temperature.** Accuracy of sensing zero current flow including temperature effects.
- **Full-scale current at 25°C.** Accuracy of sensing the full-scale current at 25°C, without the effects of temperature.
- **Full-scale current over Δ temperature.** Accuracy of sensing full-scale current flow including temperature effects.

Output Voltage versus Sensed Current
Accuracy at 0 A and at Full-Scale Current

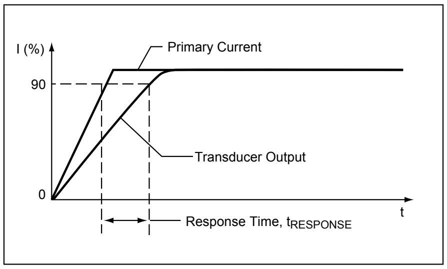


Definitions of Dynamic Response Characteristics

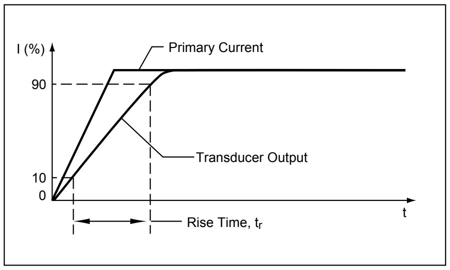
Propagation delay (t_{PROP}). The time required for the sensor output to reflect a change in the primary current signal. Propagation delay is attributed to inductive loading within the linear IC package, as well as in the inductive loop formed by the primary conductor geometry. Propagation delay can be considered as a fixed time offset and may be compensated.



Response time ($t_{RESPONSE}$). The time interval between a) when the primary current signal reaches 90% of its final value, and b) when the sensor reaches 90% of its output corresponding to the applied current.

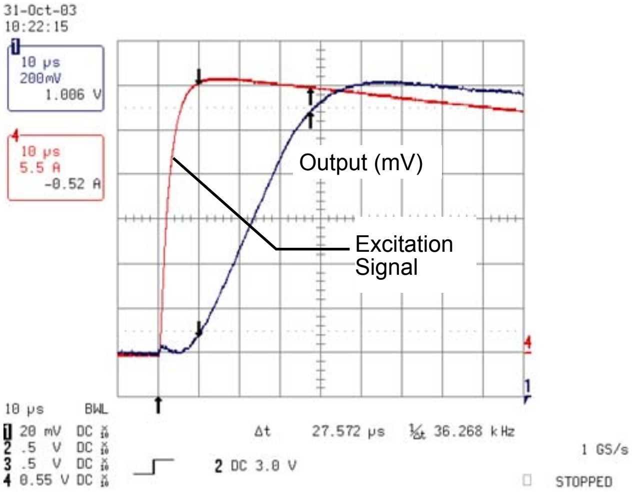


Rise time (t_r). The time interval between a) when the sensor reaches 10% of its full scale value, and b) when it reaches 90% of its full scale value. The rise time to a step response is used to derive the bandwidth of the current sensor, in which $f(-3\text{ dB}) = 0.35/t_r$. Both t_r and $t_{RESPONSE}$ are detrimentally affected by eddy current losses observed in the conductive IC ground plane.

