

## High Side Current Monitor

### Features

- ❑ 450V Maximum supply voltage
- ❑ Voltage output device
- ❑ 1% Typical gain accuracy
- ❑ 500mV Maximum  $V_{SENSE}$
- ❑ Fast response: 700ns rise and fall time
- ❑ 50 $\mu$ A Quiescent current (max.)

### Applications

- ❑ LED driver current monitor
- ❑ SMPS current monitor
- ❑ Battery current monitor
- ❑ Motor controls

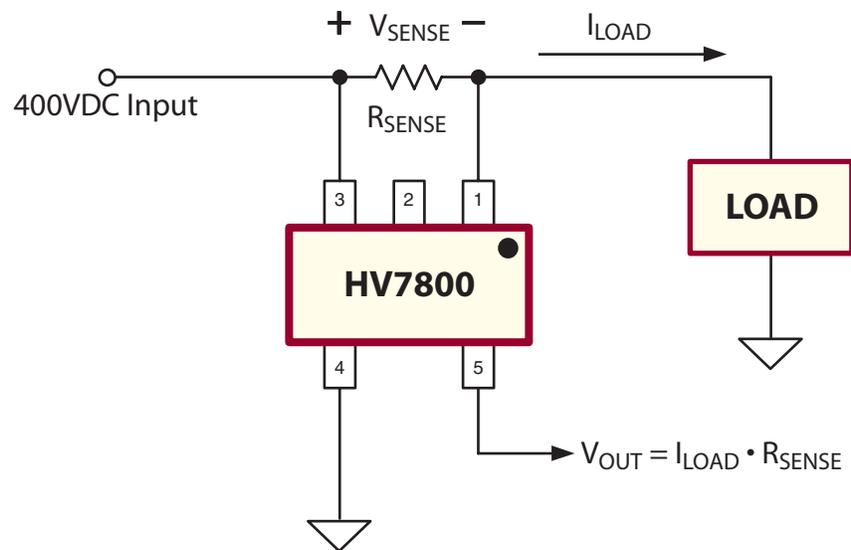
### General Description

The HV7800 is a high side current monitor IC, which senses the voltage across an external current sense resistor located in the power or “high” side of the circuit and translates this voltage to a ground referenced circuit at a gain of one.

The HV7800 has a wide operating range of 3V-450VDC, which enables its use in DC power systems of 12V/24V/48V, and in AC systems operating at voltages from 85VAC to 265VAC.

The fast response time of the HV7800 allows use of this current monitor in the feedback loop of a switching power supply or in LED driver applications.

### Typical Application Circuit



Ordering Information

DEVICE	Package Options
HV7800K1-G	5-Lead SOT-23

-G indicates package is RoHS compliant ('Green')



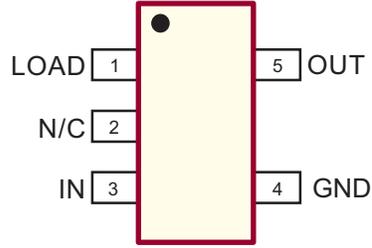
Absolute Maximum Ratings

Parameter	Value
IN	-0.5V to +450V
LOAD	-0.5V to +450V
OUT	-0.5V to +10V
Operating Ambient Temperature <sup>1</sup>	-40°C to +85°C
Operating Junction Temperature	-40°C to +125°C
Storage Temperature	-65°C to +150°C
SOT23-5 Package Thermal Resistance	260 K/W

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

<sup>1</sup> Limited by package dissipation.

