

## HX59800-SQ 1A Ultra-Low Noise High PSRR LDO

### General Description

The HX59800-SQ is an ultra-low-noise voltage regulator (6 $\mu$ VRMS) with a high PSRR and low-dropout (LDO) capability, capable of supplying a current of up to 1A. Its output voltage is adjustable within a range of 0.8V to 6V through external resistors. Additionally, the device boasts a wide input voltage range, spanning from 2.2V to 6.0V.

The HX59800-SQ is specifically tailored to power noise-sensitive components commonly found in various applications, including high-speed communications, video processing, medical devices, and test and measurement equipment. Its ultra-low output noise and wideband PSRR effectively minimize phase noise and clock jitter in a diverse array of devices, ranging from VCOs, ADCs, and DACs to high-end processors and FPGAs. This ensures optimal performance and reliability in noise-critical

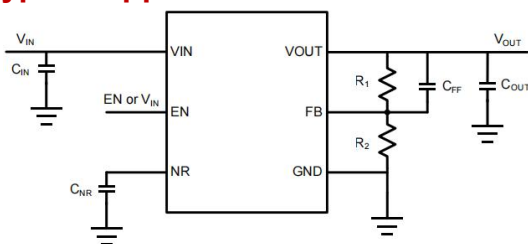
### Features

- Input Voltage Range: 2.2V to 6.0V
- Output Voltage Range: 0.8V to 6V
- Low Quiescent Current: 210 $\mu$ A (TYP)
- Ultra-Low Output Noise: 6 $\mu$ VRMS(TYP) Output Voltage Noise (100Hz to 100kHz) at 1A Load
- High PSRR: Over 70dB at 1kHz and 40dB at 1MHz
- 2.0% Accuracy Over Line, Load and Temperature
- Low Dropout: 450mV maximum at 1A Load
- Excellent Transient Response
- Thermal Shutdown and Over-Current Protection
- Stable with a 22 $\mu$ F or larger ceramic capacitor
- Operating Junction Temperature: -40 $^{\circ}$ C to +125 $^{\circ}$ C
- Available packages: DFN3x3-8L

### Applications

- High Performance Analog: VCO, ADC, DAC, LVDS
- Communication: CPU, ASIC, FPGA, CPLD, DSP
- Noise Sensitive Imaging: CMOS Sensors, Video ASICs
- Instrumentation, Medical, and Audio

### Typical Application Circuit



### DFN-8 Package Top View



### Pin Descriptio

Pin	Name	I/O	Function
1, 2	OUT	O	Regulator output voltage pin. A 22 $\mu$ F or larger ceramic capacitor from OUT to ground is required to ensure regulator stability.
3	FB	I	Output voltage feedback pin. Connect to an external resistor divider to adjust the output voltage. A 10nF feed-forward capacitor from FB to OUT is recommended to maximize the regulator ac performance.
4	GND	-	Device ground pin.
5	EN	I	Enable pin. Drive EN high to turn on the LDO and drive the EN low to turn off the LDO. The EN pin can be connected to IN for automatic startup.
6	NR	O	Noise reduction pin. A 100nF or larger capacitor from NR to GND is recommended to maximize the performance.
7, 8	IN	I	Input voltage pin. A 10 $\mu$ F capacitor from IN to GND is recommended.
	Exposed Pad		Exposed Pad must be connected to a large-area ground plane to get maximum electrical and thermal performance.

## Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
IN and EN Pins	IN, EN	-0.3 to 7	V
OUT Pin	OUT	-0.3 to $V_{IN} + 0.3$	V
NR and FB Pins	NR, FB	-0.3 to $V_{IN} + 0.3$	V
Storage temperature range	TSTG	-65 to +150	°C
Output current	IOUT	1	A

## Notes:

1. Exposure of the device under conditions beyond the limits specified by Maximum Ratings for extended periods may cause permanent damage to the device and affect product reliability. These conditions represent a stress rating only, and functional operations of the device at these or any other conditions above the operational limits noted in this specification is not implied.

