NCV4269

5.0 V Micropower 150 mA LDO Linear Regulator with DELAY, Adjustable RESET, and Sense Output

The NCV4269 is a 5.0 V precision micropower voltage regulator with an output current capability of 150 mA.

The output voltage is accurate within ±2.0% with a maximum dropout voltage of 0.5 V at 100 mA. Low quiescent current is a feature drawing only 240 μA with a 1.0 mA load. This part is ideal for any and all battery operated microprocessor equipment.

Microprocessor control logic includes an active reset output RO with delay and a SI/SO monitor which can be used to provide an early warning signal to the microprocessor of a potential impending reset signal. The use of the SI/SO monitor allows the microprocessor to finish any signal processing before the reset shuts the microprocessor down.

The active Reset circuit operates correctly at an output voltage as low as 1.0 V. The Reset function is activated during the power up sequence or during normal operation if the output voltage drops outside the regulation limits.

The reset threshold voltage can be decreased by the connection of an external resistor divider to the R_{ADJ} lead. The regulator is protected against reverse battery, short circuit, and thermal overload conditions. The device can withstand load dump transients making it suitable for use in automotive environments. The device has also been optimized for EMC conditions.

Features

- 5.0 V ± 2.0% Output
- Low 240 μA Quiescent Current
- Active Reset Output Low Down to V_Q = 1.0 V
- Adjustable Reset Threshold
- 150 mA Output Current Capability
- Fault Protection
  - +60 V Peak Transient Voltage
  - −40 V Reverse Voltage
  - Short Circuit
  - Thermal Overload
- Early Warning through SI/SO Leads
- Internally Fused Leads in SO−14 and SO−20L Packages
- Integrated Pullup Resistor at Logic Outputs (To Use External Resistors, Select the NCV4279)
- Very Low Dropout Voltage
- Electrical Parameters Guaranteed Over Entire Temperature Range
- NCV Prefix for Automotive and Other Applications Requiring Site and Control Changes
- Pb−Free Packages are Available

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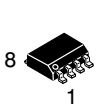
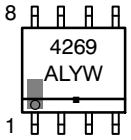
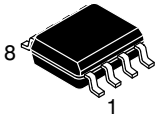
MARKING DIAGRAMS

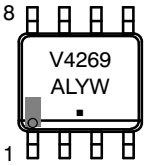


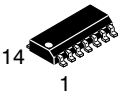
SO−8
D SUFFIX
CASE 751



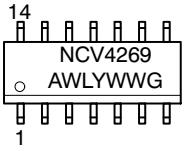


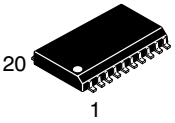
SO−8
EXPOSED PAD
D SUFFIX
CASE 751AC



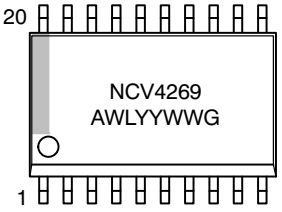


SO−14
D SUFFIX
CASE 751A





SO−20L
DW SUFFIX
CASE 751D



A	= Assembly Location
WL, L	= Wafer Lot
YY, Y	= Year
WW, W	= Work Week
G, ▪	= Pb Free

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 12 of this data sheet.

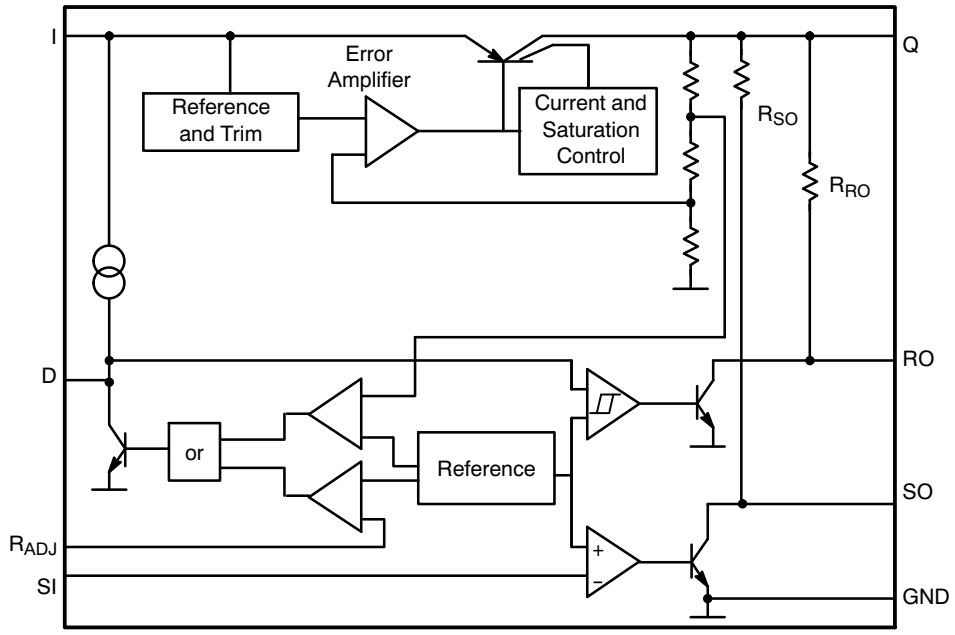
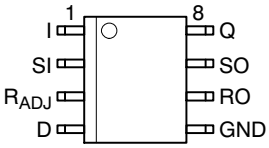
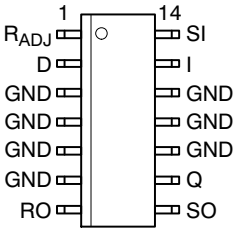


Figure 1. Block Diagram

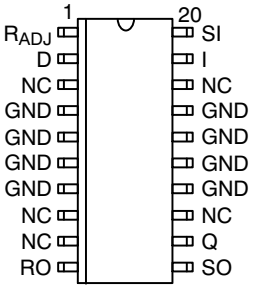
PIN CONNECTIONS



SO−8



SO−14



SO−20L

PACKAGE PIN DESCRIPTION

Package Pin Number			Pin Symbol	Function
SO−8	SO−14	SO−20L		
3	1	1	R_{ADJ}	Reset Threshold Adjust; if not used to connect to GND.
4	2	2	D	Reset Delay; To Set Time Delay, Connect to GND with Capacitor
5	3, 4, 5, 6, 10, 11, 12	4, 5, 6, 7, 14, 15, 16, 17	GND	Ground
–	–	3, 8, 9, 13, 18	NC	No connection to these pins from the IC.
6	7	10	RO	Reset Output; The Open−Collector Output has a 20 kΩ Pullup Resistor to Q. Leave Open if Not Used.
7	8	11	SO	Sense Output; This Open−Collector Output is Internally Pulled Up by 20 kΩ pullup resistor to Q. If not used, keep open.
8	9	12	Q	5 V Output; Connect to GND with a 10 μF Capacitor, ESR < 10 Ω.
1	13	19	I	Input; Connect to GND Directly at the IC with a Ceramic Capacitor.
2	14	20	SI	Sense Input; If not used, Connect to Q.

MAXIMUM RATINGS (T_J = −40°C to 150°C)

Parameter	Symbol	Min	Max	Unit
Input to Regulator	V_I I_I	−40 Internally Limited	45 Internally Limited	V
Input Transient to Regulator	V_I	–	60	V
Sense Input	V_{SI} I_{SI}	−40 −1	45 1	V mA
Reset Threshold Adjust	V_{RADJ} I_{RADJ}	−0.3 −10	7 10	V mA
Reset Delay	V_D I_D	−0.3 Internally Limited	7 Internally Limited	V
Ground	I_q	50	–	mA
Reset Output	V_{RO} I_{RO}	−0.3 Internally Limited	7 Internally Limited	V
Sense Output	V_{SO} I_{SO}	−0.3 Internally Limited	7 Internally Limited	V
Regulated Output	V_Q I_Q	−0.5 −10	7.0 –	V mA
Junction Temperature Storage Temperature	T_J T_{STG}	– −50	150 150	°C °C
Input Voltage Operating Range Junction Temperature Operating Range	V_I T_J	– −40	45 150	V °C

Lead Temperature Soldering and MSL

Parameter	Symbol	Value
MSL, 20−Lead LS Temperature 265°C Peak (Note 3)	MSL	3
MSL, 20−Lead, LS Temperature 240°C Peak (Note 4)	MSL	1
MSL, 8−Lead, 14−Lead, LS Temperature 265°C Peak (Note 3)	MSL	1
MSL, 8−Lead EP, LS Temperature 260°C	MSL	2

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.

