HV7802

High-Side Current Monitor 8V to 450V Configurable Output

Features

- 8V to 450V Supply Voltage
- Configurable as a Current or Voltage Output Device
- 15 mV Maximum Sense Amplifier Offset
- 500 mV Maximum V_{SENSE}
- 700 ns to 2 µs Fast Rise and Fall Time
- 50 µA Maximum Quiescent Current

Applications

- Switch Mode Power Supply Current Monitor
- Battery Current Monitor
- Motor Controls

General Description

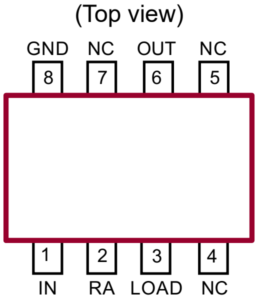
The HV7802 high-side current monitor IC contains a transconductance amplifier which translates a high-side current measurement voltage into an output current with resistor-programmable transconductance gain. An optional second resistor transforms this output current into an output voltage with an overall voltage gain set by the ratio of the two resistors.

The measurement voltage typically originates at a current sense resistor, which is located in a "high-side" circuit. An example is a circuit not directly associated with ground.

This monitor IC features a very wide input voltage range, configurable gain, small size, low component count, low-power consumption, ease of use and low cost. Offline, battery and portable applications can be served equally well due to the wide input voltage range and the low quiescent current.

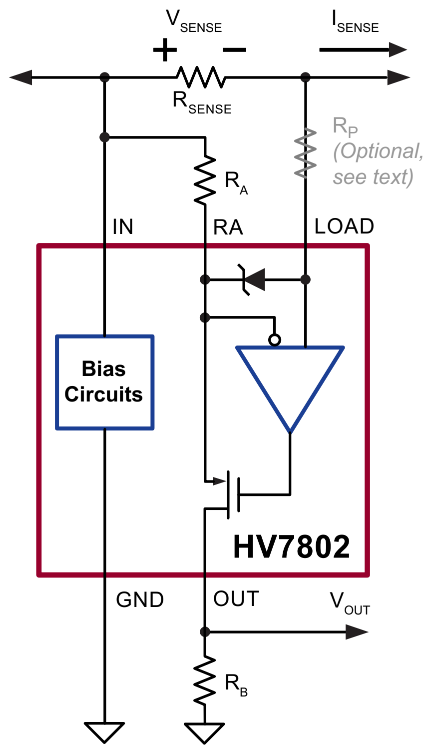
Package Type

8-lead MSOP
(Top view)