## ESD Ratings

SYMBOL	PARAMETER	Value	Unit
VESD	Electrostatic Discharge	HBM (Human Body Model)	3000
		CDM (Charge Device Model)	1000

## Recommended Operation Conditions

Parameter	Symbol	Min	Max	Unit
Input Voltage	$V_{IN}$	2.2	6.0	V
Output Voltage	$V_{OUT}$	0.8	6.0	V
Output Capacitance	$C_{OUT}$	22		$\mu F$
Output Current	IOUT	0	1	A
Operating Junction Temperature	$T_J$	-40	125	°C

## Thermal Information

Package	$R_{\theta JA}$	$R_{\theta JC}$	Unit
3x3 DFN-8	55	21	°C/W

## Electrical Characteristics

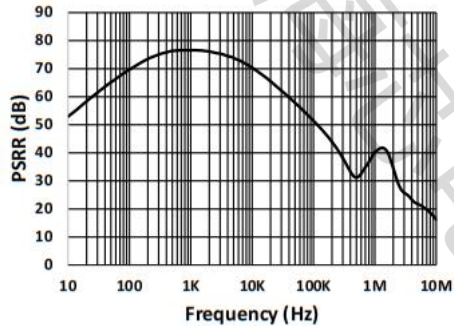
$V_{IN} = 2.2V$  or  $V_{IN} = V_{OUT} + 0.5V$  (whichever is greater),  $V_{EN} = V_{IN}$ ,  $C_{IN} = 10\mu F$ ,  $C_{OUT} = 22\mu F$ ,  $C_{NR} = 1\mu F$ ,  $C_{FF} =$  open,  $T_A = -40$  to  $+125^\circ C$  unless otherwise noted

Parameter	Symbol	Conditions	Rating			Unit
			Min	Typ	Max	
Input Voltage	$V_{IN}$		2.2		6.0	V
Reference Voltage	$V_{REF}$			0.8		V
UVLO Threshold	$V_{UVLO}$	$V_{IN}$ rising			2.5	V
UVLO Hysteresis	$\Delta V_{UVLO}$			215		mV
Output Voltage Accuracy		$5mA \leq I_{OUT} \leq 1A$	-2.0	0	2.0	%
GND Pin Current	$I_{GND}$	$V_{IN} = 6.0V$ , $I_{OUT} = 1mA$		210	0.3	$\mu A$
Shutdown Current	$I_{SHDN}$			0.2	0.9	$\mu A$
Dropout Voltage	$V_{DO}$	$V_{IN} \geq 2.2V$ , $0.8V \leq V_{OUT} \leq 6.0$ , $I_{OUT} = 1A$ , $V_{FB} = 0.8 - 3\%$			450	mV
Over Current Limit	$I_{LIM}$	$V_{IN} = 2.2 - 6.0V$		3.2		A
Line Regulation	$\Delta V_{OUT}(\Delta V_{IN})$	$V_{IN} = 2.2 - 6.0V$		0.008		%/V
Load Regulation	$\Delta V_{OUT}(\Delta I_{OUT})$	$I_{OUT} = 5mA$ to $1A$		0.07		%/A
EN pin low-level input voltage (device disabled)	$V_{IL(EN)}$		0		0.4	V
EN pin high-level input voltage (device enabled)	$V_{IH(EN)}$		1.35		6.0	V

EN PIN Leakage Current	I <sub>EN</sub>	V <sub>IN</sub> = 6.0V, 0V ≤ V <sub>EN</sub> ≤ 6.0V	-0.2	0.2	μA
FB PIN Leakage Current	I <sub>FB</sub>	V <sub>IN</sub> = 6.0V, V <sub>FB</sub> = 0.8V	-0.2	0.2	μA
Power Supply Rejection Ratio	PSRR	V <sub>IN</sub> = 5V, V <sub>OUT</sub> = 3.3V, I <sub>OUT</sub> = 1A, C <sub>OUT</sub> = 22μF, C <sub>NR</sub> = 1μF, C <sub>FF</sub> = 10nF	f = 1kHz	75	dB
			f = 100kHz	52	
			f = 1MHz	41	
Output Noise Voltage	V <sub>N</sub>	BW = 100Hz to 100kHz, V <sub>IN</sub> = 5V, V <sub>OUT</sub> = 3.3V, I <sub>OUT</sub> = 1A, C <sub>OUT</sub> = 22μF, C <sub>NR</sub> = 1μF, C <sub>FF</sub> = 100nF	6.0		μVRMS
Thermal Shutdown	TSD		160		°C
Thermal Shutdown Hysteresis	T <sub>HYS</sub>		20		°C

