NSI50010YT1G

Constant Current Regulator & LED Driver

50 V, 10 mA ± 30%, 460 mW Package

The linear constant current regulator (CCR) is a simple, economical and robust device designed to provide a cost−effective solution for regulating current in LEDs. The CCR is based on patent-pending Self-Biased Transistor (SBT) technology and regulates current over a wide voltage range. It is designed with a negative temperature coefficient to protect LEDs from thermal runaway at extreme voltages and currents.

The CCR turns on immediately and is at 40% of regulation with only 0.5 V Vak. It requires no external components allowing it to be designed as a high or low−side regulator. The high anode-cathode voltage rating withstands surges common in Automotive, Industrial and Commercial Signage applications. The CCR comes in thermally robust packages and is qualified to AEC-Q101 standard.

Features

- Robust Power Package: 460 mW
- Wide Operating Voltage Range
- Immediate Turn-On
- Voltage Surge Suppressing − Protecting LEDs
- AEC-Q101 Qualified
- SBT (Self−Biased Transistor) Technology
- Negative Temperature Coefficient
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant

Applications

- Automobile: Chevron Side Mirror Markers, Cluster, Display & Instrument Backlighting, CHMSL, Map Light
- AC Lighting Panels, Display Signage, Decorative Lighting, Channel Lettering
- Switch Contact Wetting
- Application Note AND8391/D − Power Dissipation Considerations
- Application Note AND8349/D − Automotive CHMSL

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Anode−Cathode Voltage	Vak Max	50	V
Reverse Voltage	V_R	500	mV
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C
ESD Rating: Human Body Model Machine Model	ESD	Class 1C Class B	

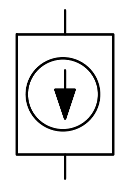
Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

ON Semiconductor®

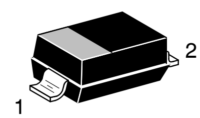
http://onsemi.com

$I_{reg(SS)}$ = 10 mA
@ Vak = 7.5 V

Anode 2

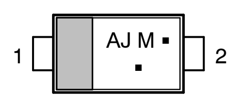


Cathode 1



SOD−123
CASE 425
STYLE 1

MARKING DIAGRAM



AJ = Device Code
M = Date Code
▪ = Pb−Free Package
(Note: Microdot may be in either location)

ORDERING INFORMATION

Device	Package	Shipping†
NSI50010YT1G	SOD−123 (Pb−Free)	3000/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.

December, 2009 − Rev. 0
Publication Order Number:
NSI50010Y/D

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Steady State Current @ Vak = 7.5 V (Note 1)	$I_{reg(SS)}$	7.0	10	13	mA
Voltage Overhead (Note 2)	$V_{overhead}$		1.8		V
Pulse Current @ Vak = 7.5 V (Note 3)	$I_{reg(P)}$	7.1	10.5	13.8	mA
Capacitance @ Vak = 7.5 V (Note 4)	C		2.5		pF
Capacitance @ Vak = 0 V (Note 4)	C		5.7		pF

1. $I_{reg(SS)}$ steady state is the voltage (Vak) applied for a time duration ≥ 10 sec, using FR−4 @ 300 mm^2 1 oz. Copper traces, in still air.
2. $V_{overhead}$ = V_{in} − V_{LEDs}. $V_{overhead}$ is typical value for 80% $I_{reg(SS)}$.
3. $I_{reg(P)}$ non−repetitive pulse test. Pulse width t ≤ 300 μsec.
4. f = 1 MHz, 0.02 V RMS.

