NCV8184

Micropower 70 mA Low Dropout Tracking Regulator/Line Driver

The NCV8184 is a monolithic integrated low dropout tracking voltage regulator designed to provide an adjustable buffered output voltage that closely tracks (±5.0 mV) the reference input.

The part can be used in automotive applications with remote sensors, or any situation where it is necessary to isolate the output of your regulator.

The NCV8184 also enables the user to bestow a quick upgrade to their module when added current is needed, and the existing regulator cannot provide.

The versatility of this part also enables it to be used as a high−side driver.

Features

- 70 mA Source Capability
- Output Tracks within ±5.0 mV
- Low Input Voltage Tracking Performance (Works Down to V_{REF} = 2.1 V)
- Low Dropout (0.35 V Typ. @ 50 mA)
- Low Quiescent Current
- Thermal Shutdown
- Wide Operating Range
- Internally Fused Leads in SO−8 Package
- NCV Prefix, for Automotive and Other Applications Requiring Site and Change Control

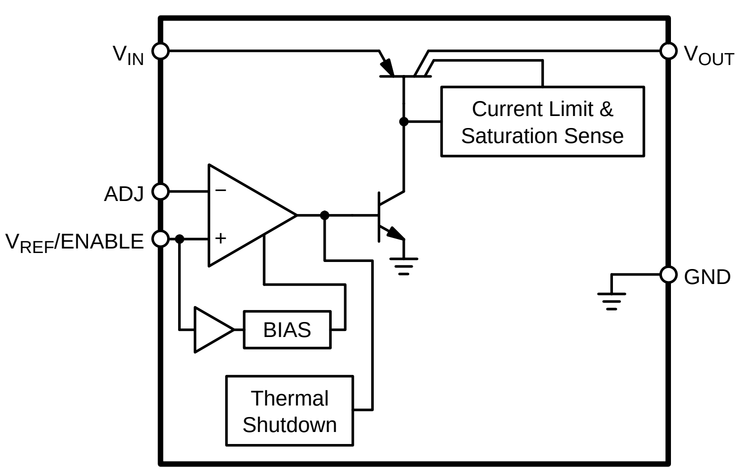

Figure 1. Block Diagram

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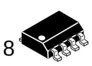
8
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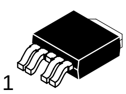
SO−8
D SUFFIX
CASE 751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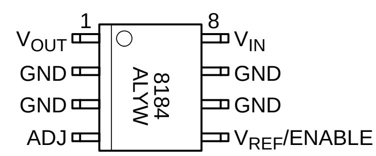
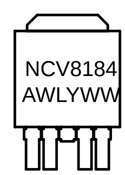
5

DPAK
5−PIN
DT SUFFIX
CASE 175AA

PIN CONNECTIONS AND MARKING DIAGRAM





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Pin 1. V_{IN}
2. V_{OUT}
3. GND
4. ADJ
5. V_{REF}/ENABLE

A	=	Assembly Location
WL, L	=	Wafer Lot
Y	=	Year
WW, W	=	Work Week

ORDERING INFORMATION*

Device	Package	Shipping†
NCV8184D	SO−8	95 Units/Rail
NCV8184DR2	SO−8	2500 Tape & Reel
NCV8184DT	DPAK	50 Units/Rail
NCV8184DTRK	DPAK	2500 Tape & Reel

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

MAXIMUM RATINGS*

Rating	Value	Unit
Storage Temperature	−65 to 150	°C
Supply Voltage Range (continuous)	−15 to 42	V
Supply Voltage Operating Range	4.0 to 42	V
Peak Transient Voltage (V_{IN} = 14 V, Load Dump Transient = 28 V)	42	V
Voltage Range (V_{OUT}, ADJ)	−3.0 to 42	V
Voltage Range (V_{REF}/ENABLE)	−0.3 to 42	V
Maximum Junction Temperature	150	°C
ESD Capability — Human Body Model Machine Model	2.5 200	kV V
Package Thermal Resistance, SO−8 (Note 3) Junction−to−Case, $R_{\theta JC}$ Junction−to−Ambient, $R_{\theta JA}$ Junction−to−Pin, $R_{\theta JP}$	 32 98 58	°C/W
Package Thermal Resistance, DPAK, 5−Pin Junction−to−Case, $R_{\theta JC}$ Junction−to−Ambient, $R_{\theta JA}$	 (Note 4) (Note 4)	°C/W
Lead Temperature Soldering: Reflow: (SMD styles only) (Note 1)	240 peak (Note 2)	°C

1. 60 second maximum above 183°C.
2. −5°C / +0°C Allowable Conditions
3. Measured on 1 inch pad.
4. Consult your local sales representative for DPAK information.

