DATA SHEET
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Linear Regulator - Low Output Voltage, Ultra-Fast Low Dropout, Enable

3.0 A

NCP5663, NCV5663

The NCP5663/NCV5663 is a high performance, low dropout linear regulator designed for high power applications that require up to 3.0 A current. It is offered in both fixed and adjustable output versions. With output voltages as low as 0.9 V and ultra−fast response times for load transients, the NCP5663/NCV5663 also provides additional features such as Enable and Error Flag (for the fixed output version), increasing the utility of this device. A thermally robust, 5 pin D^2PAK, combined with an architecture that offers low ground current (independent of load), provides for a superior high−current LDO solution.

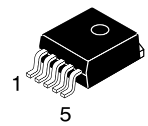
Features

- Ultra−Fast Transient Response (Settling Time: 1−3 μs)
- Low Noise Without Bypass Capacitor (28 μV_{rms})
- Low Ground Current Independent of Load (3.0 mA Maximum)
- Fixed/Adjustable Output Voltage Versions
- Enable Function
- Error Flag (Fixed Output Version)
- Current Limit Protection
- Thermal Protection
- 0.9 V Reference Voltage for Ultra−Low Output Operation
- Power Supply Rejection Ratio > 65 dB
- NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable
- This is a Pb−Free Device

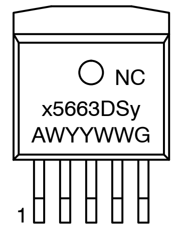
Applications

- Servers
- ASIC Power Supplies
- Post Regulation for Power Supplies
- Constant Current Source
- Networking Equipment
- Gaming and STB Modules

MARKING DIAGRAM



D^2PAK
CASE 936A



Tab = Ground
Pin 1. Enable
2. V_{in}
3. Ground
4. V_{out}
5. Adj (adjustable output)
5. Error Flag (fixed output)

x = P or V
y = A for Adjustable Version
B for Fixed 1.5 V Version
C for Fixed 1.8 V Version
A = Assembly Location
W = Wafer Lot
Y = Year
WW = 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.

NOTE: Some of the devices on this data sheet have been **DISCONTINUED**. Please refer to the table on page 12.

PIN FUNCTION DESCRIPTION

Pin Adj/Fixed	Pin Name	Description
1	Enable	This pin allows for on/off control of the regulator. To disable the device, connect to Ground. If this function is not in use, connect to V_{in}.
2	V_{in}	Positive Power Supply Input Voltage
3	Ground	Power Supply Ground
4	V_{out}	Regulated Output Voltage
5	Adj (Adjustable Version)	This pin is connected to the resistor divider network and programs the output voltage.
5	Error Flag (Fixed Version)	An Error Flag is triggered when the output voltage is out of regulation excluding transient signals that may occur. Requires a pullup resistor $\approx$ 100 kΩ.

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input Voltage (Note 1)	V_{in}	18	V
Output Pin Voltage	V_{out}	−0.3 to Vin +0.3	V
Adjust Pin Voltage	V_{adj}	−0.3 to Vin +0.3	V
Enable Pin Voltage	V_{en}	−0.3 to Vin +0.3	V
Error Flag Voltage	V_{ef}	−0.3 to Vin +0.3	V
Error Flag Current	I_{ef}	3.0	mA
Thermal Characteristics (Note 1) Thermal Resistance Junction−to−Air (Note 2) Thermal Resistance Junction−to−Case	 $R_{\theta JA}$ $R_{\theta JC}$	 45 5.0	°C/W
Operating Junction Temperature Range	T_J	−40 to +150	°C
Storage Temperature Range	T_{stg}	−55 to +150	°C

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

NOTE: This device series contains ESD protection and exceeds the following tests:
Human Body Model (HBM) JESD 22−A114−B
Machine Model (MM) JESD 22−A115−A.

1. Refer to Electrical Characteristics table and Application Information section for Safe Operating Area.
2. As measured using a copper heat spreading area of 625 mm^2, 1 oz. copper thickness.

ELECTRICAL CHARACTERISTICS

($V_{in} - V_{out}$ = 1.5 V, for typical values T_J = 25°C, for min/max values T_J = −40°C to 85°C (125°C for NCV versions), $C_{in} = C_{out}$ = 150 μF unless otherwise noted.)