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation (Note 5) T_A = 25°C Derate above 25°C	P_D	208 1.66	mW mW/°C
Thermal Resistance, Junction−to−Ambient (Note 5)	$R_{\theta JA}$	600	°C/W
Thermal Reference, Lead−to−Ambient (Note 5)	$R_{\psi LA}$	404	°C/W
Thermal Reference, Junction−to−Cathode Lead (Note 5)	$R_{\psi JL}$	196	°C/W
Total Device Dissipation (Note 6) T_A = 25°C Derate above 25°C	P_D	227 1.8	mW mW/°C
Thermal Resistance, Junction−to−Ambient (Note 6)	$R_{\theta JA}$	550	°C/W
Thermal Reference, Lead−to−Ambient (Note 6)	$R_{\psi LA}$	390	°C/W
Thermal Reference, Junction−to−Cathode Lead (Note 6)	$R_{\psi JL}$	160	°C/W
Total Device Dissipation (Note 7) T_A = 25°C Derate above 25°C	P_D	347 2.8	mW mW/°C
Thermal Resistance, Junction−to−Ambient (Note 7)	$R_{\theta JA}$	360	°C/W
Thermal Reference, Lead−to−Ambient (Note 7)	$R_{\psi LA}$	200	°C/W
Thermal Reference, Junction−to−Cathode Lead (Note 7)	$R_{\psi JL}$	160	°C/W
Total Device Dissipation (Note 8) T_A = 25°C Derate above 25°C	P_D	368 2.9	mW mW/°C
Thermal Resistance, Junction−to−Ambient (Note 8)	$R_{\theta JA}$	340	°C/W
Thermal Reference, Lead−to−Ambient (Note 8)	$R_{\psi LA}$	208	°C/W
Thermal Reference, Junction−to−Cathode Lead (Note 8)	$R_{\psi JL}$	132	°C/W
Total Device Dissipation (Note 9) T_A = 25°C Derate above 25°C	P_D	436 3.5	mW mW/°C
Thermal Resistance, Junction−to−Ambient (Note 9)	$R_{\theta JA}$	287	°C/W
Thermal Reference, Lead−to−Ambient (Note 9)	$R_{\psi LA}$	139	°C/W
Thermal Reference, Junction−to−Cathode Lead (Note 9)	$R_{\psi JL}$	148	°C/W
Total Device Dissipation (Note 10) T_A = 25°C Derate above 25°C	P_D	463 3.7	mW mW/°C
Thermal Resistance, Junction−to−Ambient (Note 10)	$R_{\theta JA}$	270	°C/W
Thermal Reference, Lead−to−Ambient (Note 10)	$R_{\psi LA}$	150	°C/W
Thermal Reference, Junction−to−Cathode Lead (Note 10)	$R_{\psi JL}$	120	°C/W
Junction and Storage Temperature Range	T_J, T_{stg}	−55 to +150	°C

5. FR−4 @ 100 mm^2, 1 oz. copper traces, still air.
6. FR−4 @ 100 mm^2, 2 oz. copper traces, still air.
7. FR−4 @ 300 mm^2, 1 oz. copper traces, still air.
8. FR−4 @ 300 mm^2, 2 oz. copper traces, still air.
9. FR−4 @ 500 mm^2, 1 oz. copper traces, still air.
10. FR−4 @ 500 mm^2, 2 oz. copper traces, still air.

NOTE: Lead measurements are made by non−contact methods such as IR with treated surface to increase emissivity to 0.9.
Lead temperature measurement by attaching a T/C may yield values as high as 30% higher °C/W values based upon empirical measurements and method of attachment.