*The maximum package power dissipation must be observed.
**Depending on thermal properties of substrate $R_{\theta JA} = R_{\theta JC} + R_{\theta CA}$.

ELECTRICAL CHARACTERISTICS

(V_{IN} = 14 V; V_{REF}/ENABLE > 2.1 V; −40°C < T_J < +125°C; C_{OUT} = 1.0 μF; I_{OUT} = 1.0 mA; ADJ = V_{OUT}; $C_{OUT-ESR}$ = 1.0 Ω, unless otherwise specified.)

Parameter	Test Conditions	Min	Typ	Max	Unit
Regular Output					
V_{REF}/ENABLE − V_{OUT} V_{OUT} Tracking Error	6.0 V ≤ V_{IN} ≤ 26 V, 100 μA ≤ I_{OUT} ≤ 50 mA 2.1 V ≤ V_{REF}/ENABLE ≤ (V_{IN} − 600 mV) V_{IN} = 12 V, I_{OUT} = 5.0 mA, V_{REF}/ENABLE = 5.0 V	−10 −5.0	− −	10 5.0	mV mV
Dropout Voltage (V_{IN} − V_{OUT})	I_{OUT} = 100 μA I_{OUT} = 5.0 mA I_{OUT} = 50 mA	− − −	100 250 350	150 500 600	mV mV mV
Line Regulation	6.0 V ≤ V_{IN} ≤ 26 V, V_{REF}/ENABLE = 5.0 V	−	−	10	mV
Load Regulation	100 μA ≤ I_{OUT} ≤ 50 mA, V_{REF}/ENABLE = 5.0 V	−	−	10	mV
ADJ Input Bias Current	V_{REF}/ENABLE = 5.0 V	−	0.2	1.0	μA
Current Limit	V_{IN} = 14 V, V_{REF}/ENABLE = 5.0 V, V_{OUT} = 90% of ADJ	70	−	400	mA
Quiescent Current (I_{IN} − I_{OUT})	V_{IN} = 12 V, I_{OUT} = 50 mA V_{IN} = 12 V, I_{OUT} = 100 μA V_{IN} = 12 V, V_{REF}/ENABLE = 0 V	− − −	5.0 50 −	7.0 70 20	mA μA μA
Ripple Rejection	f = 120 Hz, I_{OUT} = 50 mA, 6.0 V ≤ V_{IN} ≤ 26 V	60	−	−	dB
Thermal Shutdown	Guaranteed by Design	150	180	210	°C
V_{REF}/ENABLE					
Enable Voltage	−	0.8	−	2.1	V
Input Bias Current	V_{REF}/ENABLE = 5.0 V	−	0.2	1.0	μA

PACKAGE PIN DESCRIPTION

Package Lead Number		Lead Symbol	Function
SO−8	DPAK, 5−PIN		
8	1	V_{IN}	Battery supply input voltage.
5	2	V_{REF}/ENABLE	Reference voltage and ENABLE input.
2, 3, 6, 7	3	GND	Ground.
4	4	ADJ	Adjust lead, noninverting input.
1	5	V_{OUT}	Regulated output.

