# TI Over-Current Detection Products

## Protecting from Over-Current in Multiple Applications

Texas Instruments

www.ti.com/over-current

2H 2014

# Over-Current Products
## Overview

### TI- Over-Current Products

Current is one of the more common signals that is measured in electronic systems.  What varies from system to system is how that current information is utilized once it is collected.  Current information can be used in active feedback circuitry, system performance data logging as well as used in diagnostic and fault detection.

Many applications require that either indication or control of system performance be added in the event that an out-of-range condition could occur.  This can range from ground faults and short-circuit events to heavier than expected loading conditions. Regardless of the source, systems often need protection circuitry added to ensure that potentially damaging conditions are not allowed to persist for extended periods of time.

The most common implementation for protecting a system from excessive out-of-range conditions is the addition of a fuse in the design.  This is an extremely simple component that's use-case is obvious in that the device's sole purpose is to open in the event of an extended over-current condition.

While this approach to system protection is extremely simple and effective in protecting the system from gross, over-current events, there are a few draw-backs and trade-offs to this over-current protection approach.

A fuse protection scheme has a single event life-span requiring that once the component is blown, the board must be repaired to replace this device with a new one in order for the system to return to normal operation.  Another characteristic of a fuse is that in order for a quick open to occur the current must significantly exceed by four to five times or more the current rating of the fuse in order to blow making the precise level the fuse opens difficult to predict.

The sole use of a fuse as a protection component also does not enable the ability to provide information on the actual operating conditions of the system.  This is where other options for system

### Table of Contents



### Featured Products

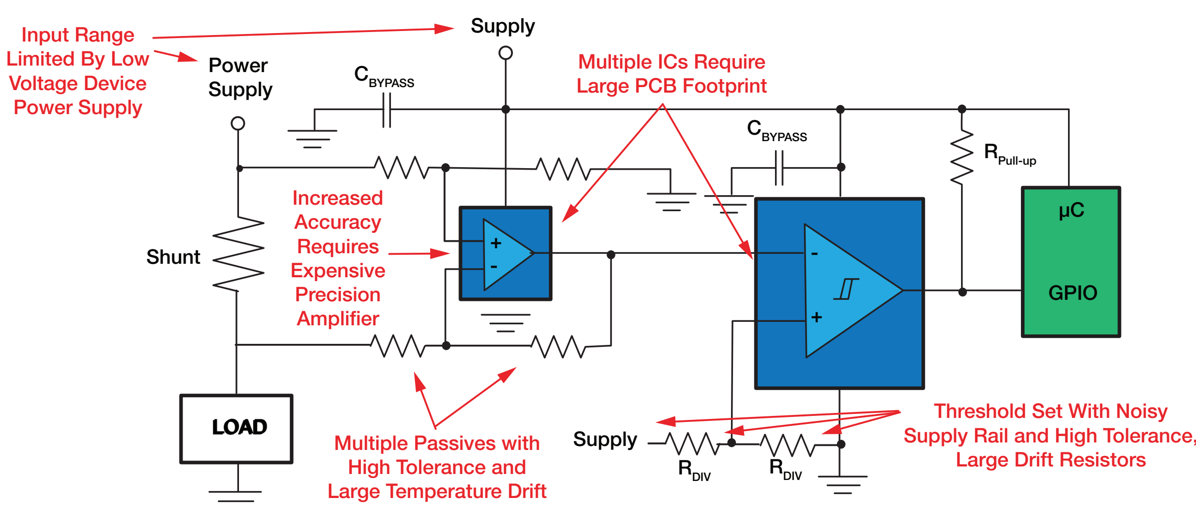


protection can be employed with TI leading the charge in providing targeted solutions to meet customer needs.  TI provides over-current detection solutions that can be optimized base on the key care-abouts of a particular application whether that be based on cost, solution size, measurement accuracy or alert response time.

Historically, an over–current detection solution has been created using a simple operational amplifier, external gain setting resistors and a low-cost comparator. The operational amplifier and external gain setting resistors are configured to create a difference amplifier configuration to amplify the voltage developed across the current sensing shunt resistor to create a single-ended output voltage that is routed to the comparator.

The threshold level of the comparator reference is set to equal to the output voltage level of the current sense amplifier corresponding to the current level needing to be monitored for.

