ANALOG DEVICES

Altering the ADM1073 Current Limit Level
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INTRODUCTION

The ADM1073 –48 V hot swap controller accurately limits the current drawn from a supply by dynamically controlling the GATE voltage on an external N-channel FET placed in the path of that supply. An internal sense amplifier detects the voltage across a sense resistor connected between its VEE and SENSE pins. This voltage level gives an indication of the load current level. The sense amplifier has a preset control loop threshold of 100 mV (±3%). This means the current control loop will regulate the load current when a voltage of 100 mV is detected across the sense resistor. In this way the value of the sense resistor sets the current level that causes the loop to regulate. 100 mV divided by R_{SENSE} yields the current value at which the sense resistor causes the loop to regulate.

In addition to the 100 mV threshold, there is a separate circuit breaker threshold below this. It is nominally 90 mV (minimum 86 mV). If the load current is at a level that exceeds the circuit breaker level then the internal counter begins timing the event as a fault. Note that the device does not begin to regulate current until the current limit control loop threshold is reached.

Table I shows the current limit levels for different values of sense resistor.

$I_{LOAD(MAX)}$ is the maximum load current level that may trigger a current fault. This corresponds to a voltage of 86 mV across the sense resistor.

$I_{LIMIT(MIN)}$ and $I_{LIMIT(MAX)}$ are the minimum and maximum load current levels at which the current limit loop will regulate. These correspond to voltages of 97 mV and 103 mV across the sense resistor, respectively.
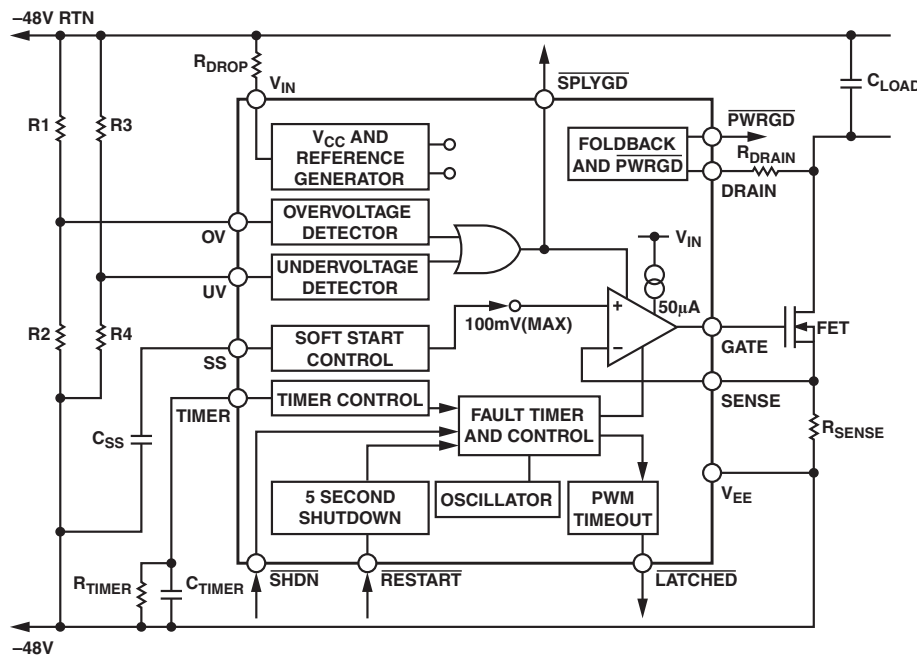

Figure 1. ADM1073 Application Diagram

Table I. Minimum and Maximum Inrush Current and Load Current Levels for Different Values of R$_{SENSE}$

R$_{SENSE}$ (mΩ)	I$_{LOAD(MAX)}$ (A)	I$_{LIMIT(MIN)}$ (A)	I$_{LIMIT(MAX)}$ (A)
5	17.20	19.40	20.60
10	8.60	9.70	10.30
15	5.73	6.47	6.87
18	4.78	5.39	5.72
22	3.91	4.41	4.68
33	2.61	2.94	3.12
47	1.83	2.06	2.19
51	1.69	1.90	2.02
68	1.26	1.43	1.51
75	1.15	1.29	1.37
90	0.96	1.08	1.14

SOFT START (SS) PIN

The Soft Start pin on the ADM1073 provides a method for altering the reference voltage on the current sense amplifier. If the voltage on the SS pin is in the region of 0.360 V to 1.95 V, then it sets the current limit control loop threshold somewhere in the region of 18 mV to 100 mV. The attenuation factor for this calculation is 19.5. When the voltage on the SS pin is below 0.360 V the current sense amplifier reference voltage clamps at around 18 mV. When the voltage on the SS pin is greater than 1.95 V, a separate internal reference clamps the current sense amplifier reference at 100 mV, so increasing the SS voltage above this level has no effect.

There are two main uses for the SS pin.

