<u>Linear Regulator</u> - Low Dropout, Very Low I_q

The NCV8674 is a precision 5.0 V or 12 V fixed output, low dropout integrated voltage regulator with an output current capability of 350 mA. Careful management of light load current consumption, combined with a low leakage process, achieve a typical quiescent current of 30 μ A.

The output voltage is accurate within $\pm 2.0\%$, and maximum dropout voltage is 600 mV at full rated load current.

It is internally protected against input supply reversal, output overcurrent faults, and excess die temperature. No external components are required to enable these features.

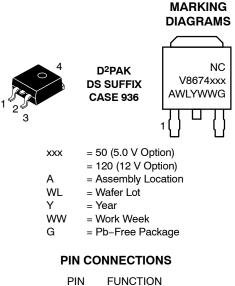
Features

- 5.0 V and 12 V Output Voltage Options
- $\pm 2.0\%$ Output Accuracy, Over Full Temperature Range
- 40 μ A Maximum Quiescent Current at I_{OUT} = 100 μ A
- 600 mV Maximum Dropout Voltage at 350 mA Load Current
- Wide Input Voltage Operating Range of 5.5 V to 45 V
- Internal Fault Protection
 - ♦ -42 V Reverse Voltage
 - Short Circuit/Overcurrent
 - Thermal Overload
- NCV Prefix for Automotive and Other Applications Requiring Site and Control Changes
- AEC-Q100 Qualified
- EMC Compliant
- This is a Pb–Free Device



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PIN	FUNCTION
1	V _{IN}
2, TAB	GND
3	Vout

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 10 of this data sheet.

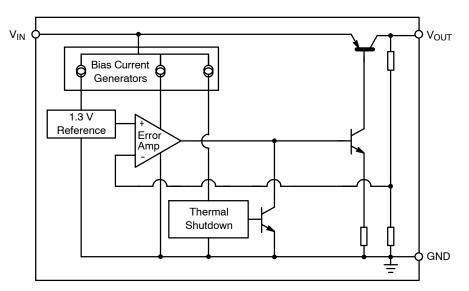


Figure 1. Block Diagram

PIN FUNCTION DESCRIPTION

Pin No.	Symbol	Function			
1	V _{IN}	Unregulated input voltage; (V _{OUT} + 0.5 V) to 45 V.			
2	GND	Ground; substrate.			
3	V _{OUT}	Regulated output voltage; collector of the internal PNP pass transistor.			
TAB	GND	Ground; substrate and best thermal connection to the die.			

OPERATING RANGE

Pin Symbol, Parameter	Symbol	Min	Max	Unit
V _{IN} , DC Input Operating Voltage	V _{IN}	V _{OUT} + 0.5 V	+45	V
Junction Temperature Operating Range	TJ	-40	+150	°C

MAXIMUM RATINGS

Rating	Symbol	Min	Max	Unit
V _{IN} , DC Voltage	V _{IN}	-42	+45	V
V _{OUT} , DC Voltage	V _{OUT}	-0.3	+16	V
Storage Temperature	T _{stg}	-55	+150	°C
ESD Capability, Human Body Model (Note 1)	V _{ESDHB}	4000	-	V
ESD Capability, Machine Model (Note 1)	V _{ESDMIM}	200	_	V

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

This device series incorporates ESD protection and is tested by the following methods: ESD HBM tested per AEC-Q100-002 (EIA/JESD22-A 114C)

- ESD MM tested per AEC-Q100-003 (EIA/JESD22-A 115C)

Thermal Resistance

Parameter	Symbol	Min	Max	Unit
Junction-to-Ambient (Note 2)	$R_{ hetaJA}$	-	40	°C/W
Junction-to-Case	$R_{ ext{ heta}JC}$	-	4.0	°C/W

2. 1 oz., 1 in² copper area.

LEAD SOLDERING TEMPERATURE & MSL

Rating	Symbol	Min	Max	Unit
Lead Temperature Soldering - Reflow (SMD Styles Only), Lead Free (Note 3)	T _{sld}	-	265 pk	°C
Moisture Sensitivity Level	MSL	1		-

3. Lead Free, 60 sec - 150 sec above 217°C, 40 sec max at peak.

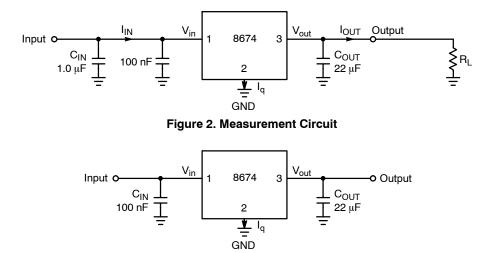
ELECTRICAL CHARACTERISTICS (VIN = 13.5 V, Tj = -40°C to +150°C, unless otherwise noted.)

