AND8028/D

Precision Sub-One Volt 1.7 Ampere Output LDO

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APPLICATION NOTE

INTRODUCTION

The following Application Note is a description of a 0.9 volt 1.7 ampere output LDO with an explanation of each circuit element. The dropout voltage is 230 millivolts for 1.7 amperes or 34 millivolts for light loads. Depending upon system design, the minimum input voltage can be less than 1.4 volts.

SYSTEM DESIGN

For an accurate output voltage, a precision voltage reference must be used for the feedback network. A device should not be used if the output voltage is within a 20% margin from the reference voltage. Since the output voltage is below 1.0 volts, the traditional TL431 and TLV431 programmable precision references cannot be used. Instead the NCP100 is selected with its 0.7 volt reference. With a low reference level, 0.9 volts is attainable with a greater than 20% margin.

In selecting the pass transistor, one must decide between a NPN and a PNP. Since this design is from a single supply, the NPN drop out voltage minimum is the greater of the saturation voltage from collector to emitter or the base to emitter on voltage. For the PNP the minimum voltage drop from input to output is the saturation voltage of emitter to collector. To maximize the output current and minimize the voltage drop, the MBT35200MT1 PNP is selected for this design. This PNP has a 2.0 ampere collector current, maximum emitter to collector saturation voltage of 0.31 volts, typical DC current gain of 200, and maximum emitter to base voltage of 0.875 volts.

With the voltage reference and the pass element selected, the remaining components in the circuit are placed. Refer to Figure 1 for the circuit schematic. Since a PNP transistor is implemented, the signal from the precision reference needs to be inverted. A small signal NPN, Q2, is used for this purpose. There is a voltage differential issue with driving the base of a NPN, 0.6 to 0.7 volt turn on, from the NCP100 cathode, 0.9 volts minimum. To level shift the voltages, a diode will be placed between the cathode and the gate. A resistor, R5, from gate to ground is used for two purposes: pull the gate to ground for turn off and provide a bias current through the diode to set a minimum voltage drop. If the minimum voltage drop is not set properly, the NPN will have a small base current that will be amplified by the NPN and the PNP providing a voltage runaway condition at the output voltage during light or no load.

In addition to Q2 to invert the control signal from the NCP100, R6 is used to pull up the gate to the input voltage to turn off the MBT35200MT1. R4 is an over current protection resistor. R4 is determined by subtracting the minimum input voltage from the maximum Vbe of Q1 and maximum Vsat of Q2, then dividing by the base current of Q1.

C3, a 1 microfarad capacitor, is necessary to support the NCP100 for normal operation. Its purpose is to stabilize the operation of the precision reference. It has a negligible effect on the response time of the system. R1 and R2 are the resistor divider feedback network. C4 is used for fast transient response of the system. R3 provides the DC bias for the NCP100. The value of R3 is limited by the response of the system at low line and low load. If the value of R3 is too large, oscillations occur on the output. If R3 is too small, the output voltage will run away at high line and low load.
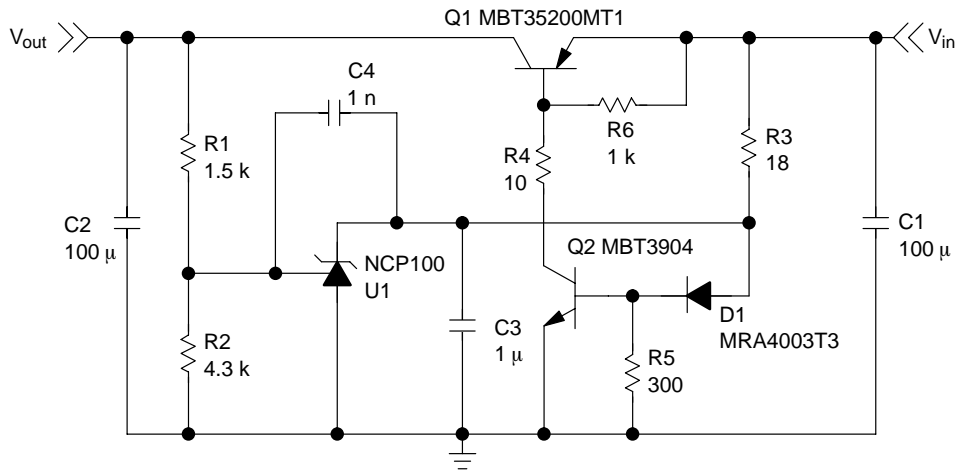
Figure 1. Circuit Schematic for 0.9 Volt 1.7 Ampere LDO

RESULTS

Utilizing the circuit in Figure 1, layout in Figure 3 and values in Table 1, the output voltage varies 40 millivolts between 1.5 volts to 3.0 volts and 0 amperes to 1.7 amperes for an output voltage centered at 0.945 volts, which equates to a +/– 2.5 % variation for load and line. The voltage droop due to load transient is small as seen in Figure 2. If R1 is varied to change the output voltage to 1.8 volts, the minimum drop out voltage is 34 millivolts under light load conditions and 230 millivolts for 1.7 amperes. The minimum input voltage to operate of the circuit in Figure 1 is 1.42 volts for 1.7 amperes and 1.37 volts for 0.5 amperes. As discussed previously, the operating range of this circuit can vary depending upon R3.