1. INRUSH CURRENT PROFILING

The SS pin can be used to determine the inrush current profile by attaching a capacitor between this pin and the VEE pin. When the FET is off, there is no voltage across the SS capacitor. When the FET is requested to turn on, the SS pin is held at VEE (device ground) until the SENSE pin reaches a few mV. A 5 µA current source is then turned on, which linearly ramps the capacitor up to 2.5 V. The reference voltage for the GATE linear control amplifier is derived from the soft start voltage, such that the inrush linear current limit is defined as

$$I_{LIMIT} = V_{SOFT\_START} / (19.5 \times R_{SENSE})$$

In this way different capacitors can be placed on the SS pin to set different ramp rates of the inrush current profile at startup. Figure 2, Figure 3, and Figure 4 show how different SS capacitors set different inrush current ramp rates in a typical application.
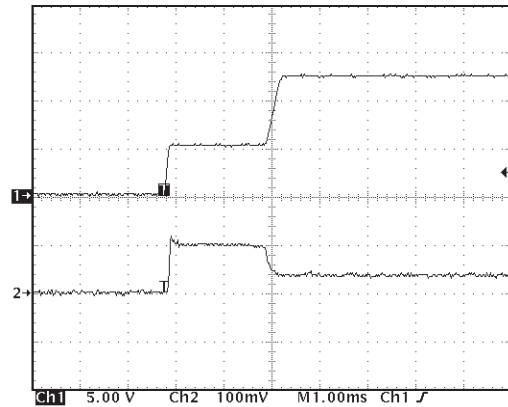

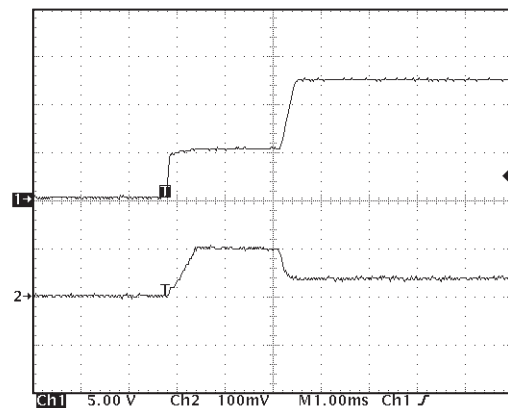*Figure 2. Soft Start Profile with a 0.1 nF Capacitor (Ch1 = GATE; Ch2 = SENSE)*

Figure 3. Soft Start Profile with a 1.5 nF Capacitor (Ch1 = GATE; Ch2 = SENSE)
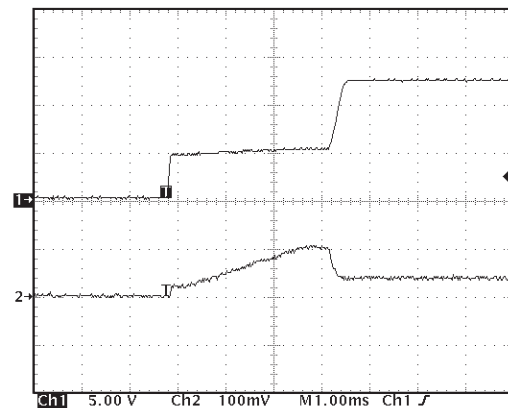

Figure 4. Soft Start Profile with an 8.2 nF Capacitor (Ch1 = GATE; Ch2 = SENSE)

2. CHANGING THE CURRENT LIMIT

The SS pin can be overdriven externally from 0.360 V to 1.95 V to set a current limit control loop threshold from 18 mV to 100 mV. Note that the current limit voltage is clamped at 100 mV maximum. For accuracy purposes it is advisable to program SS voltages in the range of 0.5 V to 1.5 V.

There are many uses for this. One is to reduce the sense amplifier reference voltage thus reducing the power dissipation in the sense resistor. At the nominal load current level there is VI power dissipation in the sense resistor. For a minimum circuit breaker level of 86 mV, the user may typically select a sense resistor so that a nominal current level may produce 65 mV – 75 mV across the sense resistor. In high current applications, this voltage drop may cause an unacceptable amount of power to be dropped in the sense resistor. In this situation, the user could place a resistor divider between the input rails to set a voltage on the SS pin to reduce the internal current sense amplifier reference by a certain amount. This will also have the effect of scaling all of the current limit thresholds.

For example, if the reference is set at a 50% level (that is $I_{LIMIT(NOM)}$ = 50 mV) this will reduce VI power dissipation in the sense resistor by 50%. To achieve this we use the equation

$$V_{SS} = 19.5 \times V_{LIMIT}$$

Thus, to reduce the $V_{LIM(TYP)}$ from 100 mV to 50 mV, the soft start voltage would have to be set to

$$V_{SS} = 19.5 \times 50\,mV = 0.975$$

The voltage can be set up on the SS pin via a resistor divider from the VIN pin (this voltage is a regulated 12.3 V). Note that there will be a reduction in accuracy because of the tolerances on the VIN voltage, the external resistors (accurate components should be used), and the internal SS circuitry.
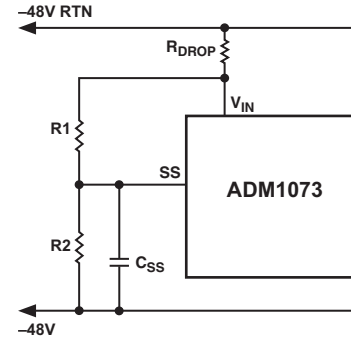

Figure 5. Altering the Reference with a Resistor Divider

This technique also allows different current limits to be selected at different points of operation without using multiple sense resistors. Certain systems may have a relatively low nominal current level for long periods and then go through bursts of operation for short periods. A dynamic current limit level can be set up to track this; resistor and switches or digipots can be used.

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