TYPICAL PERFORMANCE CHARACTERISTICS

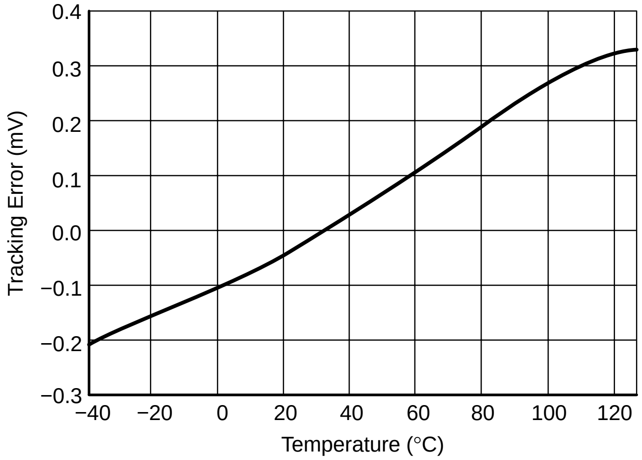


Figure 2. Tracking Error vs Temperature

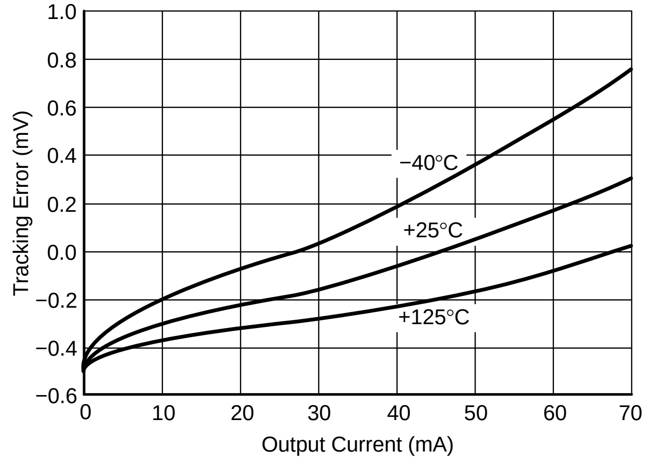


Figure 3. Tracking Error vs Output Current

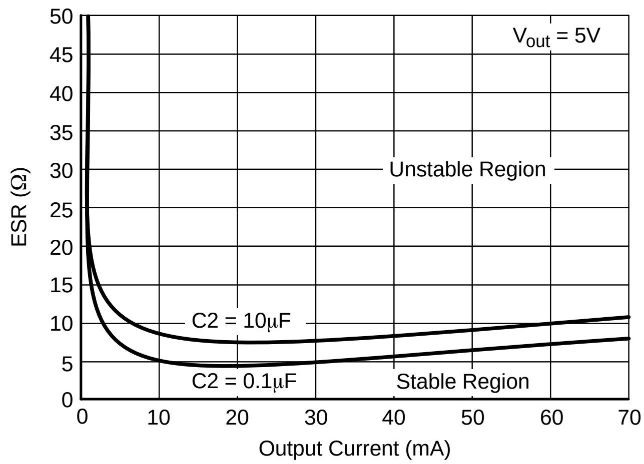


Figure 4. Output Stability with Capacitor Change

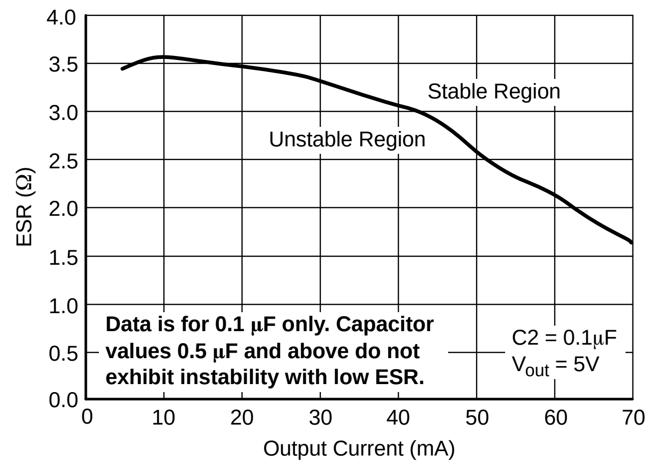


Figure 5. Output Stability with 1.0 μF at Low ESR

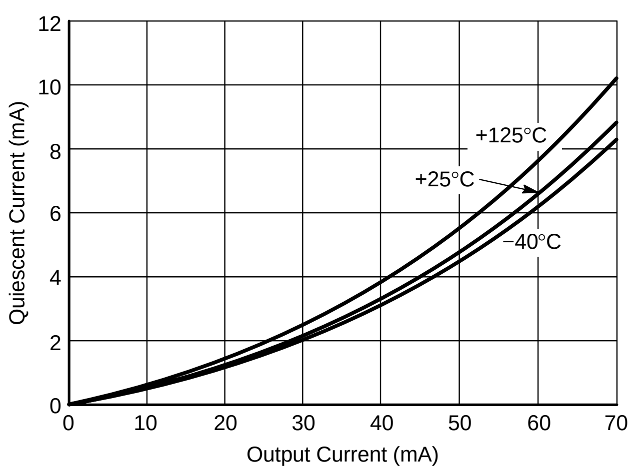


Figure 6. Quiescent Current vs Output Current

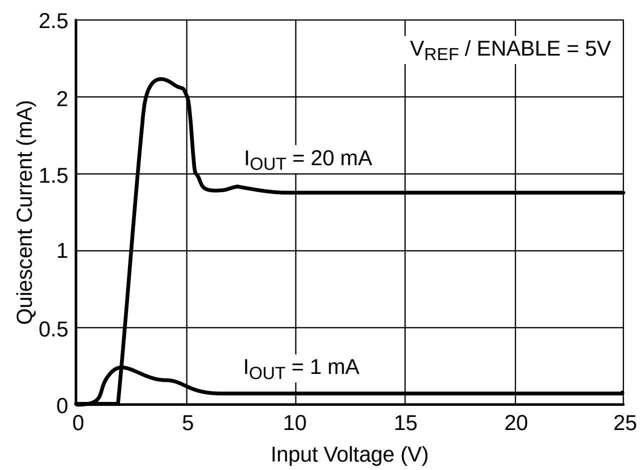


Figure 7. Quiescent Current vs Input Voltage

TYPICAL PERFORMANCE CHARACTERISTICS