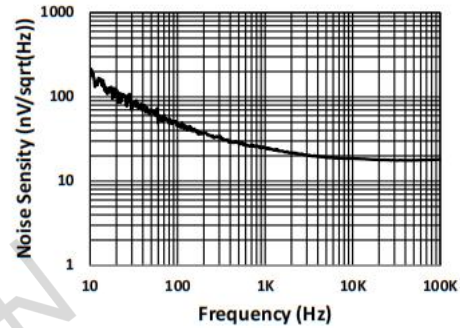
## Typical Characteristics

V<sub>IN</sub> = 2.2V or V<sub>IN</sub> = V<sub>OUT</sub> + 0.4V (whichever is greater), OUT connected to 50 Ω to GND, V<sub>EN</sub> = V<sub>IN</sub>, C<sub>IN</sub> = 10μF, C<sub>OUT</sub> = 22μF, C<sub>NR</sub> = 1μF, C<sub>FF</sub> = open, T<sub>A</sub> = -40 to +125°C unless otherwise noted



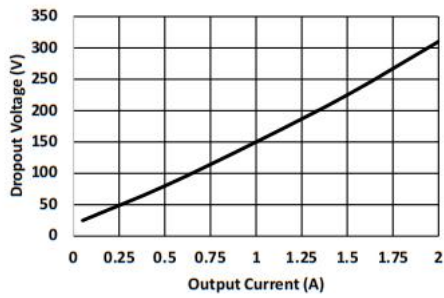
V<sub>IN</sub> = 4V, V<sub>OUT</sub> = 3.3V, I<sub>OUT</sub> = 2A, C<sub>OUT</sub> = 22μF, C<sub>NR</sub> = 1μF, C<sub>FF</sub> = open

PSRR



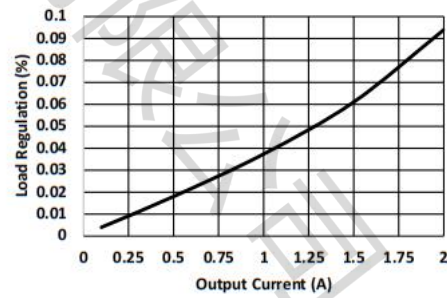
V<sub>IN</sub> = 4V, V<sub>OUT</sub> = 3.3V, I<sub>OUT</sub> = 2A, C<sub>OUT</sub> = 22μF, C<sub>NR</sub> = 1μF, C<sub>FF</sub> = open

Output Noise Density



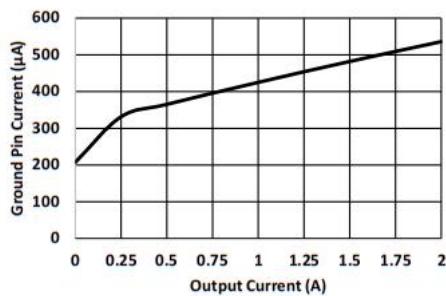
V<sub>IN</sub> = 3.3V, V<sub>EN</sub> = 3.3V

Dropout Voltage



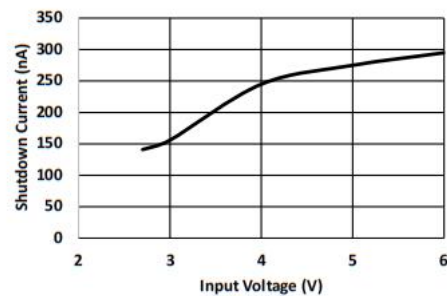
V<sub>IN</sub> = 4V, V<sub>OUT</sub> = 3.3V, C<sub>OUT</sub> = 22μF