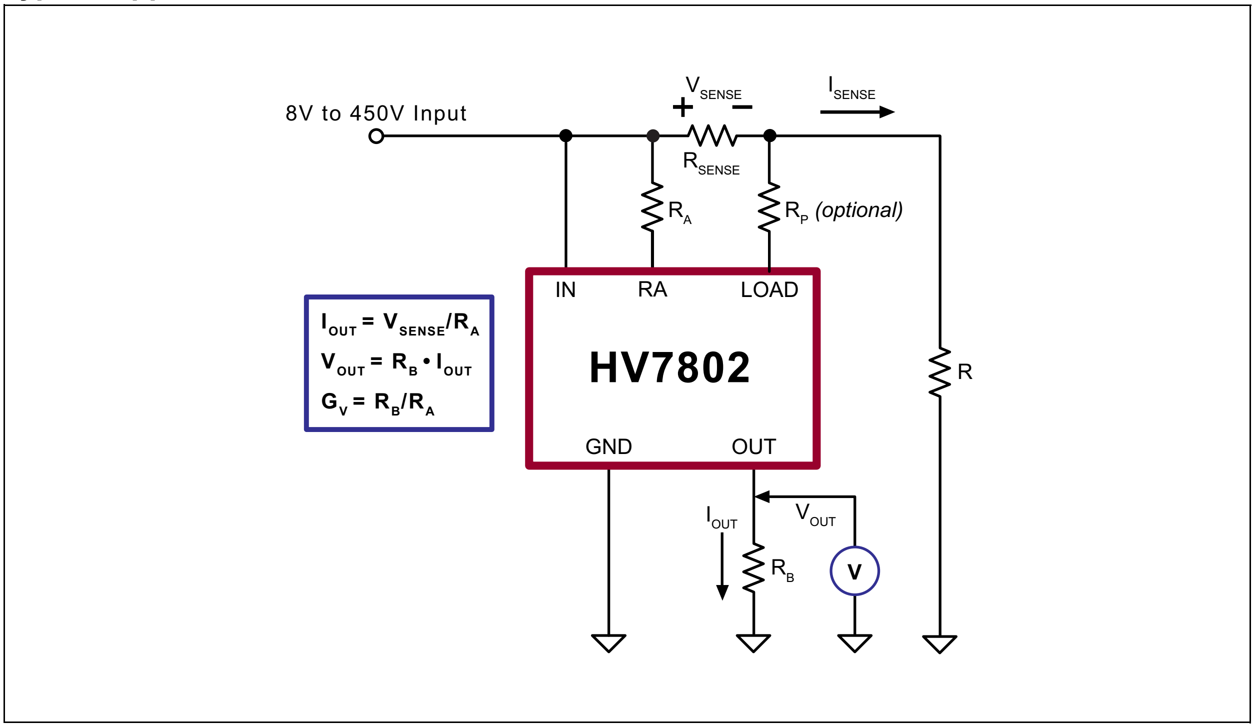


See Table 2-1 for pin information.

Functional Block Diagram



Typical Application Circuit



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings†

Supply Voltage, V_{IN}, V_{LOAD} (**Note 1**) .... –0.5V to +460V
Output Voltage V_{OUT} (**Note 1**)........ –0.5V to +10V
Sense Voltage, V_{SENSE} (**Note 2**) .... –0.5V to +5V
Current Load, I_{LOAD} (**Note 2**) .... ±10 mA
Operating Ambient Temperature, T_A .... –40°C to +85°C
Operating Junction Temperature, T_J .... –40°C to +125°C
Storage Temperature, T_S........ –65°C to +150°C

† Notice: Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only, and functional operation of the device at those or any other conditions above those indicated in the operational sections of this specification is not intended. Exposure to maximum rating conditions for extended periods may affect device reliability.

Note 1: Referenced to GND
2: $V_{SENSE} = V_{IN}–V_{LOAD}$

ELECTRICAL CHARACTERISTICS

Electrical Specifications: T_A = 25°C unless otherwise noted. $V_{SENSE} = V_{IN}–V_{LOAD}$, V_{IN} = 8V to 450V

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
SUPPLY						
Supply Voltage	V_{IN}	8	—	450	V	**Note 1**
Quiescent Supply Current	I_Q	—	—	50	µA	V_{IN} = 8V to 450V, V_{SENSE} = 0 mV
INPUT AND OUTPUT						
Output Current	I_{OUT}	—	—	200	µA	
Output Voltage, $R_A = R_B$ = 5 kΩ	V_{OUT}	0	—	15	mV	V_{SENSE} = 0 mV
		79	—	121	mV	V_{SENSE} = 100 mV
		177	—	223	mV	V_{SENSE} = 200 mV
		470	—	530	mV	V_{SENSE} = 500 mV
DYNAMIC CHARACTERISTICS						
Output Rise Time, 10% to 90%	t_r	—	0.7	—	µs	V_{SENSE} = Step 5 mV to 500 mV
		—	—	2	µs	V_{SENSE} = Step 0 mV to 500 mV
Output Fall Time, 90% to 10%	t_f	—	0.7	2	µs	V_{SENSE} = Step 500 mV to 0 mV

Note 1: Values apply over the full temperature range.

TEMPERATURE SPECIFICATIONS

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
TEMPERATURE RANGE						
Operating Ambient Temperature	T_A	–40	—	+85	°C	
Operating Junction Temperature	T_J	–40	—	+125	°C	
Storage Temperature	T_S	–65	—	+150	°C	
PACKAGE THERMAL RESISTANCE						
8-lead MSOP	θ_{JA}	—	216	—	°C/W	**Note 1**

Note 1: Thermal test board per JEDEC JESD51-7

2.0 PIN DESCRIPTION

The details on the pins of HV7802 are listed in Table 2-1. Refer to **Package Type** for the location of pins.

TABLE 2-1: PIN FUNCTION TABLE

Pin Number	Pin Name	Description
1	IN	Sense amplifier input and supply
2	RA	Provides gain setting of the transconductance amplifier. Connect gain setting resistor (R_A) between Pin 1 and Pin 2.
3	LOAD	Sense amplifier input. High-impedance input with Zener diode protection. Add an external protection resistor in series with LOAD if V_{SENSE} exceeds the range of –600 mV to +5V.
4	NC	No Connect. This pin must be left floating for proper operation.
5	NC	No Connect. This pin must be left floating for proper operation.
6	OUT	Output of the transconductance amplifier. Output current to output voltage conversion can be accomplished through the addition of an external resistor (R_B) at this pin. Overall voltage gain is determined by the ratio of R_B to R_A.
7	NC	No Connect. This pin must be left floating for proper operation.
8	GND	Supply return

3.0 APPLICATION INFORMATION

3.1 General

The HV7802 high-side current monitor IC features accurate current sensing, small size, low component count, low-power consumption, exceptional input voltage range, ease of use and low cost.