TYPICAL PERFORMANCE CURVES

Minimum FR−4 @ 300 mm^2 1 oz Copper Trace, Still Air

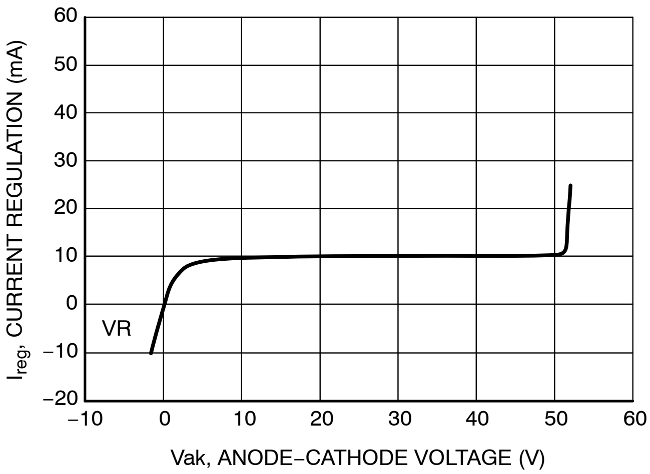


Figure 1. General Performance Curve for CCR

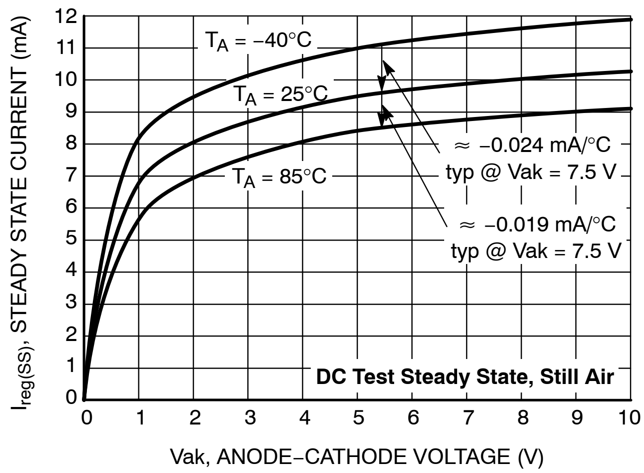


Figure 2. Steady State Current ($I_{reg(SS)}$) vs. Anode−Cathode Voltage (Vak)

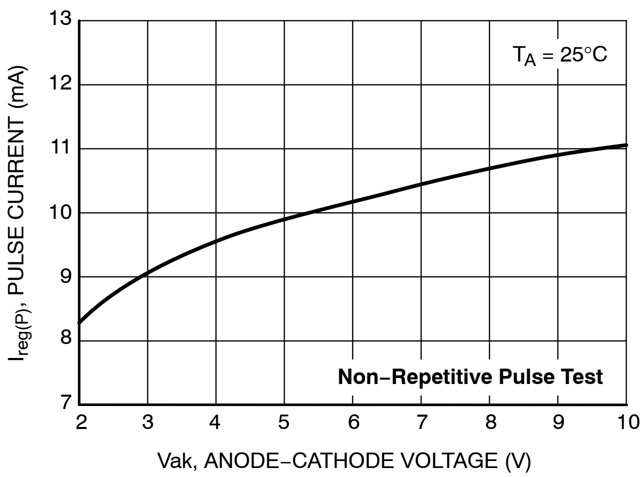


Figure 3. Pulse Current ($I_{reg(P)}$) vs. Anode−Cathode Voltage (Vak)