Load Regulation



V<sub>IN</sub> = 4V, V<sub>OUT</sub> = 3.3V, C<sub>OUT</sub> = 22μF

Ground Current vs Output Current



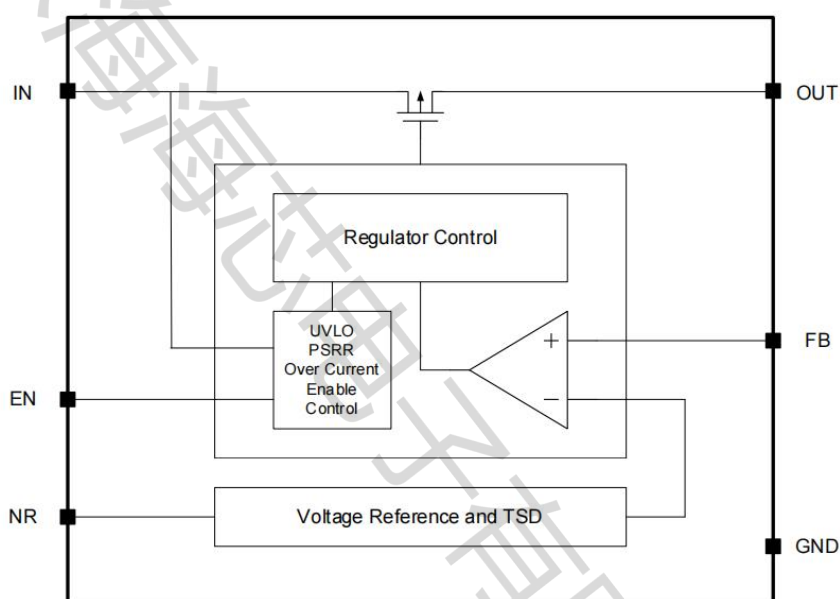
V<sub>EN</sub> = 0V

Power Down Current vs Input Voltage

## Functional Description

The HX59800-SQ is an LDO (Low Dropout) regulator that boasts low noise, high PSRR (Power Supply Rejection Ratio), and a maximum dropout voltage of 450mV. It is capable of sourcing a 1A load current and can operate with an input voltage as low as 2.2V, delivering an output voltage of 0.8V. This combination of features makes it an ideal choice for powering a wide range of loads, from noise-sensitive communication components in high-speed applications to high-end microprocessors or field-programmable gate arrays (FPGAs). Additionally, the HX59800-SQ incorporates internal protection circuitry, including under-voltage lockout, to prevent the device from turning on until the input voltage is sufficient for accurate regulation. It also features foldback current limiting, which allows the output to source the rated current when the output voltage is regulated but reduces the allowable output current during short-circuit conditions.

## Functional Block Diagram



## Feature Description

### Enable

The enable pin of the HX59800-SQ operates in an active-high mode. When the voltage on the enable pin exceeds  $V_{IH}(EN)$ , the device becomes enabled, and when it falls below  $V_{IL}(EN)$ , it is disabled. If independent control of the chip's enable state is not required, the enable pin can simply be connected to the input. Additionally, the HX59800-SQ features an internal pulldown MOSFET that connects a discharge resistor between  $V_{OUT}$  and ground. This ensures that when the device is disabled, the output voltage is actively discharged.

### Dropout voltage

Dropout voltage (VDO) is defined as the difference between the input voltage ( $V_{IN}$ ) and the output voltage ( $V_{OUT}$ ) at the rated current of 1A, when the pass transistor is fully operational and in its linear region. This VDO indirectly determines the minimum input voltage required, which must be higher than the nominal programmed output voltage, to ensure that the output voltage remains regulated. If the input voltage falls below this minimum level for maintaining output regulation, then the output voltage will closely follow the changes in the input voltage.

### Output Voltage Accuracy

Output voltage accuracy defines the minimum and maximum deviation of the actual output voltage from the expected nominal output voltage, expressed as a percentage. The HX59800-SQ boasts an output voltage accuracy of 2%, which encompasses errors resulting from the internal reference, load regulation, and line regulation variations across the entire range of rated loads and operating line conditions, regardless of temperature.

## Undervoltage Lockout (UVLO)

The HX59800-SQ uses an undervoltage lockout circuit to keep the output shut off until the internal circuitry is operating properly.

## Internal Current Limit

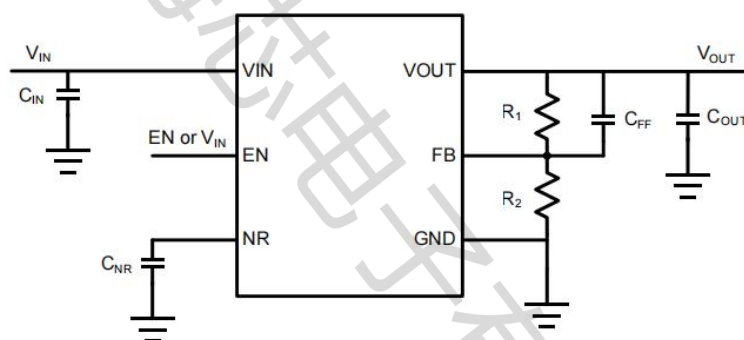
The internal current-limit circuit serves as a safeguard for the LDO, protecting it from transient high-load faults or short-circuit events. It is important to note that the LDO is not intended to operate in a current-limited state under steady-state conditions.

## Thermal Protection

The HX59800-SQ contains a thermal shutdown protection circuit to turn off the output current when excessive heat is dissipated in the LDO.

## Application Information

### Typical Application



### Input Capacitor and Output

The HX59800-SQ is specifically designed and characterized for operation with ceramic capacitors of 10 $\mu$ F or larger at the input and 22 $\mu$ F or larger at the output. It is recommended to locate the input and output capacitors as close as possible to the respective input and output pins, in order to minimize the trace inductance between the capacitors and the device.