Characteristic		Symbol	Test Conditions	Min	Тур	Max	Unit
Output Voltage	5 V Option 12 V Option	V _{OUT}	0.1 mA \leq I _{OUT} \leq 350 mA (Note 4) (V _{OUT} + 1 V) \leq V _{IN} \leq 28 V	4.90 11.76	5.00 12.00	5.10 12.24	V
Line Regulation	5 V Option 12 V Option	ΔV _{OUT} vs. V _{IN}	I_{OUT} = 5.0 mA (V _{OUT} + 1 V) \leq V _{IN} \leq 28 V	-25 -60	5.0 12	+25 +60	mV
Load Regulation	5 V Option 12 V Option	ΔV _{OUT} vs. I _{OUT}	1.0 mA ≤ I _{OUT} ≤ 350 mA (Note 4)	-35 -84	5.0 12	+35 +84	mV
Dropout Voltage		V _{IN} -V _{OUT}	I _{OUT} = 100 mA (Notes 4 & 5) I _{OUT} = 350 mA (Notes 4 & 5)		175 300	500 600	mV
Quiescent Current	5 V Option 12 V Option	Ιq	$I_{OUT} = 100 \ \mu A$ $T_J = 25^{\circ}C$ $T_J = 25^{\circ}C$		27 31	35 39	μΑ
	5 V Option 12 V Option		$T_{J} = -40^{\circ}C \text{ to } +85^{\circ}C$ $T_{J} = -40^{\circ}C \text{ to } +85^{\circ}C$	_	30 34	38 42	
Active Ground Current	5 V Option 12 V Option	I _{G(ON)}	I _{OUT} = 50 mA (Note 4) I _{OUT} = 50 mA (Note 4)		1.1 1.1	3.0 3.0	mA
	5 V Option 12 V Option		I _{OUT} = 350 mA (Note 4) I _{OUT} = 350 mA (Note 4)		18 21	27 40	
Power Supply Rejection		PSRR	V _{RIPPLE} = 0.5 V _{P-P} , F = 100 Hz	-	67	-	dB
Output Capacitor for Sta	bility	C _{OUT} ESR	I _{OUT} = 0.1 mA to 350 mA (Note 4)	22 -		- 7.0	μF Ω

PROTECTION

<u>.</u>						
Current Limit	IOUT(LIM)					mA
5 V Option		V _{OUT} = 4.5 V (Note 4)	350	-	-	
12 V Option		V _{OUT} = 10.8 V (Note 4)	350	-	-	
Short Circuit Current Limit	I _{OUT(SC)}	V _{OUT} = 0 V (Note 4)	100	600	-	mA
Thermal Shutdown Threshold	T _{TSD}	(Note 6)	150	-	200	°C

Use pulse loading to limit power dissipation.
 Dropout voltage = (V_{IN} - V_{OUT}), measured when the output voltage has dropped 100 mV relative to the nominal value obtained with V_{IN} = 13.5 V.
 Not tested in production. Limits are guaranteed by design.