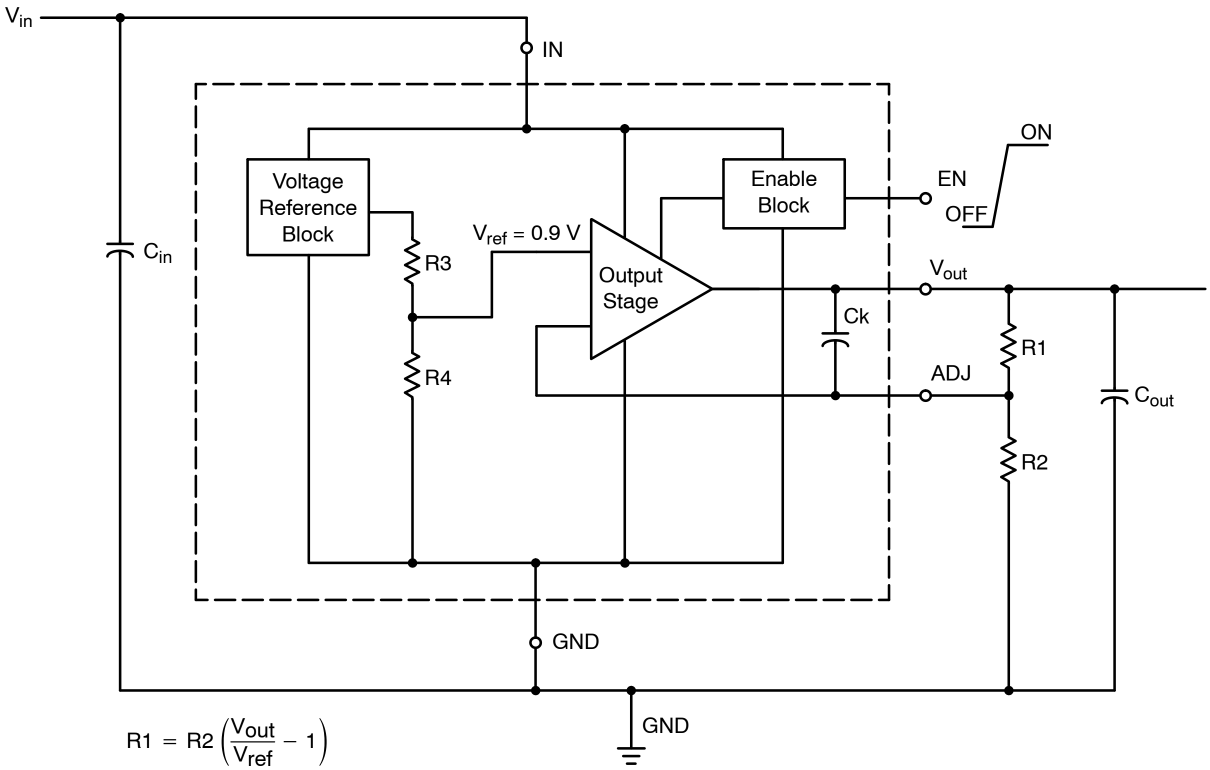
Characteristic	Symbol	Min	Typ	Max	Unit
ADJUSTABLE OUTPUT VERSION					
Input Voltage	V_{in}	2.0	–	9.0	V
Output Noise Voltage	V_n	–	28	–	μV_{rms}
Output Voltage Accuracy T_J = 25°C ($V_{in} = V_{out}$ +1.5 V to 7.0 V, I_{out} = 10 mA to 3.0 A) T_J = −20 to +125°C ($V_{in} = V_{out}$ +1.5 V to 7.0 V, I_{out} = 10 mA to 3.0 A) T_J = −40 to +150°C ($V_{in} = V_{out}$ +1.5 V to 7.0 V, I_{out} = 10 mA to 3.0 A)	V_{out}	 −1% −1.5% −2%	 – 0.9 –	 +1% +1.5% +2%	V
Adjustable Pin Input Current	I_{adj}	–	40	–	nA
Line Regulation (I_{out} = 10 mA, V_{out}+1.5 V < V_{in} < 7.0 V)	REG_{line}	–	0.03	–	%
Load Regulation (10 mA < I_{out} < 3.0 A)	REG_{load}	–	0.03	–	%
Dropout Voltage (I_{out} = 3.0 A)	V_{DO}	–	1.0	1.3	V
Peak Output Current Limit	I_{out}	3.0	–	–	A
Internal Current Limitation	I_{lim}	–	4.5	–	A
Ripple Rejection (120 Hz) Ripple Rejection (1 kHz)	RR	– –	70 65	– –	dB
Thermal Shutdown (Guaranteed by Design)	T_{SHD}	–	160	–	°C
Ground Current I_{out} = 3.0 A Disabled State	 I_q I_{qds}	 – –	 1.3 10	 3.0 300	 mA μA
Enable Input Threshold Voltage Voltage Increasing, On state, Logic High Voltage Decreasing, Off state, Logic Low	V_{en}	 1.3 –	 – –	 – 0.3	V
Enable Input Current Enable Pin Voltage = 0.3 V_{max} Enable Pin Voltage = 1.3 V_{min}	I_{en}	 – –	 0.5 0.5	 – –	 μA

ELECTRICAL CHARACTERISTICS

($V_{in} – V_{out}$ = 1.5 V, for typical values T_J = 25°C, for min/max values T_J = −40°C to 85°C (125°C for NCV versions), $C_{in} = C_{out}$ = 150 μF unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
FIXED OUTPUT VOLTAGE					
Input Voltage	V_{in}	2.0	–	9.0	V
Output Noise Voltage (V_{out} = 0.9 V)	V_n	–	28	–	μV_{rms}
Output Voltage Accuracy (Note 3)	V_{out}				V
T_J = 25°C ($V_{in} = V_{out}$ +1.5 V to 7.0 V, I_{out} = 10 mA to 3.0 A)		−1%	–	+1%	
T_J = −20 to +125°C ($V_{in} = V_{out}$ +1.5 V to 7.0 V, I_{out} = 10 mA to 3.0 A)		−1.5%	V_{out}	+1.5%	
T_J = −40 to +150°C ($V_{in} = V_{out}$ +1.5 V to 7.0 V, I_{out} = 10 mA to 3.0 A)		−2%	–	+2%	
Line Regulation (I_{out} = 10 mA, V_{out}+1.5 V < V_{in} < 7.0 V)	REG_{line}	–	0.03	–	%
Load Regulation (10 mA < I_{out} < 3.0 A)	REG_{load}	–	0.2	–	%
Dropout Voltage (I_{out} = 3.0 A)	V_{DO}	–	1.0	1.3	V
Peak Output Current Limit	I_{out}	3.0	–	–	A
Internal Current Limitation	I_{lim}	–	4.5	–	A
Ripple Rejection (120 Hz)	RR	–	70	–	dB
Ripple Rejection (1 kHz)		–	65	–	
Thermal Shutdown (Guaranteed by Design)	T_{SHD}	–	160	–	°C
Ground Current					
I_{out} = 3.0 A	I_q	–	1.3	3.0	mA
Disabled State	I_{qds}	–	30	300	μA
Enable Input Threshold Voltage	V_{en}				V
Voltage Increasing, On state, Logic High		1.3	–	–	
Voltage Decreasing, Off state, Logic Low		–	–	0.3	
Enable Input Current	I_{en}				
Enable Pin Voltage = 0.3 V_{max}		–	0.5	–	μA
Enable Pin Voltage = 1.3 V_{min}		–	0.5	–	
Error Flag (Fixed Output)	V_{cflt}	91	94	97	% of V_{out}
Error Flag Output Low Voltage Saturation (I_{ef} = 1.0 mA)	V_{cfdo}	–	200	–	mV
Error Flag Leakage	I_{efleak}	–	1.0	–	μA
Error Flag Blanking Time (Note 4)	T_{ef}	–	50	–	μs