Pinout



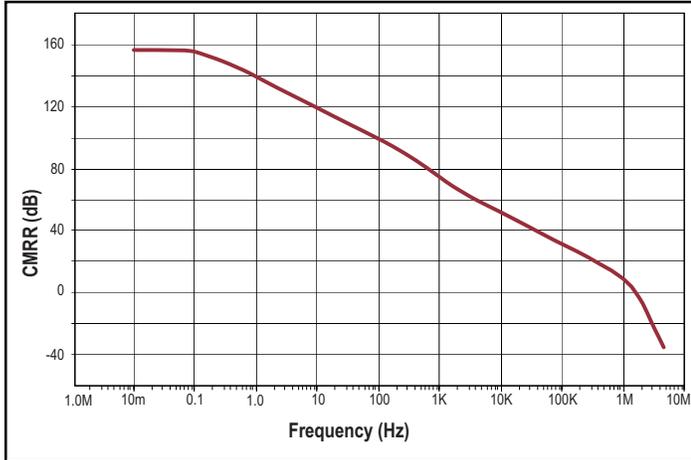
HV7800K1

Electrical Characteristics

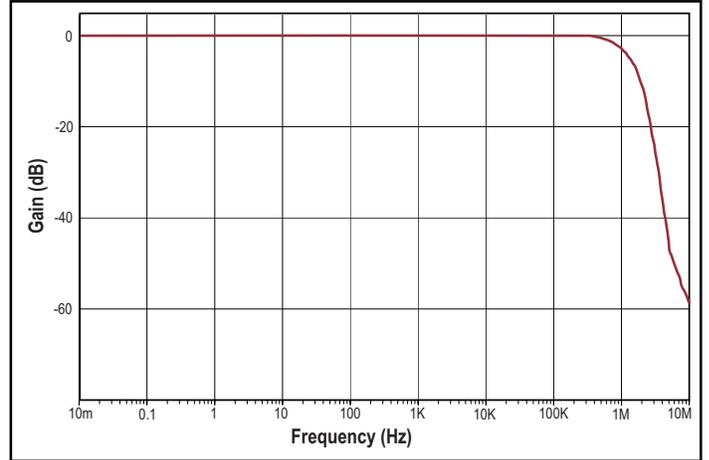
(Voltages referenced to GND,  $V_{IN} = 10V$ ,  $T_A = 25^\circ C$ , unless otherwise noted. Values of parameters marked with a • apply over the full temperature range.)

Symbol	Parameter	Min	Typ	Max		Units	Conditions
<b>ESD Characteristics, IN, LOAD</b>							
ESD	Human body model	-	±2.0	-		kV	1.5kΩ, 100pF
<b>Supply</b>							
$V_{IN}$	Supply voltage	10	-	450	•	V	---
$I_Q$	Quiescent supply current	10	-	50		μA	$V_{IN} = 400V$ , $V_{SENSE} = 0mV$
<b>Input and Output Characteristics</b>							
$I_{LOAD}$	Input current to LOAD pin	-1.0	-	1.0	•	nA	$V_{SENSE} = 500mV$
$R_{OUT}$	OUT pin output resistance	2.60	3.30	4.0		kΩ	---
$V_{OUT}$	Output Voltage	0	-	5.0		mV	$V_{SENSE} = 0mV$
		94		106			$V_{SENSE} = 100mV$
		193		207			$V_{SENSE} = 200mV$
		490		510			$V_{SENSE} = 500mV$
<b>Dynamic Characteristics</b>							
$t_{RISE}$	Output rise time, 10% to 90%	-	700	-		ns	$V_{SENSE}$ step 0mV to 500mV
$t_{FALL}$	Output fall time, 90% to 10%	-	700	-		ns	$V_{SENSE}$ step 500mV to 0mV

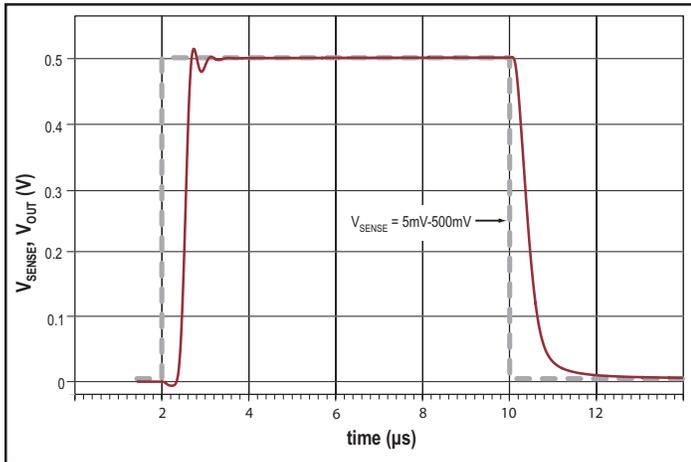
Typical Performance Characteristics



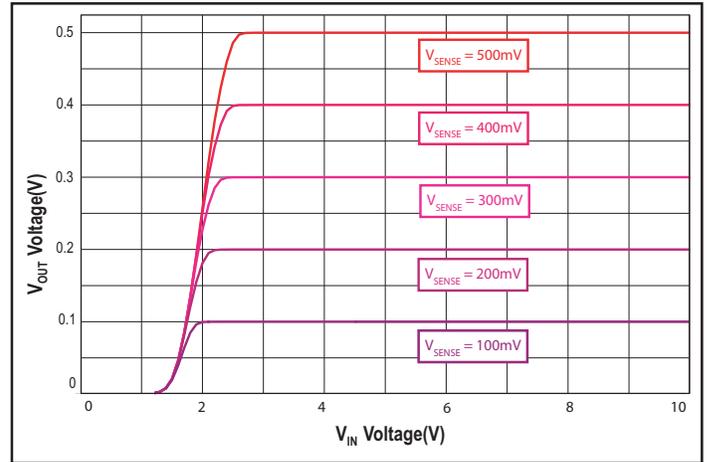
Common Mode Rejection Ratio vs Frequency



