



**LinearDimensions**  
SEMICONDUCTOR

**LND5203**

## 3 A Low Dropout Positive Voltage Regulator

### GENERAL DESCRIPTION

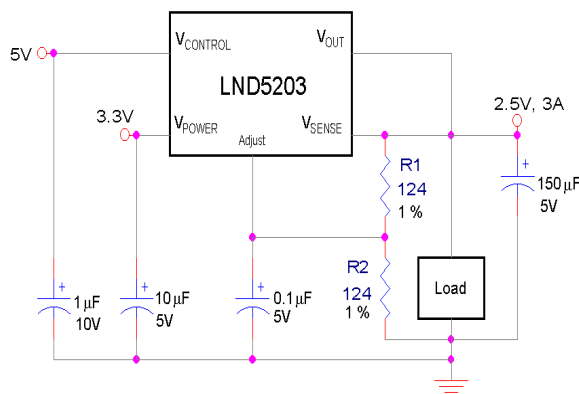
The LND5203 series of positive adjustable and fixed regulators are designed to provide 3A with higher efficiency than currently available devices. All internal circuitry are designed to operate down to 700mV input to output differential and the dropout voltage is fully specified as a function of load current. Dropout voltage of the device is 100mV at light loads and rising to 700mV at maximum output current. A second low current input is required to achieve this dropout. The LND5203 can also be used as a single supply device (3-pin version). On-chip trimming adjusts the reference voltage to 1%.

### FEATURES

- Adjustable or fixed Output
- Output Current of 3A
- Low Dropout, 700mV at 3A Output Current
- 0.04% Line Regulation
- 0.1% Load Regulation
- 100% Thermal Limit Burn-In
- Fast Transient Response
- Remote Sense

### TYPICAL APPLICATION DATA

#### 2.5 V, 3A Regulator



$$V_{OUT} = V_{REF} (1 + R2/R1) + I_{ADJ} R2$$

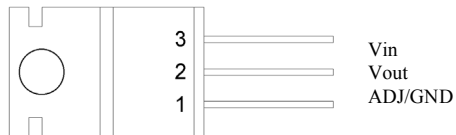
### APPLICATIONS

- High efficiency Linear Regulators
- Post Regulators for Switching Supplies
- Adjustable Power Supply



## Package Information

### 3 LEAD TO -220 (Front view)



### 5 LEAD TO -220 (Front View)



## Absolute Maximum Rating

SYMBOL	PARAMETER	MAXIMUM	UNITS
$P_d$	Power Dissipation	Internally limited	W
$V_{in}$	Input Voltage $V_{Power}$ $V_{Control}$	7 13	V
$T_J$	Operating Junction Temperature range Control Section Power Transistor	0 to 125 0 to 150	°C
$T_{STG}$	Storage Temperature	-65 to 150	°C
$T_{LEAD}$	Lead Temperature (Soldering, 10 sec)	300	°C

## Device Selection Guide (note 1)

DEVICE	OUTPUT VOLTAGE
LND5203	Adj.
LND5203-1.5	1.5V
LND5203-2.5	2.5V
LND5203-2.85	2.85V
LND5203-3.0	3.0V
LND5203-3.3	3.3V
LND5203-3.5	3.5V
LND5203-5.0	5.0V