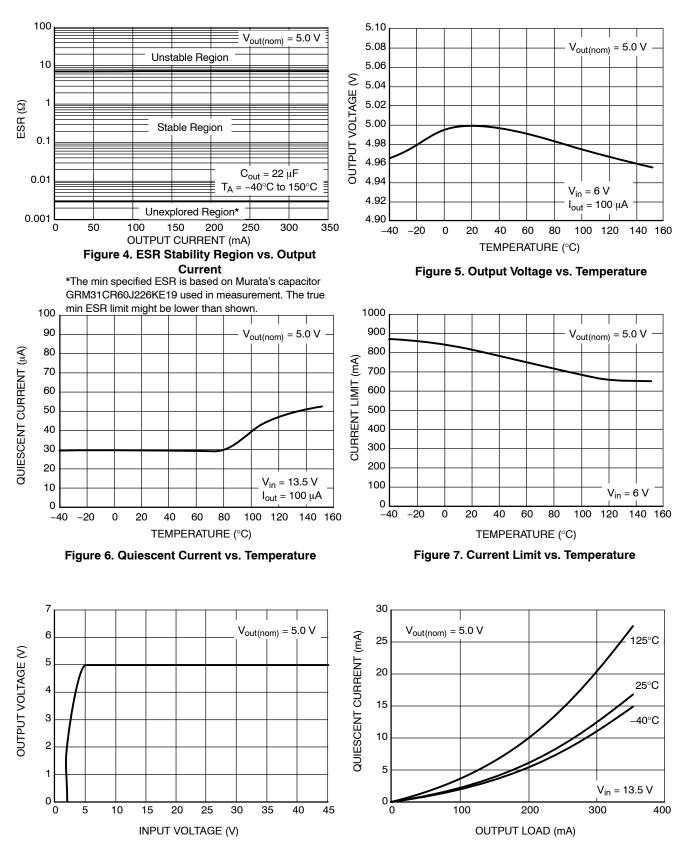


Figure 8. Output Voltage vs. Input Voltage





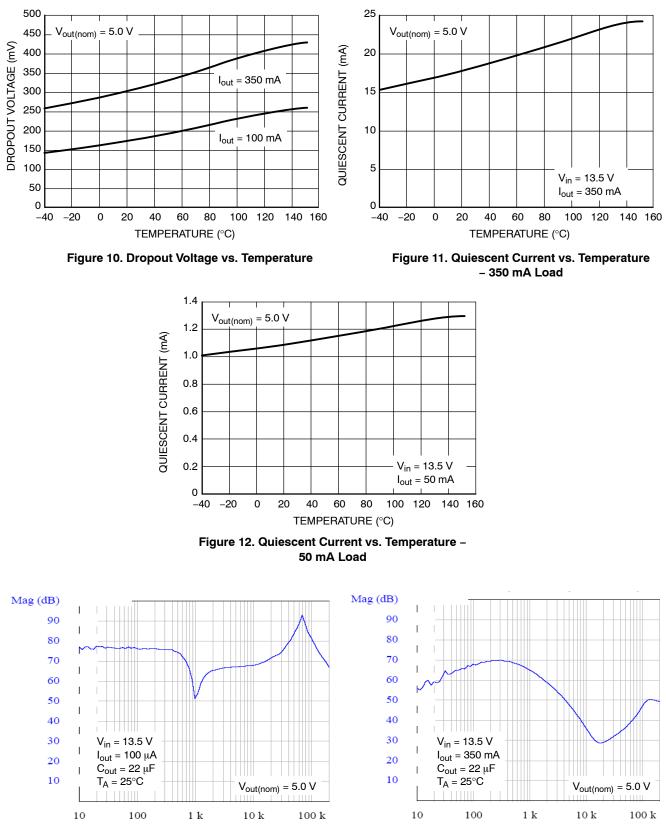
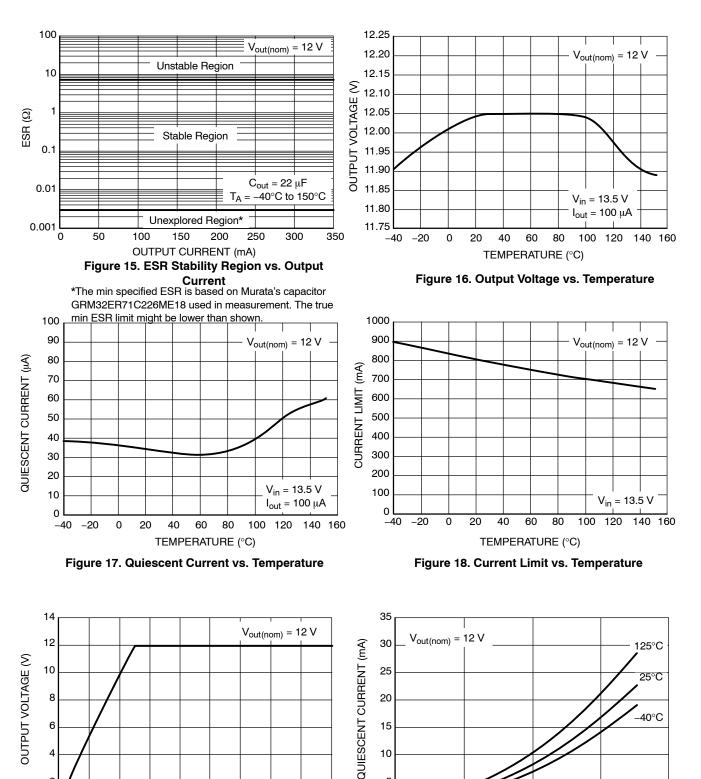