There are several options for the circuitry used to create the comparator's threshold reference signal depending on the accuracy and stability required by the application.  This reference signal can vary from a simple resistor divider network (lowest cost & least accurate) to a precision low-drift voltage reference (most expensive & highest accuracy). While this solution can be implemented using low-cost operational amplifiers, this will adversely affect the accuracy of the results or require expensive discrete external components to increase the performance.




*Discrete Current Detection – Op Amp plus Comparator Block Diagram*

## Current Sense Amplifier plus Comparator

### TI Part INA199 & LMV331

An over–current detection solution using a dedicated current-sense amplifier (CSA) paired with a comparator optimizes this protection function further.

The current-sense amplifier's integration of the operational amplifier and external gain setting resistors incorporate all of the discrete components in the measurement portion of this solution enabling both a more accurate measurement with a smaller board space requirement. The output of the current sense amplifier can be measured directly or routed to the comparator to form the detection portion of the over-current detection function.

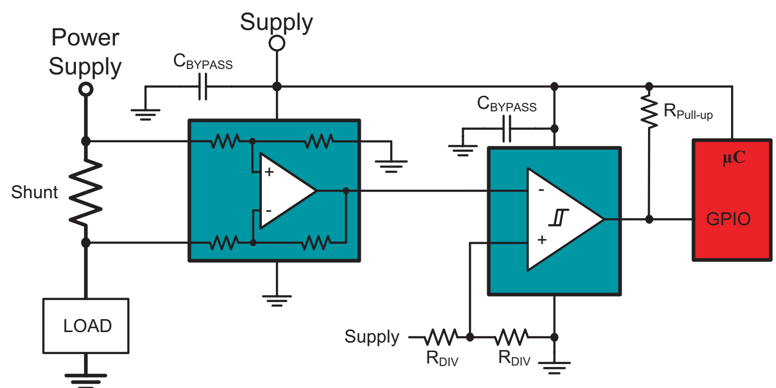
The threshold level of the comparator reference is set to equal to the output voltage level of the current sense amplifier corresponding to the current level needing to be monitored for. There are several options for the circuitry used to create the comparator's threshold reference signal depending on the accuracy and stability required by the application. This reference signal can vary from a simple resistor divider network (lowest cost & least accurate) to a precision low-drift voltage reference (most expensive & highest accuracy).

#### Strengths

- Enables both over current detection as well as current monitoring
- Response time down to as low as 2 µs

#### Weaknesses

- Multiple chips require large footprint / board space
- Requires precise external reference for precision threshold setting




*Current Sense Amplifier plus Comparator Block Diagram*

Get more information: **http://www.ti.com/product/ina199a1**

# Featured Products
## Single-Chip Over-Current Detection Solution

### Single-Chip Over-Current Detection Solution
**INA300**

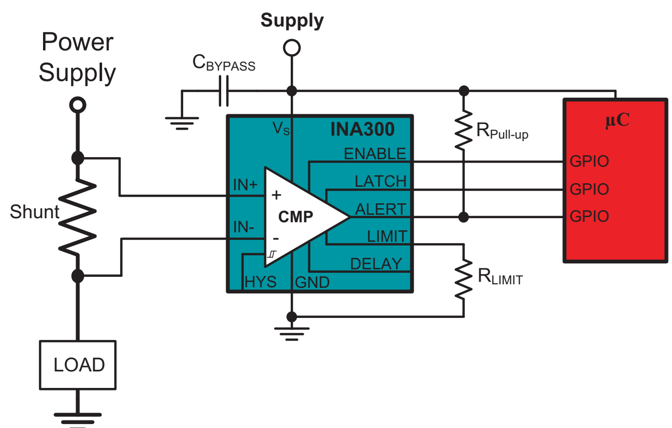
The INA300 is a dedicated current-sensing comparator that is optimized for detecting over–current conditions. This device integrates both the precision measurement circuitry as well as the comparison portion creating an all-in-one over-current detection solution.

The INA300 features an adjustable threshold range to detect an over-current event that is set using a single external limit-setting resistor. The output can be configured to operate in either a transparent mode where the output status follows the input state or in a latched mode where the alert output is cleared when the latch is cleared indicating that the over-current alert has been received.

The device response time setting is also selectable, enabling overcurrent alerts to be issued in as quickly as 10 µs.