3. Refer to Ordering Information Table for available voltage options.
4. Can be disabled per customer request.



$$R1 = R2\left(\frac{V_{out}}{V_{ref}} - 1\right)$$

Figure 1. Typical Schematic, Adjustable Output Version

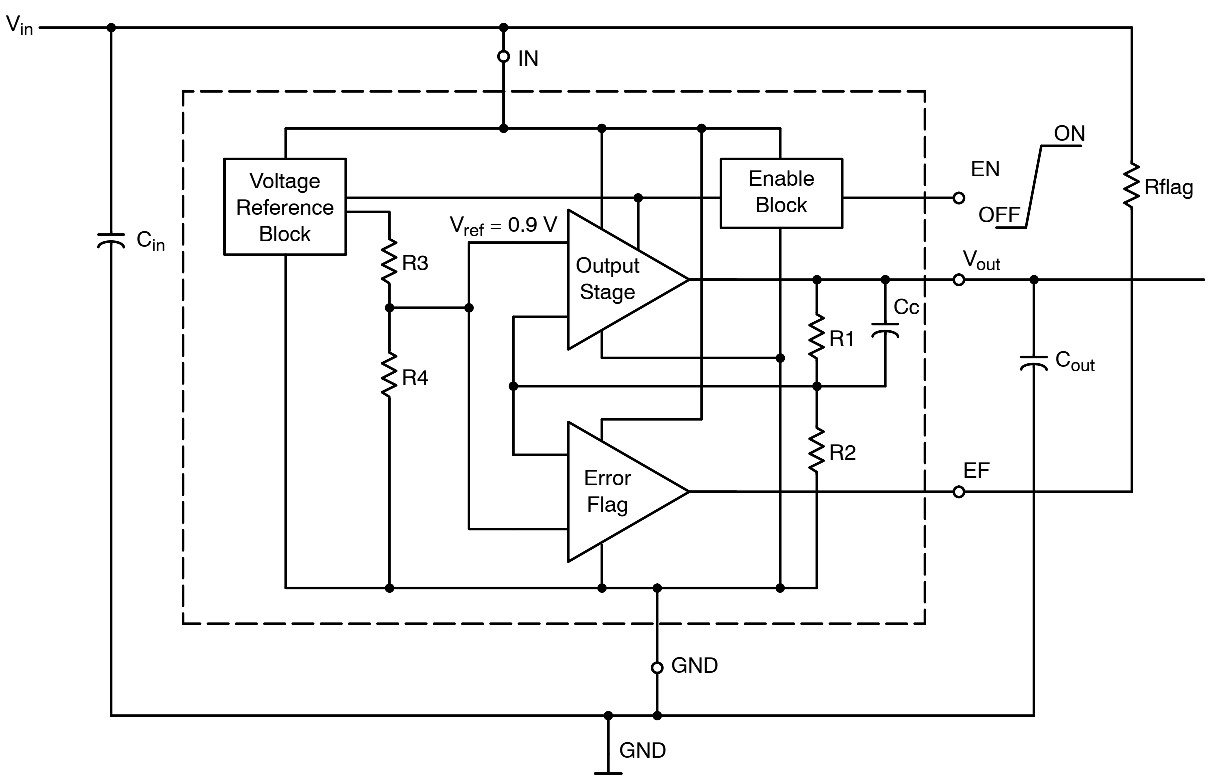


Figure 2. Typical Schematic, Fixed Output Version

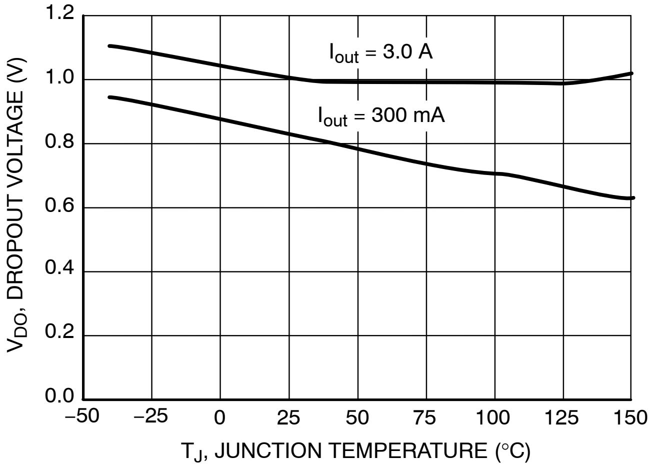


Figure 1. Dropout Voltage vs. Temperature

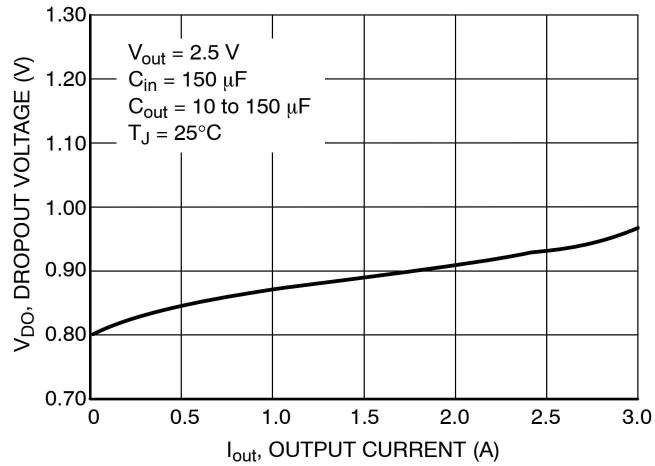


Figure 2. Dropout Voltage vs. Output Current

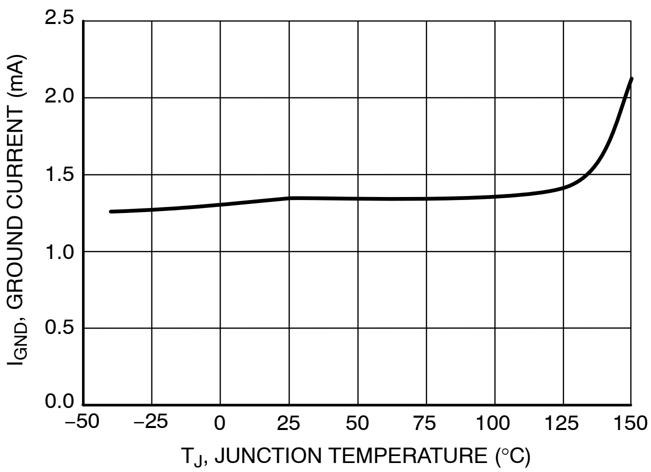


Figure 3. Ground Current vs. Temperature

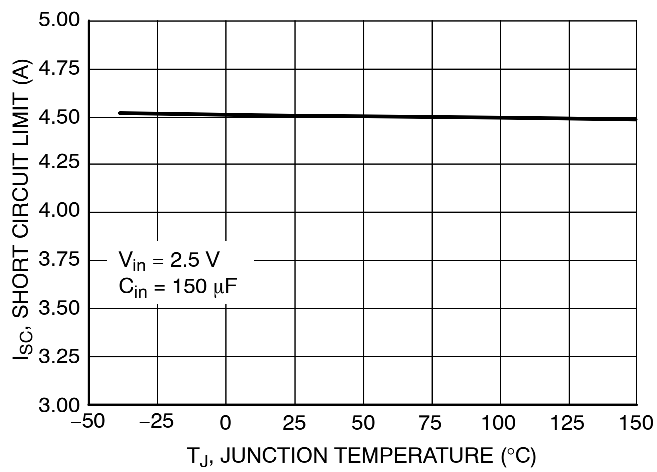


Figure 4. Short Circuit Current Limit vs. Temperature

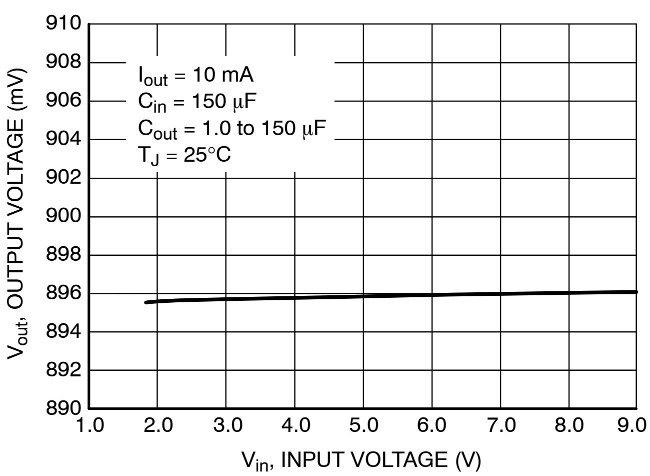