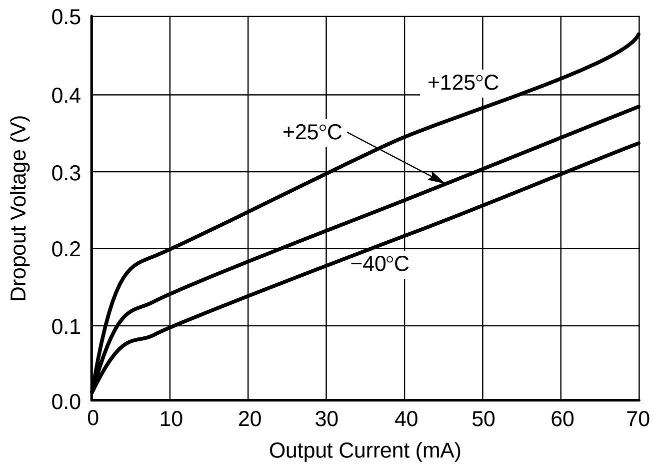


Figure 8. Dropout Voltage vs Output Current

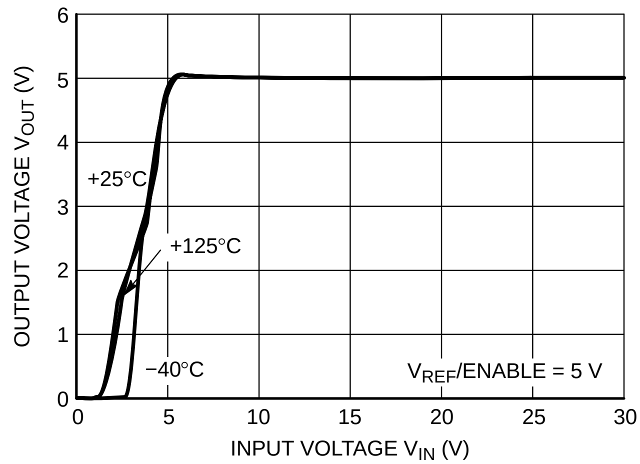


Figure 9. Output Voltage vs Input Voltage

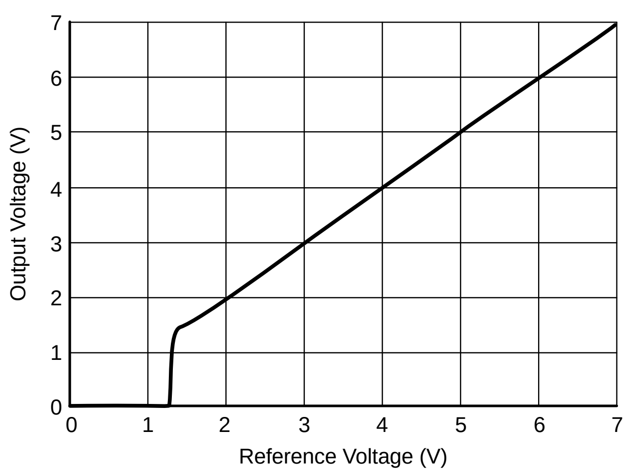


Figure 10. Output Voltage vs Reference Voltage

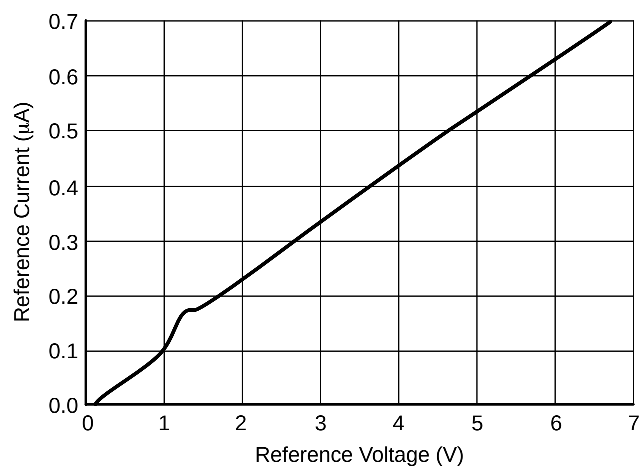


Figure 11. Reference Current vs Reference Voltage

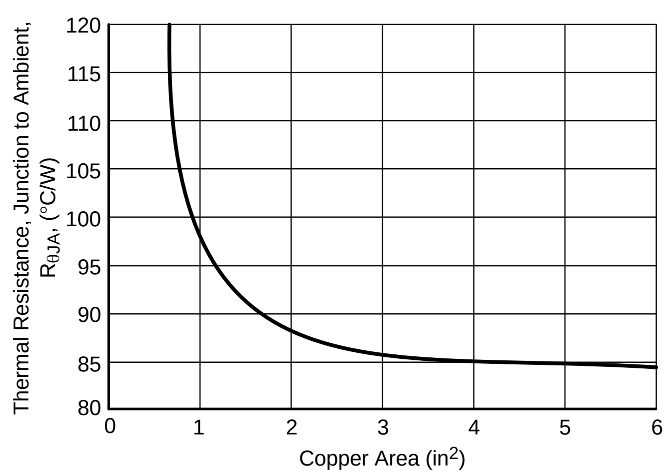


Figure 12. SO−8, θJA as a Function of the Pad Copper Area (2 oz. Cu Thickness), Board Material = 0.0625 G−10/R−4

CIRCUIT DESCRIPTION

ENABLE Function

By pulling the V_{REF}/ENABLE lead below 0.8 V, (see Figure 16 or Figure 17), the IC is disabled and enters a sleep state where the device draws less than 20 μA from supply. When the V_{REF}/ENABLE lead is greater than 2.1 V, V_{OUT} tracks the V_{REF}/ENABLE lead normally.

Output Voltage

The output is capable of supplying 70 mA to the load while configured as a similar (Figure 13), lower (Figure 15), or higher (Figure 14) voltage as the reference lead. The Adj lead acts as the inverting terminal of the op amp and the V_{REF} lead as the non−inverting.

The device can also be configured as a high−side driver as displayed in Figure 18.