1. This device series incorporates ESD protection and exceeds the following ratings:
   Human Body Model (HBM) ≤ 2.0 kV per JEDEC standard: JESD22−A114.
   Machine Model (MM) ≤ 200 V per JEDEC standard: JESD22−A115.
2. Latchup Current Maximum Rating: ≤ 150 mA per JEDEC standard: JESD78.
3. +5°C/−0°C, 40 Sec Max−at−Peak, 60 – 150 Sec above 217°C.
4. +5°C/−0°C, 30 Sec Max−at−Peak, 60 – 150 Sec above 183°C.

THERMAL CHARACTERISTICS

Characteristic	Test Conditions (Typical Values)	Unit
SO−8 Package (Note 5)		
Junction−to−Pin 4 (Ψ – JL4, Ψ_{L4})	53.8	°C/W
Junction−to−Ambient Thermal Resistance ($R_{\theta JA}$, θ_{JA})	170.9	°C/W
SO−8 EP Package (Note 5)		
Junction−to−Pin 8 (Ψ – JL8, Ψ_{L8})	23.7	°C/W
Junction−to−Ambient Thermal Resistance ($R_{\theta JA}$, θ_{JA})	71.4	°C/W
Junction−to−Pad (Ψ – JPad)	7.7	°C/W
SO−14 Package (Note 5)		
Junction−to−Pin 4 (Ψ – JL4, Ψ_{L4})	18.4	°C/W
Junction−to−Ambient Thermal Resistance ($R_{\theta JA}$, θ_{JA})	111.6	°C/W
SO−20 Package (Note 5)		
Junction−to−Pin 4 (Ψ – JL4, Ψ_{L4})	21.8	°C/W
Junction−to−Ambient Thermal Resistance ($R_{\theta JA}$, θ_{JA})	95.3	°C/W

5. 2 oz copper, 50 mm^2 copper area, 1.5 mm thick FR4

ELECTRICAL CHARACTERISTICS (T_J = −40°C ≤ T_J ≤ 125°C, V_I = 13.5 V unless otherwise specified)

Characteristic	Symbol	Test Conditions	Min	Typ	Max	Unit
REGULATOR						
Output Voltage	V_Q	1 mA ≤ I_Q ≤ 100 mA 6 V ≤ V_I ≤ 16 V	4.90	5.00	5.10	V
Current Limit	I_Q	–	150	200	500	mA
Current Consumption; $I_q = I_I - I_Q$	I_q	I_Q = 1 mA, RO, SO High	–	190	250	μA
Current Consumption; $I_q = I_I - I_Q$	I_q	I_Q = 10 mA, RO, SO High	–	250	450	μA
Current Consumption; $I_q = I_I - I_Q$	I_q	I_Q = 50 mA, RO, SO High	–	2.0	3.0	mA
Dropout Voltage	V_{dr}	V_I = 5 V, I_Q = 100 mA	–	0.25	0.5	V
Load Regulation	ΔV_Q	I_Q = 5 mA to 100 mA	–	10	20	mV
Line Regulation	ΔV_Q	V_I = 6 V to 26 V I_Q = 1 mA	–	10	30	mV
RESET GENERATOR						
Reset Switching Threshold	V_{RT}	–	4.50	4.65	4.80	V
Reset Adjust Switching Threshold	$V_{RAD,JTH}$	V_Q > 3.5 V	1.26	1.35	1.44	V
Reset Pullup Resistance	$R_{SO,INT}$	–	10	20	40	kΩ
Reset Output Saturation Voltage	$V_{RO,SAT}$	$V_Q < V_{RT}$, $R_{RO,\ INT}$	–	0.1	0.4	V
Upper Delay Switching Threshold	V_{UD}	–	1.4	1.8	2.2	V
Lower Delay Switching Threshold	V_{LD}	–	0.3	0.45	0.60	V
Saturation Voltage on Delay Capacitor	$V_{D,SAT}$	$V_Q < V_{RT}$	–	–	0.1	V
Charge Current	I_D	V_D = 1 V	3.0	6.5	9.5	μA
Delay Time L → H	t_d	C_D = 100 nF	17	28	–	ms
Delay Time H → L	t_t	C_D = 100 nF	–	1.0	–	μs
INPUT VOLTAGE SENSE						
Sense Threshold High	$V_{SI,High}$	–	1.24	1.31	1.38	V
Sense Threshold Low	$V_{SI,Low}$	–	1.16	1.20	1.28	V
Sense Output Saturation Voltage	$V_{SO,Low}$	V_{SI} < 1.20 V; V_Q > 3 V; R_{SO}	–	0.1	0.4	V
Sense Resistor Pullup	$R_{SO,INT}$	–	10	20	40	kΩ
Sense Input Current	I_{SI}	–	−1.0	0.1	1.0	μA

