



ALLEGRO CURRENT SENSOR ICs CAN TAKE THE HEAT! UNIQUE PACKAGING OPTIONS FOR EVERY THERMAL BUDGET

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INTRODUCTION

Allegro MicroSystems offers current sensor IC solutions that satisfy a wide array of applications, from smart homes and car audio speakers to on-board chargers, electric vehicles, and DC/DC converters. For applications with typical operating currents up to 50 A, Allegro offers current sensor ICs in several standard packages, including SOIC-8 (LC), SOICW-16 (MA/LA), and QFN (EX). These packages have a typical maximum continuous current rating of up to 60 A. For applications with normal operating currents from 50 A to 250 A, Allegro offers current sensor ICs in the MC, LR, and CB packages. The maximum continuous current ratings of these packages are 100 A, 120 A, and 250 A, respectively. Due to the small resistance of the integrated conductor, these current sensor ICs feature high power density with little loss when placed in series with the current being measured.

The data contained within this application note allows the user to effectively choose an Allegro current sensor package based on their system's specifications. Using the system's ambient temperature, the user can predict the sensor's maximum operating temperature and continuous current value. In addition, data here can be used to predict the IC's worst-case overcurrent conditions in terms of how long it will take the package to fail and at what current. These packages have transient current capability for overcurrent survival; Allegro has options that meet the various DC operating requirements and overcurrent demands of many different applications.

BACKGROUND

Each package evaluated in this article is depicted in Table 1 through Table 3. Allegro offers several devices in each package, consequently providing a viable solution for the majority of current sensing applications. Click

the package name in each table to be directed to the device web page of a popular product in that package.

THERMAL TESTING PERFORMED

Lab testing was conducted on Allegro's current sensor packages. Tests included:

- Time to reach the maximum junction temperature, $T_{J(max)}$, of 165°C vs. current
- Time to fuse the current conductor open vs. current
- Die temperature vs. steady state current and ambient temperature

Note that tests were conducted using the standard Allegro demonstration board.

SAFE OPERATING RANGE

The current values in Table 1 represent the greatest DC current value that can be supplied for the corresponding duration before the maximum junction temperature is exceeded or the conductor has fused open. Currents under these values are within the safe operating region of the sensor. To ensure functionality and trustworthy results, every application should stay within the safe operating range of the sensor or the die may become damaged, and the specifications of the device are no longer guaranteed.

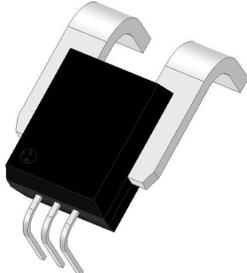
DC/RMS CURRENT CAPABILITY

Table 2 summarizes the package's maximum continuous current at varying ambient operating temperatures. Ambient temperature largely impacts the device's current capability. Table 3 summarizes the rise in die temperature at corresponding continuous currents. These tables provide the user a method of determining the best package based on their system's thermal constraints.

CONCLUSION

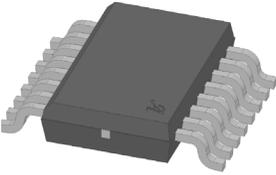
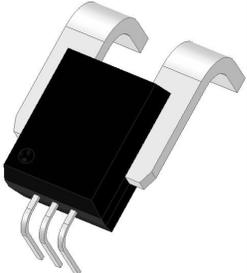
Understanding thermal capabilities is crucial for dependable operation in any current sensing application. Allegro current sensors are built with reliability and lifetime performance in mind, and with Allegro’s large portfolio, there is a fully integrated sensing solutions for a broad range of demanding, high-current applications.

Table 1: Safe Operating Area, Fuse and Overtemperature Time vs. Current^[1]

Time (ms)	DC or RMS Current					
	QFN (EX)	SOIC-8 (LC)	SOICW-16 (MA)	SOICW-16 (MC)	7-pin PSOF (LR)	5-pin CB
						
Area: 9 mm ²	Area: 29.4 mm ²	Area: 106.09 mm ²	Area: 146.77 mm ²	Area: 40.96 mm ²	Area: 311.92 mm ²	
Height: 0.75 mm	Height: 1.75 mm	Height: 2.65 mm	Height: 3.01 mm	Height: 1.5 mm	Height: 10.5 mm	
10	210 A	217 A	>400 A	>600 A	>700A	>700 A
100	120 A	137 A	350 A	>600 A	700 A	>700 A
1000	75 A	91 A	128 A	320 A	350 A	>700 A

Note: ‘>’ indicates testing was not done to failure for these devices.

Table 2: Maximum Continuous Current of Allegro Current Sensor Packages at Various Ambient Temperatures^[1]

Ambient Temperature (°C)	Continuous Current					
	QFN (EX)	SOIC-8 (LC)	SOICW-16 (MA)	SOICW-16 (MC)	7-pin PSOF (LR)	5-pin CB
						
25	60 A	55 A	60 A	100 A	120 A	250 A
65	53 A	49 A	53 A	87 A	104 A	220 A
85	48 A	45 A	48 A	79 A	95 A	200 A
125	36 A	35 A	35 A	59 A	69 A	150 A

[1] More detailed results and analysis for current capability and fuse characteristic data for these packages can be found on the Allegro website. For the EX, LC, MA, and MC packages, data can be found [here](#). For the LR and CB packages, data can be found [here](#).

Table 3: Change in Die Temperature of Allegro Current Sensor Packages at Various Continuous Currents ^[1]

Continuous Current (A)	Change in Steady-State Die Temperature (°C)					
	QFN (EX)	SOIC-8 (LC)	SOICW-16 (MA)	SOICW-16 (MC)	7-pin PSOF (LR)	5-pin CB
10	4	3	3	1	2	<1
20	12	11	12	4	4	<1
30	27	28	28	10	8	2
40	54	54	53	18	14	3
50	93	99	87	30	21	5
60	–	–	132	44	30	6
70	–	–	–	63	40	8
80	–	–	–	86	55	10
90	–	–	–	121	68	14
100	–	–	–	147	88	18
110	–	–	–	–	113	21
120	–	–	–	–	139	25
150	–	–	–	–	–	42
200	–	–	–	–	–	83
225	–	–	–	–	–	106
250	–	–	–	–	–	138

Note: '–' indicates the maximum junction temperature, $T_{J(max)} = 165^{\circ}C$, was exceeded at the corresponding continuous current value.

[1] More detailed results and analysis for current capability and fuse characteristic data for these packages can be found on the Allegro website. For the EX, LC, MA, and MC packages, data can be found [here](#). For the LR and CB packages, data can be found [here](#).

Revision History

Number	Date	Description	Responsibility
–	July 9, 2020	Initial release	Kasey Hampton

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