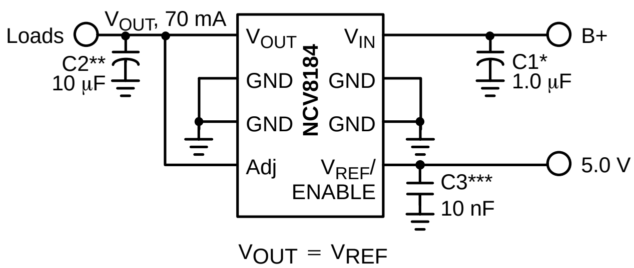


Figure 13. Tracking Regulator at the Same Voltage

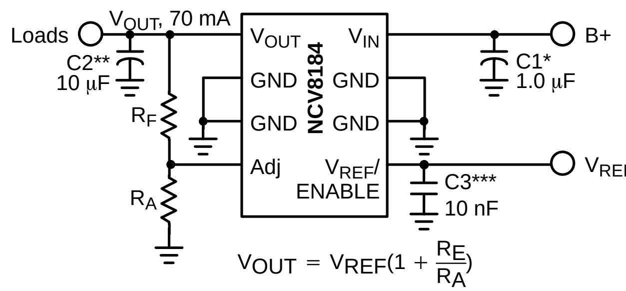


Figure 14. Tracking Regulator at Higher Voltages

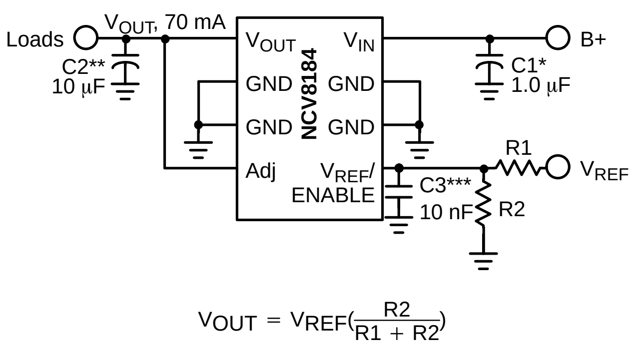


Figure 15. Tracking Regulator at Lower Voltages

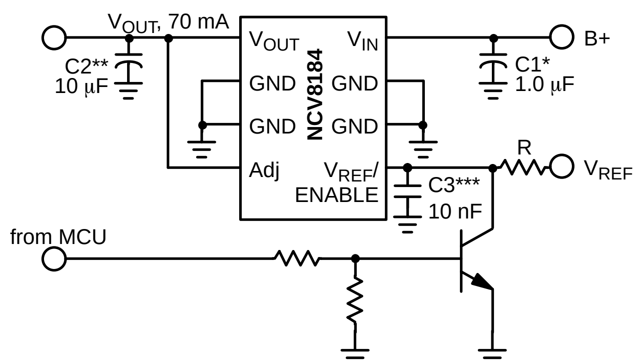


Figure 16. Tracking Regulator with ENABLE Circuit

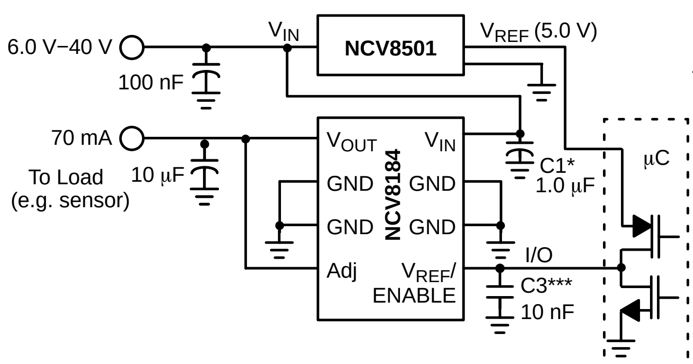


Figure 17. Alternative ENABLE Circuit

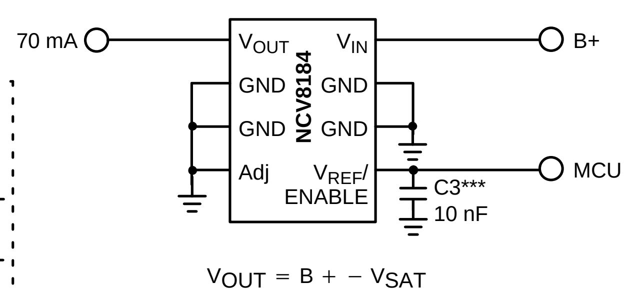


Figure 18. High−Side Driver

* C1 is required if the regulator is far from the power source filter.
** C2 is required for stability.
*** C3 is recommended for EMC susceptibility

APPLICATION NOTES

Switched Application

The NCV8184 has been designed for use in systems where the reference voltage on the V_{REF}/ENABLE pin is continuously on. Typically, the current into the V_{REF}/ENABLE pin will be less than 1.0 μA when the voltage on the V_{IN} pin (usually the ignition line) has been switched out (V_{IN} can be at high impedance or at ground.) Reference Figure 19.