V_{out}: 200 mV/div
I_{out}: 0.5 A/div
Time Scale: 100 us/div
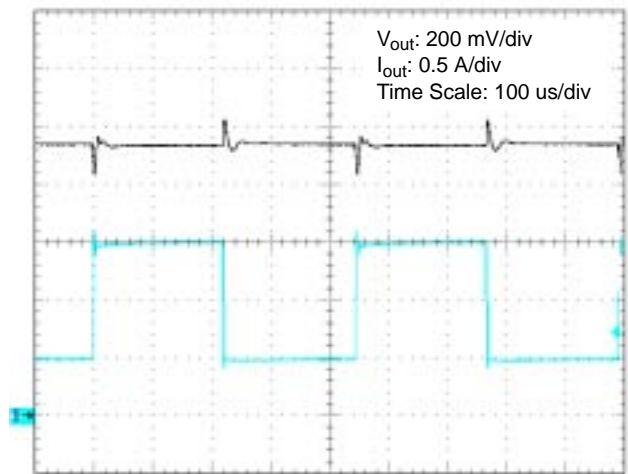
**Figure 2. Load Transient for 1.8 Volts In and Load
from 0.5 Amperes to 1.5 Amperes**
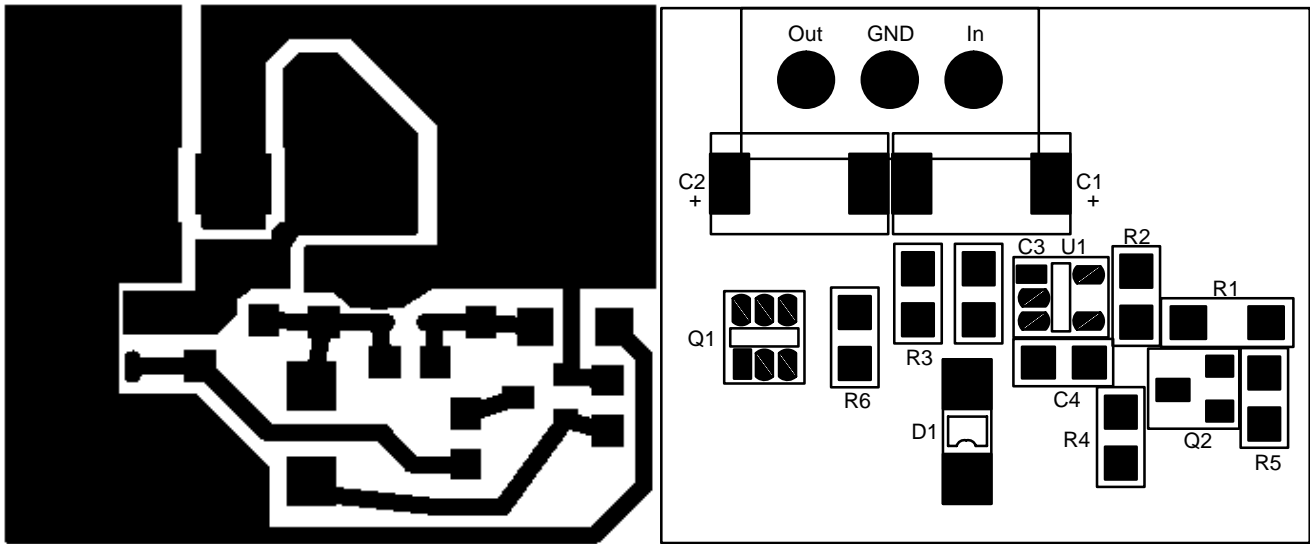
Figure 3. Layout of NCP100/MBT35200 LDO (4x)

Table 1. Part Description for LDO Circuit

Reference	Part	Description
C1	100 u	AVX Tantalum SMT
C2	100 u	AVX Tantalum SMT
C3	1 u	0805 Ceramic Chip Cap
C4	1 n	0805 Ceramic Chip Cap
D1	MRA4003T3	ON Semiconductor SMA Diode
JP1	Connector	3 Pin Connector
Q1	MBT35200	ON Semiconductor TSOP−6 PNP
Q2	MBT3904	ON Semiconductor SOT−23 NPN
R1	1.5 k	1206 Chip Resistor
R2	4.3 k	0805 Chip Resistor
R3	18	0805 Chip Resistor
R4	10	0805 Chip Resistor
R5	300	0805 Chip Resistor
R6	1 k	0805 Chip Resistor
U1	NCP100	ON Semiconductor Precision Reference

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