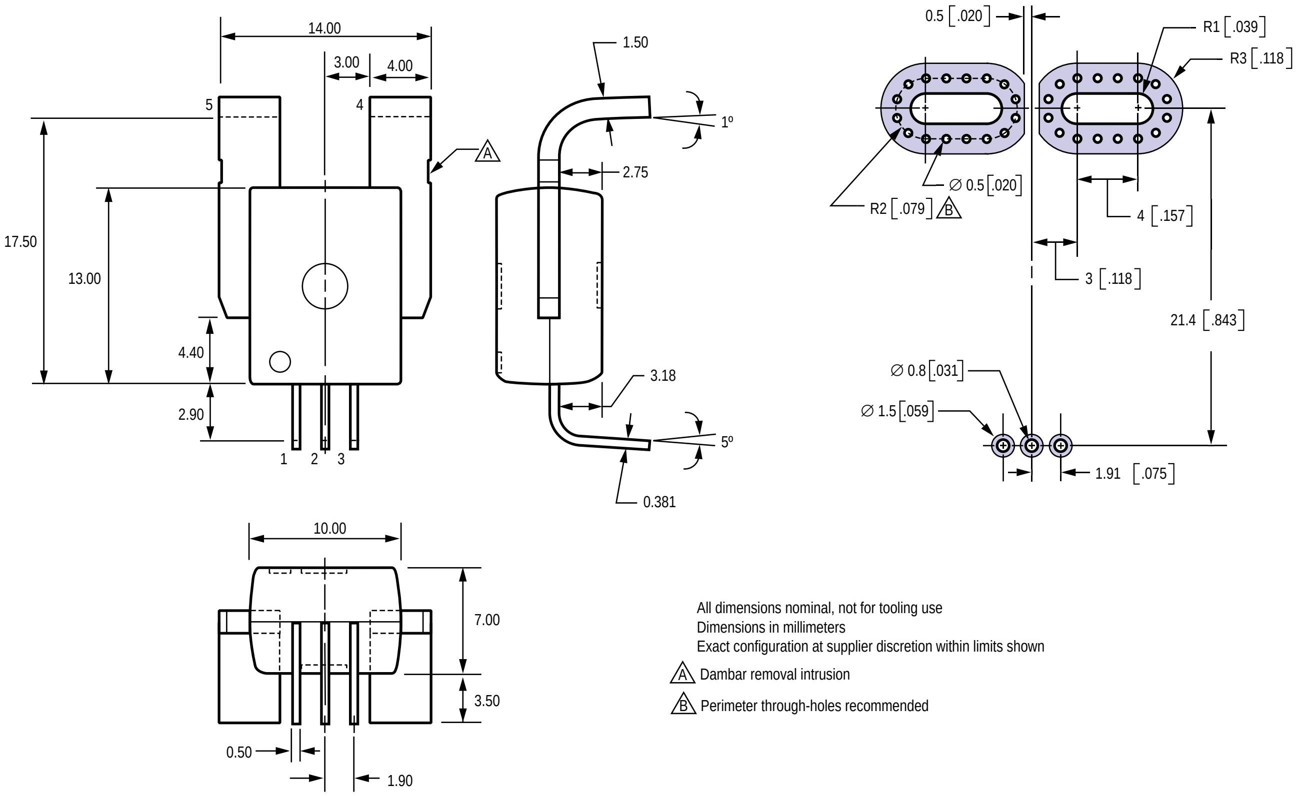


Step Response

50 A I_P Excitation Signal



Package CA, 5-pin module, leadform PFF



All dimensions nominal, not for tooling use
Dimensions in millimeters
Exact configuration at supplier discretion within limits shown
Ⓐ Dambar removal intrusion
Ⓑ Perimeter through-holes recommended

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

Package Branding

Two alternative patterns are used

ACS750 *RCAPPP* *YYWWA*	ACS	Allegro Current Sensor
	750	Device family number
	R	Operating ambient temperature range code
	CA	Package type designator
	PPP	Primary sensed current
	YY	Date code: Calendar year (last two digits)
	WW	Date code: Calendar week
	A	Date code: Shift code

ACS750 *RCAPPP* *L...L* *YYWW*	ACS	Allegro Current Sensor
	750	Device family number
	R	Operating ambient temperature range code
	CA	Package type designator
	PPP	Primary sensed current
	L...L	Lot code
	YY	Date code: Calendar year (last two digits)
	WW	Date code: Calendar week

The products described herein are manufactured under one or more of the following U.S. patents: 5,045,920; 5,264,783; 5,442,283; 5,389,889; 5,581,179; 5,517,112; 5,619,137; 5,621,319; 5,650,719; 5,686,894; 5,694,038; 5,729,130; 5,917,320; and other patents pending.

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