Gain vs Frequency

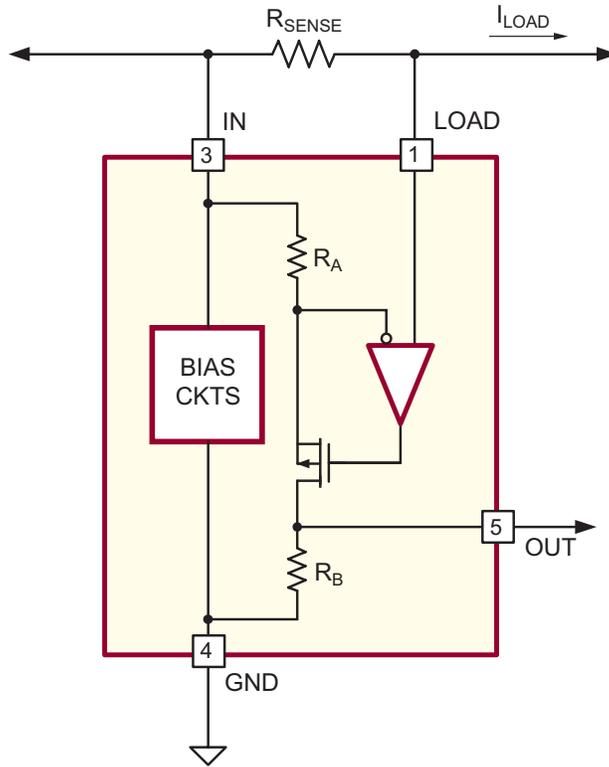


Step Response (5.0mV to 500mV)



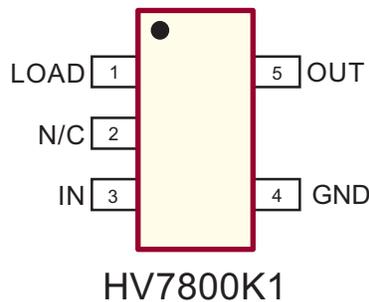
Output Characteristics ( $V_{OUT}$  vs  $V_{IN}$ )

Block Diagram



Pin Description

Pin	Name	Description
1	LOAD	This pin is an input sense pin that connects to the negative (-) side of sense resistor, $R_{SENSE}$ . The negative side denotes the system load end of the sense resistor.
2	N/C	No Connection
3	IN	Positive supply. Input voltage range is 3.0 to 450V. This pin is an input sense pin that connects to the positive (+) side of sense resistor, $R_{SENSE}$ .
4	GND	This pin is connected to the GND or return of the system.
5	OUT	Output Voltage referenced to GND terminal. The voltage at OUT will be equal to $V_{SENSE}$ . The output impedance of this pin is typically 3.3 k $\Omega$ .



## Application Information

### General

The HV7800 offers high side current sensing featuring accuracy, small size, low component count, low power consumption, ease of use and low cost. The input voltage rating of 450V extends the use to off-line applications.

The HV7800 allows measurement of line or load current for purpose of overcurrent protection, current metering and current regulation.

High side current sensing, as opposed to ground or low-side sensing, is desirable or required when:

- The current to be measured does not flow in a circuit associated with ground.
- The addition of resistance in the grounding system will cause issues with safety, EMI, or will lead to signal degradation due to common impedance coupling.

### Principle of Operation

The operational amplifier and associated MOSFET, as shown in the block diagram, force a current through resistor  $R_A$  such that  $V_{RA}$  is equal to  $V_{SENSE}$ . The current through  $R_A$  flows to ground through  $R_B$  and develops an output voltage  $V_{OUT}$ , which is equal to  $V_{SENSE}$ , given that  $R_A$  and  $R_B$  have equal resistance.

Note that the output is not buffered, having an output resistance of 3.3kΩ nominal. Loading of the output will affect gain accuracy and / or bandwidth.

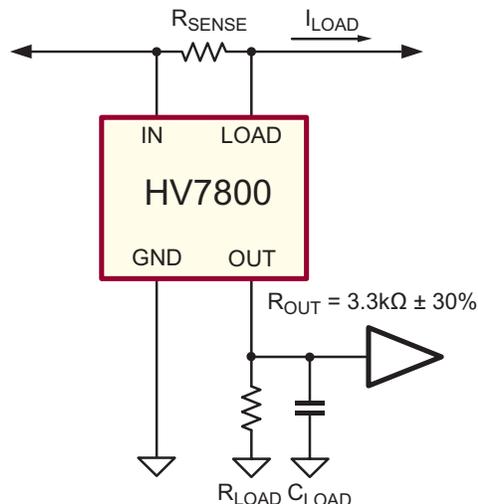
Assume in the following that  $R_{OUT} = 4kΩ$ .