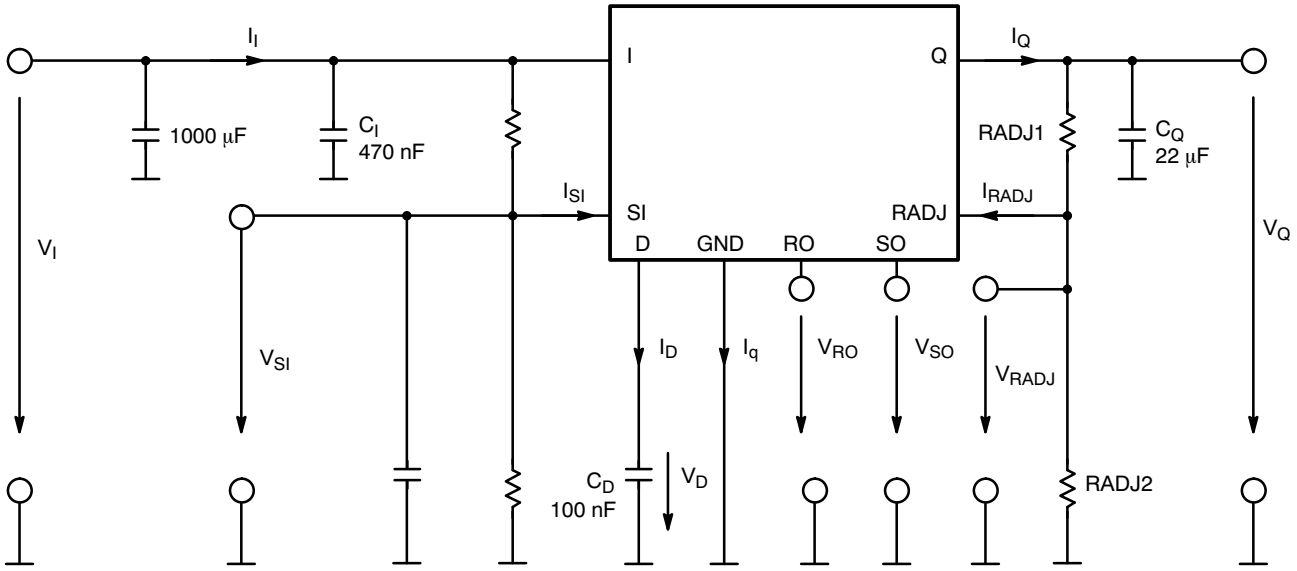


Figure 2. Measuring Circuit

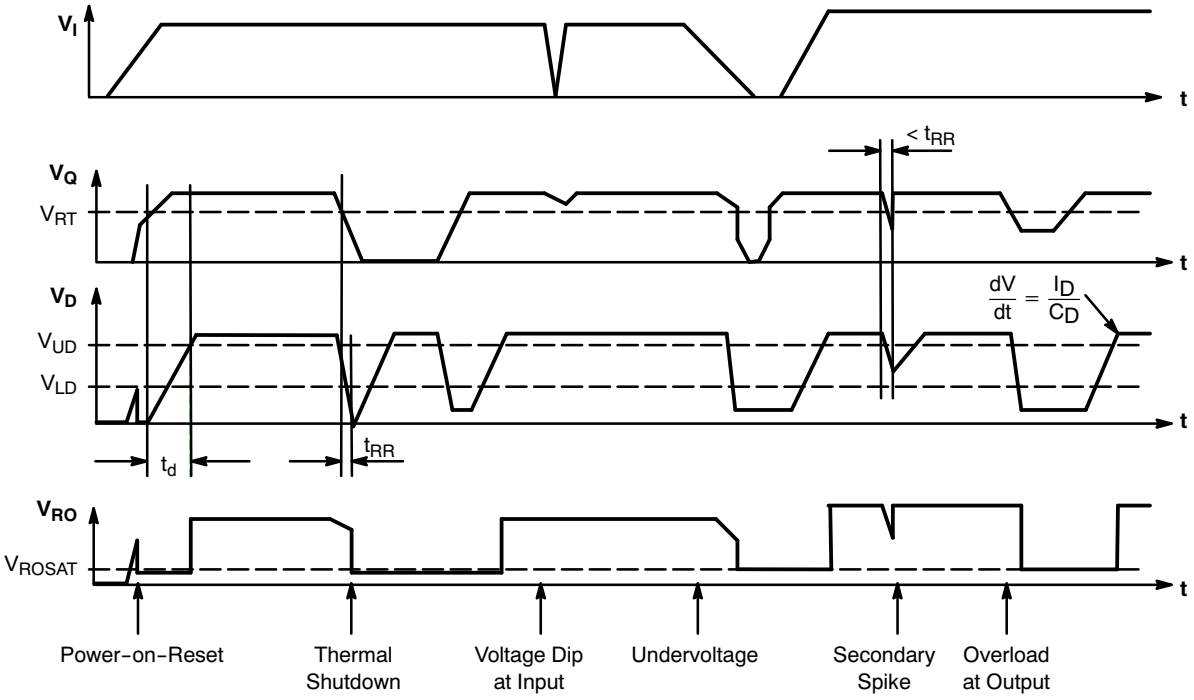


Figure 3. Reset Timing Diagram

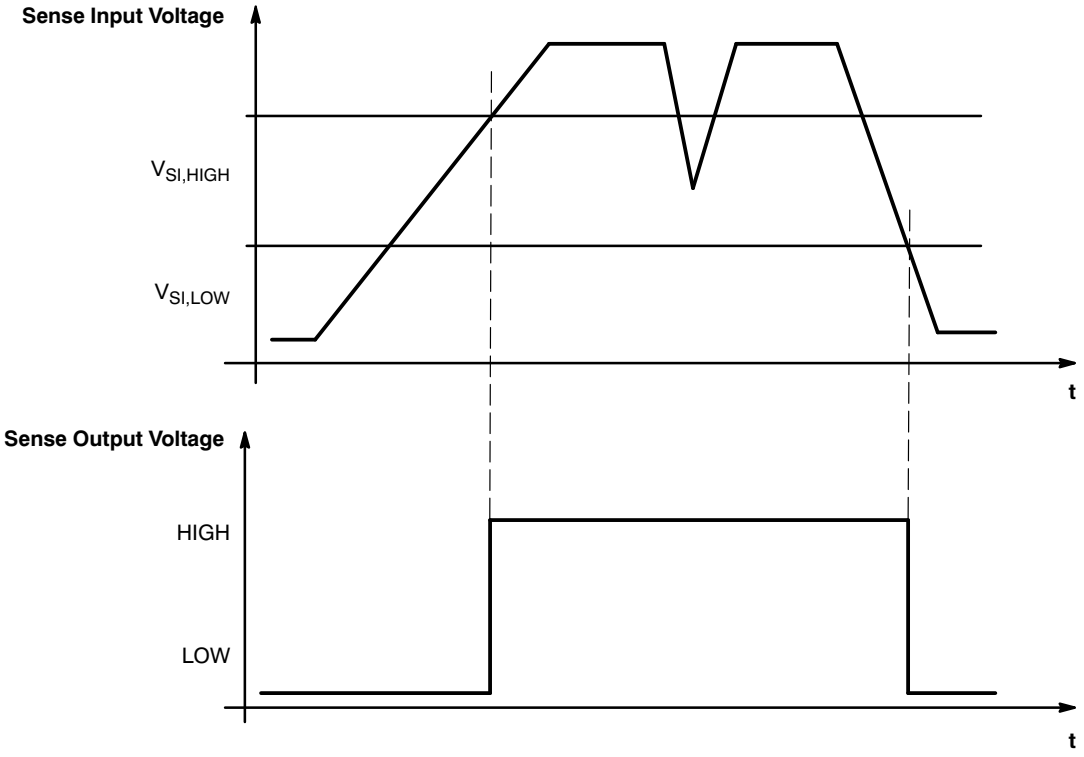


Figure 4. Sense Timing Diagram

TYPICAL PERFORMANCE CHARACTERISTICS

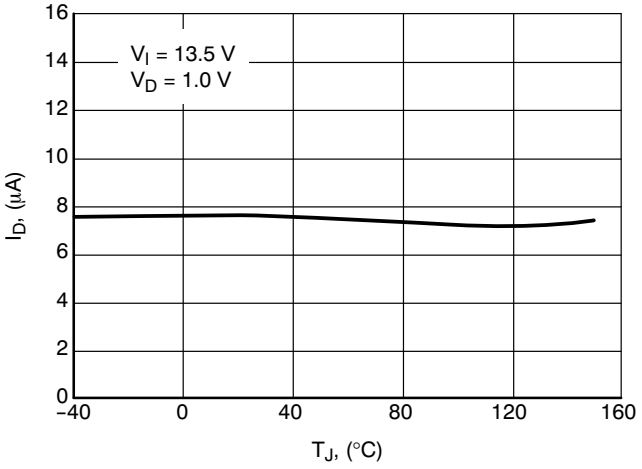


Figure 5. Charge Current I_D vs. Temperature T_J

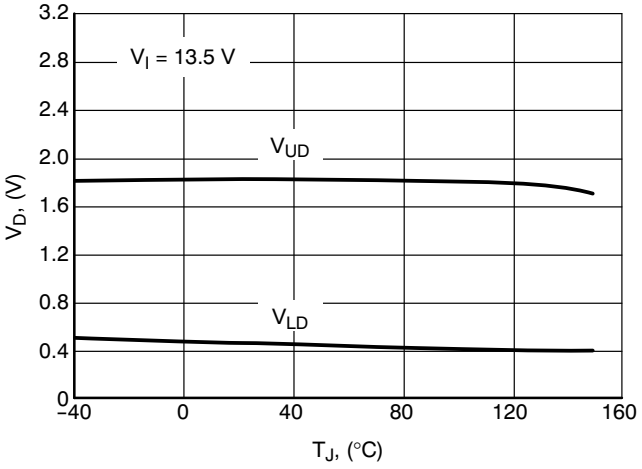


Figure 6. Switching Voltage V_{UD} and V_{LD} vs. Temperature T_J

TYPICAL PERFORMANCE CHARACTERISTICS

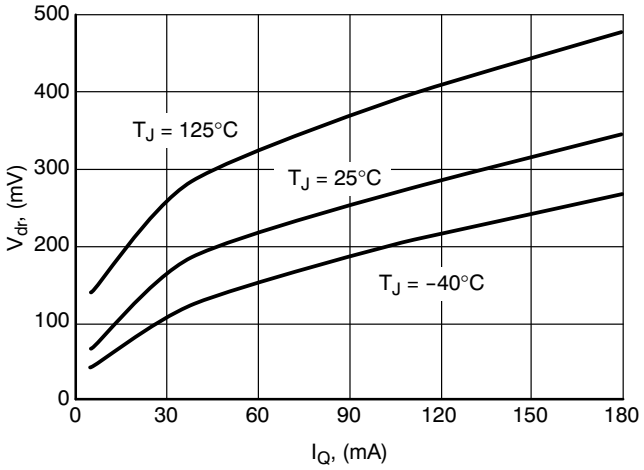


Figure 7. Drop Voltage V_{dr} vs. Output Current I_Q

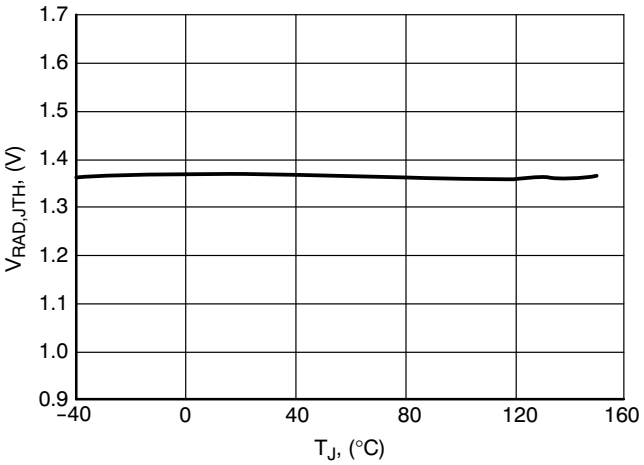