Figure 5. Output Voltage vs. Input Voltage

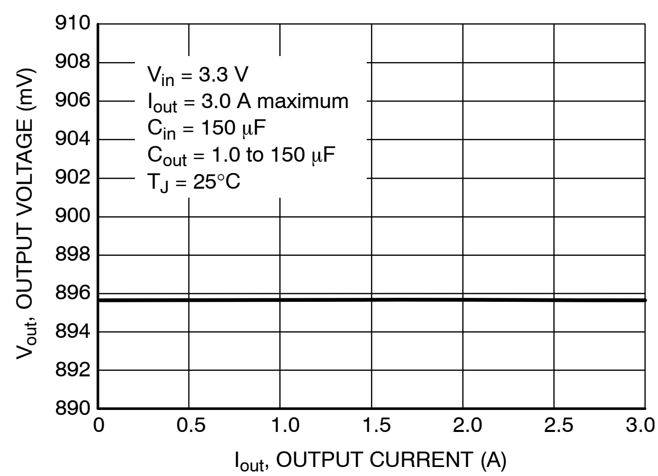


Figure 6. Output Voltage vs. Output Load Current

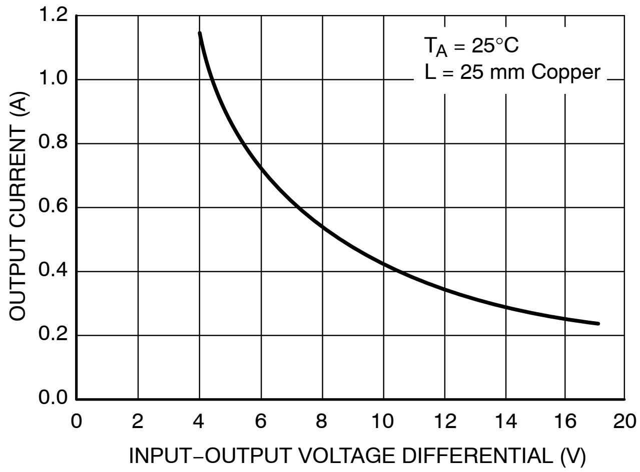


Figure 7. Output Current vs. Input−Output Voltage Differential

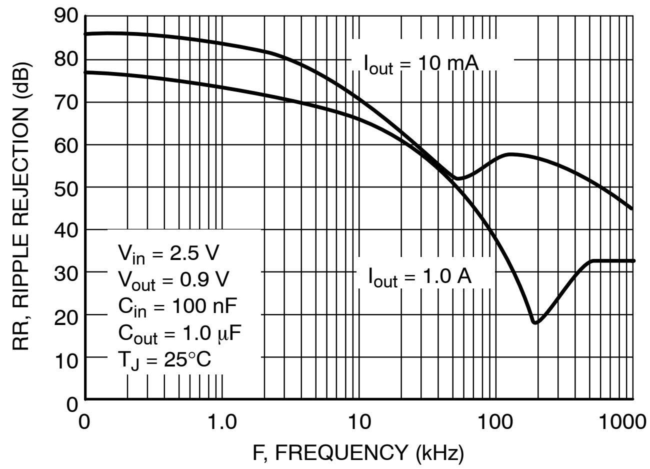


Figure 8. Ripple Rejection vs. Frequency

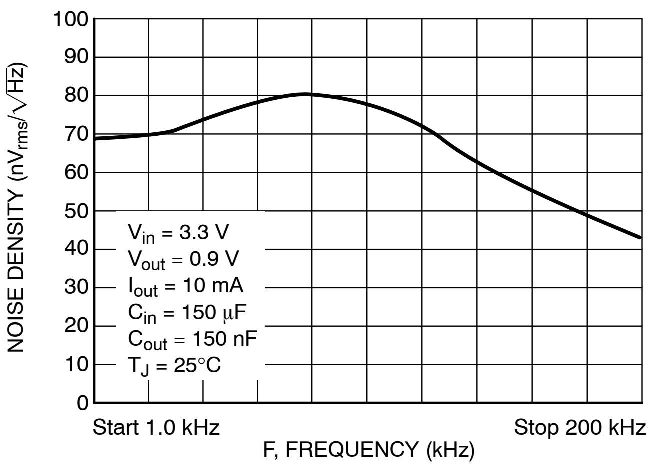


Figure 9. Noise Density vs. Frequency

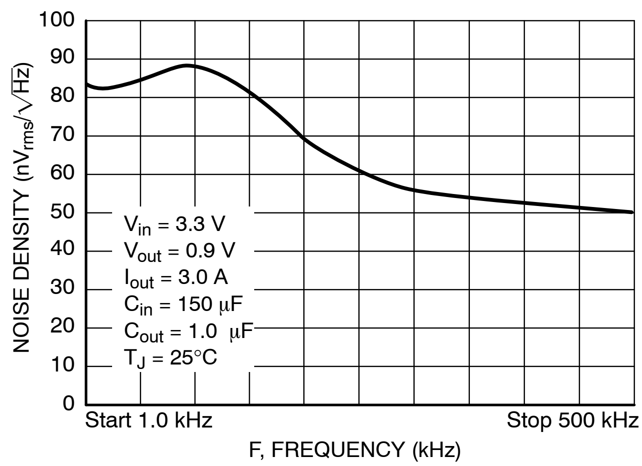


Figure 10. Noise Density vs. Frequency

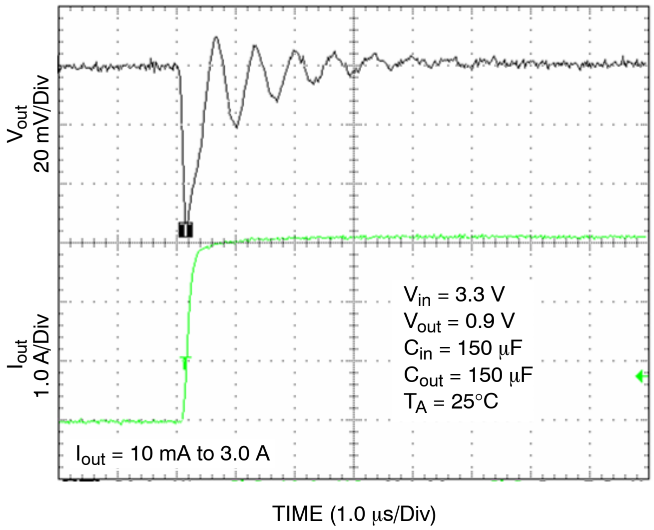


Figure 11. Load Transient Response

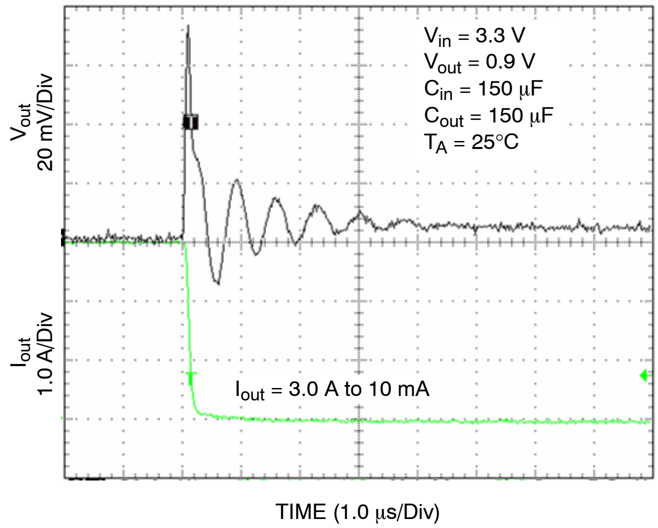


Figure 12. Load Transient Response

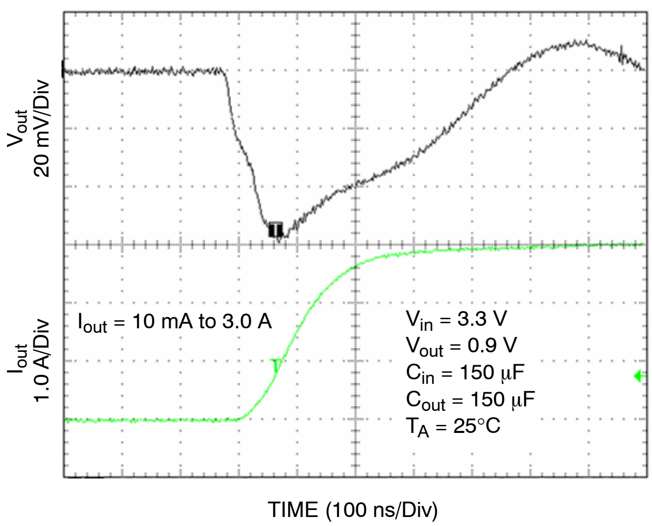


