

Negative Voltage Regulator

1. Description

The H 7011 negative voltage regulator is a low power device accepting supply voltages from -2.5 to -10V and providing an adjustable output voltage of -1.3 to -10V at currents beyond 40mA . Operating current is typically $3\mu\text{A}$, independent of the load.

Thermal and remote shutdowns provide an efficient protection of both the regulator and the circuits powered. The regulator is also protected against reverse polarity supply voltages. The device is particularly suited for portable battery driven equipment and applications requiring a very stable supply voltage. It will power CMOS and TTL circuits equally well.

2. Features

- Very low drop-out voltage (0.2V typical)
- Wide range of supply voltage (-2.5 to -10V)
- Low power consumption (typ. $3\mu\text{A}$)
- Internal -1.3V bandgap voltage reference
- Output voltage range -1.3 to -10V
- Up to 60mA output current supply typical
- Thermic protection (shutdown $T_j = 125^\circ\text{C}$)
- Output shutdown via external control signal
- Reverse supply voltage protection
- Typical output impedance 0.15Ω
- Can power positive voltage systems

3. Block Diagram

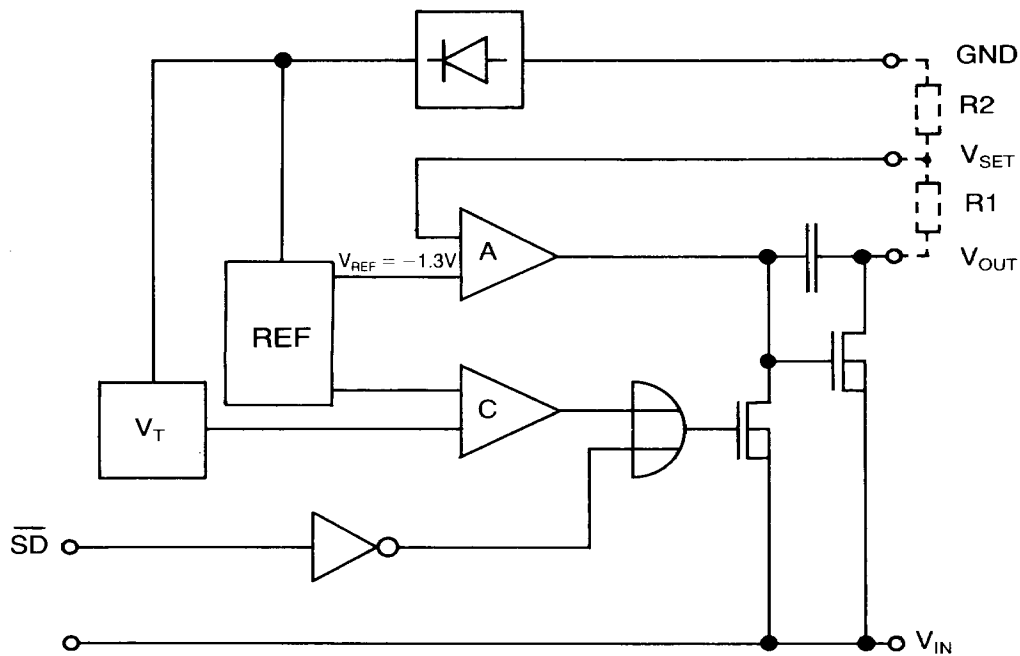
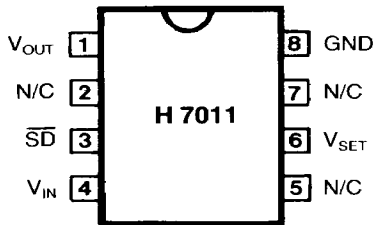


Fig. 1

4. Pin Assignments

Pin	Name	Description
1	V _{OUT}	Regulated voltage output
2	N/C	
3	\overline{SD}	Shutdown command input
4	V _{IN}	Unregulated negative voltage
5	N/C	
6	V _{SET}	Bandgap reference voltage
7	N/C	
8	GND	Common positive voltage terminal

Note: The terminals marked N/C have no internal connection.



5. Absolute Maximum Ratings

Input supply voltage	V _{IN}	-12V
Any terminal	V _{PIN} .. (Gnd +0.5V) to (V _{IN} -0.5V)	
Output sink current	I _{OUT}	80mA
Operating temperature	T _A	-25 to +80°C
Storage temperature	T _{STO}	-55 to +125°C
Power dissipation	P _{MAX}	200mW (see note)

Stresses beyond these listed maximum ratings may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Note: The power dissipation is given for the DIL 8 plastic package.