Note 1: Other fixed versions are available  $V_{Out} = 1.5v$  to 5.0V



## Electrical Characteristics

At  $I_{load} = 0mA$  and  $T_J = \pm 25^\circ C$  unless otherwise specified

PARAMETER	DEVICE	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Reference Voltage	LND5203	$V_{control}=2.75V, V_{power}=2V, I_{Load}=10mA$	1.238	1.250	1.262	V
		$V_{Control}=2.7V$ to $12V$ $V_{Power}=3.3V$ to $5.5V, I_{Load}=10mA$ to $3A$	1.230	1.250	1.270	
Output Voltage	LND5203-1.5	$V_{Control}=4V, V_{Power}=2V$ $V_{Control}=3V, V_{Power}=2.3V, I_{Load}=0mA$ to $3A$	1.485 1.475	1.500 1.500	1.515 1.525	V
	LND5203-2.5	$V_{Control}=5V, V_{Power}=3.3V$ $V_{Control}=4V, V_{Power}=3.3V, I_{Load}=0mA$ to $3A$	2.475 2.460	2.500 2.500	2.525 2.540	V
	LND5203-2.85	$V_{Control}=5.35V, V_{Power}=3.35V$ $V_{Control}=4.4V, V_{Power}=3.7V, I_{Load}=0mA$ to $3A$	2.821 2.805	2.850 2.850	2.879 2.895	V
	LND5203-3.0	$V_{Control}=5.5V, V_{Power}=3.5V$ $V_{Control}=4.5V, V_{Power}=3.8V, I_{Load}=0mA$ to $3A$	2.970 2.950	3.000 3.000	3.030 3.050	V
	LND5203-3.3	$V_{Control}=5.8V, V_{Power}=3.8V$ $V_{Control}=4.8V, V_{Power}=4.1V, I_{Load}=0mA$ to $3A$	3.267 3.247	3.300 3.300	3.333 3.353	V
	LND5203-3.5	$V_{Control}=6V, V_{Power}=4V$ $V_{Control}=5V, V_{Power}=4.3V, I_{Load}=0mA$ to $3A$	3.465 3.445	3.500 3.500	3.535 3.555	V
	LND5203-5.0	$V_{Control}=7.5V, V_{Power}=5.5V$ $V_{Control}=6.5V, V_{Power}=5.8V, I_{Load}=0mA$ to $3A$	4.950 4.920	5.000 5.000	5.050 5.080	V
Line Regulation	All	$I_{Load}=10mA, (1.5V+V_{out}) \leq V_{Control} \leq 12V, 0.8V \leq (V_{Power}-V_{Out}) \leq 5.5V$	*	0.04	0.20	%
Load Regulation	All	$V_{Control}=V_{Out}+2.5V, V_{Power}=V_{Out}+0.8V, I_{load}=10mA$ to $3A$	*	0.08	0.40	%
Minimum Load Current(Note 2)	LND5203	$V_{Control}=5V, V_{Power}=3.3V, V_{ADJ}=0V$	*	1.7	5	mA
Control Pin Current(Note 3)	All	$V_{Control}=V_{Out}+2.5V, V_{Power}=V_{Out}+0.8V, I_{Load}=10mA$ to $3A$	*		60	mA
Ground Pin Current	LND5203-1.5/-2.5/-2.85/-3.0/-3.3/-3.5/-5.0	$V_{Control}=V_{Out}+2.5, V_{Power}=V_{Out}+0.8V, I_{Load}=10mA$ to $3A$	*	5	10	mA
Adjust Pin Current	LND5203	$V_{Control}=2.75V, V_{Power}=2.05V$ $I_{Load}=10mA$	*	50	120	$\mu A$
Current Limit	All	$(V_{In}-V_{Out})=3V$	*	3	4	A
Ripple Rejection	All	$V_{Control}=V_{Power}=V_{Out}+2.5V, V_{Ripple}=1Vp.p., I_{Load}=1.5A$	60	75		dB
Thermal Regulation	LND5203	$T_A=25^\circ C, 30ms$ pulse		0.003		%/W
Dropout Voltage Note 4						
Control Input	All	$V_{Power}=V_{Out}+0.8, I_{Load}=10mA$ $V_{Power}=V_{Out}+0.8V, I_{Load}=3A$	*	1.00 1.15	1.15 1.30	V
Power Input ( $V_{Power}-V_{Out}$ )	All	$V_{Control}=V_{Out}+2.5V, I_{Load}=3A$	*	0.55	0.70	V



The\* denotes the specifications which apply over the full temperature range.