Figure 14. Power Supply Rejection – 350 mA



TYPICAL CHARACTERISTIC CURVES – 12 V OPTION

V_{in} = 13.5 V

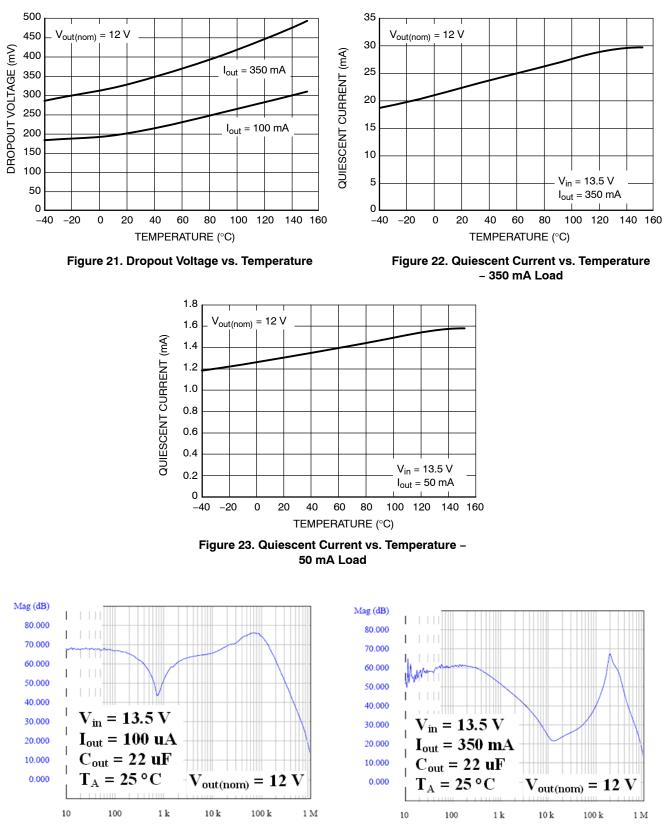
Figure 20. Quiescent Current vs. Output Load

OUTPUT LOAD (mA)

INPUT VOLTAGE (V)

Figure 19. Output Voltage vs. Input Voltage









Circuit Description

The NCV8674 is a precision trimmed 5.0 V or 12 V fixed output regulator. Careful management of light load consumption combined with a low leakage process results in a typical quiescent current of 30 μ A. The device has current capability of 350 mA, with 600 mV of dropout voltage at full rated load current. The regulation is provided by a PNP pass transistor controlled by an error amplifier with a bandgap reference. The regulator is protected by both current limit and short circuit protection. Thermal shutdown occurs above 150°C to protect the IC during overloads and extreme ambient temperatures.

Regulator

The error amplifier compares the reference voltage to a sample of the output voltage (Vout) and drives the base of a PNP series pass transistor by a buffer. The reference is a bandgap design to give it a temperature–stable output. Saturation control of the PNP is a function of the load current and input voltage. Over saturation of the output power device is prevented, and quiescent current in the ground pin is minimized. The NCV8674 is equipped with foldback current protection. This protection is designed to reduce the current limit during an overcurrent situation.

Regulator Stability Considerations

The input capacitor C_{IN} in Figure 2 is necessary for compensating input line reactance. Possible oscillations caused by input inductance and input capacitance can be damped by using a resistor of approximately 1 Ω in series with C_{IN} . The output or compensation capacitor, C_{OUT} helps determine three main characteristics of a linear regulator: startup delay, load transient response and loop stability. The capacitor value and type should be based on cost, availability, size and temperature constraints. Tantalum, aluminum electrolytic, film, or ceramic capacitors are all acceptable solutions, however, attention must be paid to ESR constraints. The aluminum electrolytic capacitor is the least expensive solution, but, if the circuit operates at low temperatures ($-25^{\circ}C$ to $-40^{\circ}C$), both the value and ESR of the capacitor will vary considerably. The capacitor manufacturer's data sheet usually provides this information. The value for the output capacitor C_{OUT} shown in Figure 2 should work for most applications; however, it is not necessarily the optimized solution. Stability is guaranteed at values $C_{OUT} \ge 22 \,\mu\text{F}$ and ESR $\le 7.0 \,\Omega$, within the operating temperature range. Actual limits are shown in a graph in the Typical Characteristics section.