Figure 8. Reset Adjust Switching Threshold, $V_{RAD,JTH}$ vs. Temperature T_J

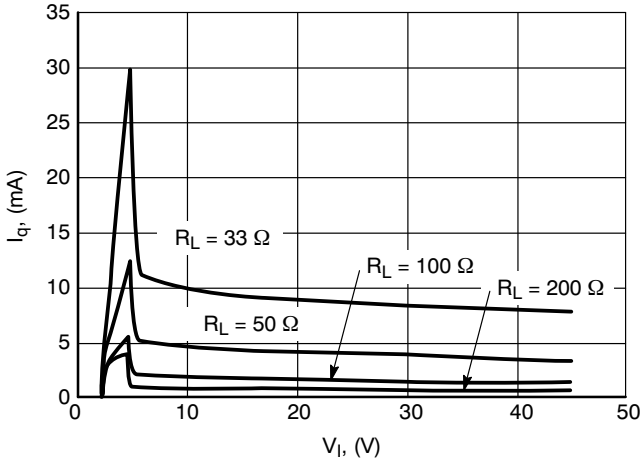


Figure 9. Current Consumption I_q vs. Input Voltage V_I

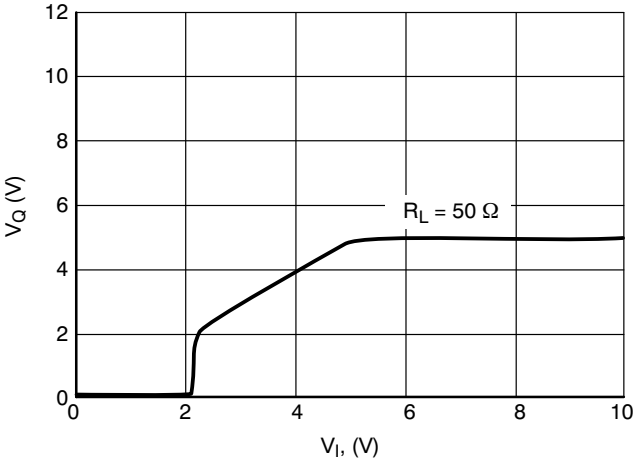


Figure 10. Output Voltage V_Q vs. Input Voltage V_I

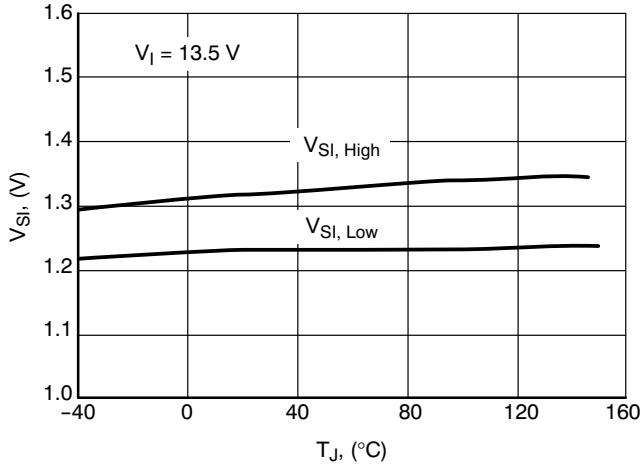


Figure 11. Sense Threshold V_{SI} vs. Temperature T_J

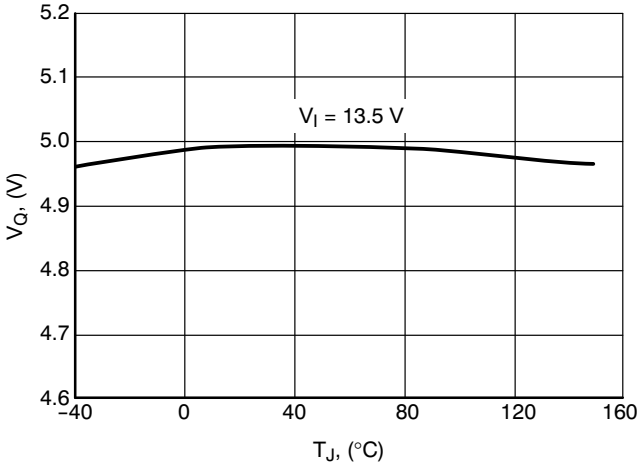


Figure 12. Output Voltage V_Q vs. Temperature T_J

TYPICAL PERFORMANCE CHARACTERISTICS

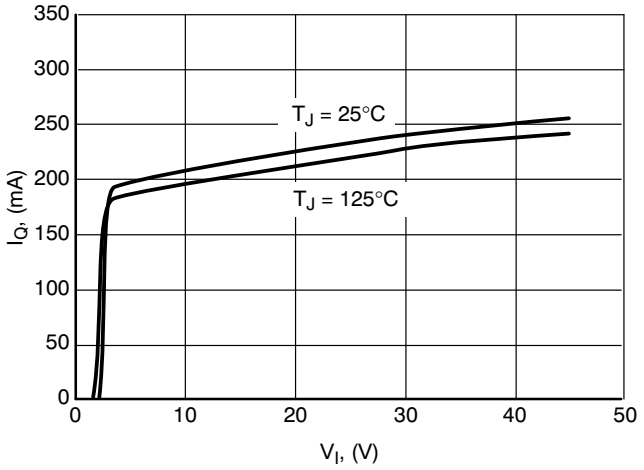


Figure 13. Output Current Limit I_Q vs. Input Voltage V_I

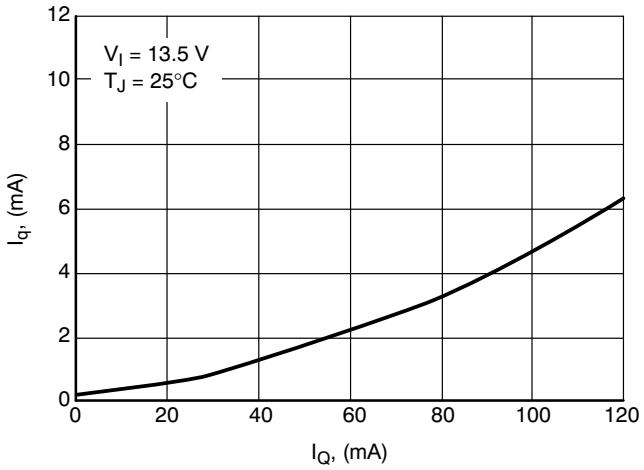