Note 1: Unless otherwise specified  $V_{out}=V_{sense}$ . For LND5203 (adj.)  $V_{adj}=0V$

Note 2: For the adjustable device the minimum load current is the minimum current required to maintain regulation. Normally the current in the resistor divider used to set the output voltage is selected to meet the minimum load current requirement.

Note 3: The control pin current is the drive current required for the output transistor. This current will track output with a ratio of about 1:100.

Note 4: The dropout voltage for the LND5203 is caused by either minimum control voltage or minimum power voltage. The specifications represent the minimum input/output voltage required to maintain 1% regulation.

## PIN FUNCTIONS (5-LEAD)

**Sense (Pin 1):** This pin is the positive side of the reference voltage. With this pin it is possible to Kelvin sense the output voltage at the load.

**Adjust (Pin 2):** This pin is the negative side of the reference voltage. Adding a small bypass capacitor from the Adjust pin to ground improves the transient response. For fixed voltage devices the Adjust pin is also brought out to allow the user to add a bypass capacitor.

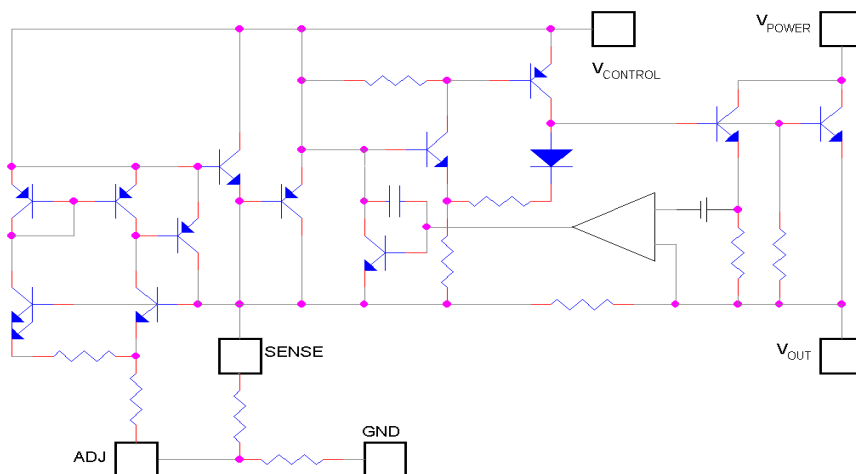
**GND (Pin 2):** For fixed voltage devices this is the bottom of the resistor divider that sets the output voltage.

**$V_{power}$  (Pin 5):** This pin is the collector of the power transistor. The output load current is supplied through this pin. The voltage at this pin must be 0.7V greater than the output voltage for the device to regulate.

**$V_{control}$  (pin 4):** This pin is the supply pin for the control circuitry. The current flow into this pin will be about 1% of the output current. The voltage at this pin must be 1.3V greater than the output voltage for the device to regulate.

**Output (Pin 3):** This is the power output of the device.

## BLOCK DIAGRAM





## APPLICATION INFORMATION

The LND5203 series of adjustable and fixed regulators are designed to power the new generation of microprocessors. The LND5203 is designed to make use of multiple power supplies, present in most systems, to reduce the dropout voltage. One of the advantages of the two supply approach is maximizing the efficiency.

The second supply is at least 1V greater than output voltage and is providing the power for the control circuitry and supplies the drive current to the NPN output transistor. This allows the NPN output transistor to be driven into saturation. For the control voltage the current requirement is small equal to about 1% of the output current. This drive current becomes part of the output current. The maximum voltage on the Control pin is 12V. The maximum voltage at the Power pin is 7V. By tying the control and power inputs together the LND5203 can also be operated as a single supply device. In single supply operation the dropout will be determined by the minimum control voltage.