Calculating Power Dissipation in a Single Output Linear Regulator

The maximum power dissipation for a single output regulator (Figure 2) is:

$$\begin{array}{l} \mathsf{P}\mathsf{D}(\mathsf{max}) \ = \ [\mathsf{V}\mathsf{IN}(\mathsf{max}) \ - \ \mathsf{V}\mathsf{OUT}(\mathsf{min})] \cdot \\ \mathsf{I}\mathsf{OUT}(\mathsf{max}) \ + \ \mathsf{V}\mathsf{IN}(\mathsf{max}) \cdot \mathsf{I}_q \quad (\mathsf{eq. 1}) \end{array}$$

Where:

V_{IN(max)} is the maximum input voltage,

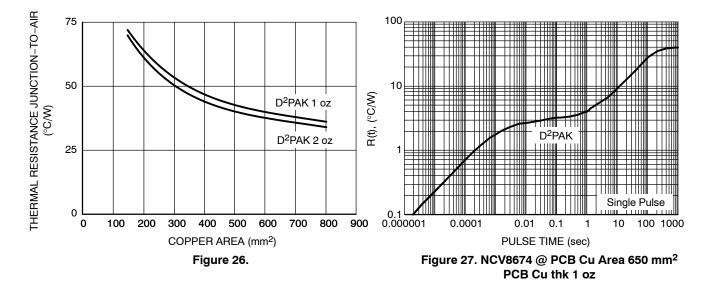
V_{OUT(min)} is the minimum output voltage,

 $I_{OUT(max)}$ is the maximum output current for the application, and I_q is the quiescent current the regulator consumes at $I_{OUT(max)}$.

Once the value of $P_{D(Max)}$ is known, the maximum permissible value of $R_{\theta JA}$ can be calculated:

$$R_{\theta JA} = \frac{150^{\circ}C - T_A}{P_D}$$
 (eq. 2)

The value of $R_{\theta JA}$ can then be compared with those in thermal resistance versus copper area graph (Figure 26). Those designs with cooling area corresponding to $R_{\theta JA}$'s less than the calculated value in Equation 2 will keep the die temperature below 150°C. The current flow and voltages are shown in the Measurement Circuit Diagram.

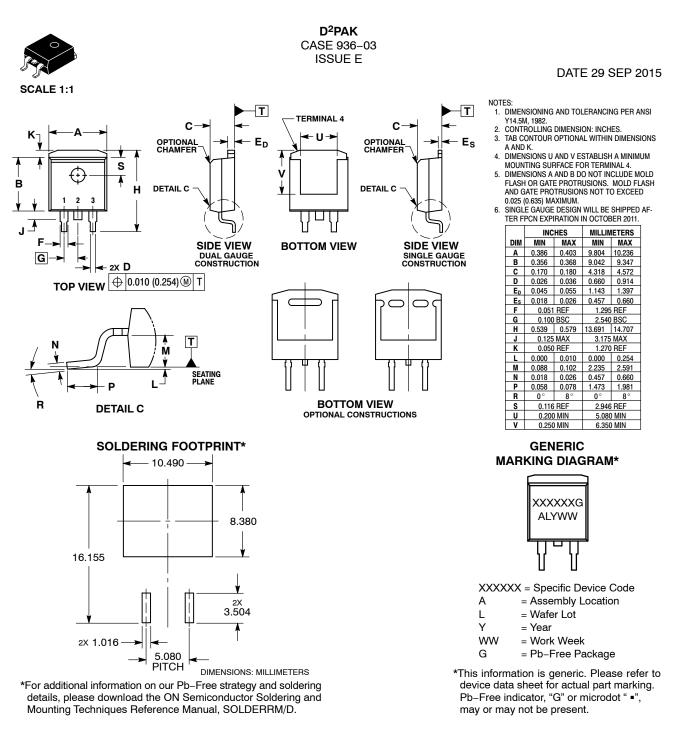


ORDERING INFORMATION

Device	Marking	Package	Shipping [†]
NCV8674DS50G	V867450	D ² PAK (Pb–Free)	50 Units / Rail
NCV8674DS50R4G	V867450	D ² PAK (Pb-Free)	800 / Tape & Reel
NCV8674DS120G	V8674120	D ² PAK (Pb-Free)	50 Units / Rail
NCV8674DS120R4G	V8674120	D ² PAK (Pb–Free)	800 / Tape & Reel

+ For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.





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