Figure 13. Load Transient Response

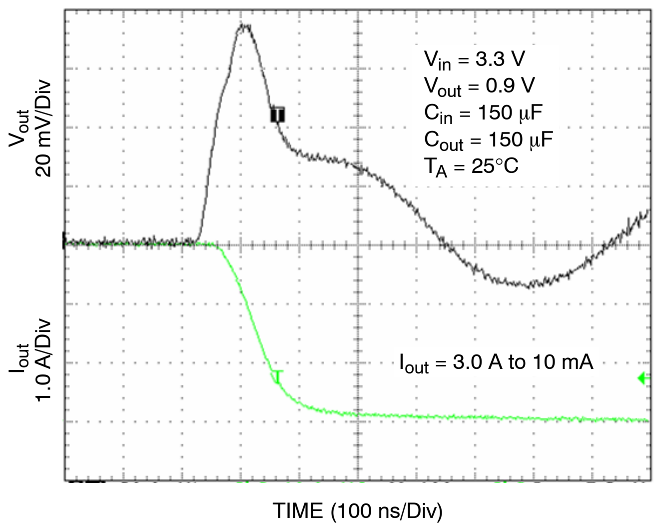


Figure 14. Load Transient Response

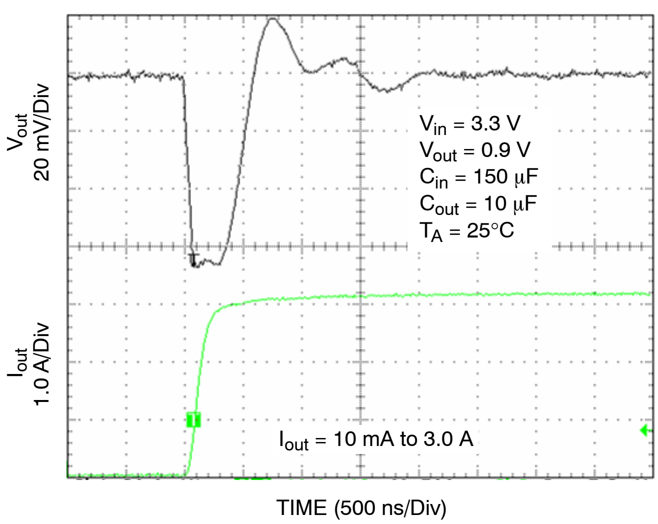


Figure 15. Load Transient Response

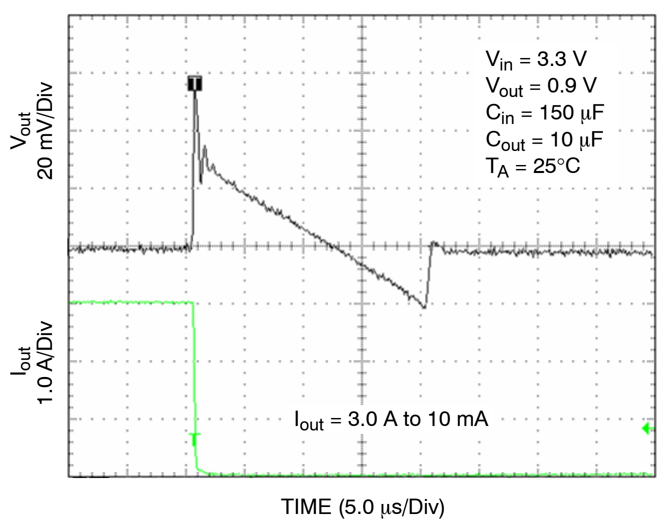


Figure 16. Load Transient Response

APPLICATION INFORMATION

The NCP5663/NCV5663 is a high performance low dropout 3.0 A linear regulator suitable for high power applications, featuring an ultra−fast response time and low noise without a bypass capacitor. It is offered in both fixed and adjustable output versions with voltages as low as 0.9 V. Additional features, such as Enable and Error Flag (fixed output version) increase the utility of the NCP5663/NCV5663. It is thermally robust and includes the safety features necessary during a fault condition, which provide for an attractive high current LDO solution for server, ASIC power supplies, networking equipment applications, and many others.

Input Capacitor

The recommended input capacitor value is a 150 μF OSCON with an Equivalent Series Resistance (ESR) of 50 mΩ. It is especially required if the power source is located more than a few inches from the NCP5663/NCV5663. This capacitor will reduce device sensitivity and enhance the output transient response time. The PCB layout is very important and in order to obtain the optimal solution, the Vin and GND traces should be sufficiently wide to minimize noise and unstable operation.