Figure 14. Current Consumption I_q vs. Output Current I_Q

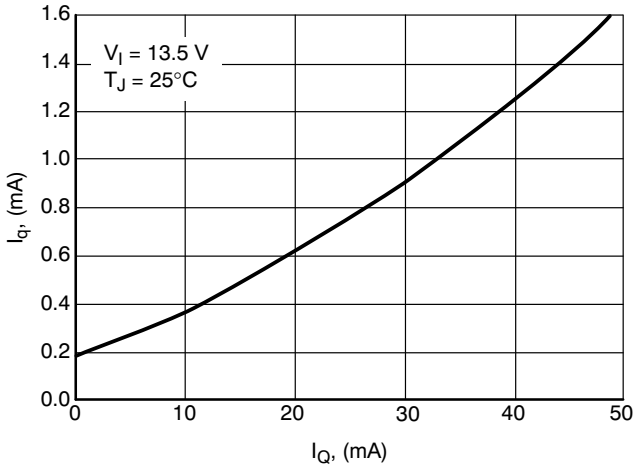


Figure 15. Current Consumption I_q vs. Output Current I_Q

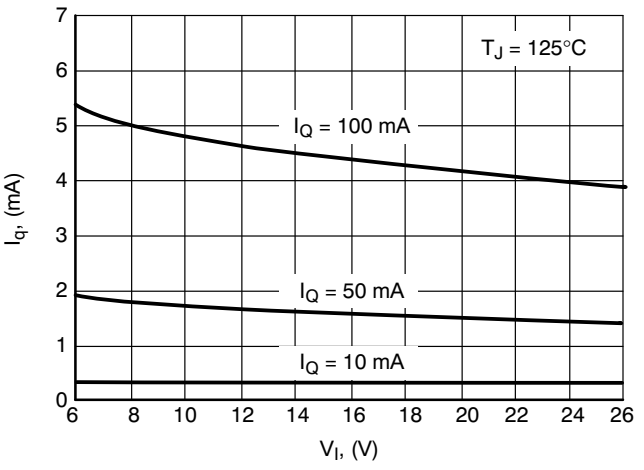


Figure 16. Quiescent Current I_q vs. Input Voltage V_I

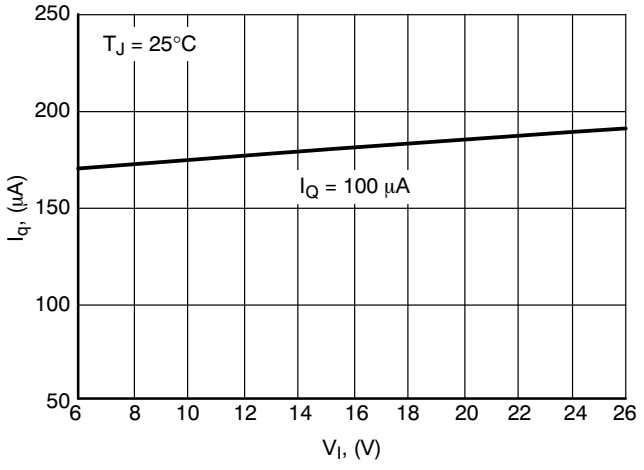


Figure 17. Quiescent Current I_q vs. Input Voltage V_I

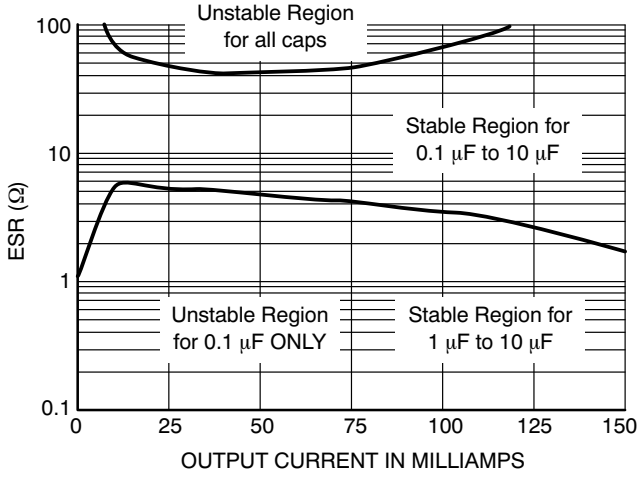


Figure 18. Output Stability, Capacitance ESR vs. Output Load Current

TYPICAL THERMAL CHARACTERISTICS

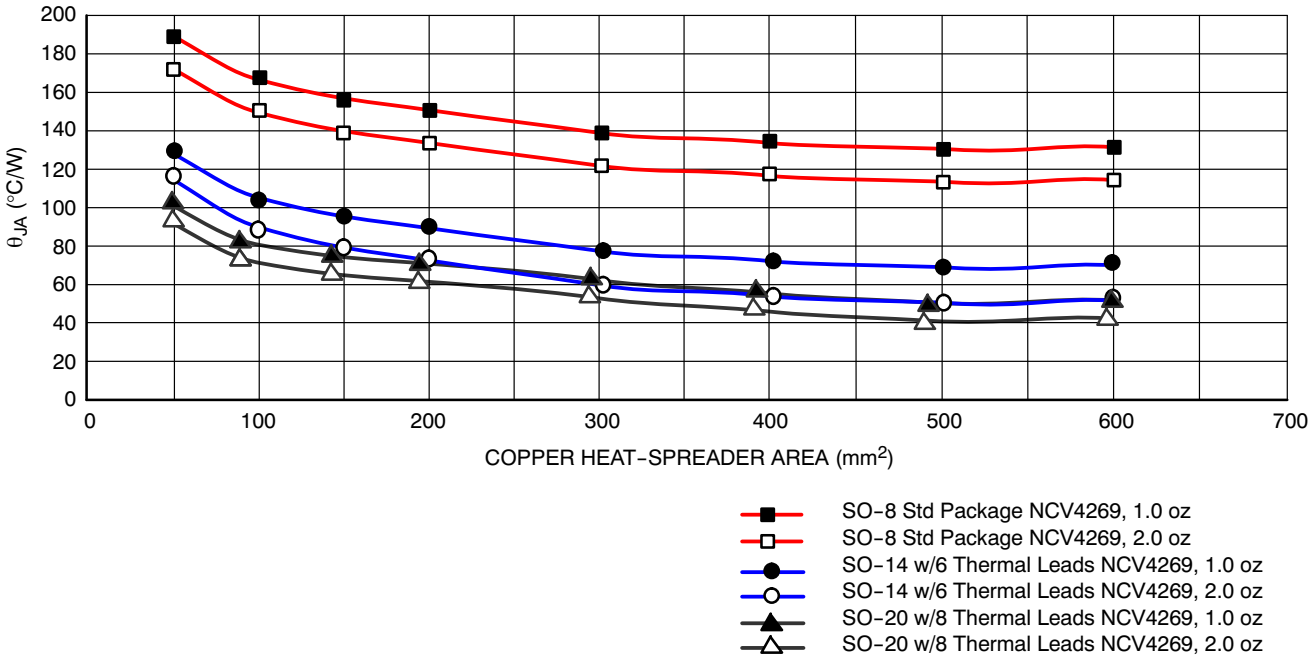


Figure 19. Junction−to−Ambient Thermal Resistance (θ_{JA}) vs. Heat Spreader Area