6. Handling Procedures

This device contains circuitry to protect the terminals against damage due to high static voltages or electrical fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this circuit. For proper operation it is recommended that all terminal voltages are constrained to the range V_{IN} < V_{TERMINAL} < GND, unless specially permitted. Unused inputs must always be tied to an appropriate logic voltage level (e.g. either V_{SS} or V_{DD}).

Electrical Specifications

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Input Voltage	V _{IN}		-2.5		-10	V
Quiescent Current (see Fig. 6)	I _Q	V _{IN} = -5V; R ₁ = 0; R ₂ = ∞ V _{IN} = -10V; R ₁ = 0; R ₂ = ∞		2.5 3	4 5	μA
Reference Voltage	V _{REF}		-1.2	-1.3	-1.4	V
Temperature Coefficient	T _C	V _{SET} = V _{REF}		±60		ppm/°C
Line Regulation		I _{OUT} = 1mA		100		ppm/V
V _{SET} Input Current	I _{SET}			±0.01	1	nA
Shutdown Input Current	I _{\overline{SD}}	V _{\overline{SD}} = V _{IN}		0.3	1	μA
Ext. Shutdown Impedance to V _{IN}	R _{OFF}	Contact closed (see Fig. 2)			30	kΩ
Shutdown Input Voltage	V _{\overline{SD}}	V _{IN} = -2.5V; V _{OUT} disabled V _{IN} = -10V; V _{OUT} disabled	-1.75 -7.0			V
Output Saturation Resistance	R _{SAT}	V _{IN} = -2.5V V _{IN} = -5V V _{IN} = -10V		20 10 5	45 25 20	Ω
Output Impedance	R _{OUT}	ΔI _{OUT} = 1mA		0.15	1	Ω
Maximum Regulated Output Current (V _{DIFF} = -0.2V)	I _{OUT}	V _{IN} = -2.5V V _{IN} = -5V V _{IN} = -10V	5 20 40	10 30 60		mA
Shutdown Temperature	T _{\overline{SD}}		+100	+125		°C
Reverse Supply Current	I _{REV}	V _{IN} = +10V		30		μA

All operating characteristics V_{IN} = -5V, V_{OUT} = -1.3V, T_A = 25°C, unless otherwise specified.



7. Functional Description

The H 7011 negative voltage regulator is a CMOS monolithic integrated circuit which contains all the functions of a voltage regulator plus protection circuitry.

The diagram in Fig. 1 reveals the functional blocks and their connections.

The bandgap reference of $V_{REF} = -1.3V$ defines the smallest possible output voltage. Amplifier A, together with the resistor network R1 and R2, generates the desired output voltage as defined by the following two equations:

$$V_{OUT} = (1 + R1/R2) \times V_{SET}$$

$$V_{SET} = V_{REF} = -1.3V$$

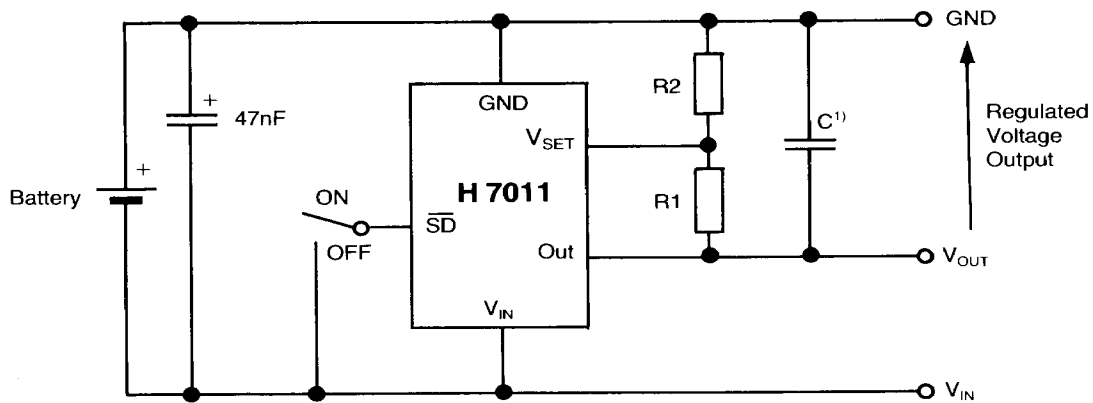
Because of the low leakage current of the amplifier input V_{SET} , the resistors R1 and R2 can be of the order of $>100M\Omega$ for minimum quiescent current. For $V_{OUT} = -1.3V$, a pure capacitive load is allowed, (i.e. $R1 = 0, R2 = \infty$).

At low output currents, the regulator has a very low drop-out differential voltage V_{DIFF} so that V_{OUT} may almost be at the V_{IN} potential (see Fig. 5).