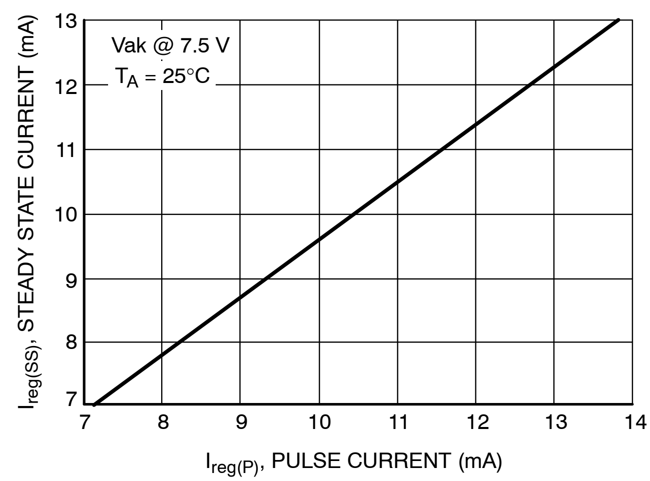


Figure 4. Steady State Current vs. Pulse Current Testing

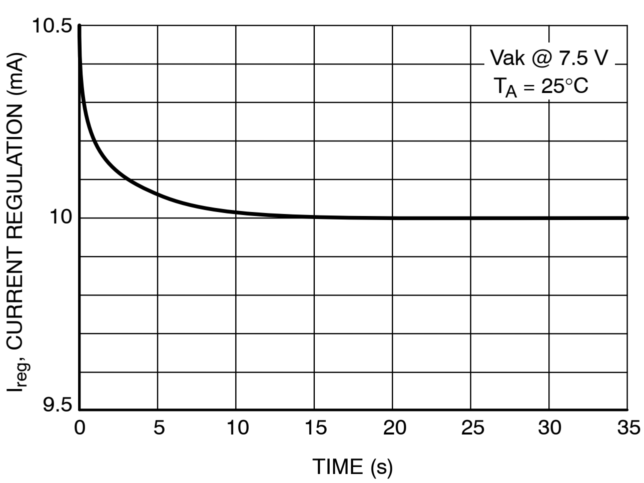


Figure 5. Current Regulation vs. Time

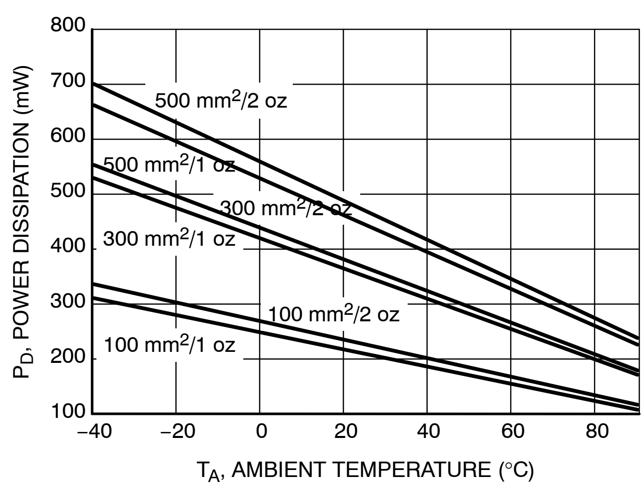


Figure 6. Power Dissipation vs. Ambient Temperature @ T_J = 150°C

APPLICATIONS

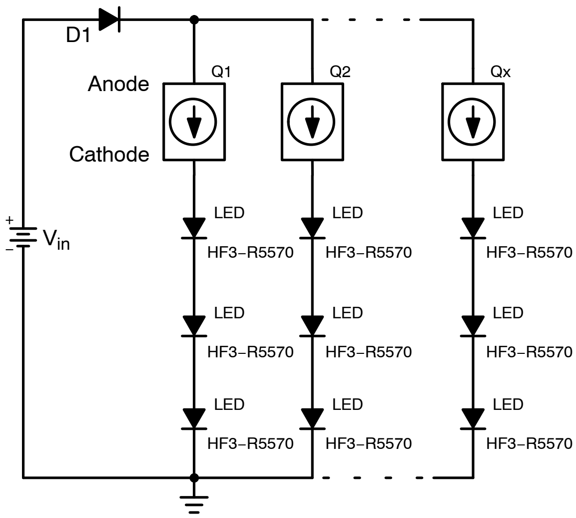


Figure 7. Typical Application Circuit (10 mA each LED String)

Number of LED's that can be connected is determined by:
D1 is a reverse battery protection diode
LED's = ((V_{in} − Q_X V_F + D1 V_F)/LED V_F)
Example: V_{in} = 12 Vdc, Q_X V_F = 3.5 Vdc, D1VF = 0.7 V
LED V_F = 2.2 Vdc @ 10 mA
(12 Vdc − 4.2 Vdc)/2.2 Vdc = 3 LEDs in series.