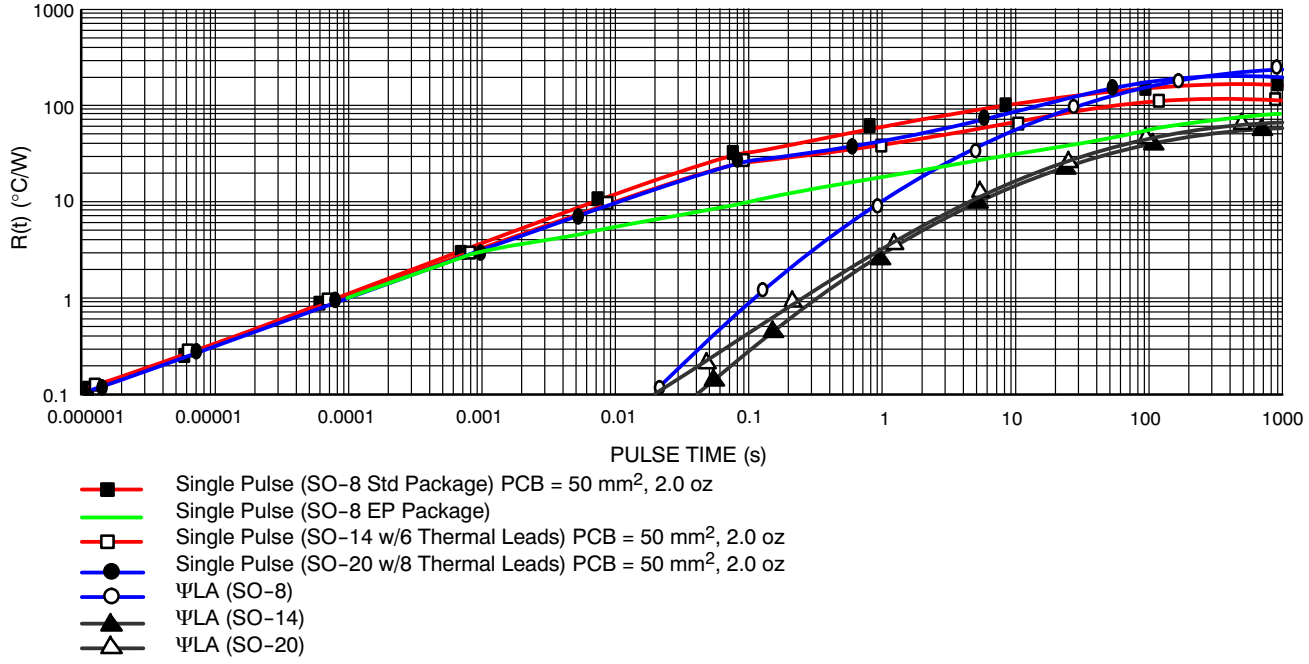


Figure 20. R(t) vs. Pulse Time

APPLICATION DESCRIPTION

OUTPUT REGULATOR

The output is controlled by a precision trimmed reference. The PNP output has base drive quiescent current control for regulation while the input voltage is low, preventing over saturation. Current limit and voltage monitors complement the regulator design to give safe operating signals to the processor and control circuits.

RESET OUTPUT (RO)

A reset signal, Reset Output, RO, (low voltage) is generated as the IC powers up. After the output voltage V_Q increases above the reset threshold voltage V_{RT}, the delay timer D is started. When the voltage on the delay timer V_D passes V_{UD}, the reset signal RO goes high. A discharge of the delay timer V_D is started when V_Q drops and stays below the reset threshold voltage V_{RT}. When the voltage of the delay timer V_D drops below the lower threshold voltage V_{LD} the reset output voltage V_{RO} is brought low to reset the processor.

The reset output RO is an open collector NPN transistor with an internal 20 kΩ pullup resistor connected to the output Q, controlled by a low voltage detection circuit. The circuit is functionally independent of the rest of the IC, thereby guaranteeing that RO is valid for V_Q as low as 1.0 V.

RESET ADJUST (R_{ADJ})

The reset threshold V_{RT} can be decreased from a typical value of 4.65 V to as low as 3.5 V by using an external voltage divider connected from the Q lead to the pin RADJ, as shown in Figure 21. The resistor divider keeps the voltage above the $V_{RADJ,TH}$ (typical 1.35 V) for the desired input voltages, and overrides the internal threshold detector. Adjust the voltage divider according to the following relationship:

$$V_{RT} = V_{RADJ,TH} \cdot (R_{ADJ1} + R_{ADJ2}) / R_{ADJ2} \quad \text{(eq. 1)}$$

If the reset adjust option is not needed, the R_{ADJ} pin should be connected to GND causing the reset threshold to go to its default value (typically 4.65 V).

RESET DELAY (D)

The reset delay circuit provides a delay (programmable by capacitor C_D) on the reset output lead RO. The delay lead D provides charge current I_D (typically 6.5 μA) to the external delay capacitor C_D during the following times:

1. During Powerup (once the regulation threshold has been exceeded).
2. After a reset event has occurred and the device is back in regulation. The delay capacitor is set to discharge when the regulation (V_{RT}, reset threshold voltage) has been violated. When the delay capacitor discharges to V_{LD}, the reset signal RO pulls low.

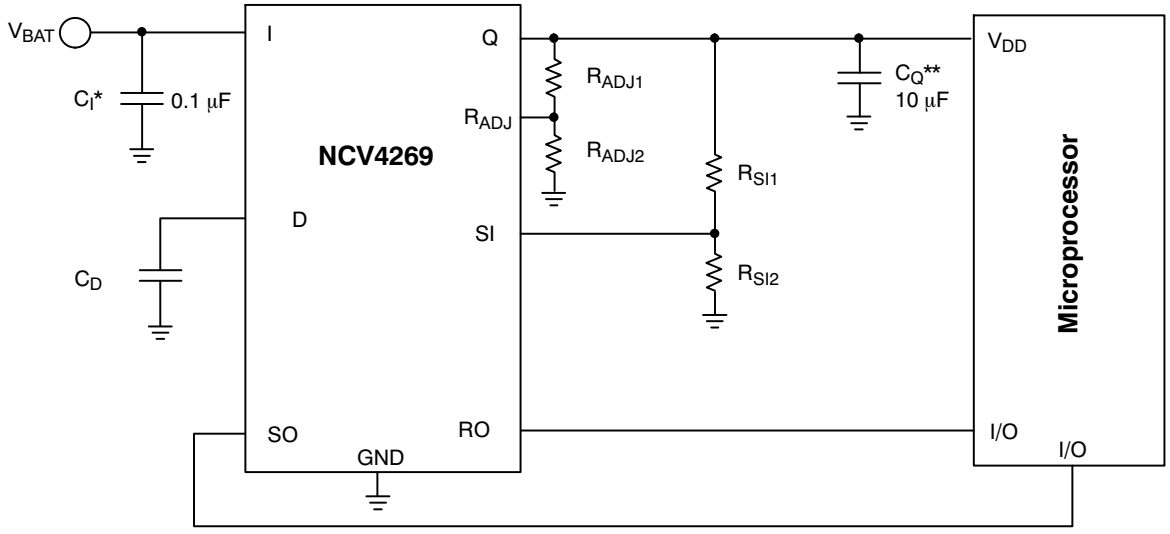
SETTING THE DELAY TIME

The delay time is set by the delay capacitor C_D and the charge current I_D. The time is measured by the delay capacitor voltage charging from the low level of V_{DSAT} to the higher level V_{UD}. The time delay follows the equation:

$$t_d = [C_D (V_{UD} - V_{DSAT})]/I_D \quad \text{(eq. 2)}$$

Example:
Using C_D = 100 nF.
Use the typical value for V_{DSAT} = 0.1 V.
Use the typical value for V_{UD} = 1.8 V.
Use the typical value for Delay Charge Current I_D = 6.5 μA.

$$t_d = [100\ nF\,(1.8 - 0.1\ V)] / 6.5\ \mu A = 26.2\ ms \quad \text{(eq. 3)}$$



*C_I required if regulator is located far from the power supply filter.
** C_Q required for Stability. Cap must operate at minimum temperature expected.