The output current under regulation ranges from 0 to 60mA typical. However, the maximum current depends on the supply voltage and on the power dissipation of the package. On-chip protection prevents destruction of the circuit by over-heating or reverse supply voltage polarity. The thermal protection disables the circuit output at chip temperatures above 125°C. This feature avoids additional external elements such as a current sensing resistor and logic to protect the regulator and the circuits powered.

The shutdown control input, when pulled to V_{IN} , disables the output, resulting in a maximum quiescent current of 5µA. When this feature is not needed, this input may be left open.

8. Typical Application and Test Configuration



¹⁾ The capacitor C will significantly reduce the PSRR (see Fig. 4),
 $C = I_{OUT} \times 20ms / V_{OUT}$

Fig. 2

9. Package Information

The H 7011 is available in the following forms:

- Chip H 7011 - C
- 8 lead DIL plastic package H 7011 - 8PI

Other packages may be made available upon request.



10. Typical Performance Characteristics

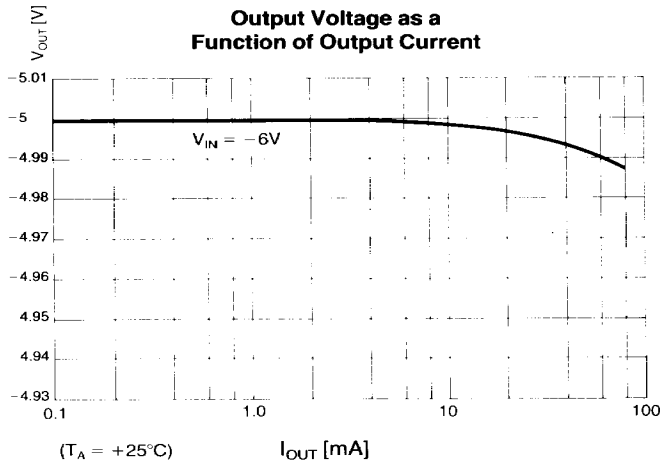


Fig. 3

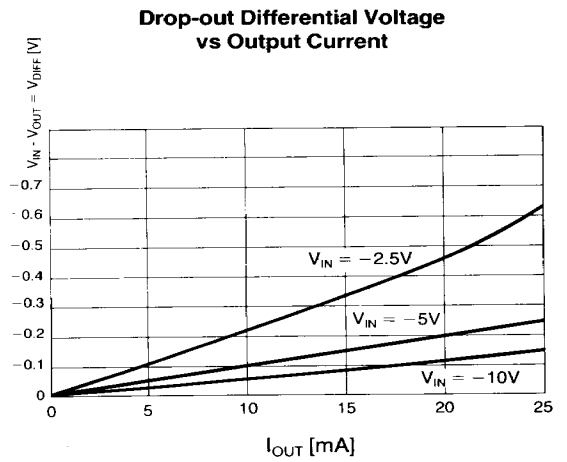


Fig. 5

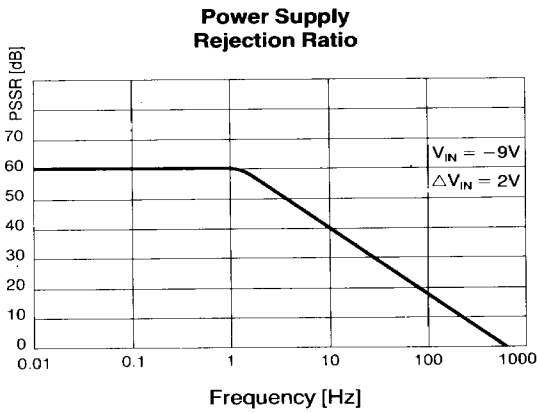


Fig. 4

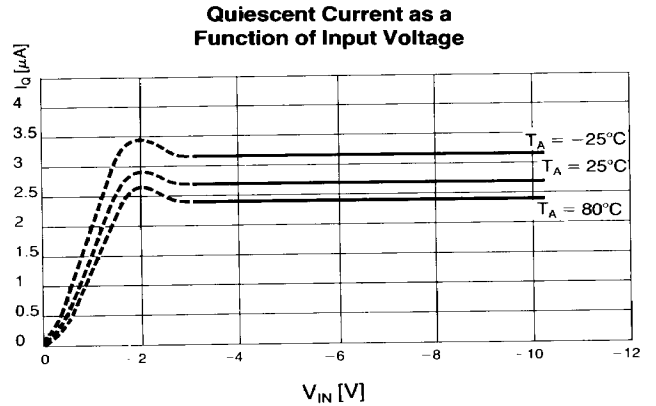


Fig. 6

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