Output Capacitor

Proper output capacitor selection is required to maintain stability. The NCP5663/NCV5663 is stable for C_{out} as low as 10 μF (Figures 15 and 16) and guaranteed to be stable at an output capacitance of, $C_{out} > 33$ μF with an ESR between 50 mΩ and 300 mΩ over the output current range of 10 mA to 3.0 A. For PCB layout considerations, place the recommended ceramic capacitor close to the output pin and keep the leads short. This should help ensure ultra−fast transient response times.

Adjustable Output Operation

The application circuit for the adjustable output version is shown in Figure 1. The reference voltage is 0.9 V and the adjustable pin current is typically 40 nA. A resistor divider network, R1 and R2, is calculated using the following formula:

$$R1 = R2\left(\frac{V_{out}}{V_{ref}} - 1\right)$$

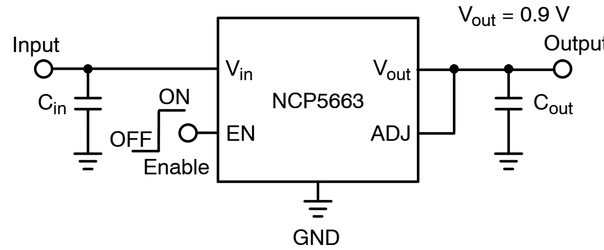


Figure 17. To achieve the minimum output voltage, ADJ to V_{out} has to be connected together

Current Limit Operation

As the peak output current increases beyond its limitation, the device is internally clampled to 4.5 A, thus causing the output voltage to decrease and go out of regulation. This allows the device never to exceed the maximum power dissipation.

Error Flag Operation

The Error Flag pin on the NCP5663/NCV5663 will produce a logic Low when it drops below the nominal output voltage. Refer to the electrical characteristics for the threshold values at which point the Error Flag goes Low. When the NCP5663/NCV5663 is above the nominal output voltage, the Error Flag will remain at logic High.

The external pullup resistor needs to be connected between V_{in} and the Error Flag pin. A resistor of approximately 100 kΩ is recommended to minimize the current consumption. No pullup resistor is required if the Error Flag output is not being used.

Thermal Consideration

This series contains an internal thermal limiting circuit that is designed to protect the regulator in the event that the maximum junction temperature is exceeded. This feature provides protection from a catastrophic device failure due to accidental overheating. It is not intended to be used as a substitute for proper heat sinking. The maximum device power dissipation can be calculated by:

$$P_D = \frac{T_{J(max)} - T_A}{R_{\theta JA}}$$

The bipolar process employed for this IC is fully characterized and rated for reliable 18 V V_{CCmax} operation. To avoid damaging the part or degrading it's reliability, power dissipation transients should be limited to under 30 W for D^2PAK. For open−circuit to short−circuit transient, $P_{DTransient} = V_{CCmax} * I_{SC}$.

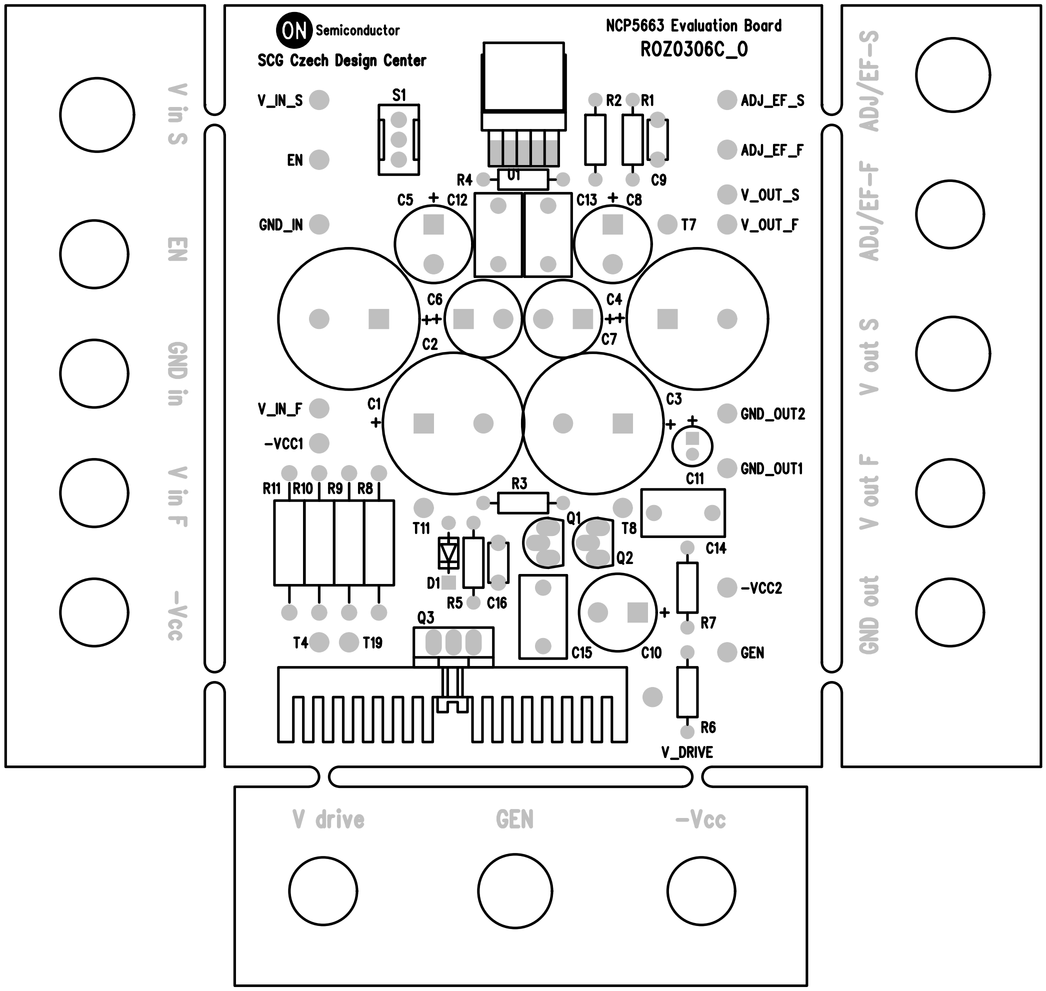


Figure 18. Test Board used for Evaluation

ORDERING INFORMATION

Device	Nominal Output Voltage	Package	Shipping†
NCP5663DSADJR4G	Adj	D^2PAK (Pb−Free)	800 Tape & Reel