Figure 21. Application Diagram

SENSE INPUT (SI) / SENSE OUTPUT (SO) VOLTAGE MONITOR

An on−chip comparator is available to provide early warning to the microprocessor of a possible reset signal (Figure 4). The output is from an open collector driver with an internal 20 kΩ pull up resistor to output Q. The reset signal typically turns the microprocessor off instantaneously. This can cause unpredictable results with the microprocessor. The signal received from the SO pin will allow the microprocessor time to complete its present task before shutting down. This function is performed by a comparator referenced to the band gap voltage. The actual trip point can be programmed externally using a resistor divider to the input monitor SI (Figure 21). The values for R_{SI1} and R_{SI2} are selected for a typical threshold of 1.20 V on the SI Pin.

SIGNAL OUTPUT

Figure 22 shows the SO Monitor timing waveforms as a result of the circuit depicted in Figure 21. As the output voltage (V_Q) falls, the monitor threshold (V_{SILOW}), is crossed. This causes the voltage on the SO output to go low sending a warning signal to the microprocessor that a reset signal may occur in a short period of time. $T_{WARNING}$ is the time the microprocessor has to complete the function it is currently working on and get ready for the reset shutdown signal.

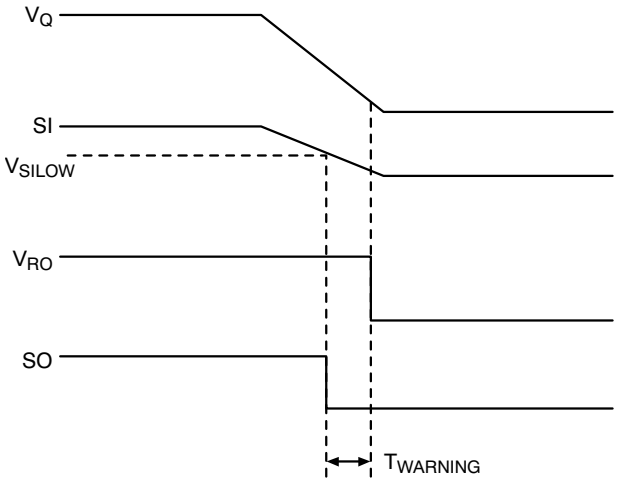


Figure 22. SO Warning Waveform Time Diagram

STABILITY CONSIDERATIONS

The input capacitor C_I in Figure 21 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 1.0 Ω in series with C_I.

The output or compensation capacitor 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. A tantalum or aluminum electrolytic capacitor is best, since a film or ceramic capacitor with almost zero ESR can cause instability. The aluminum electrolytic capacitor is the least expensive solution, but, if the circuit operates at low temperatures (−25°C to −40°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_Q shown in Figure 21 should work for most applications; however, it is not necessarily the optimized solution. Stability is guaranteed at values C_Q = 10 μF and an ESR = 10 Ω within the operating temperature range. Actual limits are shown in a graph in the typical data section.

CALCULATING POWER DISSIPATION IN A SINGLE OUTPUT LINEAR REGULATOR

The maximum power dissipation for a single output regulator (Figure 21) is:

$$P_{D(max)} = [V_{I(max)} - V_{Q(min)}]I_{Q(max)} + V_{I(max)}I_q \quad \text{(eq. 4)}$$

where:
$V_{I(max)}$ is the maximum input voltage,
$V_{Q(min)}$ is the minimum output voltage,
$I_{Q(max)}$ is the maximum output current for the application, and I_q is the quiescent current the regulator consumes at $I_{Q(max)}$.

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

$$R_{\theta JA} = (150°C - T_A) / P_D \quad \text{(eq. 5)}$$

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 heatsink will be required. The current flow and voltages are shown in the Measurement Circuit Diagram.

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 $R_{\theta JA}$:

$$R_{\theta JA} = R_{\theta JC} + R_{\theta CS} + R_{\theta SA} \quad \text{(eq. 6)}$$

where:
$R_{\theta JC}$ = the junction−to−case thermal resistance,
$R_{\theta CS}$ = the case−to−heat sink thermal resistance, and
$R_{\theta SA}$ = the heat sink−to−ambient thermal resistance.

$R_{\theta JC}$ appears in the package section of the data sheet. Like $R_{\theta JA}$, it too 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 data sheets of heatsink manufacturers. Thermal, mounting, and heatsinking considerations are discussed in the ON Semiconductor application note AN1040/D, available on the ON Semiconductor website.

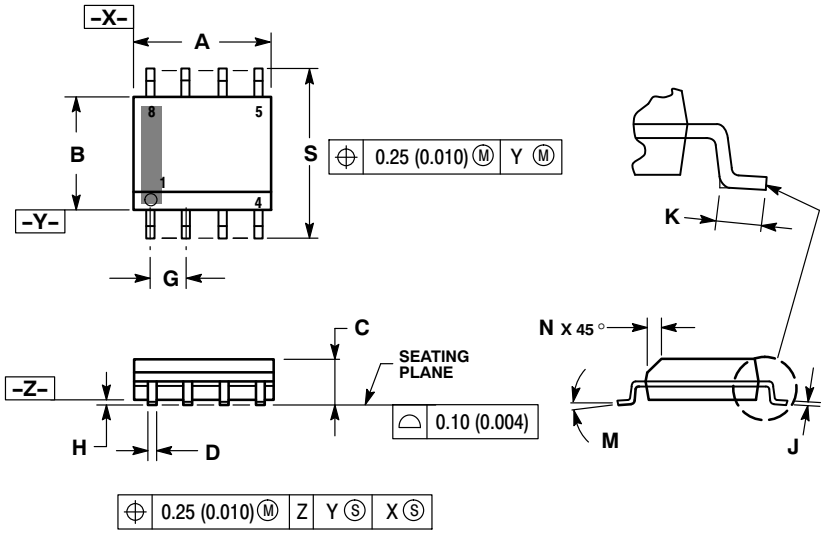
ORDERING INFORMATION

Device	Output Voltage	Package	Shipping†
NCV4269D1	5.0 V	SO−8	98 Units/Rail
NCV4269D1G		SO−8 (Pb−Free)	
NCV4269D1R2		SO−8	2500 Tape & Reel
NCV4269D1R2G		SO−8 (Pb−Free)	
NCV4269PDG		SO−8 EP (Pb−Free)	98 Units/Rail
NCV4269PDR2G		SO−8 EP (Pb−Free)	2500 Tape & Reel
NCV4269D2		SO−14	55 Units/Rail
NCV4269D2G		SO−14 (Pb−Free)	
NCV4269D2R2		SO−14	2500 Tape & Reel
NCV4269D2R2G		SO−14 (Pb−Free)	
NCV4269DW		SO−20L	38 Units/Rail
NCV4269DWG		SO−20L (Pb−Free)	
NCV4269DWR2		SO−20L	1000 Tape & Reel
NCV4269DWR2G		SO−20L (Pb−Free)	

†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.