The part typically performs the measurement of line or load current for overcurrent protection, metering, and current regulation.

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

- The current to be measured does not flow in a circuit associated with ground.
- The measurement at ground level can lead to ambiguity due to changes in the grounding arrangement during field use.
- Introduction of a sense resistor in the system ground is undesirable due to issues with safety, electromagnetic interference (EMI) or signal degradation caused by common impedance coupling.

3.2 Principle of Operation

The operational amplifier forces the voltage across R_A to track V_{SENSE}, therefore, $V_{RA} = V_{SENSE}$. Transconductance gain is equal to $(1/R_A)$.

IR_A flows from the OUT pin to low-side circuitry. Current-to-voltage conversion can be accomplished by a resistor, R_B, as shown in the **Functional Block Diagram** with a transimpedance gain equal to R_B.

Typically we would like to exploit the full current capability of the transimpedance amplifier. An RA of 5 kΩ will provide this current, assuming a full-scale sense voltage of 500 mV and a full-scale sense current of 100 µA.

In a voltage output application, the output resistor R_B is determined by the desired overall voltage gain of (R_B/R_A). For example, an R_B of 10 kΩ results in a voltage gain of two.

3.3 OUT Pin Loading Effects

Note that the output is not buffered, having an output impedance equal to R_B. Loading the output causes the voltage gain to drop and the rise/fall time to increase.

For example, assume a gain of one, using $R_A = R_B = 5$ kΩ. In this case, the load resistance should exceed 5 MΩ in order to limit the gain drop to 1 part in 1000.

Assuming an output resistance of 5 kΩ, a capacitive load of 20 pF results in a load pole with a time constant of 100 ns, not enough to materially affect the output rise and fall time (about 700 ns).

3.4 Sense Resistor Considerations

Limit the sense resistor voltage to 500 mV during normal operating conditions. Limit the power dissipation in the sense resistor to suit the application. A high-sense voltage benefits accuracy but may increase power dissipation.

Consider the use of Kelvin connections for applications where significant voltage drops may occur in the PCB traces. A layout pattern that minimizes voltage drops across the sense lines is shown in Figure 3-1.

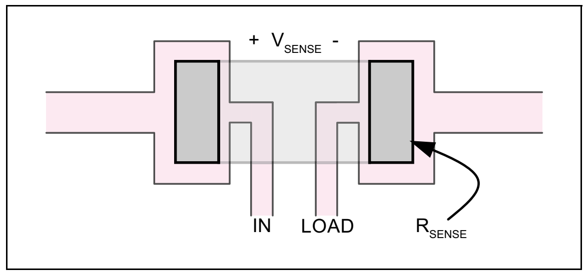


FIGURE 3-1: *Kelvin Connection for the Sense Resistor.*

Choose a low-inductance type of sense resistor if preservation of bandwidth is important. The use of Kelvin connections helps by minimizing the inductive voltage drops as well. The inductive voltage drop may be substantial when operating at high frequency.

A trace or component inductance of 10 nH contributes an impedance of 6.2 mΩ at 100 kHz, which constitutes a 6% error when using a 100 mΩ sense resistor.

3.5 Transient Protection

Add a protection resistor (R_P) in series with the load pin if V_{SENSE} can exceed 5V in a positive sense or 600 mV in a negative sense, whether in a Steady state or in transient conditions.

A large V_{SENSE} may occur during system startup or shutdown due to the charging and discharging of bulk storage capacitors. V_{SENSE} may be large due to Fault conditions, such as Short Circuit or a broken or missing sense resistor.

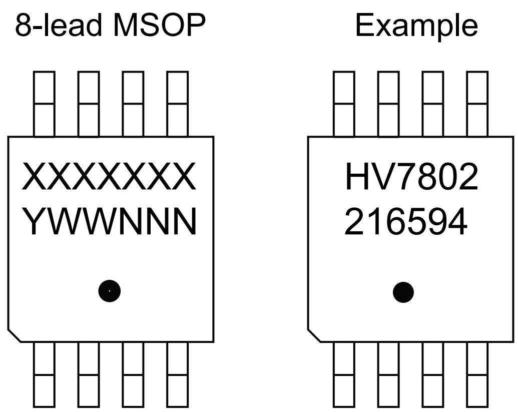
An internal 5V Zener diode with a current rating of 10 mA protects the sense amplifier inputs. The block diagram shows the orientation of this diode. The Zener diode provides clamping at 5V for a positive V_{SENSE} and at 600 mV for a negative V_{SENSE}.