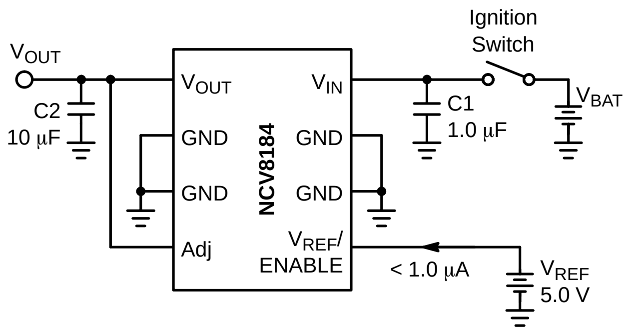


Figure 19.

External Capacitors

The output capacitor for the NCV8184 is required for stability. Without it, the regulator output will oscillate. Actual size and type may vary depending upon the application load and temperature range. Capacitor effective series resistance (ESR) is also a factor in the IC stability. Worst−case is determined at the minimum ambient temperature and maximum load expected.

The output capacitor can be increased in size to any desired value above the minimum. One possible purpose of this would be to maintain the output voltage during brief conditions of negative input transients that might be characteristic of a particular system.

The capacitor must also be rated at all ambient temperatures expected in the system. To maintain regulator stability down to −40°C, a capacitor rated at that temperature must be used.

More information on capacitor selection for SMART REGULATOR®s is available in the SMART REGULATOR application note, “Compensation for Linear Regulators,” document number SR003AN/D, available through the Literature Distribution Center or via our website at http://www.onsemi.com.

Calculating Power Dissipation in a Single Output Linear Regulator

The maximum power dissipation for a single output regulator (Figure 20) is:

$$PD(max) = \{V_{IN}(max) - V_{OUT}(min)\} I_{OUT}(max) + V_{IN}(max) I_Q \qquad \text{(eq. 1)}$$

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 PD(max) is known, the maximum permissible value of $R_{\theta JA}$ can be calculated:

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

The value of $R_{\theta JA}$ can then be compared with those in the package section of the data sheet. Those packages with $R_{\theta JA}$’s less than the calculated value in equation 2 will keep the die temperature below 150°C.

In some cases, none of the packages will be sufficient to dissipate the heat generated by the IC, and an external heat sink will be required.

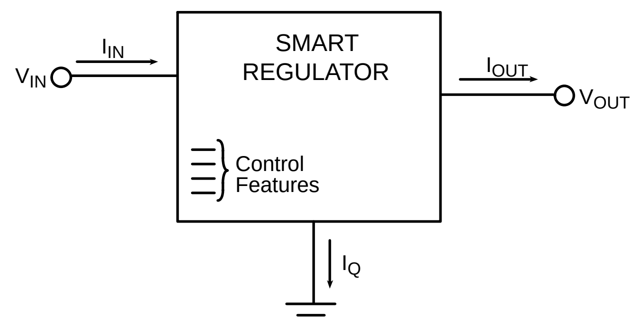


Figure 20. Single Output Regulator with Key Performance Parameters Labeled

Heatsinks

A heatsink effectively increases the surface area of the package to improve the flow of heat away from the IC and into the surrounding air.

Each material in the heat flow path between the IC and the outside environment will have a thermal resistance. Like series electrical resistances, these resistances are summed to determine the value of $R_{\theta JA}$:

$$R_{\theta JA} = R_{\theta JC} + R_{\theta CS} + R_{\theta SA} \qquad \text{(eq. 3)}$$

where:

$R_{\theta JC}$ = the junction−to−case thermal resistance,

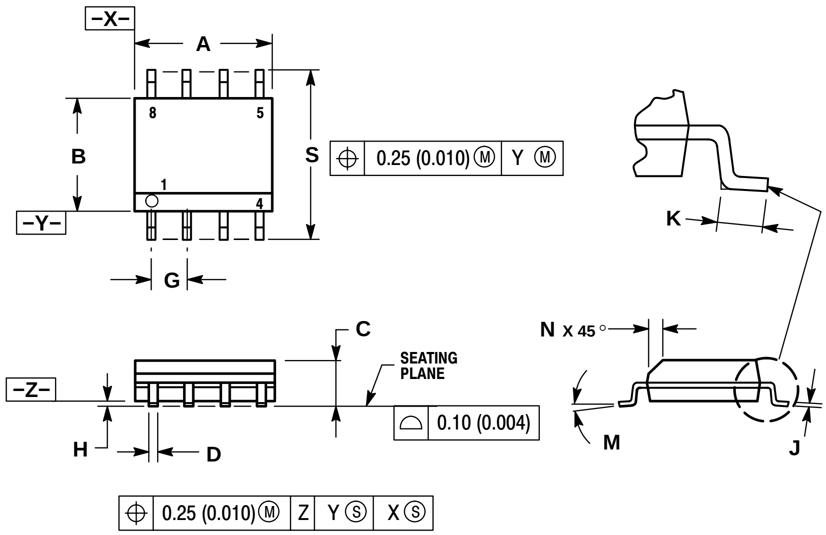
$R_{\theta CS}$ = the case−to−heatsink thermal resistance, and

$R_{\theta SA}$ = the heatsink−to−ambient thermal resistance.

$R_{\theta JC}$ appears in the package section of the data sheet. Like $R_{\theta JA}$, it is a function of package type. $R_{\theta CS}$ and $R_{\theta SA}$ are functions of the package type, heatsink and the interface between them. These values appear in heat sink data sheets of heat sink manufacturers.

PACKAGE DIMENSIONS

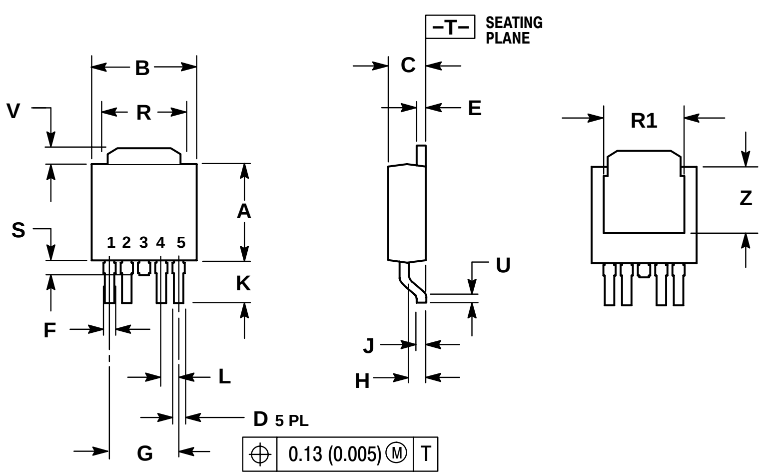
SO−8
D SUFFIX
CASE 751−07
ISSUE AA



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. 751−01 THRU 751−06 ARE OBSOLETE. NEW STANDAARD IS 751−07

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.197
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.053	0.069
D	0.33	0.51	0.013	0.020
G	1.27 BSC		0.050 BSC	
H	0.10	0.25	0.004	0.010
J	0.19	0.25	0.007	0.010
K	0.40	1.27	0.016	0.050
M	0 °	8 °	0 °	8 °
N	0.25	0.50	0.010	0.020
S	5.80	6.20	0.228	0.244

DPAK, 5−PIN CENTER LEAD CROP
DT SUFFIX
CASE 175AA−01
ISSUE O



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.235	0.245	5.97	6.22
B	0.250	0.265	6.35	6.73
C	0.086	0.094	2.19	2.38
D	0.020	0.028	0.51	0.71
E	0.018	0.023	0.46	0.58
F	0.024	0.032	0.61	0.81
G	0.180 BSC		4.56 BSC	
H	0.034	0.040	0.87	1.01
J	0.018	0.023	0.46	0.58
K	0.102	0.114	2.60	2.89
L	0.045 BSC		1.14 BSC	
R	0.170	0.190	4.32	4.83
R1	0.185	0.210	4.70	5.33
S	0.025	0.040	0.63	1.01
U	0.020	−−−	0.51	−−−
V	0.035	0.050	0.89	1.27
Z	0.155	0.170	3.93	4.32

Notes

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Literature Distribution Center for ON Semiconductor
P.O. Box 5163, Denver, Colorado 80217 USA
Phone: 303−675−2175 or 800−344−3860 Toll Free USA/Canada
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Email: orderlit@onsemi.com

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ON Semiconductor Website: http://onsemi.com

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For additional information, please contact your local Sales Representative.