PACKAGE DIMENSIONS

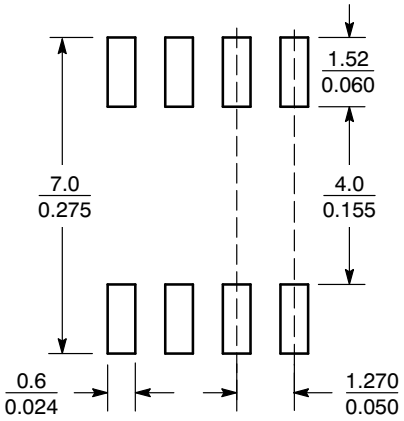
SOIC−8 NB
CASE 751−07
ISSUE AJ



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 STANDARD 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

SOLDERING FOOTPRINT*

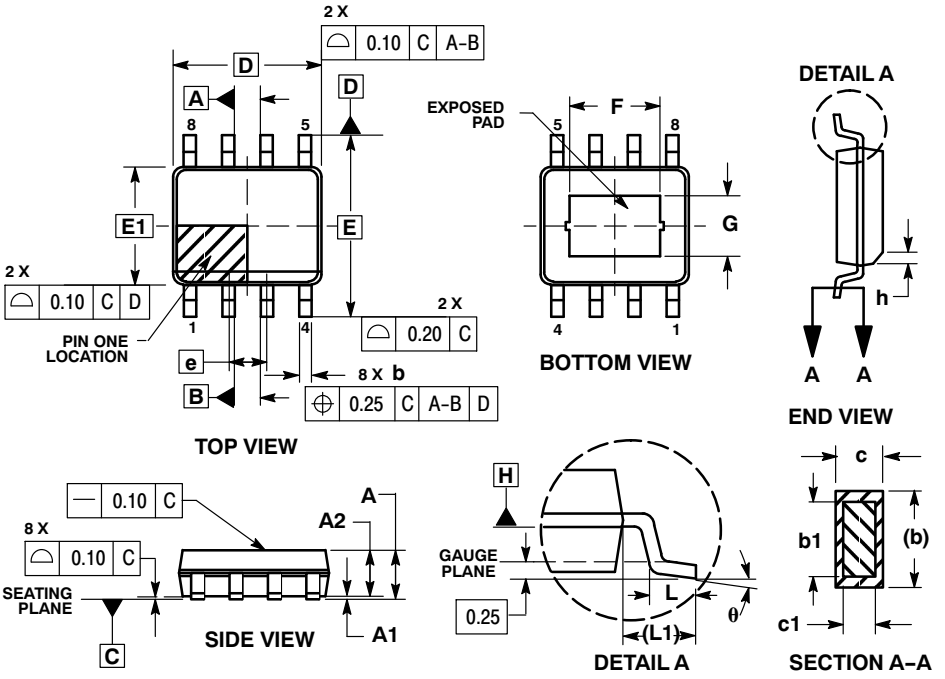


SCALE 6:1 $\left(\frac{\text{mm}}{\text{inches}}\right)$

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

PACKAGE DIMENSIONS

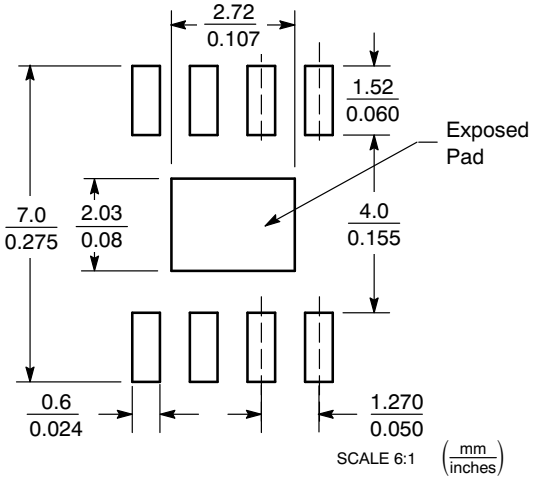
SOIC−8 EP
CASE 751AC−01
ISSUE B



NOTES:
1. DIMENSIONS AND TOLERANCING PER ASME Y14.5M, 1994.
2. DIMENSIONS IN MILLIMETERS (ANGLES IN DEGREES).
3. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 MM TOTAL IN EXCESS OF THE “b” DIMENSION AT MAXIMUM MATERIAL CONDITION.
4. DATUMS A AND B TO BE DETERMINED AT DATUM PLANE H.

	MILLIMETERS	
DIM	MIN	MAX
A	1.35	1.75
A1	0.00	0.10
A2	1.35	1.65
b	0.31	0.51
b1	0.28	0.48
c	0.17	0.25
c1	0.17	0.23
D	4.90 BSC	
E	6.00 BSC	
E1	3.90 BSC	
e	1.27 BSC	
L	0.40	1.27
L1	1.04 REF	
F	2.24	3.20
G	1.55	2.51
h	0.25	0.50
θ	0 °	8 °

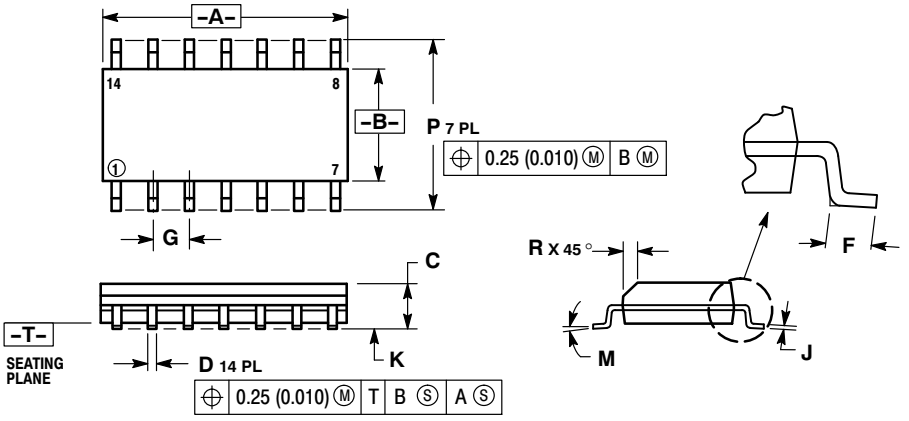
SOLDERING FOOTPRINT*



*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

PACKAGE DIMENSIONS

SO−14
D SUFFIX
CASE 751A−03
ISSUE G

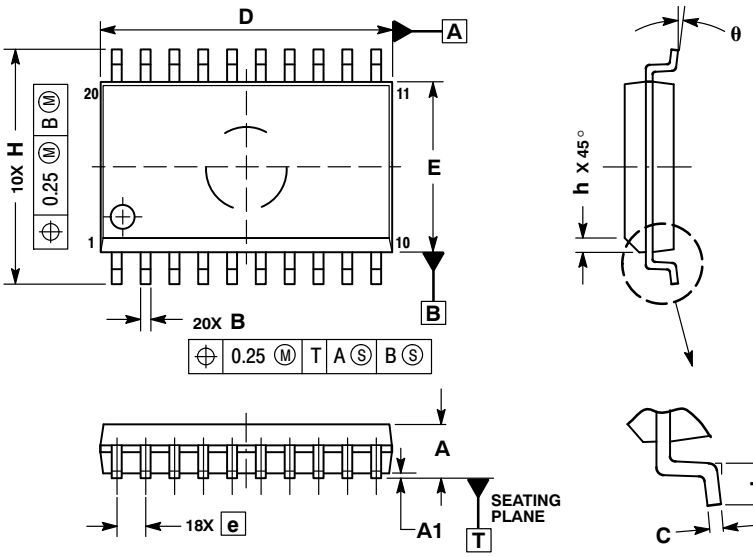


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	8.55	8.75	0.337	0.344
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 BSC		0.050 BSC	
J	0.19	0.25	0.008	0.009
K	0.10	0.25	0.004	0.009
M	0 °	7 °	0 °	7 °
P	5.80	6.20	0.228	0.244
R	0.25	0.50	0.010	0.019

-PACKAGE DIMENSIONS

SO−20L
DW SUFFIX
CASE 751D−05
ISSUE G



NOTES:
1. DIMENSIONS ARE IN MILLIMETERS.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.
3. DIMENSIONS D AND E DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.
5. DIMENSION B DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE PROTRUSION SHALL BE 0.13 TOTAL IN EXCESS OF B DIMENSION AT MAXIMUM MATERIAL CONDITION.

	MILLIMETERS	
DIM	MIN	MAX
A	2.35	2.65
A1	0.10	0.25
B	0.35	0.49
C	0.23	0.32
D	12.65	12.95
E	7.40	7.60
e	1.27 BSC	
H	10.05	10.55
h	0.25	0.75
L	0.50	0.90
θ	0°	7°

PUBLICATION ORDERING INFORMATION

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