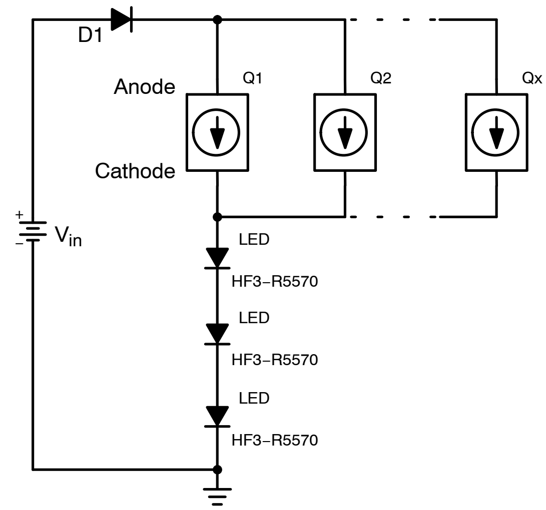


Figure 8. Typical Application Circuit (30 mA each LED String)

Number of LED's that can be connected is determined by:
D1 is a reverse battery protection diode
Example: V_{in} = 12 Vdc, Q_X V_F = 3.5 Vdc, D1VF = 0.7 V
LED V_F = 2.6 Vdc @ 30 mA
(12 Vdc − (3.5 + 0.7 Vdc))/2.6 Vdc = 3 LEDs in series.
Number of Drivers = LED current/10 mA
30 mA/10 mA = 3 Drivers (Q1, Q2, Q3)

Comparison of LED Circuit using CCR vs. Resistor Biasing

ON Semiconductor CCR Design	Resistor Biased Design
Constant brightness over full Automotive Supply Voltage (more efficient), see Figure 9	Large variations in brightness over full Automotive Supply Voltage
Little variation of power in LEDs, see Figure 10	Large variations of current (power) in LEDs
Constant current extends LED strings lifetime, see Figure 9	High Supply Voltage/ Higher Current in LED strings limits lifetime
Current decreases as voltage increases, see Figure 9	Current increases as voltage increases
Current supplied to LED string decreases as temperature increases (self-limiting), see Figure 2	LED current decreases as temperature increases
No resistors needed	Requires costly inventory (need for several resistor values to match LED intensity)
Fewer components, less board space required	More components, more board space required
Surface mount component	Through-hole components