DISCONTINUED (Note 6)

Device	Nominal Output Voltage	Package	Shipping†
NCP5663DS15R4G (Note 5)	Fixed, 1.5 V	D^2PAK (Pb−Free)	800 Tape & Reel
NCP5663DS18R4G (Note 5)	Fixed, 1.8 V		800 Tape & Reel
NCP5663DS18G (Note 5)	Fixed, 1.8 V		50 Units / Rail
NCV5663DSADJR4G*	Adj		800 Tape & Reel
NCV5663DS15R4G* (Note 5)	Fixed, 1.5 V		800 Tape & Reel

5. Other fixed output voltages available at 0.9 V, 1.2 V, 2.5 V, 3.0 V, 3.3 V per request.

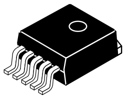
†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

*NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable

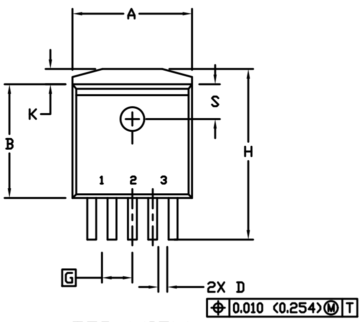
6. **DISCONTINUED:** These devices are not recommended for new design. Please contact your **onsemi** representative for information. The most current information on these devices may be available on www.onsemi.com.

D^{2}PAK 5−LEAD
CASE 936A−02
ISSUE E

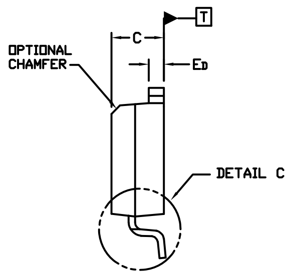
DATE 28 JUL 2021



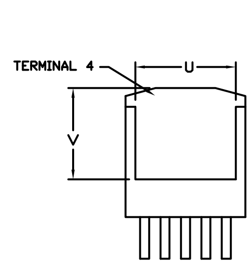
SCALE 1:1



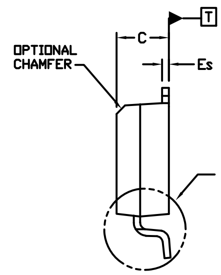
TOP VIEW



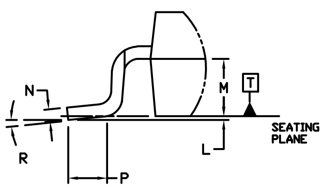
SIDE VIEW
DUAL GUAGE CONSTRUCTION



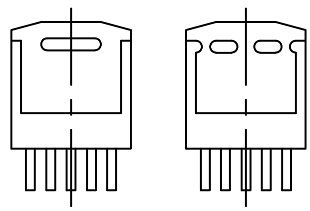
BOTTOM VIEW



SIDE VIEW
SINGLE GUAGE CONSTRUCTION



DETAIL C
TIP LEADFORM
ROTATED 90° CW



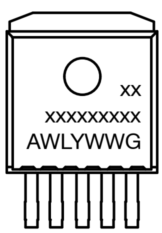
BOTTOM VIEW
OPTIONAL CONSTRUCTIONS

NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCHES
3. TAB CONTOUR OPTIONAL WITHIN DIMENSIONS A AND K.
4. DIMENSIONS U AND V ESTABLISH A MINIMUM MOUNTING SURFACE FOR TERMINAL 4.
5. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH OR GATE PROTRUSIONS. MOLD FLASH AND GATE PROTRUSIONS NOT TO EXCEED 0.025 (0.635) MAXIMUM.

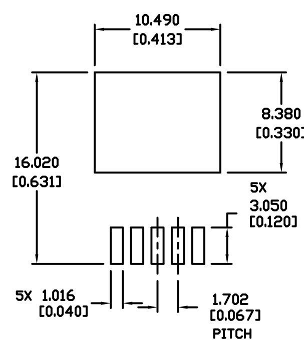
DIM	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.396	0.403	9.804	10.236
B	0.356	0.368	9.042	9.347
C	0.170	0.180	4.318	4.572
D	0.026	0.036	0.660	0.914
ED	0.045	0.055	1.143	1.397
ES	0.018	0.026	0.457	0.660
G	0.067 BSC		1.702 BSC	
H	0.539	0.579	13.691	14.707
K	0.050 REF		1.270 REF	
L	0.000	0.010	0.000	0.254
M	0.088	0.102	2.235	2.591
N	0.018	0.026	0.457	0.660
P	0.058	0.078	1.473	1.981
R	0°	8°	0°	8°
S	0.116 REF		2.946 REF	
U	0.200 MIN		5.080 MIN	
V	0.250 MIN		6.350 MIN	

GENERIC MARKING DIAGRAM*



XXXXXX	=	Device Code
A	=	Assembly Location
WL	=	Wafer Lot
Y	=	Year
WW	=	Work Week
G	=	Pb−Free Package

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, “G” or microdot “▪”, may or may not be present. Some products may not follow the Generic Marking.



RECOMMENDED MOUNTING 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.

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