Under worst-case conditions, limit the Zener current to 10 mA. A 100 kΩ resistor limits the Zener diode current to 4.5 mA when V_{SENSE} is 450V, whether positive or negative. Note that the protection resistor may affect the bandwidth. The resistor forms an RC network with the trace and pin capacitance at the load pin. A capacitance of 5 pF results in a time constant of 500 ns.

The protection resistor may cause an offset due to bias current at the load input. Under worst-case bias current (1 nA), a 100 kΩ protection resistor could cause an offset of 100 µV or 0.2% of full scale. Note that the bias current is nominally zero as the LOAD is a high-impedance CMOS input, resulting in zero bias current induced offset voltage.

4.0 PACKAGE MARKING INFORMATION

4.1 Packaging Information

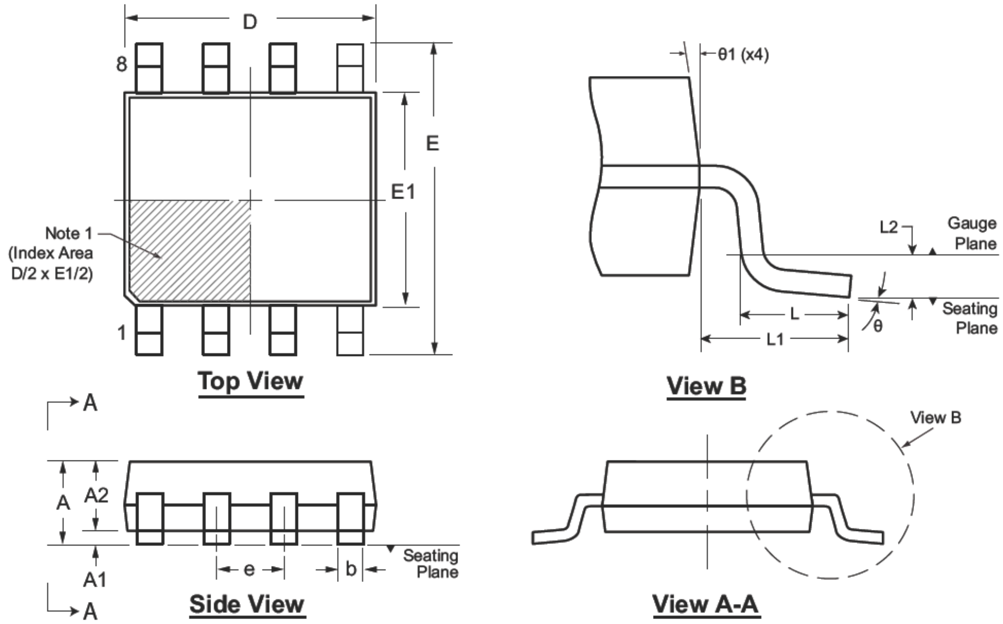


Legend:	XX...X	Product Code or Customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week '01')
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package.

Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for product code or customer-specific information. Package may or not include the corporate logo.

8-Lead MSOP Package Outline (MG)

3.00x3.00mm body, 1.10mm height (max), 0.65mm pitch



Note: For the most current package drawings, see the Microchip Packaging Specification at www.microchip.com/packaging.

Note:

1. *A Pin 1 identifier must be located in the index area indicated. The Pin 1 identifier can be: a molded mark/identifier; an embedded metal marker; or a printed indicator.*

Symbol		A	A1	A2	b	D	E	E1	e	L	L1	L2	θ	θ1
Dimension (mm)	MIN	0.75*	0.00	0.75	0.22	2.80*	4.65*	2.80*	0.65 BSC	0.40	0.95 REF	0.25 BSC	0°	5°
	NOM	-	-	0.85	-	3.00	4.90	3.00		0.60			-	-
	MAX	1.10	0.15	0.95	0.38	3.20*	5.15*	3.20*		0.80			8°	15°

JEDEC Registration MO-187, Variation AA, Issue E, Dec. 2004.
** This dimension is not specified in the JEDEC drawing.*
Drawings are not to scale.

NOTES:

APPENDIX A: REVISION HISTORY

Revision A (October 2022)

- Converted Supertex Doc# DSFP-HV7802 to Microchip DS20005901A
- Changed the package marking format
- Made minor text changes throughout the document

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, contact your local Microchip representative or sales office.

PART NO.	XX	-	X	-	X
Device	Package Options		Environmental		Media Type

Device:	HV7802	=	High-Side Current Monitor 8V to 450V Configurable Output
Package:	MG	=	8-lead MSOP
Environmental:	G	=	Lead (Pb)-free/RoHS-compliant Package
Media Type:	(blank)	=	2500/Reel for an MG Package

Example:

a) HV7802MG-G: High-Side Current Monitor 8V to 450V Configurable Output, 8-lead MSOP, 2500/Reel

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