**Strengths**
- Small footprint saves greater than 50% compared to discrete operational amplifier solution
- Integrated precision reference sets threshold trip point via single external resistor.
- Response time adjustable from 10us to 100us

**Weaknesses**
- Does not report current value



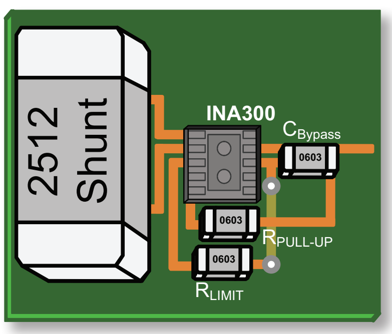

*Single-Chip Over-Current Detection Solution Block Diagram*

*INA300 is in a tiny 2mm x 2mm QFN package minimizing footprint requirements.*

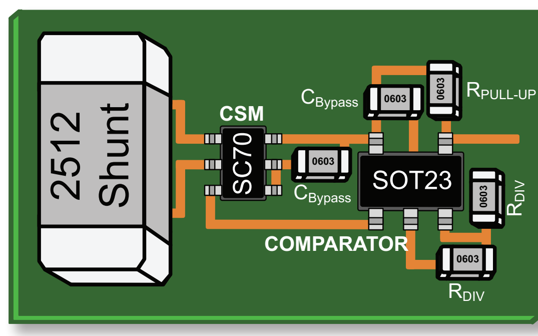
Get more information: **www.ti.com/product/INA300**

# Featured Products
## Footprint Requirements Comparison

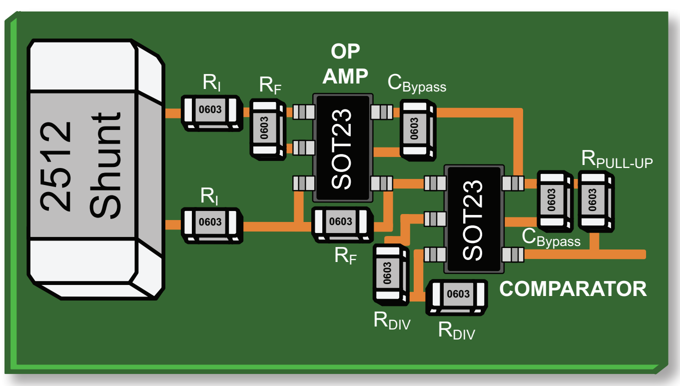
One of the most significant advantages of the INA300 implementation is the integration offered and the resulting footprint savings. The different alternatives discussed for over-current detection have very different footprint requirements. The size of the implementation will vary depending on the actual components chosen. The discussion below is based on very typical components for each of the solutions. Many typical op amps and comparators utilize the SOT23 package. The historical implementation in addition to being complex and difficult to achieve high precision with requires two such packages, as well as 9 discrete resistors, for which we will use the 0603 size. This leads to a total component footprint (not counting the routing) of just under 47 mm2. The INA199 plus comparator implementation offers savings of around 37% over the om amp plus comparator. The INA199 is offered in a SC-70 package, which requires about half the area of the op amp. the comparator remains the same size and this implantation only requires five discrete resistors, or again an almost 50% savings. The footprint for this implementation totals just over 29 mm2.The INA300 is in a very small SON package and eliminates the need for the additional comparator as well as reducing the number of external resistors. This totals a solution footprint of just over 14 mm2. This is a 70% savings over the op amp plus comparator solution and a 36% savings over the INA199 plus comparator.




*INA300 footprint is approx. 14mm²*




*INA199 + Comp. footprint is approx. 29mm²*




*Op-Amp + Comp. footprint is approx. 47mm²*

## Total Component Footprint Required not including trace routing & RSHUNT

| Device | Op-Amp + Comparator | INA199 + Comparator | INA300 |
|---|---|---|---|
| Integrated Circuits | 16.2 mm² | 12.3 mm² | 4.0 mm² |
| Discrete Components | 30.7 mm² | 17.0 mm² | 10.2 mm² |
| # of discretes | 9 | 5 | 3 |
| Area | 46.9 mm² | 29.4 mm2 | 14.2 mm² |
| % Savings | n/a | 37% smaller than op-amp implementation | 70% smaller than op-amp implementation<br>52% smaller than INA199 implementation |

# *TI Worldwide Technical Support*

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