Both fixed and adjustable versions have remote sense pins, permitting very accurate regulation of output voltage. As a result, over an output current range of

100mA to 3A, the typical load regulation are less than 1mV. For the fixed voltages the adjust pin is brought out allowing the user to improve transient response by bypassing the internal resistor divider. Optimum transient response is provided using a capacitor in the range of 0.1 $\mu$ F to 1 $\mu$ F for bypassing the Adjust pin. In addition to the enhancements mentioned, the reference accuracy has been improved by a factor of two with a guaranteed initial tolerance of  $\pm 1\%$  at 25°C and 1.6% accuracy over the full temperature and load current range.

Typical applications for the LND5203 include 3.3V to 2.5V conversion with a 5V control supply, 5V to 4.2 V conversion with a 12V control supply. The device is fully protected against overcurrent and overtemperature conditions.

### Grounding and Output Sensing

The LND5203 allows true Kelvin sensing for both the high and low side of the load. As a result the voltage regulation at the load can be easily optimized. Voltage drops due to parasitic resistance's between the regulator and the load can be placed inside the regulation loop. The advantages of remote sensing are illustrated in figures 1 through 3. Figure 1 shows the device connected as a conventional 3 terminal regulator with the sense lead connected directly to the output of the device.  $R_p$  is the parasitic resistance of the connections between the device and the load. Trace A of figure 3 illustrates the effect of  $R_p$ .

Figure 2 shows the device connected to take advantage of the remote sense feature. The Sense pin and the top of the resistor divider are connected to the top of the load. The bottom of the resistor divider is connected to the bottom of the load. The effect on output regulation can be seen in trace B of figure 3. It is important to note that the voltage drops due to  $R_p$  are not eliminated; they will add to the dropout voltage of the regulator regardless. The LND5203 can control the voltage at the load as long as the input-output voltage is greater than the total of the dropout voltage of the device plus the voltage drop across  $R_p$ .

### Stability

The circuit design used in the LND5203 series requires the use of an output capacitor as part of the device frequency compensation. The addition of 150  $\mu$ F aluminum electrolytic or a 22  $\mu$ F solid tantalum on the output will ensure stability for all operating conditions



Figure 1. Conventional Load Sensing

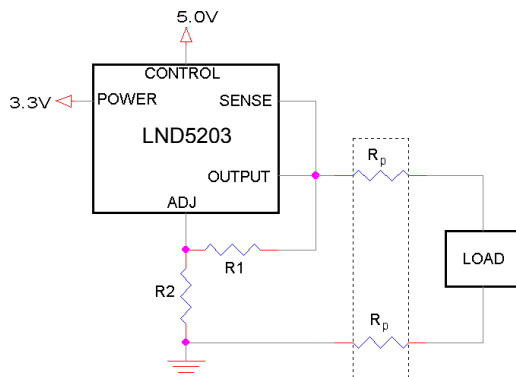


Figure 2. Remote Load Sensing

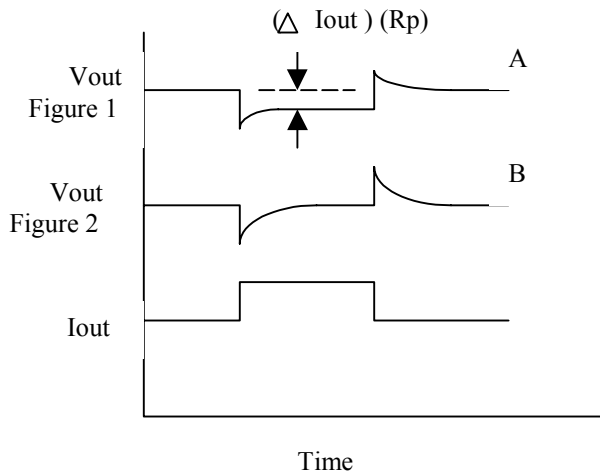
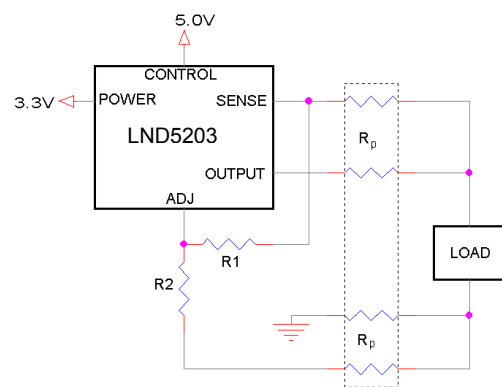


