

# LM4132, LM4132-Q1 Pin FMEA

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## ABSTRACT

The LM4132 family of precision voltage references performs comparably to the best laser-trimmed bipolar references, but in cost-effective CMOS technology. Unlike other LDO references, the LM4132 can deliver up to 20 mA and does not require an output capacitor or buffer amplifier.

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## 1 Pin FMEA

This application provides Failure Modes and Effects Analysis (FMEA) for the device pins of the LM4132 and LM4132-Q1 voltage reference. The failure conditions covered in this document include the typical pin-by-pin failure scenarios:

- Pin short-circuited to Ground;
- Pin is open circuited;
- Pin short-circuited to LM4132  $V_{IN}$ ; and
- Pin short-circuited to an adjacent pin.

This application note also details how these pin conditions affect the device:

- Does the pin condition cause permanent damage?
- Is the device is functional under the pin condition?
- How does a particular pin condition affect the device operation?

## 2 Scope

The LM4132 is a series voltage reference that provides low power consumption because it does not have to idle the maximum possible load current under no-load conditions. This device also comes with an enable pin for disabling the LM4132. The LM4132 has two functional states:

- Enabled, where the output voltage is enabled through the EN pin and is regulated to a specific value within a range of output load currents.
- Disabled, where the output voltage is disabled through the EN pin.

In many applications, the EN pin is isolated from the VIN pin voltage by a control device.

For the purposes of this report:

- Unless otherwise specified, the voltage applied to the VIN pin and EN pin is within the LM4132 Recommended Operating Range.
- The EN pin is driven from an external source.
- Functionality = Yes indicates that the LM4132 status can be remotely changed between the two functional states (ENABLED and DISABLED) by the external control connected to the EN pin.

### 3 LM4132 Pin Configurations and Functions

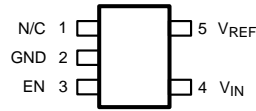


Figure 1. 5-Pin SOT-23 Package (Top View)

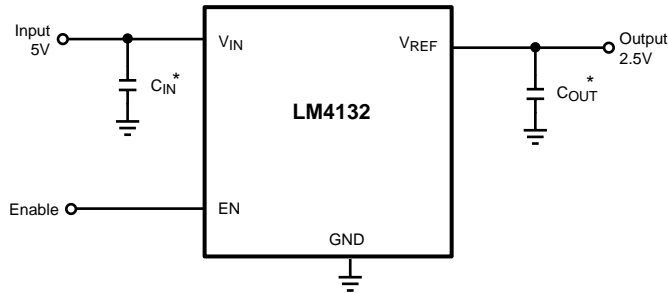


Figure 2. Typical LM4132 Schematic

#### Pin Functions

PIN		I/O	DESCRIPTION
NUMBER	NAME		
1	N/C	—	No connect pin, leave floating.
2	GND	G	Ground
3	EN	I	Enable pin
4	VIN	I	Input supply
5	VREF	O	Reference output

## 4 FMEA Analysis

**Table 1. Pin FMEA Analysis for Pin Short Circuit to Ground**

PIN		SHORT TO $V_{IN}$		
NUMBER	NAME	DAMAGE	FUNCTIONAL	COMMENTS
1	N/C	No	Yes	In the actual application, make sure N/C pin is always floating.
2	GND	No	Yes	No effect.
3	EN	No	No	No output voltage. Output is forced OFF.
4	VIN	No	No	No output voltage.
5	VREF	No	No	No, or low, output voltage. Output current is at short-circuit current limit; thermal shutdown may be activated.

**Table 2. Pin FMEA Analysis for Pin Open Circuit**

PIN		SHORT TO $V_{IN}$		
NUMBER	NAME	DAMAGE	FUNCTIONAL	COMMENTS
1	N/C	No	Yes	No effect
2	GND	No	No	Output is not regulated.
3	EN	No	No	EN pin is floating and its state is indeterminable.
4	VIN	No	No	No output voltage.
5	VREF	No	No	No output voltage to load.

**Table 3. Pin FMEA Analysis for Pin Short Circuit to  $V_{IN}$** 

PIN		OPEN		
NUMBER	NAME	DAMAGE	FUNCTIONAL	COMMENTS
1	N/C	No	Yes	In actual application, make sure N/C pin is floating.
2	GND	No	No	No output voltage.
3	EN	No	No	Output forced ON.
4	VIN	No	Yes	No effect.
5	VREF	No	No	No VREF regulation. Output voltage is same as input voltage. Power supply might experience a current increase.

**Table 4. Pin FMEA Analysis for Pin Short Circuit to an Adjacent Pin**

PIN		SHORT TO PIN		SHORT TO ADJACENT PIN		
NUMBER	NAME	NUMBER	NAME	DAMAGE	FUNCTIONAL	COMMENTS
1	N/C	2	GND	No	Yes	In the actual application, make sure N/C pin is always floating.
2	GND	3	EN	No	No	No output voltage. Output is forced OFF.
3	EN	4	VIN	No	No	Output forced ON.
4	VIN	5	VREF	No	No	No VREF regulation. Output voltage is same as input voltage.
5	VREF	1	N/C	No	Yes	In actual application, make sure N/C pin is floating.

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