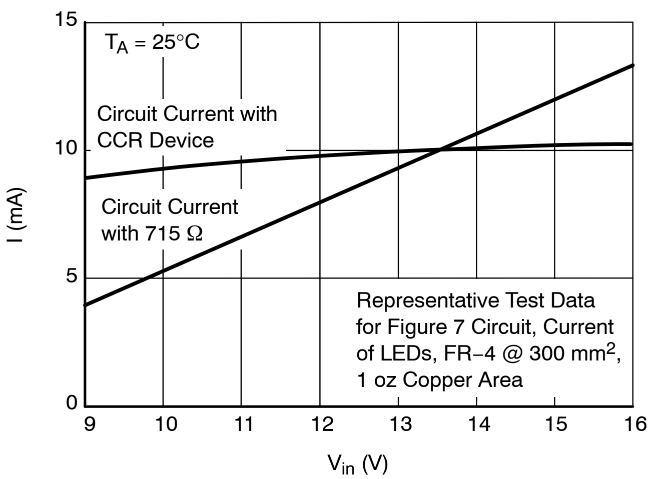


Figure 9. Series Circuit Current

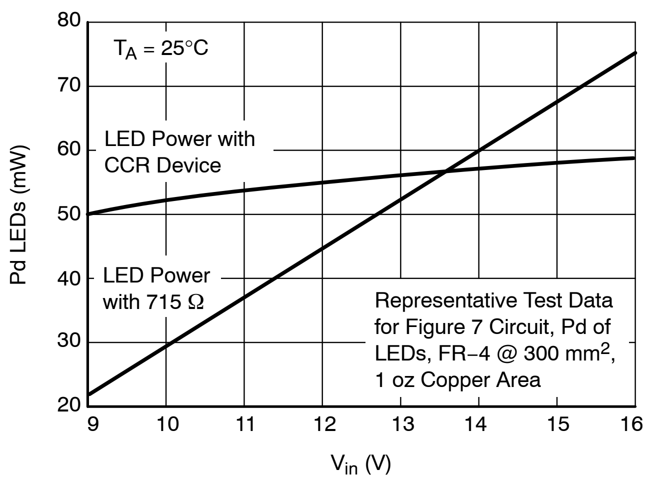


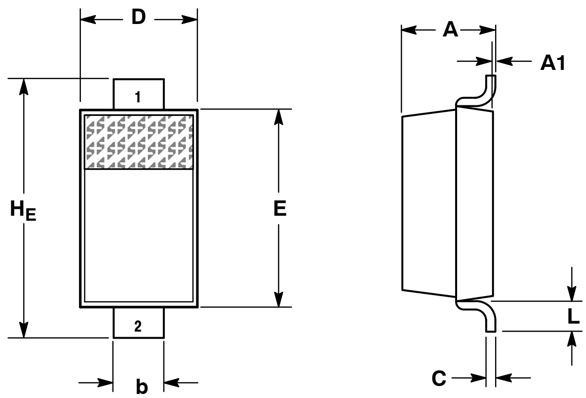
Figure 10. LED Power

Current Regulation: Pulse Mode ($I_{reg(P)}$) vs DC Steady-State ($I_{reg(SS)}$)

There are two methods to measure current regulation: Pulse mode ($I_{reg(P)}$) testing is applicable for factory and incoming inspection of a CCR where test times are a minimum. ($t \leq 300\ \mu s$). DC Steady-State ($I_{reg(SS)}$) testing is applicable for application verification where the CCR will be operational for seconds, minutes, or even hours. ON Semiconductor has correlated the difference in $I_{reg(P)}$ to $I_{reg(SS)}$ for stated board material, size, copper area and copper thickness. $I_{reg(P)}$ will always be greater than $I_{reg(SS)}$ due to the die temperature rising during $I_{reg(SS)}$. This heating effect can be minimized during circuit design with the correct selection of board material, metal trace size and weight, for the operating current, voltage, board operating temperature (T_A) and package. (Refer to Thermal Characteristics table).

PACKAGE DIMENSIONS

SOD−123
CASE 425−04
ISSUE E

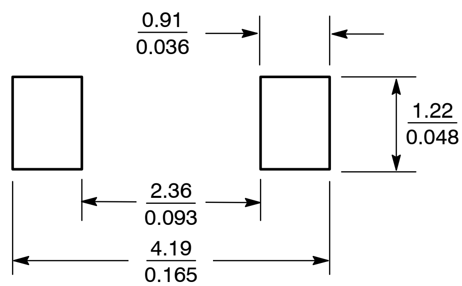


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

	MILLIMETERS			INCHES		
DIM	MIN	NOM	MAX	MIN	NOM	MAX
A	0.94	1.17	1.35	0.037	0.046	0.053
A1	0.00	0.05	0.10	0.000	0.002	0.004
b	0.51	0.61	0.71	0.020	0.024	0.028
c	---	---	0.15	---	---	0.006
D	1.40	1.60	1.80	0.055	0.063	0.071
E	2.54	2.69	2.84	0.100	0.106	0.112
H_E	3.56	3.68	3.86	0.140	0.145	0.152
L	0.25	---	---	0.010	---	---

STYLE 1:
PIN 1. CATHODE
2. ANODE

SOLDERING FOOTPRINT*



SCALE 10:1 $\left(\frac{\text{mm}}{\text{inches}}\right)$

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

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
Fax: 303−675−2176 or 800−344−3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

N. American Technical Support: 800−282−9855 Toll Free USA/Canada
Europe, Middle East and Africa Technical Support:
Phone: 421 33 790 2910
Japan Customer Focus Center
Phone: 81−3−5773−3850

ON Semiconductor Website: **www.onsemi.com**

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For additional information, please contact your local Sales Representative