Figure 3. Remote sensing improves Load Regulation



### Output Voltage

The LND5203 (adjustable version) develops a 1.25V reference voltage between the Sense pin and the Adjust pin (Figure 4). Placing a resistor between these two terminals causes a constant current to flow through R1 and down through R2 to set the output voltage. In general R1 is chosen so that this current is the specified minimum load current of 5mA. The current out of the Adjust pin is small, typically 50  $\mu$ A and it adds to the current from R1. For the best regulation the top of the resistor divider should be connected directly to the Sense pin.

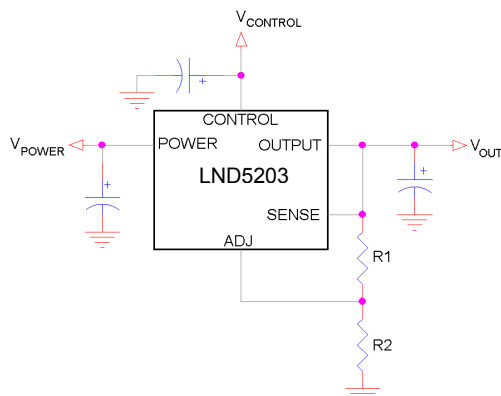


Figure 4. Settling Output Voltage

### Thermal Considerations

The LND5203 series have internal power and thermal-limiting circuitry designed to protect the device under overload conditions. However, maximum junction temperature ratings should not be exceeded under continuous normal load conditions. Careful consideration must be given to all sources of thermal resistance from junction ambient, including junction-to-case, case to-heat sink interface and heat sink resistance itself.

Junction temperature of the control section can run up to 125°C. Junction temperature of the Power section can run up to 150°C.

### Protection Diodes

In normal operation LND5203 family does not need any protection diodes between the adjustment pin and the output to the input to prevent die overstresses. Internal resistors are limiting the internal current paths on the ADJ pin. Therefore even with bypass capacitors on the adjust pin no protection diode is needed to ensure device safety under short-circuit conditions. The adjust pin can be driver on a transient basis  $\pm 7$ V with respect to the output with out any device degradation. A protection diode between the Output pin and Vpower pin is not usually needed. Microsecond surge currents of 50A to 100A can be handled by the internal diode between the Output pin and Vpower pin of the device. In normal operations it is difficult to get those values of surge currents even with the use of large output capacitance. Only with high value output capacitors, such as 1000 $\mu$ F to 5000 $\mu$ F and the Vpower pin are instantaneously shorted to ground, damage can occur. A diode from output to input is recommended (Figure 5). If LND5203 is connected as a single supply device with the control and power input pins shorted together the internal diode between the output and the power-input pin will protect the control input pin.

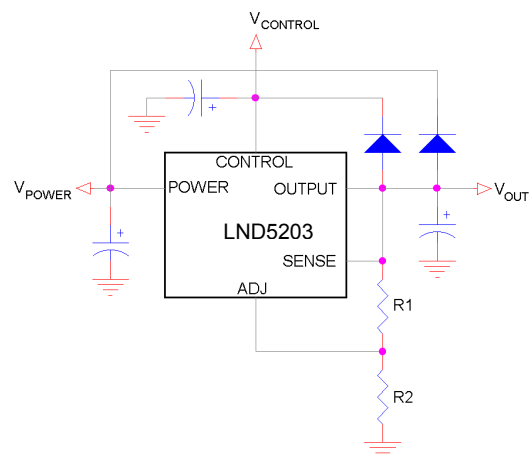


Figure 5. Optional Clamp Diodes Protect Against Input Crowbar Circuits