To limit gain error to say 1 part in 1000, the external load impedance should exceed 4MΩ.

Capacitive loading forms a load pole. The break frequency follows from:

$$f = \frac{1}{2 \cdot \pi \cdot \tau} \quad \text{where} \quad \tau = (R_B \parallel R_{LOAD}) \cdot C_{LOAD}$$

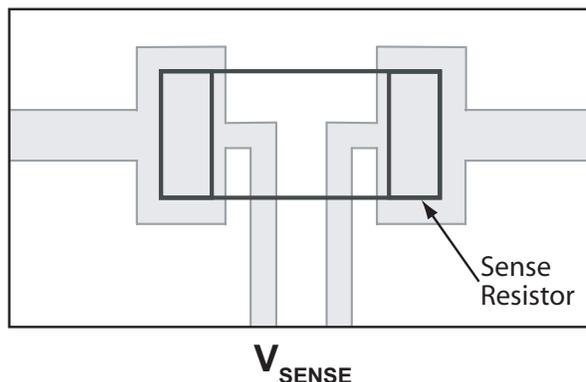
E.g. let  $R_{LOAD} = \infty$  and  $C_{LOAD} = 1nF$ , then the load pole is located at 38.8kHz, giving rise and fall times of 8.8us.



### Sense Resistor Considerations

The choice of value of the sense resistor entails a trade-off between power dissipation from the sense resistor and accuracy. Power dissipation from the sense resistor is equal to  $(V_{SENSE} \cdot I_{LOAD})$ . It is generally desirable to maximize  $V_{SENSE}$  to enhance accuracy, but not to the extent that power dissipation from the sense resistor becomes objectionable.

Consider the use of Kelvin connections for applications with a large load current. A typical layout pattern, which minimizes voltage drops across the sense lines is shown below:

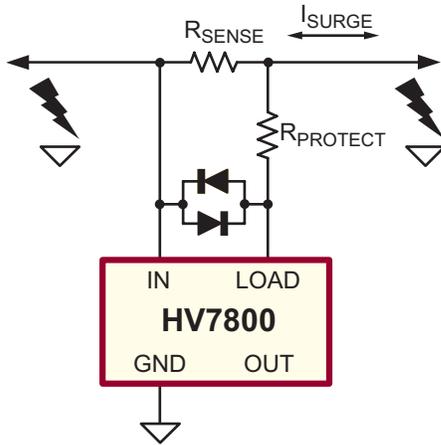


Preservation of bandwidth requires careful attention to trace layout and choice of sense resistor. Note that the resistance of the sense resistor is typically small, and that both the impedance of printed circuit board traces and the equivalent series inductance of the sense resistance can be a major part of the total sense/impedance at high frequency operation. An inductance of just 1nH contributes an impedance of 3mΩ at 500kHz.

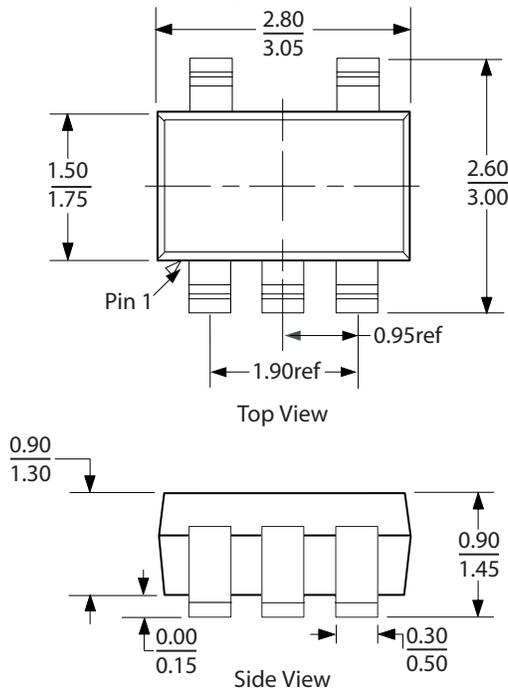
## Protection of the LOAD input

In situations where the sense voltage can significantly exceed 500mV, the LOAD input to the differential amplifier should be protected by the addition of a protection resistor and two diodes as shown below:

An excessive sense voltage might occur when line or load current is significantly larger during the startup or shutdown event, or during overcurrent or short circuit events. A large differential voltage can also exist if the sense resistor fails open, or is inadvertently not installed.



## 5-Lead SOT-23 (K1) Package Outline



All dimensions are in millimeters  
Legend:  $\frac{\text{min}}{\text{max}}$

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to <http://www.supertex.com/packaging.html>.)

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