### Feed-Forward Capacitor (CFF)

Although a feed-forward capacitor (CFF), from the FB pin to the OUT pin is not required to achieve stability, a 10nF, feed-forward capacitor improves noise and PSRR performance.

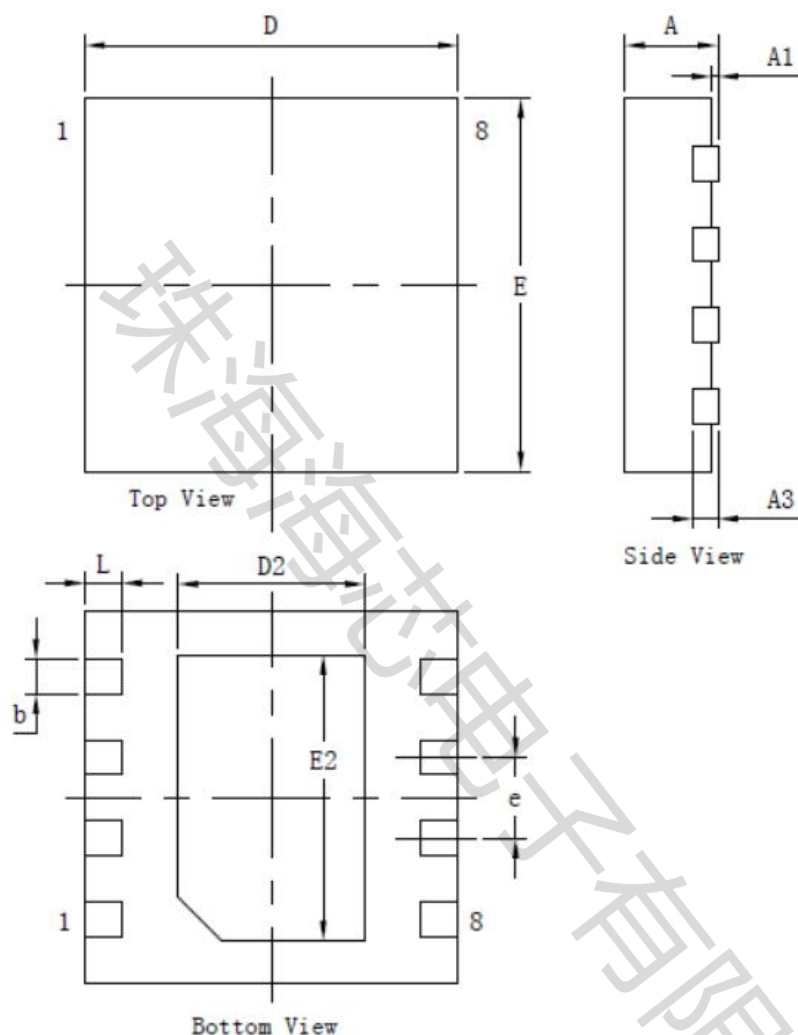
### Adjustable Output

The output voltage of the HX59800-SQ can be fine-tuned within the range of 0.8V to 6V by utilizing a resistor network, as demonstrated in the typical application diagram.

The table below provides an overview of the resistor combinations required to achieve some of the most commonly used voltage rails, utilizing commercially available resistors with a 0.1% tolerance.

VOUT(TARGET) (V)	FEEDBACK RESISTOR VALUES		CALCULATED OUTPUT VOLTAGE (V)
	R1 (k $\Omega$ )	R2 (k $\Omega$ )	
0.8	Short	Open	0.800
1.00	2.55	10.2	1.000
1.20	5.9	11.8	1.200
1.50	9.31	10.7	1.496
1.80	1.87	1.5	1.797
2.50	2.43	1.15	2.490
3.00	3.16	1.15	2.998
3.30	3.57	1.15	3.283
5.00	10.5	2	5.00

## Packing



标注	尺寸			尺寸标注	尺寸		
	最小(mm)	标准(mm)	最大(mm)		最小(mm)	标准(mm)	最大(mm)
A	0.70	0.75	0.80	E	2.90	3.00	3.10
A1	—	—	0.05	D2	1.40	1.50	1.60
A3	0.203 REF			E2	2.20	2.30	2.40
b	0.23	0.28	0.33	0.65 TYP			
D	2.90	3.00	3.10	L	0.25	0.30	0.35

Part Number	Package Type	package	quantity
HX59800-SQ	DFN-8L(3x3)	Taping	2500



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